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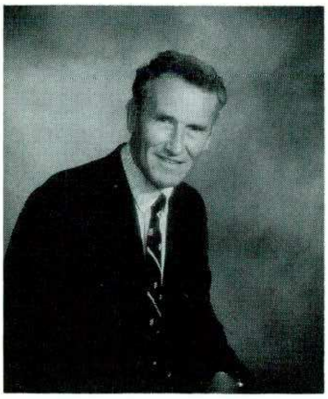


Dear Fellow Member

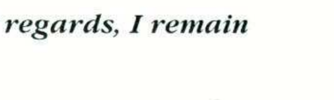
Since moving into the new offices earlier in the year the staff have been busy reorganising our affairs to ensure that we can offer the level of service to members that is expected in our current competitive working environment. A key part of this programme is the installation of new computer networks; the first phase is currently in hand and will result in the accounts system being transferred over to a fully integrated system. We will then move on to include the education, membership and meeting activity. The objective of all this work is to contain our operational cost base, in order to have affordable meeting fees and membership subscriptions. The first results of these programmes will soon be apparent as next year we will have an increase in subscriptions lower than the inflation rate; the first time for many years we have been able to achieve this.

We are of course a Professional Institution and finance should not be one of our primary measures of performance. The autumn programme of meetings has included two residential conferences in Windermere, Reproduced Sound 14 and Speech and Hearing. Our thanks are due to the organising committees, led by Julian Wright from the Electro-acoustics Group and Bill Ainsworth from Speech Group, for the work they put in to ensure that they were both technical and social successes. The programme of one-day meetings has seen events from the Building Acoustics, Measurement and Instrumentation and Environmental Noise Groups; again the contribution made by the promoters and contributors to these meetings is much appreciated.

The Institute intends to lead the formation of opinion in respect of the formulation of Government noise policy; to ensure that the resulting output is both reasonable and achievable. As part of this process we were to have run a meeting and workshop in November to work through the implications of the EU Green Paper on Future Noise Policy. This has had to be delayed to the New Year as most of the speakers were called to an EU meeting in Berlin on the scheduled day. This does give us more time to get our thoughts together and to provide a reasoned response to the suggestions of unified noise measurement indices, noise mapping etc. If you are involved with Environmental Noise then watch for the re-scheduled date and come along and make your contribution to the debate.

That is for next year but for now may I wish you all the compliments of the season and every best wish for the New Year.

With kindest regards, I remain
Yours truly



Ian Campbell

THE SPECTRUM ADAPTATION TERMS IN BS EN ISO 717-1:1997

Philip Wright MIOA & Les Fothergill FIOA

Introduction

BS EN ISO 717-1:1997, which supersedes BS 5821:Part 1:1984, describes the way airborne sound insulation in buildings and of building elements is to be rated. It introduces *spectrum adaptation terms*, and the aim of this article is to provide readers with an understanding of the background, significance, and practical application of these. In addition, some research findings are described which demonstrate their potential usefulness.

Background

In this country, airborne sound insulation has normally been rated in terms of single number indices: for example R_w when testing a building element in the laboratory, and $D_{nT,w}$ when testing a wall between dwellings. For simplicity, this article is restricted to the $D_{nT,w}$ term, although the discussion applies equally to R_w. Implicit in this rating method is the idea that a single number index adequately describes the sound insulation of a wall, floor or façade, against the range of noise sources encountered by those constructions in everyday life. The basis of this rating system is a reference curve that approximates to the insulation attained by a typical 225 mm (9 inch) thick brick wall. Social surveys carried out by BRE in the 1950s showed that such walls generally provided acceptable sound insulation, and they have subsequently been adopted as the benchmark against which to assess performance.

Introduction of the spectrum adaptation terms represents a shift away from the implicit assumption, and allows the rated sound insulation to reflect differences in source spectra, albeit to a limited extent. In part, this shift has been due to recognition of a greater availability of sources of low frequency sound – such as amplified music.

The Significance of the Terms

Before the introduction of BS EN ISO 717-1, several rating methods were in use in Europe. The main ones were: the curve shifting method used in the UK and described in BS 5821:1984; and the A-weighted level difference methods, which work as follows.

- First, the insulation is measured in the usual way (including a reverberation time correction).
- Second, the dBA level of a specified source room spectrum is calculated.
- Third, the dBA level of the corresponding receiving room spectrum is calculated.
- Fourth, the A-weighted level difference is calculated as the difference between these two dBA values.

In order to establish a European rating method it was necessary to devise a method that embodied the main features of the two existing systems. This is the achievement of BS EN ISO 717-1:1997.

The actual function of the adaptation terms is not explicit in the standard. It should be understood that the addition of an adaptation term to a $D_{nT,w}$ value in fact converts it to an A-weighted level difference.

A-weighted level difference

There is something to commend a system of rating sound insulation in which a change in insulation giving rise to an x dB change in the sound level in the receiving room is also reflected in a change in the insulation rating of x dB. If one accepts the receiving room A-weighted SPL as a measure of sound level that is reasonably well correlated with subjective disturbance, then simply calculating the difference between the A-weighted source and receiving room dBA levels provides such a measure of insulation. For any given building structure, this A-weighted level difference, X_A, will be a function only of the building structure and the source spectrum, so for a given structure it will vary according to the source spectrum.

In this context the adaptation terms can in fact be thought of as corrections whereby if, for a defined source spectrum, one needs to know X_A, the adaptation term represents the correction it is necessary to add to the $D_{nT,w}$ value to obtain X_A. The C term represents this correction where the defined source spectrum corresponds to pink noise (spectrum no 1); the C_{tr} term represents this correction where the source spectrum nominally reflects that of urban road traffic noise (spectrum no 2). In this way the introduction of adaptation terms can be seen to represent a move towards X_A as the single number rating, whilst the Standard maintains the primacy of the old system of $D_{nT,w}$ in the interests of backwards compatibility for those who have used it and wish to continue doing so.

The new system invites the question as to how many terms are necessary, ie how many representative source spectra should be defined? At the moment just two spectra are defined, and the standard provides guidance on which of these it is appropriate to consider in different situations: the traffic noise spectrum is appropriate for sources with significant low frequency content, while the pink noise spectrum is better suited for other sources.

Theoretically, the most suitable adaptation term is chosen with a view to its associated spectrum being representative of the likely source(s) in question. But the extent to which either or both of the C and C_{tr} terms will adequately deal with diverse source spectra is by no means clear. The way is open for other, perhaps more specialized, spectra and their adaptation terms in future, if the additional complexity is found worthwhile.

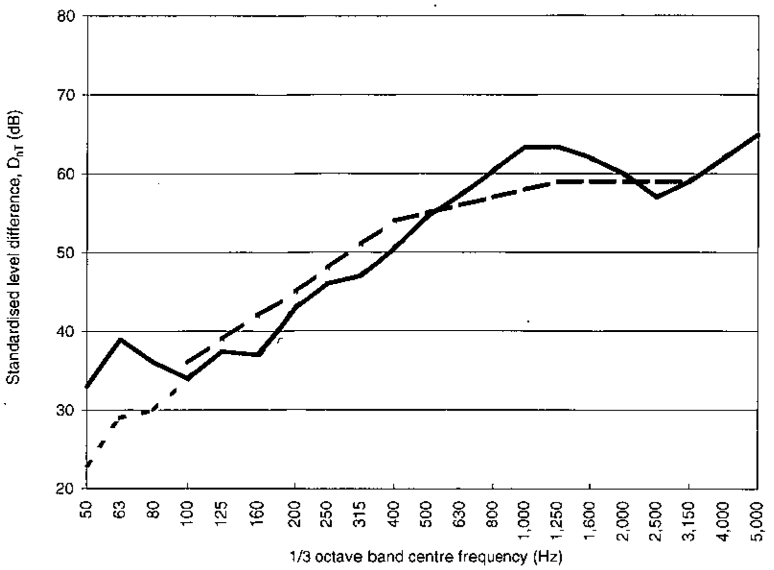


Fig. 1. Simulated measurement data for two walls with different low frequency insulation

spectrum represented by C_{tr}, poorer low frequency insulation will result in a lower C_{tr} value.

Figure 1 illustrates the effect of changes in the measured insulation performance on the values of the adaptation terms. Two sets of simulated measurement data for a solid wall with plasterboard lining are overlaid and fitted against the reference curve (long dashes). The measurement data are identical from 100 Hz upwards, but below 100 Hz one wall (short dashes) has significantly poorer insulation. Both sets of data give a $D_{nT,w}$ value of 55 dB; the values of the spectrum adaptation terms are given in Table 1.

(Note that when presenting adaptation term values along with a $D_{nT,w}$ value, the correct notation is of the form: $D_{nT,w}$ ($C;C_{tr}$) dB, ie 55 (−1;−6) dB in the above cases.)

In practice it is unlikely that two such walls will differ in their insulation only below 100 Hz (and measurements become increasingly unreliable in this region), but the example is used to show clearly the effect of the spectrum and extended frequency range on the values of the adaptation terms. As Table 1 shows, only those terms with an extended range below 100 Hz change value from wall to wall and the C_{tr} terms by more than the C terms because of the road traffic spectrum's relatively greater low frequency energy.

Practical Application

Extended frequency ranges

A degree of flexibility in terms of the frequency range to which the adaptation terms correspond is allowed in the standard. By default, the C and C_{tr} terms, like the conventional $D_{nT,w}$ term, correspond to measurements over the 100 Hz to 3150 Hz range. But the range can be extended down to 50 Hz and/or up to 5000 Hz. In such cases, the extended range is indicated in the notation used, for example $C_{tr,50-3150}$. The use of the extended frequency range is of use where there is reason to believe that relatively poor insulation and/or significant sound energy is likely to be encountered above or below the conventional 100 Hz to 3150 Hz range.

Typical values

To some extent, it is possible to associate typical values of C and C_{tr} with certain generic construction types. The standard suggests that in most cases C will not have a value much below −1, except where there are significant adverse deviations (see below). The C_{tr} term normally takes a lower value, and is more likely to vary according to the type of building structure. Because of the relatively greater low frequency energy in the road traffic noise

solid line		short dashed line	
C	−1 dB	C	−1 dB
C_{tr}	−6 dB	C_{tr}	−6 dB
$C_{50-3150}$	−2 dB	$C_{50-3150}$	−3 dB
$C_{tr,50-3150}$	−7 dB	$C_{tr,50-3150}$	−11 dB
$C_{50-5000}$	−1 dB	$C_{50-5000}$	−2 dB
$C_{tr,50-5000}$	−7 dB	$C_{tr,50-5000}$	−11 dB
$C_{100-5000}$	−1 dB	$C_{100-5000}$	−1 dB
$C_{tr,100-5000}$	−6 dB	$C_{tr,100-5000}$	−6 dB

Table 1

Adverse deviation

In the previous edition of the standard, when the reference curve was fitted to the measured level differences in

Proposed New Certificate Course

Management of Exposure to Hand Arm Vibration

The Institute of Acoustics is considering the possibility of running a course entitled The Management of Hand Arm Vibration, along the lines of the existing certificate of competence courses. It is believed that there is an urgent need for training nationally (and probably internationally).

A working party has been established by Dr Andy Moorhouse at the University of Liverpool, and a draft syllabus has been prepared. It is proposed to run a pilot course in the summer of 1999.

The Institute is now particularly interested to hear from

- Institutions with an interest in running such a course
- Institutions or individuals interested in pursuing funding for course development
- Institutions or individuals with an interest in developing course material:

Contact: Roy Bratby, Chief Executive, Institute of Acoustics, 77A St Peter's Street, St Albans, Herts AL1 3BN Tel: 01727 848195 Fax: 01727 850553

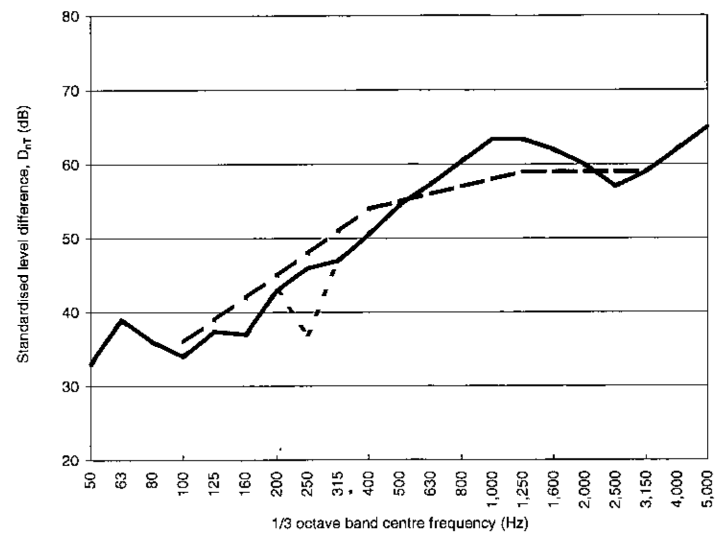


Fig. 2. Simulated measurement data for two walls; one with 10.5 dB adverse deviation at 250 Hz

solid line		short dashed line	
C	−1 dB	C	−3 dB
C_{tr}	−6 dB	C_{tr}	−8 dB
$C_{50\text{–}3150}$	−2 dB	$C_{50\text{–}3150}$	−3 dB
$C_{tr,50\text{–}3150}$	−7 dB	$C_{tr,50\text{–}3150}$	−9 dB
$C_{50\text{–}5000}$	−1 dB	$C_{50\text{–}5000}$	−2 dB
$C_{tr,50\text{–}5000}$	−7 dB	$C_{tr,50\text{–}5000}$	−9 dB
$C_{100\text{–}5000}$	−1 dB	$C_{100\text{–}5000}$	−2 dB
$C_{tr,100\text{–}5000}$	−6 dB	$C_{tr,100\text{–}5000}$	−8 dB

Table 2

the prescribed way, adverse deviations of more than 8 dB in any frequency band had to be noted. (No action was required because it was possible, particularly with laboratory measurements, that the dip was an artefact of the measurement procedure rather than a characteristic of the element being tested.) One additional benefit of the adaptation terms is that they effectively restore this safeguard into the rating by being more sensitive than $D_{nT,w}$ to such adverse deviations.

Figure 2 illustrates this property. As before two sets of nearly identical simulated measurement data are overlaid and fitted against a reference curve (long dashes); the only difference between them being that one (short dashes) displays a significant adverse deviation of 10.5 dB in the 250 Hz band. Again, both sets of data give a $D_{nT,w}$ value of 55 dB, but as can be seen from Table 2 the adverse deviation at 250 Hz has caused a 1 or 2 dB reduction in the values of the various spectrum adaptation terms.

Research Findings

A subjective listening experiment was conducted recently at BRE as part of a DETR funded Partners in Technology research project into the sound insulation required between structurally attached commercial and residential premises. The tests simulated the situation in which a flat is situated above a pub or bar which plays amplified music, and were designed to allow the effect of typical floor constructions, low frequency insulation performance, frequency content of music, and level of exposure to be investigated. During the tests, subjects were asked to provide ratings of acceptability of the level of a series of amplified music stimuli, from the point of view of the occupant in the flat who did not wish to hear the music.

Two pairs of idealized floor conditions were simulated in the tests: one solid concrete and the other with a floating layer. Within each pair the two floors differed only in their performance at low frequencies, mainly below 100 Hz. These four simulated floor conditions were matched for overall $D_{nT,w}$ value during the tests, but with their effective $D_{nT,w}$ setting varied during the tests by gain adjustment of the replay equipment (in 4 dB steps).

Rating of insulation

It was possible to compare the subjective acceptability ratings against several different physical single number ratings of airborne sound insulation of the floors. As well as the conventional $D_{nT,w}$ value the spectrum adaptation terms defined in BS EN ISO 717–1:1997 were invoked to provide three A-weighted level difference ratings, each taking into account the source spectrum and frequency range in a different way, to wit: $D_{nT,w} + C$; $D_{nT,w} + C_{tr}$; $D_{nT,w} + C_{tr,50-5000}$. Each of these was compared to the ratings of acceptability obtained for each type of music (ie source spectrum). The results of these analyses indicated that in this area of sound insulation there may indeed be benefits in rating insulation, or setting insulation requirements, in a manner sensitive to the frequency spectrum of the particular type of music likely to be

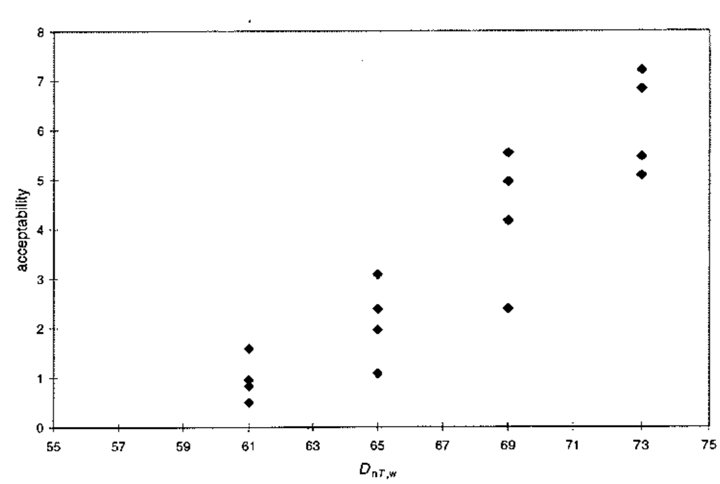


Fig. 3. Mean subjective acceptability versus $D_{nT,w}$

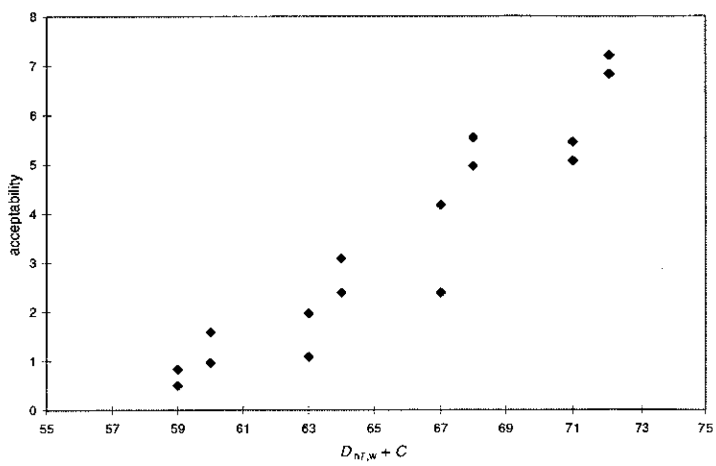


Fig. 4. Mean subjective acceptability versus $D_{nT,w} + C$

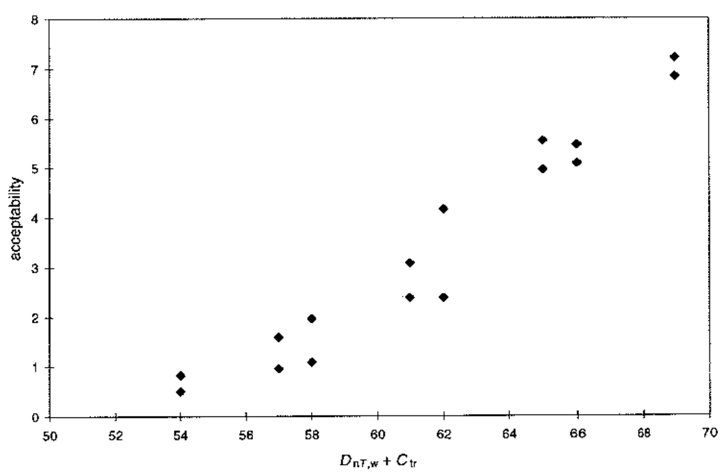


Fig. 5. Mean subjective acceptability versus $D_{nT,w} + C_{tr}$

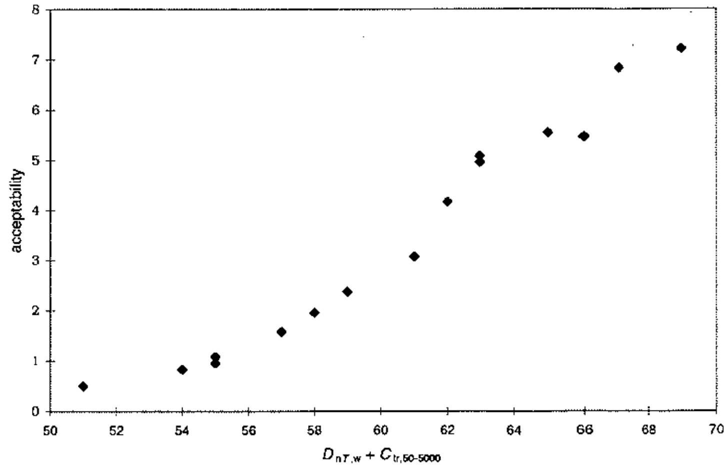


Fig. 6. Mean subjective acceptability versus $D_{nT,w} + C_{tr,\ 50-5000}$

encountered (if it is known, and is unlikely to change). For example, Figures 3 – 6 show the relationship between the mean acceptability rating, and each of the four insulation ratings in the case of one piece of dance music with a pounding bass beat. (On the acceptability scale 0 corresponds to 'totally unacceptable', 7 to 'totally acceptable' and 8 to inaudible).

Figure 3 shows clearly the four simulated floors matched at each $D_{nT,w}$ setting, but with a significant difference in their acceptability. In Figure 4 introduction of the C adaptation term causes the two pairs of floors to be displaced slightly along the insulation rating axis, with a correspondingly small improvement to the shape of the relationship. Adding the C_{tr} term instead (Figure 5) increases this displacement between the pairs to the benefit of the relationship. Finally, extending the frequency range of the C_{tr} term down to 50 Hz (Figure 6) provides a nearly ideal s-curve because now the difference in low frequency performance within each floor pair is taken into account. It is interesting to note that the frequency spectrum *of the particular music used* in the above example closely resembles the idealized road traffic spectrum represented by the C_{tr} term.

Implications for the Building Regulations

All the Approved Documents contain a clause which says *When an approved document makes reference to a named standard, the relevant version of the standard is the one listed at the end of the publication. However, if this version of the standard has been revised or updated by the issuing standards body, the new version may be used as a source of guidance provided it continues to address the relevant requirements of the regulations.* BS EN ISO 717-1:1997 comes into this category. Although Approved Document E refers to ratings obtained using BS 5821, it gives no guidance on the use of adaptation terms. Because of this, they could be used in a non-uniform way, and so it does not seem reasonable to adopt them for purposes connected with the Building Regulations. It is recommended that users either continue to use BS 5821, or use BS EN ISO 717–1:1997 without stipulating values for the adaptation terms. They can of course be used freely for other purposes.

Philip Wright MIOA is at the BRE Acoustics Centre, Garston, Watford and Les Fothergill FIOA is at the Building Regulations Division, Department of the Environment, Transport and the Regions. ❖

ACOUSTIC PERFORMANCE OF ENTERTAINMENT VENUES FOR THE MILLENNIUM

Jim Griffiths FIOA

Introduction

Peoples' current and future expectations for good sound quality when they attend an event coupled with residents' rights not to be unduly disturbed by sound from a venue, indicates the importance of good professional acoustic advice provided at all stages of a project.

This paper sets out to review the acoustic parameters and interrelated disciplines that need to be considered when dealing with sporting and entertainment venues, in particular stadia. The design development is discussed with reference to the compliance with relevant Standards and Codes and also with respect to the client's operational requirements.

Although all the acoustic disciplines will be highlighted, this paper focuses on the requirements of the stadium bowl, in particular with respect to the acoustic performance of the building envelope and the integration of the natural and reinforced sound within the bowl itself. Case studies of venues such as Wembley Stadium, the Millennium Stadium, Hong Kong Stadium and Ibrox Stadium will be used to demonstrate the development of criteria and designs for various acoustic aspects.

Acoustic Disciplines and Their Effects

The acoustic, noise and sound requirements of a venue are interrelated and should not be considered in isolation. The successful integration of the behaviour of sound in acoustic environments is required to:

1. Provide effective sound reinforcement throughout the building.
2. Allow each activity in a given space to operate without interference.
3. Minimise the risk of environmental noise impact to local communities.

The main acoustic disciplines that need to be considered and their effects on environmental noise and/or sound quality are shown in Figure 1. These disciplines interface with the full spectrum of professional disciplines associated with a design team (architect, structural engineer etc) as demonstrated in Figure 2. This relationship is important as acoustic engineering can have a significant effect on the overall venue design. Often, the acoustic advice is required before some of the other disciplines as at the inception stage, an environmental noise impact study is required as part of the planning process [1], where the following noise aspects should be investigated:

1. Baseline noise study to describe the existing local environs.
2. Operational noise survey of current events from an existing facility.
3. Prediction of operational noise sources (eg audience, concert, other events, sound systems, building services).
4. Prediction of transport and construction noise.
5. Assessment of all noise sources to baseline conditions, existing venue noise levels, absolute criteria and relevant Standards and Codes.
6. Assessment of potential noise mitigation options and their effects.

Transportation

As mentioned earlier, this paper concentrates on the acoustic aspects associated with the Stadium bowl, however, transportation noise is discussed in outline below as it can have a significant impact during event days.

We have found the most common complaints associated with transportation are generally related to the inconvenience the additional traffic (road) causes in terms of congestion etc rather than noise aspects directly. The additional traffic can make local journeys very difficult and residents can often also be seriously annoyed if car parking facilities at the stadium are inadequate or not used and those attending the events park in local residential roads.

Although, as mentioned, generally it is not the noise directly from the transport that causes problems, if these issues are not addressed properly it tends to sensitise the local residents and makes them far less tolerant to any

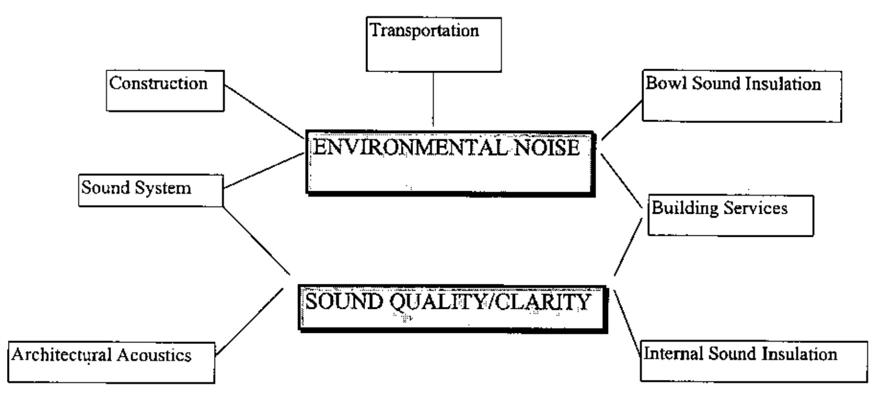


Fig. 1. Acoustic disciplines that need consideration and their effects

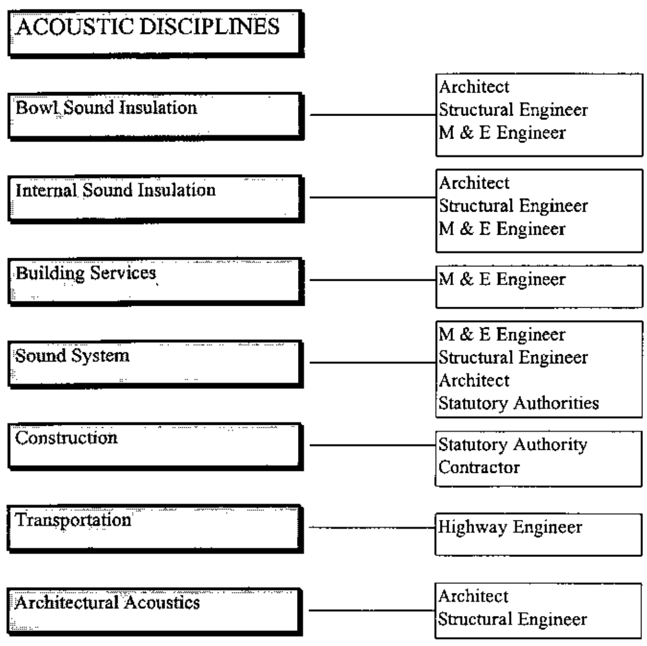


Fig. 2. Acoustic interface with other engineering disciplines

noise, be it emanating from the events or indeed due to transport. Noise is in fact often used as a proxy when the actual cause of complaint is the inconvenience of traffic. It is important therefore that in addition to transportation noise directly, the other implications of traffic control are dealt with properly.

Nevertheless, transportation noise on event days, can be a significant problem in its own right and should be assessed and dealt with accordingly. When assessing the impact of noise from transport it is necessary to establish the breakdown of attendance patterns into car, bus, rail, foot etc which is usually provided by specialist highway planners. Using this information and knowledge of the baseline situation (ie traffic levels on similar days without events) the impact in terms of noise increases or absolute levels can be determined.

The actual noise levels from road and rail traffic are calculated using the methodologies contained in *Calculation of Road Traffic Noise* [2], and *Calculation of Railway Noise* [3] respectively. Guidance on acceptable noise levels can be found in *PPG24 Planning and Noise* [4] or a particular local authority may have adopted their own standards. The frequency and number of events held at the venue should be borne in mind when selecting an appropriate standard, recognising that normally events are held relatively infrequently at major stadia.

Construction

The term construction often encompasses demolition activities. This is normally the case for entertainment venues where new developments are often to be located on the same site as the existing facility. The development of the stadium is a major construction activity in the area, often being positioned close to sensitive premises, and lasting in excess of 2 years.

Clearly, both noise and vibration are inherent in all types of demolition and construction activities and they can never be completely eliminated. The levels of noise and vibration generated will depend primarily on the type of plant and equipment utilised.

To provide a representative assessment of the likely noise aspect of construction operations, it is important to have detailed discussions with the main shell contractor to establish the preferred construction methods and activity period for each phase of the programme of works. This information can then be used to predict receptor noise levels using BS 5228:1997 [5]. Typical plant used for construction and demolition activities for stadia include various piling rigs, hydraulic crushing grabs, lancing equipment, pneumatic breakers, excavators, tower cranes, generators, air compressors, assorted power tools and lorry movements.

For the Millennium Stadium, currently under construction at Cardiff, a detailed acoustic study was completed which included the prediction of noise and vibration levels, the development of noise and vibration criteria and the recommendations of mitigation options for reducing the impact. Following negotiations between the contractor and local authority, the noise and vibration conditions shown in Table 1 were agreed.

These values are based on the commonly adopted daytime limit of 75 dB L_{Aeq} 0800 – 1800 hrs with a reduced level for the hour either side of the day period, allowing the contractor to make some noise during mobilisation on site and the gradual closure of the site in the early evening. The agreed vibration levels were based on BS 6472:1992 [6] for minimising disturbance

Noise Limits

Days	Hours	Time Period T (hrs)	Noise Limit $L_{Aeq,T}$
Monday-Friday (ex public holidays)	0700-0800	1	65
Monday-Friday (ex public holidays)	1800-1900	1	70
Monday-Saturday	0800-1800	10	75

No noise from the site to be audible at the curtilage of residential property at any other times, without prior approval

Vibration Limits

Criteria	Period	Limit
Disturbance Residential	Daytime	0.40 $ms^{-1.75}$ VDV
Disturbance-Other buildings	Daytime	0.80 $ms^{-1.75}$ VDV
Building Damage	All periods	12.5 mm/s ppv

Table 1 Construction noise and vibration limits for the Millennium Stadium, Cardiff

Piling Techniques	Typical ppv at nearest premises (40 m)
Vibratory – (12 m pile)	0.1 mm/s
Impact hammer –1 m drop height (12 m pile)	0.3 mm/s

Table 2 Vibration levels from piling tests at the Millennium Stadium

and BS 7385:1993 [7] for reducing the risk of structural damage.

As well as residential properties, other sensitive receptors need to be considered. Prior to the construction of the Millennium Stadium, concern was raised by several commercial premises (using specialist instruments and machinery) as to the potential high levels of vibration from piling. To address this concern, and review piling methods, a pilot test study was undertaken to evaluate the vibration and noise from two types of piling techniques (vibratory and impact piling). Typical vibration levels are indicated in Table 2, and although the vibratory rig produced the lowest levels, it was unable to operate effectively below a certain depth due to the hard ground conditions. However, the vibration levels from the impact driver were found to be acceptable at the nearby premises. This piling system was therefore accepted for this piling phase of the works, although recommendations were provided for reducing the noise impact. These included: the use of mobile temporary screens suspended near to the piling operation, the use of the vibratory rig to a certain depth followed by the impact hammer and a limit on the operation time of the piling during the day.

The Bowl Sound Insulation

To determine the acoustic requirements of the bowl sound insulation it is critical to establish two primary variables; the source noise levels and the acceptable receptor noise levels. Both are variable by virtue of the potential range of activities proposed in the venue, which in turn may affect the noise rating level applicable to community receptors.

Source Noise

A wide range of events are likely to be considered to be held at modern day venues in order to create a commercially viable multi-use sports and entertainment facility. Such events may well include the diverse range of activities such as football, rugby, American football, hockey, show jumping, athletics, boxing, greyhound racing and speedway racing. Other leisure and cultural activities are likely to include pop or rock concerts, choral, opera and orchestral events as well as non-musical activities such as conferences, theatres and rallies. The activity of relaying live matches or concerts via the stadium daylight screens and sound system from other venues is also becoming popular and is a further potential activity and hence a source of noise.

In general the noise from the majority of these events is generated by the audience who often produce high peak noise levels but for short durations and often for events during the daytime. An example of the noise profile of approximately 50,000 spectators during a football match at Ibrox Stadium is shown in Figure 3. Pop concerts however, generate by far the highest continuous noise levels with an unbalanced frequency spectrum biased towards the low frequency [8]. A typical frequency analysis is shown in Figure 4. Furthermore, these events are usually held into the late evening which further increases the community awareness to this source of noise, along with the low frequency content and high noise emission.

If pop concerts are proposed to be held on a long term basis, well into the millennium, and as noise is one of the four primary factors used to determine an entertainment licence for concert events [9], [10], concerts should be used to establish the worst case source noise level and hence highest sound insulation performance of a venue.

Noise data from concerts have been collected by Symonds Travers Morgan (STM) at over 300 events in the UK and

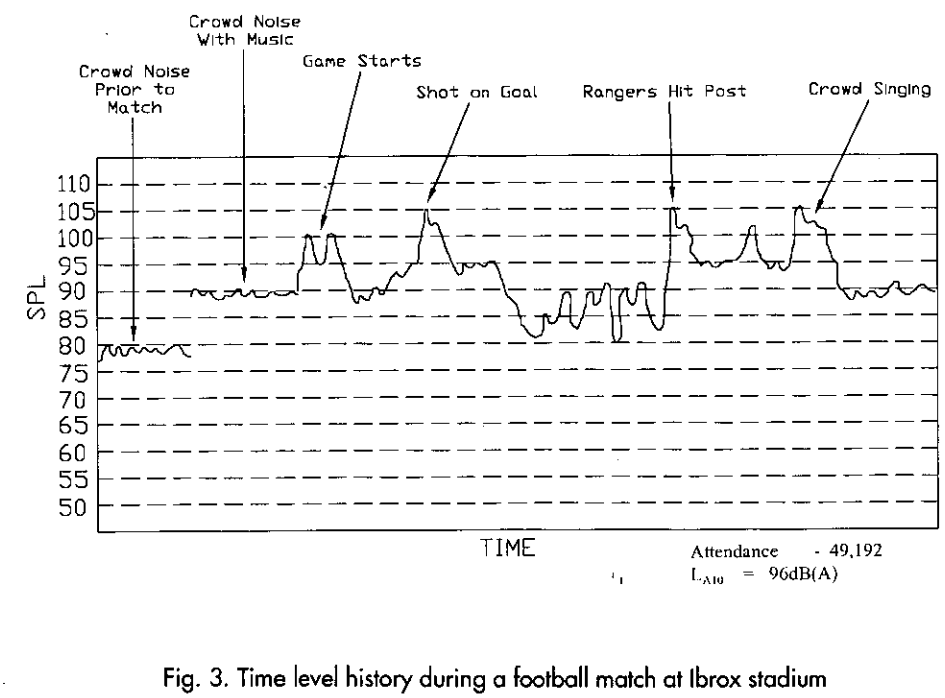


Fig. 3. Time level history during a football match at Ibrox stadium

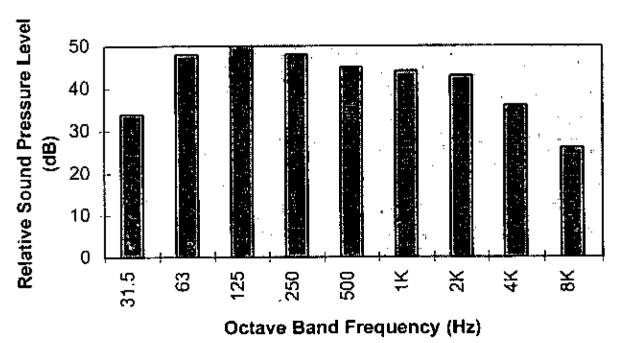


Fig. 4. Typical frequency spectrum of pop concerts

overseas and our noise study of concert noise levels commissioned by the HSE was published in 1991 [11]. From these data and experience, it has generally been acceptable to control outdoor concert noise levels to give an $L_{Aeq,15min}$ of 100 dBA at 40 m from the sound system whilst maintaining an effective form of entertainment for the audience. This source level is therefore generally used in the process of establishing the bowl insulation.

Environmental Standards

Acceptable receptor noise levels for concerts have been developed over the past twenty years. The first notable guidance was published by the GLC in 1976 and with several revisions [12], the environmental noise criterion was based on the increase of the L_{Aeq} noise level over the ambient L_{Aeq} noise level with respect to complaints data. These data were published in 1985 [13] and are reproduced graphically in Figure 5.

Further refinements to the guidelines were developed from research [14] in the early 1990s which reviewed variables such as baseline noise levels, venue types and concert numbers as well as the response to the rhythmic low frequency bass sound of modern music [15]. The revised guidelines were published in the Noise Council Code of Practice [16] and are summarised in Table 3.

Sound Insulation

Given the source noise level, the additional reverberant sound energy and the propagation of sound due to spherical spreading and excess attenuation, the composite bowl sound insulation can be determined to meet the appropriate environmental criteria. For open stadia, barrier effects can also be included in the evaluation process.

An empirical model has been developed based on historical data to assist this prediction process, although it was recognised from an early date that consideration of the meteorological data needs to be considered in the analysis. This was identified in 1987 [17] where the effect of meteorology was reviewed among other variables for eleven concerts held at Wembley Stadium (Figure 6).

The barrier effect of an open stadium is clearly frequency dependent, especially with respect to concert spectra which has a low frequency dependence. The variation of A-weighted attenuation with path difference for a typical concert spectrum is shown in Figure 7.

Having predicted the level of sound insulation that is required, it is necessary to establish whether the current designs meet the required performance. Three main areas need to be considered and the composite sound insulation predicted having regard for:

1. The main wall/underside of the seating tier which, for the most part, form the vertical interface between the stadium and external environment.
2. The roof or partial roof.
3. Penetrations through either of the above for the purpose of, for example, personnel access, vehicular access, ventilation and other servicing requirements.

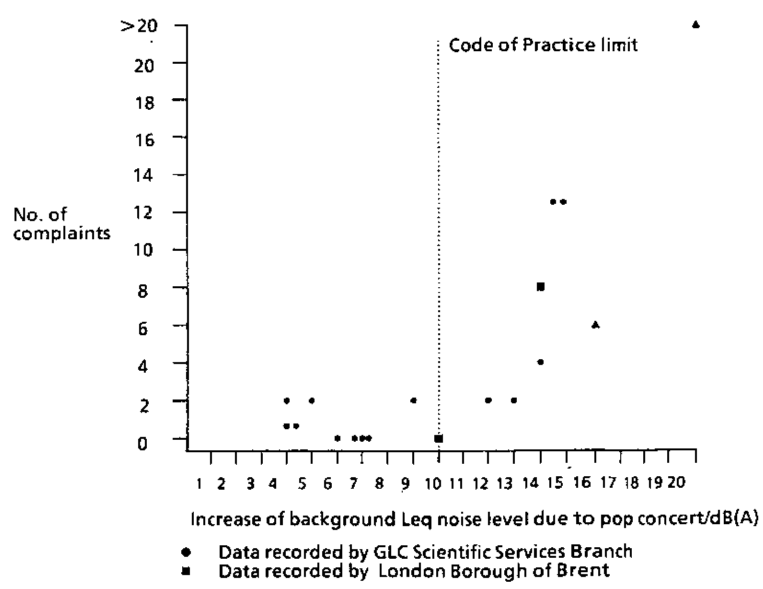


Fig. 5. Number of complaints vs L_{Aeq} noise level from pop concerts

Case Studies

Where the sound insulation is predicted to be below the required insulation, acoustic weak links need to be evaluated and designs developed in order to improve the acoustic performance. Examples of sound insulation problems and their potential solutions are discussed below.

The Millennium Stadium is being constructed with a closing roof which has the potential of greatly increasing the overall sound insulation as compared to an open roof structure. However, weak acoustic transmission paths, such as ventilation systems need to be carefully considered. For example, the closing roof at the Ajax stadium has relatively large apertures between the fixed and closing roofs for ventilation and provides only a 2–3 dBA reduction [18] in noise level at nearby properties (200 m) as compared with when the roof is open.

An example of where the acoustic performance of a structure needs to be

Concert days per year, per venue	Venue Category	Guidelines
1 to 3	Urban Stadia/Arenas	MNL should not exceed 75 dBA over 15 minute period
1 to 3	Other urban/rural venues	MNL should not exceed 65 dBA over 15 minute period
4 to 12	All venues	MNL should not exceed L_{A90} by more than 15 dB over a 15 minute period.

MNL (Music Noise Level) is the L_{Aeq} of the music measured at 1 m from the facade

Table 3 Concert Environmental Guidelines

carefully considered if it is proposed to hold regular music events in a venue, is The Hong Kong Stadium. The new stadium, surrounded by high rise dwellings, opened in March 1994 and provides an impressive landmark, in particular at night during an event. The eastern and western sides of the stadium are covered by a Teflon coated roof, which although visually impressive, provides negligible sound insulation.

On being commissioned to assess the noise impact three months prior to the opening of the venue, we showed that noise from concerts would exceed the Environmental Protection Department (EPD) standard of 65 dB $L_{Aeq,30mins}$ at many receptors. This was concluded even after considering the use of stringent noise control techniques, including the use of the stadium sound system with the concert system, the use of field delay speakers, careful configuration of the concert system, the construction of local temporary noise barriers, sound propagation tests and continuous noise monitoring and control.

As predicted, the levels from the first four concerts marking the opening of the stadium, exceeded the limit by up to 10 dBA and many complaints were received. Several local canto-pop music events followed the opening concerts and although the external levels were lower (due to lower internal levels acceptable for this type of music) the EPD limits were still exceeded. These breaches led to the issue of a Noise Abatement Notice requiring that any future event must meet the EPD prescribed limit. Further options were considered and tests were carried out on sound system devices having highly directional characteristics. The stage was also located in a different position, orientated away from the majority of the nearest residential premises. These showed that the prescribed limit could be met, although the seating capacity had to be roughly halved.

A trial concert was staged to assess both whether the audience found the sound level and coverage acceptable and whether the EPD limit could be achieved in a live situation. The social survey indicated that the majority of the audience were satisfied and the music noise met the EPD limit. However, the noise from the crowd with the music exceeded the limit and a lengthy debate continued as to whether crowd noise should be included in the assessment. It is understood that no further concerts have been held at the stadium, even though there has been a demand for such events from major international acts.

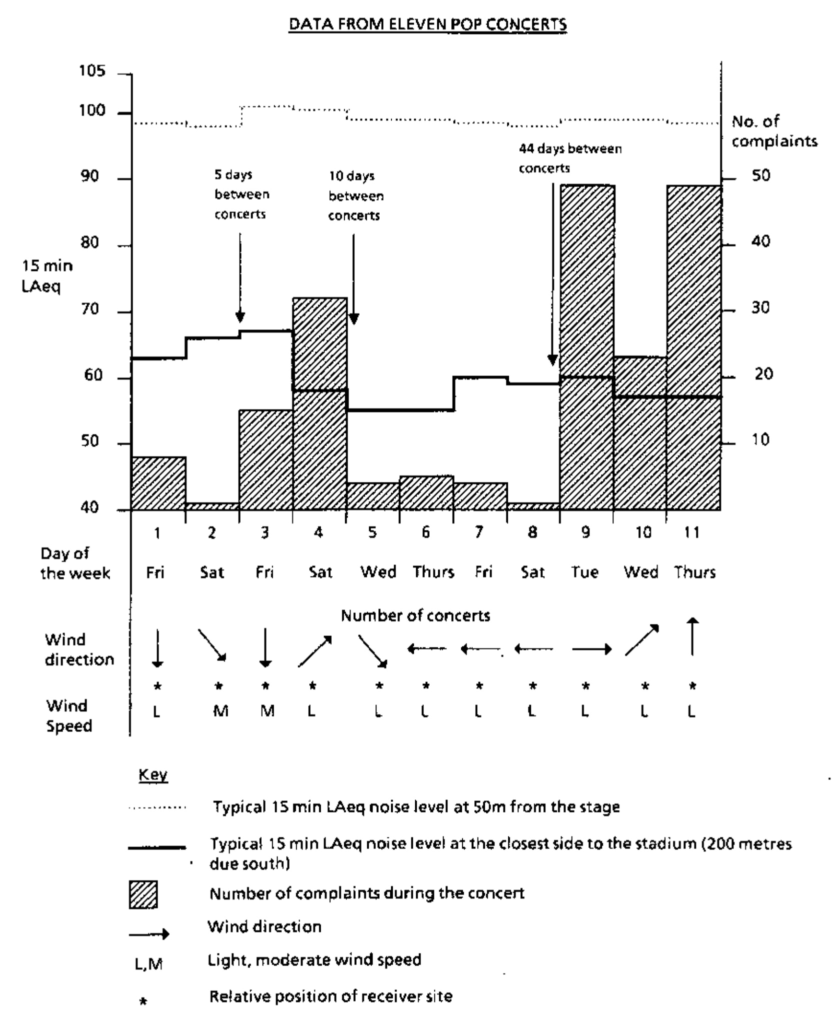


Fig. 6. Variables recorded at Wembley pop concerts

Sound Systems and Bowl Acoustics

Acoustics

The bowl acoustics are governed primarily by the size, shape of the stadium and the building fabric and indeed can be variable in nature when considering modern venues which may incorporate such features as a closing roof, large

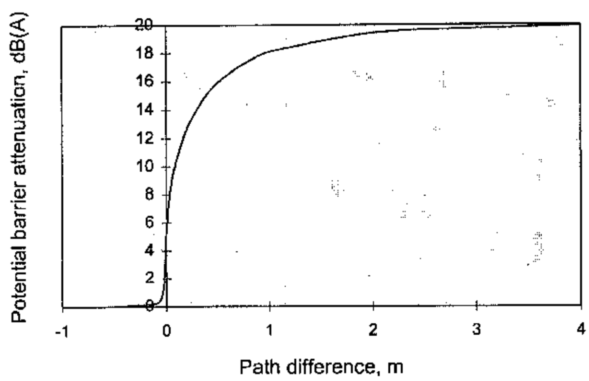


Fig. 7. Barrier attenuation for concerts

removable video screens, etc. The interface of the natural acoustics with the sound from the stadium system is particularly important in order to achieve a high ratio of the direct sound to the reverberant sound for the provision of good speech intelligibility. The interface with concert systems is also a consideration so that long delayed reflections causing echoes are minimised as they can significantly degrade the sound clarity for large sections of audience.

Acoustically treating large exposed areas is clearly beneficial, and a detailed acoustic analysis of the space should be completed to identify problem areas for given excitation intensities and source positions.

Following an acoustic analysis of the Millennium Stadium acoustic treatment is incorporated within the underside of the majority of the fixed and closing roof. This comprises 50 mm rockwool above a perforated profiled aluminium liner panel giving a mid frequency absorption coefficient of around 0.8. RTs have been predicted to range from 8, 4.5 and 3 seconds at low, mid and high frequencies respectively with the roof closed to 6, 4 and 3 seconds with the roof open.

As mentioned earlier, the acoustics coupled with the focusing of the sound system, can be particularly important during concert events. This was highlighted at Wembley Stadium, when the stage location for the Eagles concert was moved from the traditional West End stage to the North side of the stadium. The sound from the main system was focused directly into the opposite stand (across the pitch) and a long delayed reflection resulted (200 ms acoustic separation from the direct sound) for the seated spectators located on the far side of the pitch (affecting approximately 1000 spectators). This was due to the strong reflection from the roof canopy and although some re-alignment was carried out for the following show, a number of complaints were received from people seated in this area of the stadium.

Sound Systems

In addition to the traditional performance requirements of sound systems (life safety announcements and commentary), sound systems for modern venues are often required to perform the following functions:

- To relay important messages to all public areas.
- To provide commentary related to the event.
- To be suitable for the reproduction of music.
- To convey messages from sponsors and advertisers.
- Interface with screens and other visual equipment.
- Interface with concert sound systems.
- Provide the full audio requirements for the venue attractions (tours, museums etc).
- Provide a communications system for the hard of hearing.

The systems will need to serve all public areas, including but not limited to, the bowl, the pitch and track, the concourses, executive boxes, function rooms, lounges, restaurants, operational areas, the turnstiles, exit gates, external walkways and car parks within the curtilage of the site.

The sound systems also provide emergency evacuation communications for civil commotion and bomb alerts and must be inter-linked to the fire detection system as a voice alarm. They must also be designed with a surveillance system to report any faults. These and other aspects are required in order to meet British Standards [19], [20] and Codes of Practice [21] enforced under the powers of the Authorities.

As discussed earlier, the electro-acoustic design should be incorporated within the architectural acoustic modelling, so that the optimum quantity and types of loudspeakers can be established for each given acoustic space to meet the necessary performance criteria (eg not less than 0.5 STI). The designs must also have due regard to the environmental impact, in particular, external loudspeakers. Where possible the sound from the system should be designed not to exceed the existing background noise in the community.

Both the sound systems installed at Wembley Stadium (1990) and that currently being designed for the Millennium Stadium are examples of systems developed to perform many of the aforementioned functions now required for modern venues. The Wembley system [22], in particular, was the first of its kind to be fully integrated with concert touring systems and has been used by every artiste performing at the Stadium. The system using digital signal processors, for equalisation, signal delay and routing has shown that external sound levels during concerts can be reduced by up to 3 dBA as compared with the Stadium system when it was not in operation. The sound quality in the stands has also generally improved as the sound is focused into the seating areas by local speakers designed for the acoustic space rather than being served by a multi-purpose concert system located some distance from the audience, where both unwanted reflections and high frequency absorption are common problems.

The new system installed for Rangers Football Club at Ibrox Stadium, is an example of a system being upgraded to provide good music reproduction as well as performing a life safety function. This became an important issue when the new video screens were installed at Ibrox as the quality of the sound from the previous sound system was inadequate to complement the video reproduction due to the limited frequency response and sound pressure level. The new system has a flat frequency response 50 Hz to 12 kHz (± 5 dB) and can produce a sound pressure level in excess of 102 dBA over 95% of

Sound Criteria	Minimum R_w	Typical Wall Construction
Low level of insulation acceptable for general areas	40 dB	Stud wall partition, 12.5 mm wallboard each side of 70 mm metal studs, 25 mm mineral wool in cavity.
Medium level of insulation normally acceptable for presentation and conference areas	50 dB	Stud wall partition, two layers of 12.5 mm wallboard each side of 70 mm metal studs 50 mm mineral wool in cavity.
High level of insulation for broadcast areas and strictly private rooms	60 dB	Ideally, 'Room within a room' construction or high specification staggered stud construction.

Table 4

the seating areas. 102 dBA was specified allowing for a 6 dB headroom on the measured audience L_{A10} sound level of 96 dB.

Internal Acoustics and Sound Insulation

As with most developments, the acoustics of internal rooms and the sound insulation between them requires careful consideration. This is particularly the case in entertainment venues where there are normally a number of areas requiring specific low noise acoustic environments while other areas generate high noise levels (eg plant rooms). From the outset, therefore, careful space planning in respect of acoustic separations between high and low noise environments needs to be addressed.

Areas requiring specific acoustic treatment are television and radio broadcast suites, presentation and function suites and conference areas. Television and radio suites are particularly important as in modern venues the suites are often built in the grandstand whereby commentators have a clear line of sight of the playing field or performance area. To conduct quiet interviews, therefore, whilst being adjacent to high noise levels from the audience (Figure 3) requires a high level of sound insulation normally in excess of 60 dB R_w. A 'room within a room' design is likely to be required especially when live broadcasts are transmitted to the audience via the sound system where feedback problems can arise.

This was illustrated at Ibrox Stadium, where the poor acoustic performance of the broadcast suite was established when the new sound system was installed. The signal gain before feedback was such that during live broadcasts being transmitted to the audience, the sound level in the bowl from the sound system had to be limited to avoid feedback. This occurred even after applying electronic feedback reduction techniques. This situation is further exacerbated in television broadcast where omnidirectional microphones are operated some distance (300 mm) from the announcer, which requires high signal gain and thus increases the likelihood of feedback.

Room data sheets are normally prepared giving the full technical specification for each room. With respect to acoustics, the performance for most areas is specified by surface finishes with typical absorption coefficients, sound insulation values for each given partition and NR values. Often generic wall constructions are identified to meet various levels of sound insulation, examples of which are identified in Table 4.

Clearly, other factors such as suspended ceilings, suitable door construction, glazing requirements, flanking transmissions and A/V mounts for plant need to be specified as appropriate taking account of the activity within the room and the activities in adjacent areas.

Building Services

As indicated in Figure 1, noise generated by heating, ventilation, air conditioning and associated generator systems can affect both the internal areas and also the external environment. The transmission of noise from these sources should therefore be controlled before it is radiated internally and externally. This is normally achieved by the careful selection of acoustic attenuators to minimise the sound level at both the inlet and outlet of the ventilation systems. Vibration isolation is also required for the mechanical plant to avoid structure-borne noise.

The most appropriate criteria for assessing this type of noise source, and indeed, the standard preferred by most local authorities, is BS 4142:1997 [23]. As this noise rating relates to the existing background noise level which is likely to vary from one community area to another around the site, the acceptable noise standard will also vary. At the Millennium Stadium this has been addressed by recording the background noise in each area. The stadium has then been divided into eleven zones applicable to each nearby community area and target noise levels have been predicted 1 metre from the facade of the stadium in each zone taking account of the distance attenuation and intervening barriers from the community sites to the venue. Target noise levels range from 65 dBA to 82 dBA for the various locations around the perimeter of the stadium. These have been specified to assist in the location of noisy plant in least sensitive areas and in order to specify the performance of the attenuators in each zone for given plant sound power levels.

For the internal environment, NR criterion are normally provided for each given room function and are included within the technical information given in the room data sheets. This enables the appropriate size of attenuators to be calculated for each area. Typical NR values for stadium areas are identified in Table 5.

Summary

This paper has outlined the various acoustic disciplines that need to be addressed when dealing with the facilities that are required for stadia now and in the future. With the patrons' increasing expectations of good standards which includes that of the sound and acoustics, coupled with the general emphasis for environmental enhancement, the need to properly address all aspects of sound,

Area	Range of NR values
Stadium Bowl	45–50
Gymnasia	40–50
Conference areas	25–35
Broadcast suites	20–30

Table 5 Typical NR values for Stadium spaces

noise and acoustics for entertainment venues is becoming of greater importance, to complement the traditional engineering and architectural disciplines required for this type of development.

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FIXING FLANKING FOR FLOORS

Peter Henson MIOA, David O'Neill MIOA & John Miller MIOA

Introduction

Although Approved Document E to the Building Regulations gives clear guidance, the effect of flanking transmission on the sound insulation of domestic separating floors is not well understood in the construction industry. Flanking transmission is a recurring theme in Bickerdike Allen Partners' investigative work and in the development of remedial treatments, as the following cases illustrate.

Case 1: Beam and Block

Our first contact on this project came from a contractor who we had worked with on several large developments. The company had completed a housing development in the West Country for a housing association and their tenants were complaining of noise disturbance from flats above and below their own. Airborne, rather than impact, noise was the main source of complaint.

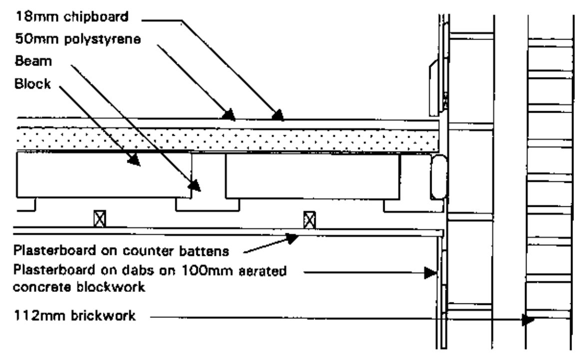
The flats were in three storey blocks, with two flats per floor, handed about a common staircase, with identical stacking of flat layouts.

Airborne and impact testing was carried out on representative floors. A mean airborne result of 46 dB $D_{nT,w}$ was obtained – well below the new-build figure of 52 dB implied in Approved Document E to the Building Regulations (albeit for prototype field constructions). The impact result met the Approved Document figures.

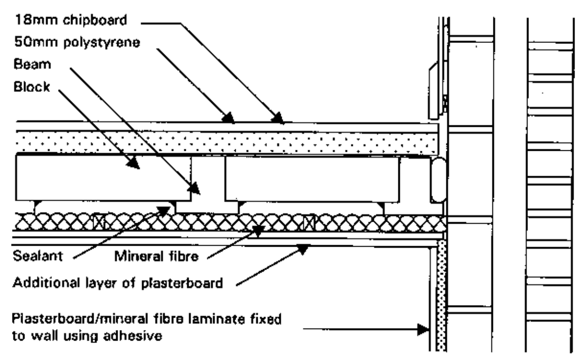
The failure to meet the airborne requirements of the Regulations led us to investigate the building construction. The floor construction comprised a concrete beam-and-block (285 kg/m²) base floor plus a 12 mm plasterboard ceiling on battens and a resilient layer of 50 mm polystyrene carrying a floating layer of 18 mm chipboard. The external walls were of cavity construction, with an inner leaf of 115 mm aerated blockwork (68 kg/m²). The internal structural spine wall comprised 100 mm blockwork (200 kg/m²) and the internal finish on these walls was a plasterboard lining fixed using plaster dabs. Internal partitions were of timber stud construction with plasterboard linings.

The basic floor construction failed to comply with the constructional recommendations given in Approved Document E for this floor type, in many respects. The floating floor resilient layer/floating layer specifications did not conform to the construction given in the Approved Document and there were problems of bridging around the edges and where a metal services duct had been built into the floor. No sealing had been provided between the base floor blocks. The inner leaf of the external wall did not meet the Approved Document recommended mass (120 kg/m²) and the floor beams did not pass through the wall leaf.

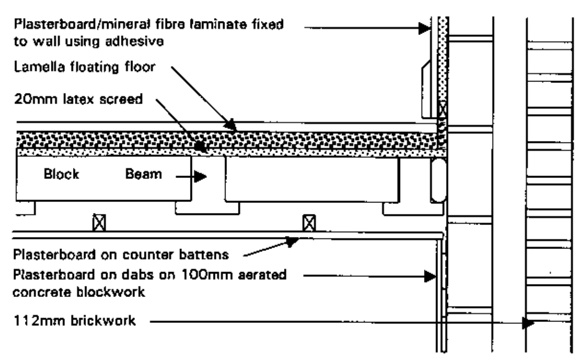
It was clear that remedial works were required and that these would have to address both sound transmitted



CASE 1: SECTION THROUGH AS-BUILT CONSTRUCTION



CASE 1: SECTION SHOWING IMPROVEMENT TO FIRST FLOOR CEILING



CASE 1: SECTION SHOWING IMPROVEMENT TO FIRST FLOOR

through the floor construction (direct transmission) and sound transmitted via the walls (flanking transmission). Our client engaged us further to develop an economical solution to the problem.

As part of our further investigation, we carried out an airborne sound insulation test between a pair of small rooms where the flanking conditions were favourable. (The rooms were enclosed mainly by stud partitions and the external wall had a large window in it). A result of 51 dB $D_{nT,w}$ was obtained. This clearly demonstrated to us that whilst the floor/ceiling construction was deficient, flanking transmission was the major problem.

The contractor needed further convincing. He embarked on a trial treatment of the ceilings in two rooms – one room with favourable flanking conditions and one with unfavourable flanking conditions. The treatment, which was based on a treatment found successful on similar floors in favourable flanking conditions, involved sealing the edges of the base floor construction, blowing mineral fibre into the cavity above the ceiling and fixing an additional layer of plasterboard to the ceiling. A result of 50 dB $D_{nT,w}$ was obtained in unfavourable flanking conditions and 55 dB in favourable conditions. This clearly demonstrated to us that the ceiling treatment was effective but that flanking transmission would have to be tackled if the Regulations were to be met.

The contractor was convinced. In the meantime, the housing association was becoming litigious and the contractor's insurers had become involved. Practical objectives were set.

In the interests of controlling our client's costs and minimising disruption to the tenants, it was proposed that all remedial works should be carried out in the first floor flats. This meant that the tenants in ground and second floor flats could remain in occupancy while the works were being carried out. The treatment would, therefore, involve work on the floor construction, as well as the ceiling and the flanking walls. A practical constraint imposed on us was that the floor-to-ceiling dimension should not be reduced significantly below its existing height of 2.3 m. The ceiling treatment previously tested was adopted (reducing the ceiling height by 15 mm).

The existing floating floors were removed and a 20 mm latex screed was applied to the top of the base floor to seal the gaps between the beams and blocks and around the edges. A proprietary 'Lamella' floating floor system, comprising 18 mm chipboard bonded to 20 mm of dense mineral wool, was carefully detailed and installed to avoid bridging. This left the finished floor height unchanged. The floor-to-ceiling height was, therefore, reduced by only 15 mm, as a result of the additional ceiling layer.

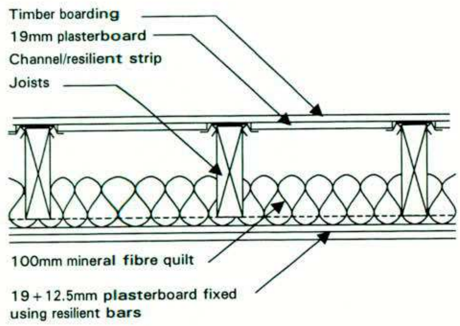
A wall lining of 9.5 mm plasterboard bonded to 20 mm mineral wool was fixed to the walls using adhesive. A trial demonstrated that it was necessary to apply this treatment to the external walls and to the spine wall to secure a result of 52 dB $D_{nT,w}$.

All in all, this was a neat solution, tailored to the minimum requirements of the Building Regulations. The specification was implemented across the whole development.

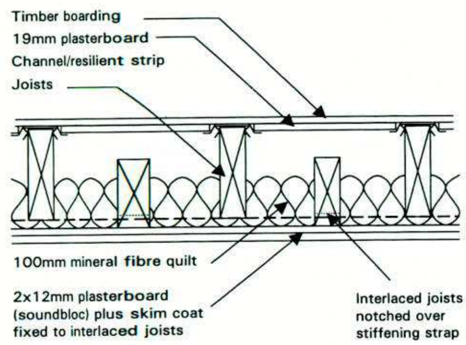
Case 2: Timber Joist

Case 2 involves luxury apartments in North-West London. We were approached by two flat owners living in a block of newly-built luxury flats in Hampstead. The building was a four storey block, with one apartment per floor. The ground and first floor residents were complaining of excessive noise transmission between their flats, and this included both airborne and impact noise.

The developers were keen to resolve the issue amicably. They considered it their responsibility to satisfy the requirements of Building Regulations, but were unwilling



CASE 2: SECTION THROUGH AS-BUILT FLOOR/CEILING CONSTRUCTION



CASE 2: SECTION THROUGH MODIFIED FLOOR/CEILING CONSTRUCTION

to offer more than the minimum standard. They agreed to take on board BAP's advice.

For structural reasons, the weight of the building was limited by installing timber joist separating floors, to the following specification:

- British Gypsum SI System floating floor, comprising timber floor boarding on 19 mm plasterboard, supported on a special channel section and resilient strip on top of the floor joists.
- 19 mm + 12.5 mm plasterboard fixed to the underside of the joists using the British Gypsum Gyproc resilient bar system.
- 100 mm glass fibre quilt in the cavity.

The room sizes were large and this led to large floor spans and use of some structural steel beams within the floor/ceiling construction.

Testing was carried out on all three separating floors (ie first, second and third floors). Although the residents were complaining about impact noise, the tests showed that the floors achieved the Approved Document impact standard. A figure of 51 dB $L'_{nT,w}$ was obtained, which is better than the Approved Document's upper limit of 61 dB. It is not uncommon for us to find that timber joist floors which meet Building Regulations standards for impact noise still attract complaint, as a consequence of low frequency thuds and bumps.

The results of airborne sound insulation testing provided us with a valuable insight into the extent of flanking transmission in the property. The first floor and second floor constructions both achieved a $D_{nT,w}$ value of 47 dB, some 5 dB worse than the Approved Document

INSUL

For predicting the airborne sound insulation performance of walls, floors and glazing

MARSHALL DAY ACOUSTICS

This software was developed by Keith Ballagh, Senior Partner with Marshall Day Acoustics, New Zealand. It was developed in order to automate the repetitive calculations associated with the prediction of the sound insulation of those constructions commonly encountered in Building Acoustics.

The software is marketed in Europe by NES Acoustics, a team ofhighly motivated individuals providing a premium acoustic consultancy service.

NATIONAL **environmental** *Sciences*

NES is a multi-disciplinary environmental consultancy with offices in the UK and Ireland. They can be contacted as follows:

UK Office
Tel +44 (0)161 474 7202
email: nes.int@dial.pipex.com

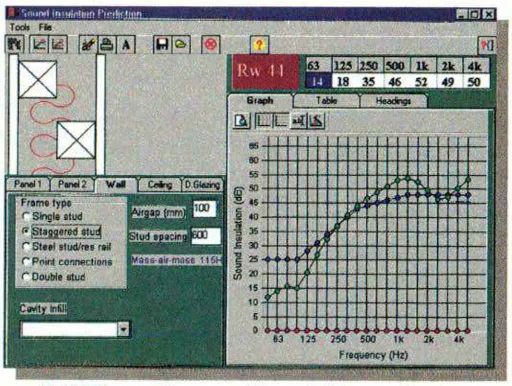
Head Office(Dublin)
Tel: +353 (0)1 450 4922
email: nes@iol.ie

Sound Insulation Prediction Software

FEATURES:

- **predicts the sound insulation performance of Walls, Floors, Ceilings and Windows**
- **accurate estimates of Transmission Loss (TL) and Weighted Sound Reduction Index (R_w)**

INSUL is a program for predicting the sound insulation of walls, floors, ceilings and windows. It is based on simple theoretical models that require only minimal construction information. The program can make reasonable estimates of the *Transmission Loss (TL)* and *Weighted Sound Reduction Index (R_w)* for use in noise transfer calculations.

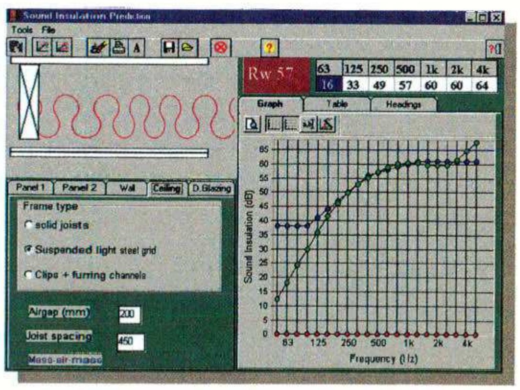


INSUL can be used to quickly evaluate new materials and systems, or to investigate the effects of changes to existing designs. It models materials using the simple mass law and coincidence frequency approach and models more complex partitions using work by Sharp, Cremer and others. It has evolved over several versions into an easy to use tool that takes advantage of the Windows™ environment, and has refined the theoretical models by continued comparison with laboratory tests to provide acceptable accuracy for a wide range of constructions.

The program will run on a PC equipped with a 386 processor or better, and requires only minimal hard disk space.

Like any prediction tool INSUL is not a substitute for measurement. However, comparisons with test data indicate that INSUL reliably predicts R_w values to within 3dB for most constructions.

INSUL will greatly enhance the ability of acoustic consultants and product manufacturers to quickly and confidently specify constructions in order to achieve a desired airborne sound insulation performance.



Contact NES at either of our offices in the UK or Ireland for further information or to arrange a demonstration:

Tel: +44 (0) 161 474 7202

email: nes.int@dial.pipex.com

INSUL ver 4.4 - Main Features

- Database of common builderswork materials
- Material parameters are user definable
- Tabular and graphical output format for quick assessment
- Save complicated constructions to disk for analysis at a later date

standard for new-build floors. The third floor construction achieved 54 dB, meeting the standard by a 2 dB margin.

The walls of the ground, first and second floors were of brick/block cavity construction. The third floor apartment was an attic flat, constructed within a timber-framed mansard roof. There were, therefore, no continuous flanking walls extending across the third floor construction and this was clear evidence that the airborne sound insulation on other floors was being severely limited by flanking transmission.

Further investigation revealed that the inner leaf of the external wall had been constructed using lightweight aerated blockwork, providing a surface mass of less than 100 kg/m² compared with an Approved Document requirement (in relation to timber joist floors) of 375 kg/m². Vibration testing on the flanking walls and other surfaces confirmed that the external flanking walls were to blame for the poor airborne test result.

Consideration of the remedial measures available led us to believe that it was not reasonably practicable to reduce flanking transmission to the point where the full potential of the floor/ceiling could be realised. We therefore recommended that some treatment should be carried out to the first floor and second floor, in addition to treating some flanking walls. The main aim of the remedial works was to meet the requirements of the Building Regulations, but consideration was also given to improving the impact insulation, where this was consistent with the main aim.

To control flanking transmission, we recommended the installation of a wall lining, comprising 12.5 mm plasterboard, bonded to 40 mm mineral fibre and fixed to the wall using adhesive (as in Case 1). This was installed in the ground floor and first floor flats only.

To improve the sound insulation of the first floor construction, separating the ground and first floor flats, we recommended the installation of an independent ceiling under the existing ceiling. This comprised two layers of plasterboard, supported on independent joists, with 100 mm mineral fibre in the cavity. This is similar to an Approved Document construction for use in flat conversions (Section 5, Floor Treatment 1). Together with the flanking wall treatment, this improved the airborne sound insulation from 47 dB to 56 dB $D_{nT,w}$. Impact sound transmission was improved from 51 dB to 39 dB $L'_{nT,w}$.

The floor-to-ceiling height was restricted on the first floor and there was not sufficient space for an independent ceiling under the existing ceiling. We recommended removal of the existing ceiling and the installation of an independent ceiling supported on joists which were interlaced between the existing joists. This is similar to another Approved Document treatment used in flat conversions in situations where other Approved Document treatments are not practicable (Section 5, Floor Treatment 4).

There were a number of practical difficulties. A major consideration was that removal of the existing ceiling reduced the stiffness of the joists and it was necessary to adopt a novel arrangement. This required straps to be fixed to the underside of the existing joists and the new, interlaced, joists to be notched to accommodate the straps. This required careful detailing and workmanship and regular visits to inspect the work in progress.

Taken together with the flanking wall treatment, the work to the second floor construction improved the airborne sound insulation from 47 dB to 53 dB $D_{nT,w}$. Impact sound transmission was reduced from 51 dB to 42 dB $L'_{nT,w}$.

As with Case 1, it proved necessary to tailor a solution closely to take account of client requirements and site conditions. In both cases, the understanding of flanking conditions was essential to achieving the desired outcome. Also, in both cases, more careful reading of Approved Document E by the original developers, would have steered them away from the flanking constructions which they adopted.

Notes

1. The 1985 Building Regulations were in force when construction work started. The numerical performance standards of the current (1991) Regulations for new-build properties are unchanged, but the mass requirements for the base floor construction increased from 220 kg/m² to 300 kg/m² when the new Regulations came into force.

Peter Henson MIOA, David O'Neill MIOA & John Miller MIOA are with Bickerdike Allen Partners, a member of the Association of Noise Consultants. ❖

BUILDING FOR A SOUND EDUCATION

Commonwealth Institute, London, 23 September 1998

This successful meeting addressed many important current issues in the acoustic design of schools. Mukund Patel, Head of Architects and Building Branch, DfEE, opened proceedings by explaining why acoustics is a very key topical issue. Reasons included the political pressure to increase standards; hearing impaired pupils now learning in mainstream schools; and very significantly, the substantially increased funds available over the coming years for education. The DfEE Building Bulletin 87 'Guidelines for Environmental Design in Schools' has recently superseded Design Note 17 in giving acoustic criteria for schools. Raf Orlowski, Arup Acoustics, presented this new booklet, explaining the acoustic criteria given and describing some of the case studies used in revising the guidelines. This presentation also included Building Bulletin 86, 'Music Accommodation in Secondary Schools', which contains acoustic guidance for this specific building type.

Heriot-Watt University has been conducting an extensive study of acoustic conditions in schools. In the first of two papers about this research, Sharon Airey described how the study has determined RT, background noise, STI, %ALcons and subjective intelligibility for numerous occupied and unoccupied spaces. In many cases it was found that the noise levels were excessive and the introduction of absorption gave signficant benefits in intelligibility. The next paper was presented by Geoff Leventhall who described how in the USA, guidelines for the Americans with Disabilities Act (1990) may soon include acoustics in classrooms. This has produced responses from bodies such as ASHRAE and ASA. These responses were summarised with background noise, RT and Signal/Noise criteria discussed. A surprising statistic included is that it is estimated that 25–30% of young children will not hear normally on a given day (mainly due to temporary illnesses). The previous paper had also found a similar situation and suggested that the DfEE BB87 criteria for the hearing impaired should be adopted universally.

The morning session was concluded by Roz Comins, who described the stresses and strains on teachers' voices, the general lack of any voice training and the work of the Voice Care Network. A paper by David Brierly was also printed in the proceedings, which described how some teachers had suffered permanent voice damage thought to be partly attributable to poor-acoustics in the spaces in which they taught.

The afternoon papers looked in more detail at building constructions and achieving criteria. John Miller, Bickerdike Allen Partners, described the recent application of the BB87 criteria for a school by London City Airport with respect to increasing aircraft movements. A measurement exercise was used to determine the necessary improvement in sound insulation against the L_{Aeq} and L_{A1} criteria and a secondary glazing arrangement giving attenuation and ventilation was detailed.

David Fleming discussed several music school projects, focusing on sound insulation between music practice rooms, showing how careful vigilance is required during construction to avoid shortfalls in performance. Alan Fry went on to discuss three cases where modular music practice rooms had been used, which avoid many construction site problems and can provide a high level of sound insulation. The objective and subjective acoustic testing of the acoustic conditions in these modular systems was also detailed.

The final paper was by David MacKenzie describing more of the findings of the research at Heriot-Watt. The survey data, having included STI measurements at an ear of each pupil in some classrooms, showed dramatic differences in intelligibility depending on the position in the room. This variability was thought to be partly due to the geometry of some rooms with pitched roofs contributing to poor acoustic conditions. Other issues raised in case studies were high levels of rain noise on roofs and solar shading and problems where planning had not respected a new school's noise environment.

The meeting concluded with a discussion session chaired by Les Fothergill where criteria and building constructions were addressed. There was general agreement that the DfEE Building Bulletin 87 gives appropriate criteria though this could be further extended, to take a step forward in some areas, such as catering more widely for the hearing impaired in mainstream classrooms.

The meeting was organised by the Building Acoustics Group who would like to thank all the authors for their contributions, John Miller for chairing the meeting, Les Fothergill for chairing the discussion session and the IOA office for their administration.

Stephen Chiles AMIOA

ACUSTICA acta acustica

After 5 years service, Jean-Dominique Polack, the founding Editor-in-Chief, is to be succeeded by Michael Vorlander, supported by Marc-Pierre Verge and Xavier Pelorson who will also be responsible for the journal's web site eaa.essex.ac.uk/eaa/. A new initiative to introduce technical and applied papers brings together a team of three Editors, including Roger Higginson FIOA, and a fast procedure for publishing technical papers.

Only a few IOA members have subscribed in the past, but with its intended appeal to a wider audience, it is hoped that more IOA members will do so. The subscription rate for personal copies for Institute members of any grade for 1999 will be £54.00 for six issues, each of some 200 pages, which are published each year.

ONE DAY MEETING AND WORKSHOP

(organised by the Environmental Noise Group)

EU Noise Policy

Is this the end of L_{10} and L_{90} and the beginning of the Eurodecibel?

NPL, Teddington
Friday 22 January 1999

In the most significant and far-reaching development in noise policy in the last 30 years, the EU has begun the process of developing a "Framework Directive on the Assessment and Reduction of Environmental Noise". The Commission aims to have the basic Directive developed as early as 1999, with full development by 2002. As part of this process a number of Working Groups have been set up, on which the UK is represented.

There are widespread implications for every facet of legislation in the UK. It is in the interests of every professional working on any aspect of environmental noise to know about this process and have a chance to interact with the UK representatives.

At this one day meeting, reports on progress so far will be presented in the morning session by the UK representatives, with the afternoon session comprising group discussions on the issues raised.

The meeting will be chaired by Ken Collins and speakers will include:

Ian Campbell, President IOA - *Introduction*
Martin Joseph (DETR) - *Overview and UK Government Position*
Ian Flindell (ISVR) - *Working Group 1, Indicators*
Bernard Berry (NPL) - *Working Group 2, Dose/Effect*
Tim Johnson (AEF) - *Working Group 3, Computation and Measurement*
John Hinton (City of Birmingham) - *Working Group 4, Noise Mapping*

Registration will be at 9.30am for a prompt 10.00am start. A buffet lunch and refreshments will be provided. The meeting will close at 4.30pm. CPD Certificates will be available.

EU Noise Policy, 22 January 1999

Name:

Organisation:
Address:

Tel: Fax: Email:

☐ I enclose a cheque for the delegate fee
☐ Members £95 + VAT = £111.63 ☐ Non-members £125 + VAT £146.88

Cancellations received after 2 January 1999 will be payable in full. Please return this form to the Institute office.

Institute of Acoustics, 77A St Peter's Street, St Albans, Herts AL1 3BN
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ONE-DAY WORKSHOP

(Organised by the Measurement & Instrumentation Group)

DAT'll be the day

LEARN, University of North London

Wednesday 17th February 1999

The use of Digital Audio Tape (DAT) technology is widespread in the acoustics community, for applications such as noise nuisance identification, capture of transient events, or simply storing noise and vibration signals in the field, for later analysis in the laboratory.

The path to successful DAT recordings is a tortuous one, with many pitfalls along the way, including calibration levels, considerations of frequency response and linearity, and subsequent analysis procedures. This workshop is designed to address these issues, both theoretically as well as practically, by examining the whole procedure from recording to analysis.

The morning features presentations from members of the M&I Group:

The performance of typical DAT recorders and how they shape up to BS EN 60651 (formerly BS 5969) *Richard Tyler, CEL Instruments*

The selection of suitable front ends for DAT recorders *Ian Campbell, Gracey & Associates*

Setting up and making successful DAT recordings *speaker to be announced*

Procedures for correct analysis of DAT recordings *John Shelton, AcSoft Ltd*

The afternoon builds on this with a hands-on workshop on setting up DAT recorders, recording various signals, and analysing the resulting tapes. Delegates will be encouraged to bring along their DAT recording kit, so maximum benefit can be gained from the day.

The workshop is likely to be of interest to Environmental Health Officers, consultants and anyone who relies on the use of DAT recorders for their measurements.

Meeting Organiser:
John Shelton MIOA, AcSoft Limited, 6 Church Lane, Cheddington, Leighton Buzzard LU7 0RU

DAT'll be the day, 17 February 1999

Name:

Organisation:

Address:

Tel: Fax: email:

Please register me as a delegate and invoice me for the meeting fee which includes lunch.
☐ Members £111.63 inc VAT ☐ Non-Members £146.88 inc VAT
Cancellations received after 1 February will be payable in full.

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Tel 01727 848195 Fax 01727 850553 email Acoustics@clus1.ulcc.ac.uk Registered Charity No 267026

CONFERENCE NOTICE

25th ANNIVERSARY CONFERENCE

Thursday 13 May 1999

The Barbican Centre, London

To mark the 25th Anniversary of the Institute a one-day conference is to be held at The Barbican Centre London, one of Europe's premier arts and conference centres.

This Conference will provide a unique opportunity to gain an overview of the past and examine current and future developments in the world of acoustics presented by leading experts in their field.

The Specialist Groups participating will include the following:

The Building Acoustics Group, Electroacoustics Group, Environmental Noise Group, Industrial Noise Group, Measurement and Instrumentation Group, Musical Acoustics Group, Speech and Hearing Group and the Underwater Acoustics Group.

The morning session will be in the form of review papers covering the development of each speciality over the last 25 years. These papers will be presented in a plenary session to enable all members to broaden their knowledge of all aspects of our profession and will be published in a special 25th Anniversary issue of 'Acoustics Bulletin'.

The afternoon session will comprise parallel technical meetings run by each of the Specialist Groups reflecting current developments and new techniques. The selected papers will be published in a volume of the proceedings of the Institute.

Awards will be presented at the luncheon to be held in the Garden Room at The Barbican Centre and the Institute's AGM, which will take place immediately after the conference, will be preceeded by a reception.

Space at the Conference is strictly limited and will be allocated on a first come first served basis. To register your interest as a delegate please complete this form and fax back to the Institute on Fax 01727 850553 today.

Reserve this date in your diary

25TH ANNIVERSARY CONFERENCE

Name:
Address:

Post Code:

☐ I am interested in registering as a delegate

Institute of Acoustics, 77A St Peter's Street, St Albans, Herts AL1 3BN
Tel 01727 848195 Fax 01727 850553 email Acoustics@clus1.ulcc.ac.uk Registered Charity No 267026

EDUCATION

Certificate of Competence in Workplace Noise Assessment

The following were successful in the October 1998 examination

Bristol
Green, A R
James, E A
Jones, A J

Colchester
Carmichael, J R
Goriah, A
Grace, P C
Hartley, S
Inkpen, R K
Jones, T H
Marshall, D H
Norris, H
Ross, C D
Scott, R
Thomson, S
Waterson, A L

Derby
Lucas, N D
Urbanski, I D

EEF Sheffield
Croasdale, S M
Fairclough, A L
Kieran, V L
Kinder, J B
Lim, G B
Muller, H
Nowosielski, I M
Rhodes, D J

Leeds
Blakeley, J
Charlesworth, P S
Gallagher, M
King, J A
Redhead, M J
Robertson, M J

Liverpool
Gaines, M R
Holdsworth, S
Ismail, M R
Jones, G V
Krishna-Das, A
McCaul, D J
Williams, G J

Loughborough
Attenborough, D J
Calvert, P G
Cann, R J
Davies, S N
Durkin, N
Eliot, K
Green, R E
Hennell, S A
Martin, D
Millard, J
Palmer, K O
Smith, G S
Taylor, R
Tranter, R
White, J E
Wilkinson, T J
Wooler, J

NESCOT
Bean, A
Bean, A P
Dunlop, L
Whiston, I

Newcastle
Graham, F
Slater, J A

Ulster
Breen, M
Butler, P J
Doherty, H G
Dowling, N
Holmes, J M
Houston, K R
Sands, I A
Yorke, R

Certificate of Competence in Environmental Noise Measurement

The following were successful in the October 1998 examination

Bell College
Lamb, J
Wason, L A

Birmingham
Duty, S P
Gannon, G P
Parkes, S D
Wootton, R

Bristol
Ashmore, I
Carleton, P
Owen, G

Colchester
Hall, J A
Kershaw, A D
McClymont, K
McKechnie, A
Mills, R D
Moore, K
Ross, C
Whitmore, M R

Derby
Ashton, E A
Butterfield, G
Davenport, J A
McCrystal, M A
Rose, D M

Leeds
Bentley, M L
Dale, S P
Gritten, T M
Hill, P R
Hunt, P V
Kirby, S
Raper, J
Thomas, D

Liverpool
Abbot, K
Brown, S
Cockett, S
Everley, E A
Jump, D E
Macleod, G M
McCaul, D J
Parry, R M
Richardson, S J
Simpson, J
Threlfall, D J
Waddington, D C
Whalley, A W

NESCOT
Bradfield, M J
Brosnan, H
Courts, S J
Gilbert, S J
Goddard, M
Hurst, C J
Kennedy, J W C
Kettles, S T
Taylor, M D
Winchcombe, K R

Strathclyde
Brannigan, J
Cassells, W
Donnelly, E
Gordon, D S
Johnston, G
McGinley, M
McPherson, A T
Rankine, P
Robertson, A E C
Wall, J
Watt, J

INSTITUTE DIARY 1999

22 JAN
Env Noise Group Mtg:
EU Noise Policy
NPL Teddington

27 JAN
Scottish Branch Mtg:
Classroom Acoustics

5 FEB
IOA CofC in W'Place
Noise exam
Accredited Centres

17 FEB
M & I Group Wo'shop:
DATIl be the Day
London

22 MAR
M & I Group Mtg:
Good Practice in
Acoustical M'ment
Bristol

19-21 APR
Underwater Acoustics
Group Conference
Sonar Transducers 99
Birmingham

13 MAY
IOA 25th Anniversary
Conference & AGM
The Barbican, London

14 MAY
IOA CofC in W'Place
Noise exam
Accredited Centres

11 JUN
IOA CofC in Env Noise
Measurement exam
Accredited Centres

17–18 JUN
IOA Diploma exams
Accredited Centres

8 OCT
IOA CofC in W'Place
Noise exam
Accredited Centres

29 OCT
IOA CofC in Env Noise
Measurement exam
Accredited Centres

REPRODUCED SOUND 14

Windermere, 22 – 25 October 1998

The English Lake District can be relied upon to provide such a range of weather conditions from year to year that the conference reporter does not have to repeat himself when describing what the accompanying persons (wives and the like) have to put up with when attempting to enjoy their trip. There are times when it is a distinct advantage to be a delegate; this year was one of them! To be honest there were some sunny intervals but in general the district did its best to ensure that its flood reports were at least as impressive as those in Wales.

The organising committee for this year comprised: Julian Wright FIOA (Celestion), Chairman; James Angus FIOA (University of York); Mark Bailey AMIOA (JBL Professional); Peter Barnett MIOA (AMS Acoustics); Robin Cross MIOA (BT Acoustics); Paul Darlington MIOA (University of Salford); Ken Dibble FIOA (Ken Dibble Acoustics); Guy Hawley (JBL Professional); Peter Mapp MIOA (Consultant); Allen Mornington-West FIOA (ITV Network Ltd); Bob Walker FIOA (BBC).

Although the title of the conference might imply that the presentations were entirely devoted to the marvels of surround sound, such a restricted interpretation would be unjustified. Certainly surround sound, in all its manifestations, formed a focal point for the conference, in particular the workshops, but the range of subject matter was wide and extremely interesting. The highlights of the conference as is so often the case were the keynote papers and this year the occasion was enriched by the presentation of an Honorary Fellowship to Professor Frank Fahy at the conference dinner; the citation for this award is given elsewhere in this Bulletin.

Thanks are due to the exhibitors whose excellently prepared stands added interest and colour to the proceedings; this year the exhibitors were AcSoft Ltd, Fabritrak, Neutrik (UK) Ltd, SigNET (AC) Ltd, Shure Brothers Europe and Sound Dept.

For assistance in preparing the following summaries of the papers thanks are due to the session chairmen.

Technical Sessions: Friday

Chairman: James Angus

After an opening address by Julian Wright the conference started with the Keynote paper given by Alex Burd and co-authored by Neil Spring (Sandy Brown Associates) entitled *The development of control room design – an historical and critical review.* Alex prefaced his paper with the comment that he thought that he would rather be known as a Low Keynote speaker; such modesty! Admitting his early years with the BBC he started by describing early broadcasts over the telephone and went on to discuss studies by the BBC on the acoustics (reverberation times) of sitting rooms in the 1950s and the effects of control room acoustics on the perception of quality in domestic living rooms. He mentioned the fact that although most music control rooms of the period had little or no acoustic treatment, the experienced engineer could compensate for this fact when making adjustments to the broadcast sound.

Early BBC absorbers used in studios used roofing felt which had certain desirable acoustic characteristics; it was also comparatively cheap. Unfortunately the manufacturers changed the specification of the felt making it much less effective and so this material had to be abandoned.

Alex described early stereo control rooms and the effect of IBA regulations on control room acoustics and concluded with a discussion of multi-track and quadraphonic recordings and their effect on control room design. This brief note can only convey a taste of what was a wide ranging and very interesting review of control room design; read all about it in the IOA Proceedings.

The next paper by Professor E J Voelker (IAB, Oberursel), *The V-Criterion for good listening conditions in control rooms* – on the importance of the first 15 ms, discussed the effect of early reflections in control rooms. Professor Voelker highlighted the need for early reflections when recording acoustic instruments and introduced the concept of the direct sound package (DSP) which includes both the direct and the very early reflections (ie < 15 ms). He examined experimentally the psychoacoustic sensitivity of the human ear to early reflections and used the results to introduce the concept of a V criterion which sets the maximum level of early reflections in the first 15 ms. In a provocative way he suggested that diffusers were bad and that reverberation times were more a matter of fashion. The importance of the impulse response of monitor loudspeakers in control rooms was also discussed together with the additional problems posed by stereo and multichannel recording.

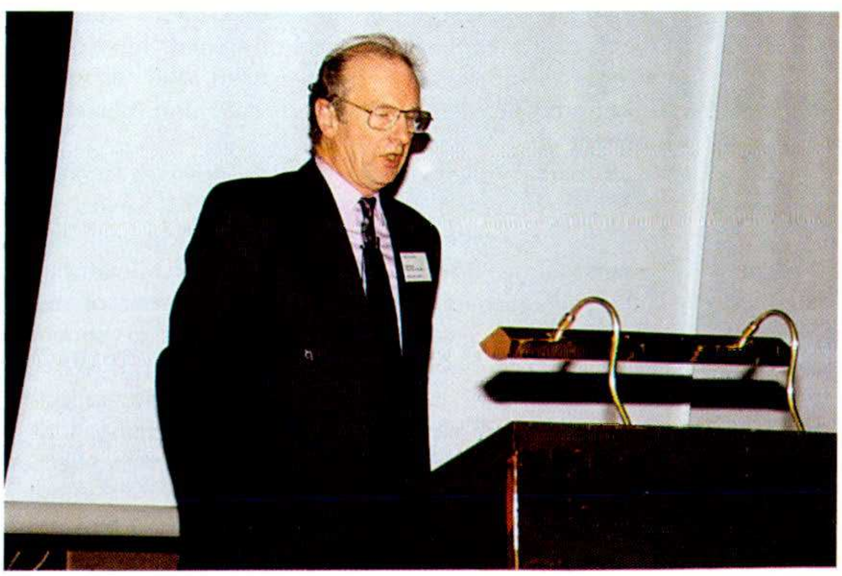
Robert Walker (BBC) in his paper *A controlled-reflection listening room for multichannel sound* talked about early reflection control in multichannel control rooms; that is, how do you achieve the ITU (International Telecommunications Union) recommendations of requiring that levels of reflections earlier than 15 ms should be at least 10 dB below the level of direct sound? With five loudspeakers, controlling 1st and 2nd order reflections becomes unmanageable. However spreading loss in standard studio sizes eliminates the 2nd order reflections and so only 1st order reflections have to be controlled. He described the analysis of early reflections from multichannel speaker layouts and presented a controlled reflection design which met the ITU specifications, although in the trials the treatment of the floor required the use of floor bolsters to kill floor reflections – not a a very practical solution!

After the coffee break Phil Newell (consultant) presented a paper co-authored by K Holland (University of Southampton) *Acoustic considerations for a mobile recording vehicle.* Phil described the design of a mobile control room similar in conception to one built by the author 25 years before. He made the point that the frequency responses of early mobiles were lumpy and not able to be equalised. In fact his experience was that notwithstanding the provision of a flat frequency response in the same room, different engineers used different settings and thus produced different room sound. The implication was that equalisers were a bad idea! The objective was to design a so-called Non-Environment room in the small space of a mobile truck, the major problem being the restriction in the depth of the treatment. Part of the solution was to use the vehicle's thin walls to let out the low frequency sound and so form part of the low frequency treatment. Phil then described a shallow 100 mm deep, wide bandwidth wall treatment and also the difficulty in designing a rear wall trapping system of about 600 mm depth. He discussed the contentious subject of whether or not these structures actually work and presented frequency responses where the major problems were due to control desk reflections. An animated discussion followed on how they would work.

Julian Wright, Chairman of the Organising Committee

Andy Munro (Munro Associates) gave the next paper entitled *A new standard for audio visual mixing theatres.* Andy discussed the ITU specification for DVD mastering and its conflicts with the current practice in the film industry, for example a 60° stereo angle is desirable for DVD mastering whereas 45° is more usual for film work. The rear channel recommendation also conflicts with theatre practice where distributed surround speakers are used rather than two discrete speakers. Andy suggested that one should examine the practice of the theatre industry. He highlighted the fact that in the film industry the mixing is done beyond the critical distance which places stringent requirements on the acoustic design of the room. He also pointed out that this has implications for the design of small rooms for surround sound reproduction where it could be harder to be beyond the critical distance. The implication is that one should have live small rooms and non-directional speakers.

Bob Walker closed the morning session with his paper on *The measurement of time-frequency responses in small rooms.* Bob spoke about the difficulty of measuring a room's time/frequency response and discussed the difference between room and audio equipment measurements. He pointed out that the concept of frequency does not physically exist and any measurement of 'frequency' has a resolution limited by the time taken by the measurement. He then presented examples of measurements of energy/time and frequency/time responses which give different results for the same data due to the fact that energy/time curves are frequency blind. Bob then presented a simple test model and showed how the measurement results of this system depended on the measurement approach.



Alex Burd presenting his Keynote lecture

Chairman: Bob Walker

The afternoon session was launched by Bill Davies who presented a joint paper co-authored by Theodoros Niaounakis (both of Salford University) *The perception of small changes in reverberation time within recording studio control rooms.* This paper described experiments to determine the perceptibility of small changes in reverberation time (RT) when music is reproduced within recording studio control rooms as judged by a number of subjects. The aim of the study was to determine the difference limen for RTs shorter than 0.6 sec which are usually encountered in control rooms. A lively discussion followed the presentation, covering methodology, results and ideas for future work and for covering some of the aspects of the investigation which some members of the audience felt had not been dealt with in the original work.

This was followed by Mark Avis who delivered a paper as joint author with P Darlington and A Makivirta (all of Salford University) *A frequency domain approach for the active control of low frequency room modes.* Mark described an extension of their earlier work on low frequency active absorbers to reduce room mode effects (resonance peaks). Using a secondary source to cancel the mode resonances, the first system simply had the effect of reducing the gain. The second system tended to reduce the early decay time. The decay/time response then tended towards the uncorrected value (two slope decay). In the following discussion a question was asked about the last point; was it a limit cycle or a progressive reduction in the effects of the control system. The answer was the latter.

The last paper before tea was given by James Angus (York University) on *Frequency response effects of specular versus diffuse reflections.* As usual James gave a most perceptive and stimulating presentation, on this occasion about the predictable effects of diffusers, showing that in comparison with a specular reflection the reflected energy remained about the same but spread out in time. In the frequency domain, the low frequency irregularities may well be longer with diffusers but the high frequency irregularities smaller. A lively discussion followed with a number of questions, mostly supporting the hypothesis and the results obtained.

After the tea break Ned Crow (Munro Associates) gave a paper written by his colleague Amber Naqvi, *A study of room geometry and diffusion in sound control rooms.* This was very well presented especially as this was his first experience in conference lecturing and was in front of his previous university tutor (Frank Fahy)! The paper was based on a case study of a critical listening/ music control room based on ideal room dimensions and the methods employed to achieve a well diffused sound field at the listening position. The discussion was wide ranging especially with Phil Newell on the perennial subject of room standardisation.

Indeed it was Phil who rounded off the day's technical sessions with his paper *A monitor loudspeaker system for a mobile recording vehicle.* Phil gave a description of a new loudspeaker design for a control vehicle, illustrating the problems in small vehicles and methods of reaching a compromise between the conflicting requirements. This stimulated an extensive discussion.

Workshop

After the exhibitors' sherry reception and dinner, the first workshop of the conference was held in the conference room with the benefit of the open bar. The demonstration, compered by Mark Bailey (JBL Professional) gave the audience the opportunity to compare surround sound experiences with the use of film and music material. DTS, Sony, Dolby, AC3 and 5.1 were explained, discussed and demonstrated with technical and verbal support from Phillip Newell. During a film clip of a well known blues singer in impressive Dolby digital surround sound, the Irish barman was overheard saying in a loud whisper 'I would rather hear Tammy Wynette'! Thanks are due to Mark Bailey and his team for a fascinating and enjoyable evening.

Technical Sessions: Saturday Morning

Chairman: Mark Bailey

Neil Harris delivered a paper jointly authored by Sheila Flanagan (both of New Transducers Ltd (NXT)) *Stereophonic localisation in rooms, comparing the distributed-mode loudspeaker (DML) with conventional two-way cone-based loudspeakers.* A demonstration of a DML speaker was given at last year's conference which made this paper of special interest.

The authors proposed a hypothesis that diffuse loudspeakers such as the DML lessen the degradation caused by room acoustics on stereophonic localisation when carrying out listening tests compared with cone loudspeakers. They tested this hypothesis by making a series of double blind psychometric listening tests to compare the ability of these two classes of radiator to localise a stereo image in an untreated room. Neil claimed that the results showed that, in contrast to anecdotal evidence, the performance of the conventional loudspeaker system was worse than the DML system even when tested from the former's 'sweet spot'.

Then followed a paper *A new compression drive unit* given by M Dodd (Celestion International) in which the use of finite element analysis and boundary element analysis to design the new compression unit was described.

High performance computing network techniques for vibroacoustic analysis was the title of the paper jointly written by P C Macey (PAFEC Ltd), N K Allsopp and A S Gill (Parallel Applications Centre) and delivered by P Macey. The paper considered vibroacoustic analysis techniques using the finite element (FE) and boundary element (BE) methods and whether parallel computation techniques can be used for FE/BE analysis. The complexities of this subject area were clarified by the authors and the non-experts in the audience now had a better idea of the potential of these analytical methods.

Julian Wright (Celestion International) provided much needed light relief in his presentation *Seeing sound.* His paper discussed the importance of animation in the study of sound and ways of producing these animations and systems which use them. Julian explained that animations usually require a computer and are generated by taking a short sequence of still frames representing different times or phases of the motion. The frames are replayed sequentially, with the last followed by the first, forming a cyclic or 'closed loop' animation. Julian described the various computer graphics files available for this work. Throughout his presentation, Julian projected stunning examples of animated acoustic phenomena on the screen and emphasised that the ability to visualise the behaviour of complex soundfields or vibrations takes engineering comprehension to a new level.

After the coffee break the session restarted with a paper on *Virtual instruments for audio testing.* This was written by Steve Temme (LISTEN, Inc Boston, USA) and John Shelton (AcSoft Ltd) and given by Steve Temme. Steve described the ways in which, with today's personal computer technology and software development tools, the capabilities of dedicated instrumentation can be recreated in a virtual environment. The test system accuracy is limited only by the quality of the data acquisition board or sound card. All of the signal generation, filtering, analysis and data handling can be performed in software such that the PC becomes the test platform. The user interface can even be made to emulate familiar analogue instrumentation using standard Windows controls. In a convincing way the authors made a case that properly implemented 'virtual instruments' can be a cost effective, flexible, portable and powerful solution for collecting accurate audio test data.

Then followed *A multi-channel spatial simulation system for computer music applications,* a paper by Damian Murphy and David Howard (University of York) presented by Damian Murphy. Damien outlined the background to the concept of sound heard in the context of its environment and the sense of location for the acoustic space within which it is heard. Although for many years composers have manipulated and used these properties of sounds in space in their compositions by grouping the performers in certain ways, it is only in recent years that composers and computer musicians have sought control over this particular musical element by electronic means. The processing of audio signals by simulating the acoustics of an enclosed space is a technique widely used to enhance recorded and synthesised sounds in the computer music and recording industries. He explained that the acoustic properties of an enclosed space can be uniquely defined by measuring the Room Impulse Response (RIR) at a specific listener location for an input signal applied at a given sound source location and went on to describe their work on the ongoing implementation of a Multi-channel Spacial Simulation System called WaveVerb which uses a digital waveguide model as an alternative method of generating an RIR, valid for both low and high frequencies. Results were presented that validated the current model for low frequencies and demonstrated how audio can be processed using multi-channel RIRs for presentation to a listener in a multi-speaker surround sound environment.

Colin McCulloch gave a paper co-authored by E de Geest (both of VPR, LMS, Belgium), *The virtual room; deriving acoustic characteristics by modelling.* This paper dealt with modelling rooms and other spaces using geometrical acoustics. Methods based on beam tracing were described with details of various techniques which enhance the quality and accuracy of the results and both coherent and incoherent sound sources and background noise were considered. Colin dealt with the assessment of speech intelligibility using the results of beam tracing models and a process which produces stereo auralizations of the sound at a selected position. He supported his presentation with an impressive series of computer generated colour displays.

Peter Chapman (Bang & Olufsen A/S, Denmark) finished off the working day with a description of his work on *Thermal simulation of loudspeakers*. Peter described a new mathematical model for the representation of the thermal behaviour of moving coil loudspeakers. The system could simulate both the voice coil and magnet temperatures accurately without the loudspeaker under operation, thus allowing flexible, repeated simulations to be made with any signal and without damaging loudspeaker units. He explained that the requirements of the model were that it should be able to receive a standard digital audio signal, filter the input signal with a high order crossover to emulate real filters in the loudspeaker system, introduce an amplifier by means of a voltage gain and clipping function, calculate accurately the temperature of the voice coil and magnet assemblies and run in real time.

The paper detailed the elements of the model, discussed the accuracy and concluded that the model successfully fulfilled the objectives.

Saturday Afternoon and Evening

As usual, Saturday afternoon was available for walking, visiting, shopping, boating or just sleeping. A thoroughly relaxed gathering then re-assembled in the evening for the IOA sherry reception and the Conference Dinner.

The highlights of the after-dinner events were the presentation of an Honorary Fellowship of the IOA to Professor Frank Fahy and an inaugural address by the new President, Ian Campbell. Before the presentation to Frank, Alex Burd read the citation which went on for some time and prompted an off-the-cuff comment from Alex 'Is there nothing this man has not done in the field of acoustics and vibration?'. After the presentation by the President, Frank responded by making a warm and sincere expression of thanks.

In Ian Campbell's address he outlined his hopes for the future of the Institute and acknowledged in a manifestly sincere and heartfelt manner, his thanks and indebtedness to the Institute staff for their support. He thanked particularly the Chief Executive, Roy Bratby for his skill and competence in guiding the Institute through the many changes since his appointment, in particular the move to the new premises in St Peters Street, St Albans. He ended this eulogy by claiming that Roy was a 'little gem'. No doubt due to the generous consumption of wine etc by the delegates during dinner, this comment was greeted with gales of laughter as the comparison of our CE with a variety of lettuce seemed a somewhat inaccurate description to say the least; but we all knew what he meant!

After order was restored, those interested moved into the lecture hall (with open bar) for the final Workshop of the conference, a *Demonstration of an Ambisonic Replay System with height information*. This was introduced by Robin Cross and used digital B–format Soundfield recordings to highlight the strengths and weaknesses of Ambisonic systems. The recorded material used included jazz, blues and folk music and a selection of sound effects from Robin's collection; these included aircraft movements at Heathrow and train movements at a station.

The set-up consisted of four loudspeakers mounted on about seven foot high supports placed at each corner of a square large enough to allow a person, or small group, to listen at its centre. The lower definition of the acoustic space was defined by four other loudspeakers resting on the floor at each corner of the square. To begin with one or two people listened to the demonstration at the centre position but as time went on and patience ran out, there developed the somewhat amusing spectacle of around ten people, most having beer glasses in their hands, struggling to reach centre position to best hear the demonstration. The barman was too confused to make any comment this time! Thanks are due to Robin for an instructive and enjoyable evening.

Technical Sessions: Sunday Morning

Chairman: Robin Cross

Paul Malpas presented the Keynote paper *Current trends and the future of audio in theme parks* on behalf of Linda Gederner (Ove Arup & Partners). The paper, backed by an impressive Powerpoint 7 presentation, took the audience through the history of theme parks. From the first in Denmark; the Deer Haven Park through Coney Island to Tivoli Gardens – the inspiration for Walt Disney, via World Expositions to current theme parks and beyond.

The use of audio from past to present showed a steady increase through the years, tracking the technological advances at an early stage. A taste of things to come was provided by a scary description of a 'safe fear' exhibit whereby compelling immersive audio delivers a range of aural nail biting effects involving escaped aliens determined to do what aliens do best. The point was effectively made that the convergence of audio and video technologies gives the designer of Theme Park experiences a truly boundless palette.

Robin Cross introducing the Ambisonic Workshop

Peter Barnett presented two papers in sequence, *Preliminary findings of research into the effect of amplitude compression on speech intelligibility in the presence of noise and reverberation* and its sister paper *Study of word score test results to determine the robust components of speech subject to noise and reverberation.* Peter described an elegant and rigorous methodology used to construct a controlled experiment to determine the intelligibility of compressed and uncompressed speech material in various acoustic spaces. The material consisted of both PB words and CVC lists. Initial high quality recordings were replayed via the PA system or Omni source, depending on the location. The resulting signal was then binaurally recorded for future scoring by a balanced subject panel using headphones. Early results point to a worthwhile improvement in correctly scored words following the application of amplitude compression to the speech.

The second paper dealt with further analysis of the word score data, with the view to determining which components of speech were robust in the presence of noise and reverberation masking. Conclusions were drawn from the data showing that pre-recorded announcements could be manipulated by rules to further enhance the intelligibility, using beneficial words and word placement.

Robin Cross (BT Acoustics) then gave the first paper after the break, *Internet audio quality*. This interesting and unusual subject explored the variation in sound quality, both speech and music, delivered over the Internet, due to the several compression, bit rate and coding systems used.

The use of VOIP or Voice Over Internet Protocol is being used more often as a cheap alternative to the telephony provided by conventional operators and as a result the coding schemes are being standardised. Robin then carried out an ad hoc listening test on the audience which comprised the playing of six music clips using different recording bit rates and required those taking part to fill in a form sheet giving their opinions on reproduction quality and their estimate of what bit rate was being used.

The next paper was given by M Uchiyama and M Tohyama (both of Kogakuin University, Tokyo), *Sound image control for Internet.* The authors described a 3D sound image projection system (SIPS) for transmission over the Internet. As a reproduction system SIPS requires head related transfer functions (HRTFs) if it is to successfully create 3D acoustic spaces or 3D acoustic collaboration spaces like a virtual mall. When a moving source is reproduced, the system needs the HRTFs of all directions which requires a lot of room for the data base. The paper discussed ways of reducing the data requirements by limiting the number of HRTFs measured and using a form of interpolation.

The privilege of giving the closing presentation of the whole conference fell to Peter Mapp (Peter Mapp Associates), *Improving the gain before feedback margin in Video-Teleconferencing and closed loop Electroacoustic systems.* Peter gave the background to the problem of acoustic feedback (howlround) in public address, sound reinforcement and duplex teleconferencing systems. Peter made an interesting historical point in showing that feedback was not a recent problem; the first reported case dated back to 1890 when 'humming' occurred when the separate transmitter and receiver of the early telephones came into close proximity with each other and created a feedback loop via the air path between them. Over the last 30 years a number of techniques have been developed to help improve the gain before feedback margin and this paper reviewed the progress to date. He then demonstrated that a new class of transducer, the Distributed Mode Loudspeaker (DML) possesses inherently a number of characteristics which potentially make it less prone to feedback and had the potential to provide a passive means of gaining improved feedback margin as a by-product of the complex acoustic characteristics of the device.

Thus ended another successful Reproduced Sound conference; with a somewhat smaller attendance than usual but we are sure with a high concentration of discriminating and appreciative delegates.

As usual grateful thanks were due, and were given by Julian Wright in his closing address, to the presenters, the organisers of the conference and the workshops, to the staff of the IOA office, to the exhibitors and to the staff of the Hydro Hotel who never fail to maintain their high standards of service and catering.

As usual, if readers would like more information on the papers given at the 14th Reproduced Sound conference they can purchase a copy of the IOA Proceedings from Institute headquarters.

John W Tyler FIOA ❖

CITATION

Honorary Fellowship

Professor Francis John Fahy

Frank Fahy graduated with a Bachelors degree in Aeronautical Engineering from Queen Mary College, University of London in 1958 and then worked for five years at the Aircraft Research Association. In 1963 he joined the Institute of Sound and Vibration Research at the University of Southampton as a Research Fellow, gaining his PhD in Statistical Energy Analysis in 1969. As part of the teaching staff at ISVR from 1966, Frank Fahy has been responsible for courses in engineering acoustics, noise and vibration control, building acoustics, advanced measurement techniques, high frequency structural dynamics, and room acoustics and music. He was appointed Reader in Engineering Acoustics in 1985, Professor of Engineering Acoustics in 1989 and Emeritus Professor of Engineering Acoustics in 1997.

His early research was concerned with aircraft interior noise which later developed into vibroacoustic studies of aerospace structures, following which he led a research team investigating vibroacoustic problems in nuclear reactors and industrial pipework. Through such work, Professor Fahy has studied many aspects of the interaction between structures and acoustic waves in contiguous fluids, and has developed and validated statistically based theoretical methods of predicting the response of complex structures to intense, broad band acoustic excitation. He has also developed a fundamental theoretical analysis of propagation of higher-order vibroacoustic modes in liquid filled pipes, together with means for experimental mode detection.

Professor Fahy contributed significantly to the advance of acoustical engineering through his pioneering work on the development of sound intensity techniques. His cross spectral algorithm for sound intensity, first published in 1977, has now been fully implemented in commercial equipment which has revolutionized the experimental determination of acoustic power of sound sources, of transmission loss of partitions, of sound absorption of materials and of source location. This research culminated in the publication in 1989 of his book *Sound Intensity*, which was reprinted in 1995. Professor Fahy was also the Chairman, by invitation, of the ISO Committee which developed the first two Standards for the determination of sound power using intensity measurement.

Among Professor Fahy's many other research interests have been the acoustics of industrial spaces, the measurement of sound transmission through submerged structures, the control of transmission of propeller noise into aircraft cabins, and the design of high performance electro-acoustic horns. His current research concerns the development of new techniques in Statistical Energy Analysis, development of new surface vibration transducers, applications of vibroacoustic reciprocity, violin acoustics and the improvement of sound packages for passenger cars.

His research has gained an international reputation and he has presented fifteen invited plenary lectures to major international conferences. The relevance to practical engineering of Professor Fahy's academic work is demonstrated by the impressive range of organisations, in the UK and overseas, by whom he has been retained as consultant. In addition to his engineering consultancy, he has acted as the acoustical consultant to the architects of some 20 theatres, opera houses and multi-purpose auditoria. He has written, edited or contributed to several text books and has given service to various national and international Standards Committees.

Professor Fahy and the President at Reproduced Sound 14

Professor Fahy is a Fellow of the Institute of Acoustics and over the years has been an active participant in Institute affairs, having been Chairman and Secretary of the Southern Branch and also a member of the Diploma SubCommittee and a Diploma Examiner. From 1975 to 1983 he served as a member of the Institute's Council, the last six of these in the capacity of Honorary Secretary. In 1982 he was awarded the Tyndall Medal for his contributions to teaching and research in acoustics, and in 1990 was awarded the Rayleigh Medal for his fundamental contributions to the understanding of acoustics. He has also been honoured by the French Acoustical Society through the award of their Medaille d'Etranger in 1995.

The Institute of Acoustics is pleased to award Professor Frank Fahy an Honorary Fellowship for his outstanding contributions to the science and application of acoustics.

NOISE IMPACT ASSESSMENT WORKING PARTY

Update Report

The joint Institute of Acoustics/Institute of Environmental Assessment working party which is producing a guide to noise impact assessment has been making steady rather than spectacular progress over the past year. The group is now working on a consolidated document which now includes the important chapter on the assessment process.

Following a recent meeting, it has been confirmed that the document will be in two parts, the first comprising reference material on the process of environmental impact assessment and the issue of noise effects and noise rating. The second part will provide detailed guidance covering the different elements of the noise assessment process.

The expected chapter headings for Part I are;

1. Introduction This will set the scene regarding the background to the Environmental Assessment process, together with the aims and scope of the guidelines.

2. The Environmental Process and Noise This will describe what is involved in the process of Environmental Impact Assessment including the relevant legislation. It will also set out the role of noise and vibration in Environmental Impact Assessment and how the information produced is used in the overall process.

3. The Effects of Noise This will consider the effects of noise on people under three categories:

- subjective effects, eg annoyance,
- direct interference with activities, eg speech interference and sleep disturbance, and
- direct physiological effects.

In addition, the effects of noise on animals and birds will be considered, and it will also comment upon the effects of noise on amenity area such as places of quiet countryside.

4. Noise Units and Concepts This chapter will consider the various noise units in popular use, and how they relate to the effects of noise considered in chapter 3.

The expected chapter headings for Part II are:

5. Summary This will set out the key issues which should be addressed during the assessment and will summarise the main points described in chapters 6 – 9.

6. Scope This will describe the issues which should be considered at the start of the noise assessment process.

7. Baseline Noise This chapter will explore how a description of the baseline noise environment can be obtained. It will examine the necessary area for study, together with the selection of receptors, and also any temporal requirements. The question of whether measurement or prediction should be used, and the conditions under which any survey should be undertaken will be considered. It will also discuss the accuracy of the results.

8. Prediction of Noise Levels This chapter will focus on the issues affecting the prediction of noise. This will include source specific models. Other technical data will be presented in an Appendix.

9. Assessment This is the core of the guidelines and has proven to be the most difficult to write. Our current thoughts on this section will be discussed in a little more detail later. Overall the aim is to take the baseline and future noise levels, together with other relevant information, and draw a conclusion on the severity of the overall noise impact.

10. Mitigation Strategies for mitigation will be discussed under the headings of avoidance, reduction and compensation.

11. Presentation Methods of presentation will be described, including non-technical summaries, the Environmental Statement, Technical Appendices and public consultation.

12. Review and Follow-up Although not a legal requirement, current best practice includes review and follow-up to ensure that the benefits of undertaking an Environmental Impact Assessment are realised in the implementation of a project. This chapter will focus on the review, implementation, monitoring and auditing phases of the EIA process.

The Assessment Chapter

The current philosophy of the working party on this chapter can be summarised as:

- The guidance should result in all the relevant factors which influence the noise impact of the proposals being properly addressed.
- The recognition that at the heart of any noise assessment is the provision of a conclusion regarding the severity or otherwise of the expected change in the acoustic environment arising from the implementation of the proposal.
- The recognition that many gaps exist in our detailed knowledge and understanding of the effects of noise so a detailed structured and precise methodology cannot be set out.
- Except in a few cases, the final determination of the overall severity of the impact is going to have to be subjective.
- The assessment process is being described through a framework which starts, for a particular receptor, with a basic noise change between future and baseline. The process then requires judgements to be made regarding how the conclusion about the noise impact which might be drawn from the size of this change should be altered once the following issues have been addressed.

Averaging time period Is the averaging period of the parameter used for the basic noise change so long that greater impact than is indicated by the basic change might be being masked?

Time of day Is the change occurring at a time of day which might cause a different impact from that indicated by the basic change?

Nature of the noise source Is there a change in the nature (or character) of the noise source which might alter the impact from that indicated by the basic change?

Frequency of occurrence How does the frequency of occurrence affect the impact?

Spectral characteristics Is there a change in spectral characteristics which might affect the impact?

Absolute level How does the basic change relate to guideline levels?

Noise parameter Does the change in the noise parameter used for basic change actually reflect the noise change which will be heard?

The document is likely to propose that the noise impact at a property/location be categorised according to a table such as:

Noise Change (dB)	Category
0	No impact
0.1–2.9	Slight impact
3.0–4.9	Moderate impact
5.0–9.9	Substantial impact
10.0 or more	Severe impact

For example, the basic change might be an increase of +2.7 dBA. This would be categorised as a slight impact. The various factors described above must then be considered to determine whether that conclusion should change in either direction, ie either be placed in a higher or lower category. This process should be followed for all receptors. The justification for altering a category must be clearly described in the reporting process.

When that analysis is completed a summary of all receptors can be drawn up. For example:

Category	Number
No impact	100
Slight adverse impact	30
Moderate adverse impact	20
Substantial adverse impact	10
Severe adverse impact	5

And it is from this set of data that the judgement must be made regarding the severity of the overall noise impact.

There has been some debate regarding whether this final step can be made. On the one hand it is the information the decision maker is seeking, so that the severity of the overall noise impact can be set alongside the other environmental impacts, enabling an overall judgement about the project to be made. If the noise assessor does not provide the answer, the decision maker will do so.

On the other hand, how should the data that has been generated be used to determine whether the overall noise impact is neutral or whether it will have a slight/moderate/severe adverse (or beneficial) effect?

Assuming the working party reaches a consensus on this point, it is hoped that a consultation draft will be available early in the new year.

K M Collins MIOA and S W Turner FIOA

Group News

Industrial Noise Group

Although membership statistics show that a large number of members support this group (in fact it is the third largest group), you may have noticed that this group has been less active in recent times. The decrease in activity, seems to stem from the creation of the Environmental Noise Group which has met many needs for covering noise topics, especially since environmental considerations seem to have had a higher profile in recent years. Consequently a new lively organising committee is required for the industrial group.

Also it seems that there may well be different requirements for members associated with an industrial grouping, under perhaps two main headings:

(1) Occupational noise – H & S aspects, eg noise surveys and assessments, hearing conservation and personal protection, audiology etc.

(2) Noise control engineering – mechanical engineering aspects, eg machinery noise emissions and EC Directives on transmission and attenuation of noise, building services and automotive noise.

Should we combine all such interests under one grouping? Would smaller more specialist groups be more successful?

There seem to be obvious dangers in splitting into smaller groupings, particularly in relation to having volunteer members to organise group activities. Such activities, based on the theme of the group relates to disseminating latest information, acting as a forum for comment and debate, originating and organising group meetings and representing the views of the Institute.

Your views on the Industrial Noise Group will be much appreciated. We need to generate some new activity for the group to respond to the challenge of participating in the 25th Anniversary Conference of the Institute next spring (as announced in the previous issue of the Bulletin). In particular volunteers to join a new organising committee will be particularly welcome; please leave your name with HQ at St Albans.

It is proposed to have a meeting of all interested parties early in 1999 when a programme of activities will be planned for this important group of members' interests.

David Bull FIOA

Measurement & Instrumentation Group

The M&I Group of the IOA was set up over two years ago to address many of the issues in the industry regarding sound and vibration measurement instrumentation, and to promote best practice in a wide range of applications.

Guided by Richard Tyler, the Group has organised several very successful meetings, covering subjects as diverse as the proposed new sound level meter standards, the Noise Act, and sound intensity techniques.

Many of the ideas for these meetings have come from the Group committee itself, consisting for the most part of representatives of instrumentation manufacturers. Delegates also put forward ideas for future meetings, as well as giving valuable feedback on how useful the sessions have been.

Although the committee members are well placed to observe some of the common deeds and misdeeds in the measurement field, we would welcome input from the membership on subject matter for future meetings or conference sessions. One session that has come directly from delegate feedback is the one-day meeting in February on DAT recording procedures (see elsewhere in this issue for the Meeting Notice).

Other ideas we are kicking about include human-body vibration measurements, indices for environmental noise measurement, sound power determination.

However, we cannot continue to make a successful meeting programme without your input, so we welcome any ideas you may have on suitable subject matter for the future.

Please contact John Shelton at AcSoft on 01296 662852 with your suggestions.

Branch News

Eastern Branch

The sixth meeting of 1998 was held at the Cambridge offices of South Cambridgeshire DC on 16 September. Over forty 40 people attended a presentation given by Ken Dibble entitled Entertainment Noise Control in Public Houses, Nightclubs, and Live Performance Venues. Ken structured his talk around three main aspects:

(1) typical sound/noise exposure levels and source spectra;

(2) measurement parameters and criteria, and

(3) environmental impact prediction and control.

Early in his talk he illustrated how recent large increases in the power of audio amplifiers has mainly gone into generating levels at the lower acoustic frequencies. For example, 250 kW devices with good quality loudspeakers now produce up to 126 dB in the 63 Hz $^1/_3$ octave band; this is apparently essential to create the well-known bass beat which seems acceptable, even desirable, to many people! The basic prescription for discos etc was the beat, plus a general level of at least 100 dBA, otherwise the event was not acceptable!

He discussed the role of electronic sound limiters, but felt they were only a 'back stop' and could cause many difficulties in running events, so only sophisticated ones were recommended. Because of the nature of the noise, L_{eq} measurements usually underestimate the problem and generally L_{10} tended to agree more closely with the subjective impression.

The difficulties of preventing the transmission of such intense low frequency sound were also discussed. He advocated the radical stiffening of building structures to enhance low frequency attenuation above simple mass law predictions. An example was mentioned of a three-ply sandwich construction using dry linings, plus a complete damp proof membrane to mechanically damp out structural resonances in the usual problem region of 63 Hz.

Thirty minute environmental noise sampling was favoured in terms of L_{max}, L_{min}, L_{eq}, L_{10} and L_{90}. Simple overall measurements were usually not sufficient to show up the nature of the problem; frequency analysis at least in terms of $^1/_3$ octaves was recommended.

A lively question and discussion session followed the talk in which inaudibility as a criterion was debated. Ken made the point that he did not favour such a criterion, and suggested a definition such as the source L_{10} not exceeding the background L_{90}. The final discussions centred on other sources of 'people' noise when reducing the tempo and volume was advocated, with security staff being present at the doors and in the car parks.

The seventh meeting of the branch for 1998 was held at the Colchester Institute on 13 October. Some 25 people attended a presentation on the vibration isolation of buildings given by Allister Clarke of Tiflex Ltd.

Typical purpose-made cork/rubber slab type products were described and displayed. These have a long history of reliable and maintenance-free use in a whole range of applications in heavy industry as well as under buildings. Test facilities were described to measure the stiffness and damping properties of the isolation material. It was emphasised that Tiflex design bearings (either continuous slab or individual mountings) to the required acoustic/vibration specifications and to the requirements of the structural engineer, particularly in relation to building deflection when the bearings are loaded.

A lively question session included extensive discussions on the dynamic transmissibility characteristics of isolated buildings. This included the role of the damping properties of the materials, and the advantages and disadvantages in the dynamic response of isolated buildings.

David Bull FIOA

North-west Branch

On Wednesday 21 October, Peter Philipson of the Department of Acoustics and Audio Engineering at Salford University gave an interesting and well-researched talk at the University on spatial audio. Starting with a review of Blumlein's historic work on intensity stereo, the presentation progressed through quadrophonic, binaural and on to ambisonic formats. Developments in surround systems for cinema were covered with a discussion of 5.1 type systems; the suitability of these systems for replay of hi-fi music signals provoked a lively discussion.

The evening ended with demonstrations of a binaural recording system based around a KEMAR test head and a four loudspeaker ambisonic setup using a soundfield microphone. There was a good balance of technical content and practical demonstration, and the event was a useful introduction to the field, especially for those unable to attend Reproduced Sound 14 'Surrounded by Sound'.

Mark Avis AMIOA

Institute Branch Meetings

One very important purpose of Branch meetings is to provide interesting and informative presentations so that members, associates and students can keep technically up to date. Such meetings also give an ideal opportunity for getting to know, and networking with, local colleagues.

Institute members on branch committees give of their own time so that all those in the Branch may benefit. If you are within reach of a centre and do not attend meetings, you may not be deriving the fullest benefit of Institute membership. Forthcoming events are shown in the Diary in the blue pages. I strongly urge you to make every effort to attend and take advantage of what branch meetings can offer you.

David Bull FIOA
Vice President Groups and Branches ❖

Hansard

3 November 1998
Road Noise
Mr Letwin: To ask the Secretary of State for the Environment, Transport and the Regions what studies into the potential for reducing noise from roads in residential areas he undertook during the preparation of the roads White Paper.
Ms Glenda Jackson: *A New Deal for Trunk Roads in England* confirmed that we will continue to develop noise reducing surfaces. Account was taken of recent developments in road surfacing technology but no new studies were undertaken.

4 November 1998
Aircraft Noise (Heathrow)
Mr Colman: To ask the Secretary of State for the Environment, Transport and the Regions, pursuant to his answer of 3 July 1997, Official Report, column 256, on aircraft noise, what steps have been taken to monitor aircraft noise levels on incoming flights to Heathrow Airport; and what progress has been made in reviewing noise limits on those flights.
Ms Glenda Jackson: The Aircraft Noise Monitoring Advisory Committee (ANMAC), which advises the DETR on aircraft noise and monitoring at Heathrow, Gatwick and Stansted, is investigating the feasibility of setting noise limits for arriving aircraft; and of other possible means of ameliorating arrivals noise. ANMAC has established a working group, which is presently conducting a study of the causes of variability of noise levels.
A study of the effect of changed air traffic control procedures for Heathrow arrivals from the east in the early morning is in its final stages.
Daytime noise contours for summer 1996 at Heathrow have recently been published.

9 November 1998
M20
Mr Green: To ask the Secretary of State for the Environment, Transport and the Regions how many representations he has received about noise from the M20 through Ashford; and if he will make a statement.
Ms Glenda Jackson: (holding answer 5 November 1998) Since the Roads Review was announced in July 1998 we have received 65 representations and one petition containing over 50 signatures about traffic noise from the M20 within the District of Ashford (between Charing and Brabourne Lees).
We recognise that traffic noise is a major source of concern to people. This is why in *A New Deal for Trunk Road in England* we announced that low noise surfaces would be used when roads are built or, where appropriate in those areas where noise is a particular concern, when they undergo major maintenance. I understand the Highways Agency plan to carry out technical surveys between Junctions 9 and 11 on the M20 later this year, which should determine the condition of the road surface and establish whether it should be included in the Agency's programme of future maintenance work.
We also announced our intention, where re-surfacing cannot be justified on normal maintenance grounds, to establish a revised noise criteria and ring-fenced annual budget to enable the Highways Agency, over a reasonable period of time, to deal with some of the most serious and pressing cases.

Civil Subsonic Jet Aircraft
Mr Todd: To ask the Secretary of State for the Environment, Transport and the Regions if he will make a statement on his policy towards the proposed EU directive on civil subsonic jet aircraft.
Ms Glenda Jackson: To gain the benefits of early implementation the measure has been transformed into a Regulation which the UK supported when it was agreed at the Transport Council on 1 October as reported in the Parliamentary Answer given by my right hon Friend the Minister of Transport on 20 October 1998, Official Report, columns 1099-1101. It is essential to maintain progress in reducing aircraft noise at source. This measure will help to ensure that the environmental gains achieved by the phasing out of older, noisy Chapter 2 aircraft by 2002 are not lost.

10 November 1998
Aircraft Noise
Dr Cable: To ask the Secretary of State for the Environment, Transport and the Regions what action he is taking to ensure that no area is disproportionately affected by overflying aircraft landing at Heathrow.
Ms Glenda Jackson: Landing aircraft need to make their final approach aligned with the runway, which limits the scope for varying their final approach track. The Aircraft Noise Monitoring Advisory Committee (ANMAC), which advises the DETR on aircraft noise at Heathrow, Gatwick and Stansted, is currently investigating the feasibility of setting noise limits for arriving aircraft and other possible means of ameliorating arrivals noise. ANMAC has also established a working group which is looking at the causes of variability in the noise levels of landing aircraft.
In the second stage consultation paper on night restrictions at Heathrow, Gatwick and Stansted, to be issued shortly, we will be inviting views on various options for changes to the preferential use of Heathrow runways at night.
Dr Cable: To ask the Secretary of State for the Environment, Transport and the Regions if he will establish an independent monitoring body to measure aircraft noise at Heathrow.
Ms Glenda Jackson: We have no plans to do so. Aircraft noise is already measured satisfactorily by Heathrow Airport Limited to check compliance with the take-off noise limits set by my right hon Friend, the Secretary of State, and to detect infringements. The integrated aircraft noise and track-keeping (NTK) system installed by BAA plc in 1993 is used for this purpose. Data from the system are

also used by the Department of Operational Research and Analysis of the CAA/NATS in producing the annual historical aircraft noise exposure contours published by the DETR, and for study purposes.

Aircraft noise around Heathrow is monitored by the Heathrow Airport Consultative Committee (HACC) and has been the subject of technical studies by DORA on behalf of the Aircraft Noise Monitoring Advisory Committee (ANMAC), which advises my Department. Both include representatives of local government, local interest groups and the aviation industry.

Extracts provided by Rupert Taylor FIOA

BSI News

New and Revised British Standards

BS 7854: Mechanical vibration – Evaluation of machine vibration by measurements on non-rotating parts.

BS 7854-3:1998 Industrial machines with nominal power above 15 kW and nominal speeds between 120 r/min and 15000 r/min when measured in situ. The vibration criteria in this Part of BS 7854 apply to machine sets with, for example, steam turbine or electrical drives, having power above 15 kW and speeds between 120 r/min and 15000 r/min. No current standard is superseded.

BS EN Publications

BS EN ISO 140: Acoustics – Measurement of sound insulation in buildings and of building elements.

BS EN ISO 140-4:1998 Field measurements of airborne sound insulation between rooms (ISO 140-4:1998). Supersedes BS 2750-4:1980.

BS EN ISO 140-5:1998 Field measurements of airborne sound insulation of façade elements and façades (ISO 140-5:1998). Supersedes BS 2750-5:1980.

BS EN ISO 140-6: 1998 Laboratory measurements of impact sound insulation of floors (ISO 140-6:1998). Supersedes BS 2750-6:1980.

BS EN 60318: Electroacoustics – Simulators of human head and ear.

BS EN 60318-1:1998 Ear simulator for the calibration of supra-aural earphones. Relates to ear simulators covering the frequency band 20 Hz to 10000 Hz. Supersedes BS 4669:1971 which will be withdrawn on 1 May 2001.

British Standard Implementations

BS ISO TR 389: Acoustics – Reference zero for the calibration of audiometric equipment.

BS ISO TR 389-5:1998 Reference equivalent threshold sound pressure levels for pure tones in the frequency range 8 kHz to 16 kHz. No current standard is superseded.

BS ISO 11342:1998 Mechanical vibration – Methods and criteria for the mechanical balancing of flexible rotors. Supersedes BS 7508:1995.

Amendments to British Standards

BS 7422:1991 Specification for filters for the measurement of audible sound in the presence of ultrasound [IEC 61012:1990] AMENDMENT No 1 AMD 10092. NOTE: This amendment implements EN 61012:1998 as a British Standard and renumbers BS 7422:1991 as BS EN 61012:1998.

British Standards Withdrawn

BS 2750: Measurement of sound insulation in buildings and of building elements.

BS 2750-4:1980 Field measurements of airborne sound insulations between rooms. Superseded by BS EN ISO 140-4:1998.

BS 2750-5:1980 Laboratory measurements of airborne sound insulation of façade elements and façades. Superseded by BS EN ISO 140-5:1998.

BS 2750-6:1980 Laboratory measurements of impact sound insulation of floors. Superseded by BS EN ISO 140-6:1998.

BS 5721:1979 Specification for frequency weighting for the measurement of aircraft noise (D-weighting). Identical to IEC 537:1976 withdrawn in 1992.

BS 7189:1989 Specification for sound calibrators. Superseded by BS EN 60942:1998.

BS 7508:1995 Mechanical vibration – Methods and criteria for the mechanical balancing of flexible rotors. Superseded by BS ISO 11342: 1998.

International New Work Started

(No number shown) Mechanical vibration and shock – Guidelines for the design and implementation of base

isolation systems to attenuate ground vibration.
ISO 10816-2 Mechanical vibration – Evaluation of machine vibration by measurements on non-rotating parts – Part 2: Land-based steam turbine generator sets in excess of 50 MW. Will revise ISO 10816-2.
ISO 7919-2 Mechanical vibration – Evaluation of machine vibration by measurements on rotating shafts – Part 2: Landbased steam turbine generator sets in excess of 50 MW. Will revise ISO 7919-2.
ISO 8041 Human response to vibration – Measuring instrumentation. Will revise ISO 8041.
IEC 60704-2 Test code for the determination of airborne acoustical noise emitted by household and similar electrical appliances – Part 2: Particular requirements:
IEC 60704-2-1: Vacuum cleaners
IEC 60704-2-3: Dishwashers
IEC 60704-2-4: Washing machines and spin dryers.
Will revise the above Parts of IEC 60704 (possible revisions of the corresponding Parts of BS EN 60704).
IEC 60942 Electroacoustics – Sound calibrators will revise IEC 60942.

Drafts for Public Comment

98/203787 DC Revision of IEC 60704-2-3 Household and similar electrical appliances – Test code for the determination of airborne acoustical noise – Part 2-3: Particular requirement for dishwashers (IEC 59A/76/CD).
98/203788 DC Revision of IEC 60704-2-4 Household and similar electrical appliances – Test code for the determination of airborne acoustical noise – Part 2-4: Particular requirements for washing machines and spin dryers (IEC 59D/144/CD).
98/203789 DC Revision of IEC 60704-2-1 Household and similar electrical appliances – Test code for the determination of airborne acoustical noise – Part 2-1: Particular requirements for vacuum cleaners (IEC 59F/90/CD).
98/232369 DC Draft amendment to BS 3539:1986 Sound level meters for the measurement of noise emitted by motor vehicles.
98/232370 DC Draft amendment to BS 7580-2:1997 Specification for the verification of sound level meters – Part 2: Shortened procedure for type 2 sound level meters.
98/232371 DC Draft amendment to BS 7580-1:1997 Specification for the verification of sound level meters – Part 1: Comprehensive procedure.
98/563248 DC prEN ISO 2922 Acoustics – Measurement of noise emitted by vessels on inland waterways and harbours (Draft revision of ISO 2922:1975) (Possible new British Standard – BS EN ISO 2922) (ISO/DIS 2922).

CENELEC Publications

EN 60318-1: August 1998 (IEC 60318-1:1998) Electroacoustics – Simulators of human head and ear – Part 1: Ear simulator for the calibration of supra-aural earphones (IEC 60318-1:1998)

IEC Publications

IEC 60318: Electroacoustics – Simulators of human head and ear.
IEC 60318-2: August 1998 An interim acoustic coupler for the calibration of audiometric earphones in the extended high-frequency range.
IEC 60318-3: August 1998 Acoustic coupler for the calibration of supra-aural earphones used in audiometry.

ISO Standards

ISO 140: Acoustics – Measurement of sound insulation in buildings and of building elements.
ISO 140-4:1998 (Edition 2) Field measurements of airborne sound insulation between rooms. NOTE: Implemented as BS EN ISO 140-4:1998.
ISO 140-5:1998 (Edition 2) Field measurements of airborne sound insulation of façade elements and façades. NOTE: Implemented as BS EN ISO 140-5:1998.
ISO 140-6:1998 Laboratory measurements of impact sound insulation of floors. NOTE: Implemented as BS EN ISO 140-6:1998.
ISO 140-7:1998 (Edition 2) Field measurements of impact sound insulation of floors. Will be implemented as BS EN ISO 140-7.
ISO 12713:1998 Non-destructive testing – Acoustic emission inspection – Primary calibration of transducers. Will not be implemented as a British Standard Equivalent.

CEN Work Under Preparation

ISO 13753:1998 Mechanical vibration and shock – Hand-arm vibration – Method for measuring the vibration transmissibility of resilient materials when loaded by the hand-arm system. Will be implemented as BS EN ISO 13753.
ISO/TR 11688-2:1998 Acoustics – Recommended practice for the design of low-noise machinery and equipment – Part 2: Introduction to the physics of low noise design. Will be implemented as BS ISO TR 11688-2:1998.

DISC PD 2000-1:1998

A Definition of Year 2000 Conformity Requirements

Introduction

This document addresses what is commonly known as Year 2000 conformity (also sometimes known as century or millennium compliance). It provides a definition of this expression and requirements that must be satisfied in equipment and products which use dates and times.

The Definition

Year 2000 conformity shall mean that neither performance nor functionality is affected by dates prior to, during and after the year 2000. In particular: Rule 1: No value for current date will cause any interruption in operation. Rule 2: Date-based functionality must behave consistently for dates prior to, during and after year 2000. Rule 3: In all interfaces and data storage, the century in any date must be specified either explicitly or by unambiguous algorithms or inferencing rules. Rule 4: Year 2000 must be recognized as a leap year.

Amplification of the Definition and Rules

1 General Explanation

1.1 Problems can arise from some means of representing dates in computer equipment and products and from date-logic embedded in purchased goods or services, as the year 2000 approaches and during and after that year. As a result, equipment or products, including embedded control logic, may fail completely, malfunction or cause data to be corrupted.

1.2 To avoid such problems, organizations must check, and modify if necessary, internally produced equipment and products and similarly check externally supplied equipment and products with their suppliers. The purpose of this document is to allow such checks to be made on a basis of common understanding.

1.3 Where checks are made with external suppliers, care should be taken to distinguish between claims of conformity and the ability to demonstrate conformity.

2 Amplification of the definition

2.1 PD2000-1 (all editions) is solely concerned with the performance and functionality of a single version, release or system. It does not address differences in performance or functionality between different versions, releases or systems.

2.2 Variations in performance immeasurably small in the context of use do not make a version, release or system non-conformant.

3 Amplification of the Rules

3.1 Rule 1

3.1.1 This rule is sometimes known as general integrity.

3.1.2 If this requirement is satisfied, roll-over between all significant time demarcations (eg days, months, years, centuries) will be performed correctly.

3.1.3 Current date means today's date as known to the equipment or product, ie the actual date of operation [Note – this refers to normal operation and does not prevent testing.]

3.2 Rule 2

3.2.1 This rule is sometimes known as date integrity.

3.2.2 This rule means that all equipment and products must calculate, manipulate and represent dates correctly for the purposes for which they were intended.

3.2.3 The meaning of functionality includes both processes and the results of those processes.

3.2.4 If desired, a reference point for date values and calculations may be added by organizations; eg as defined by the Gregorian calendar.

3.2.5 No equipment or product shall use particular date values for special meanings; eg '99' to signify 'no end value' or 'end of file' or '00' to mean 'not applicable' or 'beginning of file' unless the values in question lie outside its possible date range.

3.3 Rule 3

3.3.1 This rule is sometimes known as explicit/implicit century.

3.3.2 It covers two general approaches:

(a) explicit representation of the year in dates: eg by using four digits or by including a century indicator. In this case, a reference may be inserted (eg 4-digit years as allowed by ISO 8601: 1988) and it may be necessary to allow for exceptions where domain-specific standards (eg standards relating to Electronic Data Interchange, Automatic Teller Machines or Bankers Automated Clearing Services) should have precedence.

(b) the use of inferencing rules: eg two-digit years with a value greater than 50 imply 19xx, those with a value equal to or less than 50 imply 20xx. Rules for century inferencing as a whole must apply to all contexts in which the date is used, although different inferencing rules may apply to different date sets. Where any date element is represented without a century, the correct century shall be unambiguous for all manipulations involving that element.

3.4 Rule 4

3.4.1 A leap year is defined in ISO 8601:1988 (amended in 1991) as follows: 'year, leap: In the Gregorian calendar, a year which has 366 days. A leap year is a year whose number is divisible by four an integral number of times, except that if it is a centennial year it shall be divisible by four hundred an integral number of times.'

3.4.2 Thus, for example, 2000 is a leap year but 1900 is not.

4 General Note

4.1 For Rules 1 and 2 in particular, it is recommended that the allowable ranges for values of current date and dates to be manipulated be documented, recognizing that all systems have some limitation on the valid date ranges. The ranges may relate to one or more of the feasible life-spans of equipment or products or the span of dates required to be represented by the organization's business processes.

4.2 Tests for specifically critical dates may also be added (eg for leap years, end of year, etc). Organizations may

wish to append additional material in support of local requirements.
4.3 Where the term 'century' is used, clear distinction should be made between the 'value' denoting the century (eg 20th) and its representation in dates (eg 19xx); similarly, 21st and 20xx
This information was announced in the September and October 1998 issues of BSI Update.

Book Reviews

Stereophonic Sound Recording: Theory and Practice
Christian Hugonnet and Pierre Walder
John Wiley & Sons 1998
ISBN 0-471-97487-0
hard cover 291 pp £29.95

This is a translation from the French text first published in 1995, aimed at sound recording engineers (not to be confused with sound mixing engineers) and those intending to enter the profession. It claims to guide the reader in acquiring the knowledge required for successful sound recording and indeed gives good coverage of the diverse fields involved. These range from analysing the situation, meeting and discussing with musicians, producers and technicians and putting them at their ease, studying the recording location, to selecting, arranging and testing the recording equipment.

A historical overview gives the development of sound recording. A chapter on basic acoustics covers all relevant areas concentrating on the behaviour of sound in rooms. The spatial perception of sound is given a complete chapter and the two most important factors for stereophonic listening, time delay and intensity difference, are described in detail. The construction of microphones is explained and the principals that govern performance, especially directivity, are discussed. Many stereophonic microphone systems are described and the way the directivity patterns combine to provide the useful acceptance angle, the critical angle for recording, are illustrated in detail with very clear diagrams. The authors then explain how physical acoustic corrections and additional microphones can be used to enhance a recording. The methodology of recording is discussed including the use of phase meters for testing systems.

The book is not prescriptive, it does not specify microphone systems, rather it provides the reader with the basic knowledge of how to select and use equipment to achieve the objective aesthetic criteria in creating a sound image, including spectral balance, dynamic range, localisation in depth and perspective, lateral localisation, transparency and intelligibility. How these criteria are assessed subjectively is only touched upon, not taught. Presumably this is a skill that must be learned through long experience.

The text is not too technical and should be understood by anyone with an elementary knowledge of acoustics. There is a good index, a useful bibliography, a list of test disks and even a list of exhibitions of recording equipment. The style of writing, the layout and diagrams are very clear making the book easy and even enjoyable to read. It is sturdily bound in hard covers. Whilst aimed primarily at sound recording engineers, this book would also be useful to anyone wanting an insight into what is involved in stereophonic sound recording.

Graham Rock MIOA

Progress in Speech Synthesis
JPH Van Santen and others
Springer, 1997

The most important goal of this book is to provide an overview of Text-to-Speech (TTS) research areas by asking 'key players' to contribute articles in their areas. In this, it succeeds. It is difficult to provide an overall opinion of the book because of its breadth of scope, but it will serve as a useful reference book to anyone interested in what one might call 'Applied Speech Synthesis.' It is not, nor is it intended to be, a speech synthesis primer. This book is an enlarged and edited version of some of the papers presented at the 1994 ESCA/IEEE/AAAI Workshop on Text-to-Speech Synthesis. As it took three years to publish the book and another year for it to be reviewed, this describes the state of the art about five years ago. The organisation of the book reflects the current emphasis on improving the suprasegmental aspects of speech synthesis (intonation, timing, stress), in contrast to earlier work, which was largely focused on getting segmental information (vowel and consonant quality) correct and on working out the transitions between segments.

The entire text, complete with demonstrations, is on the CD which accompanies the book. While reading from a screen might not be everyone's idea of fun, doing so has the advantage of being able to click on any reference to get the full entry, to switch back and forth between articles, and to listen to examples in the text. An Acrobat reader is included which makes all this available to everyone with a big enough computer (it seems to need about 1Mb on the hard disk: other files are pulled in from the CD as needed). The system worked very well on a Powermac 6100/60. The CD also allows the reader to estimate the success of the various synthesis schemes. Listening to the demos gives very convincing evidence that the focus on suprasegmental aspects of the synthesis is not misplaced: timing and intonation clearly present problems in most cases.

It is understandable that the authors display many idiosyncrasies in their use of English: many of them are native speakers of unrelated languages. The editing is too permissive, though perhaps this is a way of introducing an international flavour. Sentences such as the mind-bending 'Both stylization algorithms have some characteristics in common' crop up regularly.

Section I: Signal Processing and Source Modelling, is composed of articles about techniques for voice synthesis and how to make a synthetic voice sound more natural.

Section II: Linguistic Analysis. This somewhat oddly-assorted section deals with (a) interpretation of symbols found in text and (b) the sort of linguistic framework which is best for TTS applications. The second set of papers fall more solidly into what is normally thought of as linguistics.

Section III: focuses on the relationship between visual and auditory information in speech processing and looks at the possibility of using both types of information in speech synthesis.

Section IV: Concatenative Synthesis and Automated Segmentation. This section discusses what sorts of units should be used in concatenative synthesis and how they should be combined for best naturalness and intelligibility.

Section V: Prosodic Analysis of Natural Speech, has introductions by Collier (Chapter 27), who is optimistic about the contribution of recent research in intonation to TTS, and by Gronum (Chapter 28), who emphasises that it is up to linguists to provide models of the links between prosody and pragmatics. Articles take up Gronum's challenge to deal with pragmatics and deal as well with other factors which can affect intonation, especially grammar and emotional state. Other suprasegmental aspects of speech such as segment durations and pauses are also considered.

Section VI: Synthesis of Prosody, is introduced twice, once by Nooteboom (Chapter 34), who warns that getting the prosody right involves understanding emotional, attitudinal, pragmatic, and grammatical properties of the message, and once by Bailly and Auberge (Chapter 35), who agree that the way that the cognitive representation of an utterance is encoded in the speech signal is still an open question. Articles deal with co-referentiality, intonational domains, and speech style. Chapter 37 describes a complete system which executes prosody based on a symbolic input.

Section VII: Evaluation and Perception. Benoit (40) emphasises the need for tests to quantify the performance of a TTS system, but doubts that such can be constructed so as to be applied across languages and/or applications. Pols and Jekosch (41) report the results of a questionnaire on synthesis development and assessment which was distributed in 1993. Figures from 16 sites suggest that there are too many tests already and that results are of variable value depending on the use to which the system is to be put. Evaluating synthetic speech is difficult because human speech perception is extremely robust and flexible: identifying where problems lie is not straight-forward.

Section VIII: Systems and Applications. Hess (Chapter 44) offers a brief history of TTS applications as introduction and the two following chapters are descriptions of systems already in operation.

Linda Shockey

with thanks to Simon Arnfield for technical advice.

Recording Spaces
Philip Newell
Focal Press 1998
ISBN 0 240 51507 2
Price £35

Recording Spaces aims to describe the variety of studios, and in many cases other spaces, which have been used for recording purposes. The book is written for practitioners in the music industry – perhaps studio owners and operators primarily. However, it also has much to offer to other people involved in the industry – studio designers and other consultants, performers, acoustic material suppliers etc. The author has impeccable credentials for this task having been the designer of, or the engineer in, many of the famous and successful studios in England and elsewhere. His lists of the groups whose output he has recorded are manifold; I admit that I have to assume that the strange names listed are indeed all musical groups!

It is a recurrent theme of the book that the performance of musicians is affected, for better or worse, by the environment in which they work and it is the responsibility of the studio designers and operators to create the right environment to achieve the best recordings. Many different room types are described ranging from neutral (acoustic) rooms through live and stone faced rooms to vocal booths and orchestral studios although it is acknowledged that few studios can accommodate or afford more than a limited selection of these. It came as a surprise to me to find that the use of many of these types has been originally 'discovered' accidentally.

The principles of sound insulation and sound absorption are clearly differentiated in the early part of the book. Various types of construction for both uses are simply described in terms that can be understood by technical or non-technical readers alike. It has to be said that the examples of the details of studio containment shell construction and acoustic treatment could blur this distinction by demonstrating that both insulation and absorption can be provided by the individual elements used. In fact there are many novel ideas in the selection and use of materials which serve to minimise the depth of the finishes and thus to optimise the space available for studio use. However, it will be a source of great disappointment to other designers that little or no quantitative data is provided to illustrate these achievements.

A distinction is drawn between the requirements of broadcasting studios, which generally serve for one-off performances, and music recording studios whose performances must stand the test of time. I was reassured by this thought which confirmed that I may not have wasted all my efforts over the last forty years.

The line drawings, graphs and other illustrative material are clear and legible and illustrate the text well but I felt that the photographs of studios gave the impression that many of the studios are built in old dungeons. However, I found very few mistakes or misprints, the only major one being the suggestion that using conventional sound absorbing materials inside a conventionally sound insulated shell within a space of $3m^2$ (rather than a 3 metre cube) would leave a space the size of a telephone box rather than the size of a pencil box which would actually result.

The book is priced at £35, which I feel is expensive for general reading and given the paucity of factual information for the technical reader.

A N Burd FIOA

New Products

NOISE & VIBRATION ENGINEERING LTD

VIBRAS-7000 Vibration Measurement System

VIBRAS are vibration measurement systems manufactured by Walesch Electronic GmbH of Switzerland. These systems operate on a principle using microcomputers.

The Vibras-7000 is the latest compact and modular system. The system consists of the evaluation instrument and the sensors, which can be either analogue or digital. Up to two analogue, and with a digital extension up to 12 digital, sensors may be connected to a single evaluation instrument. The system therefore enables simultaneous measurement of vibration at up to 12 independent locations, each in three orthogonal directions, ie 36 channels.

Due to the digital transmission of data it is possible to have the sensors located at considerable distances from the evaluation instrument, (eg a single digital sensor can be located at a distance of up to 1500 m using a standard cable). However, if for practical reasons the cables cannot be accommodated, a wireless version of the system that works on the radio signal principle is also available. Measurements can then be taken at locations situated up to approximately 10 km away from the evaluation instrument.

Although the Vibras-7000 is virtually completely programmable parametrically, the operation remains extremely simple. For general applications the default parameters of the instrument may be used and acquisition commenced as soon as the sensors required are defined. Long strings of parameter entry are therefore unnecessary.

The Vibras-7000 is said to be ideal for the registration of short duration events as well as for unattended monitoring of vibration over extended periods of time. During monitoring in the ramming or traffic mode the current vibration levels are constantly displayed on LCD. Furthermore, the last 60 events stored in the memory can be reviewed at any time. The clear presentation of measurement data in tabular and/or graphical formats on the Vibras printer allows initial analysis on the spot, so that any necessary measures can be implemented immediately.

The Vibras-7000 provides the following:

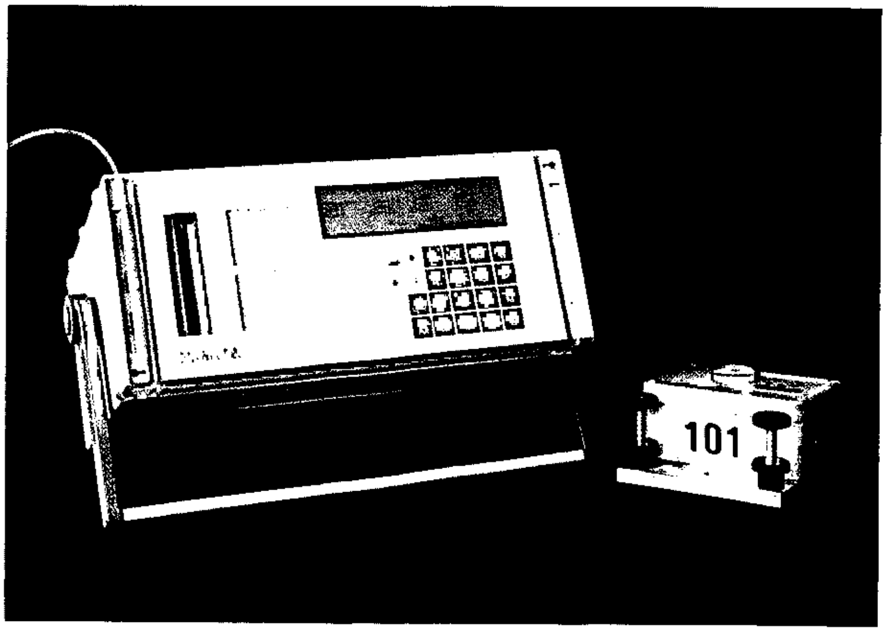
- Vibrograms of the components along x, y and z axes in terms of the peak particle velocity in mm/s (measurement range 0.01 to 200 mm/s);
- Vector curve of the maximum sum of the peak particle velocity of x, y and z components:;
- Envelope curve (time-history) of the true peak values of the vector;
- Report of the true peak values of the vector equal to or exceeding a defined maximum level;
- Distribution (%) curve of the true peak values of the vector;
- Adjustable frequency range for the sensors (1 – 80 Hz, 1 – 315 Hz or 4 – 315 Hz);
- Envelope curve of the rms value of each component and also of the vector sum of rms value of the three components for a sustained event;
- KB-Values according to the DIN 4150.

To facilitate supplementary or after-event evaluations, the recorded data can be stored on the Vibras hard disk memory. The stored data can then be transferred to a PC, which can be done either directly via an RS232 connection or indirectly via a modem and standard telephone line. For this purpose, an easy-to-use Window based software for data transmission/remote control is available, ie VibModem, which runs under 3.1x, W95/98 or NT. Remote control is functionally equivalent to operating directly with the evaluation instrument. To aid in evaluation and documentation of the Vibras data a Window based software for viewing and printing data on a PC is also available, ie VibChart, which runs under W95/98 or NT.

The above functions together with fully automatic trigger and alarm facilities are said to make the Vibras-7000 an ideal system for monitoring of vibration from a wide range of sources under various conditions.

The Vibras-7000 Vibration Measurement System is constructed on an open architecture computer concept, which permits the adaptation of the instrument to meet future requirements.

Further details can be obtained from: Tom Brodowski, Noise & Vibration Engineering Limited, 1 Rothesay Avenue, Wimbledon Chase, London SW20 8JU Tel: 0181 542 9226 Fax: 0181 540 8481 e-mail: tbrodowski@noise-vibration. co.uk



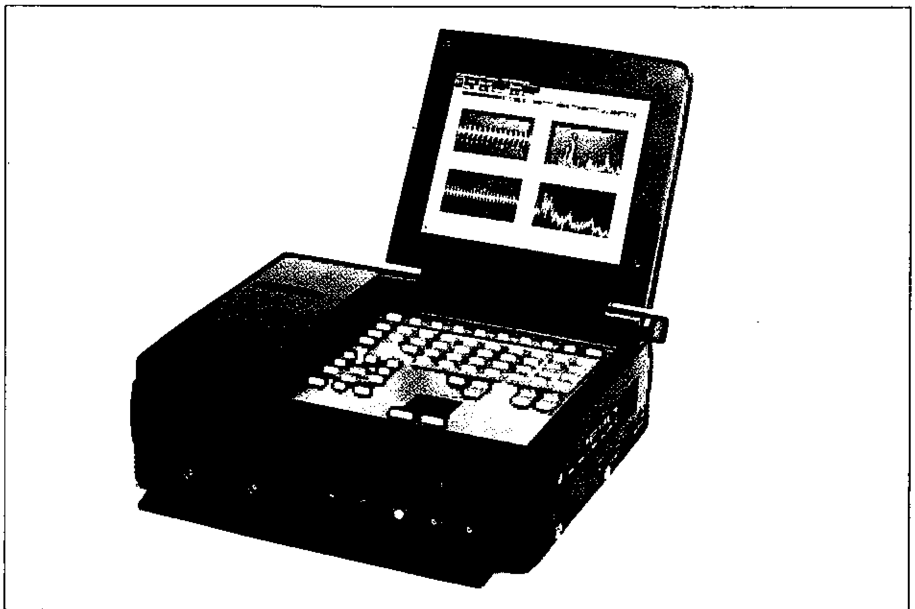
ONO SOKKI

New Portable FFT Analysers

Two stylish newcomers to the portable FFT analyser market have been introduced by Ono Sokki which are stated to offer maximum flexibility and versatility for automotive and precision engineering applications.

The CF-3200 and CF-3400 (2 channel and 4 channel) analysers, available from CEL Instruments Ltd, have been designed for field measurement applications that include FFT analysis and frequency response, tracking analysis, precise diagnosis of facilities and equipment, field balancing and real-time octave analysis.

Weighing 6 kg and with dimensions similar to that of a small briefcase, the instruments are equipped with built-in printers, PCMCIA interfaces, built-in sensor amplifiers as well as large capacity flash memories and floppy disk drives. The addition of battery operation allows measurements to be taken where mains power is not available.



A 10.4 inch colour LCD screen lifts up from instrument's case to reveal a button array from which the operator can access the various functions. The instruments can measure frequency response by inputting signals from an impulse hammer and an rpm tracking analysis feature produces a graph of the amplitude of the vibration or noise emanating from rotating machinery at varying speeds.

The condition of a variety of machinery-like motors, bearings, pumps and blowers can be assessed using the Rotating Machinery diagnosis capability and the field balancing mode reduces the time usually associated with making vector calculations and drawing a vector graph by automating the process and showing the result on the screen.

The real-time Octave Analysis feature allows both the CF-3200 and CF-3400 to be used as 2 channel real-time analysers. With a digital filter, each octave or $^1/_3$ octave can be displayed and two data can be measured simultaneously and compared.

Both models offer a wide choice of input and output ports for maximum flexibility in data capture, recording and processing for vibration, noise and rpm measurements. The user can connect an impulse hammer, a choice of acceleration pick ups, CEL sound level meters or rotation detectors. Recording and data processing options include an external CRT display, Centronics printer, keyboard, mouse and headphones.

CEL INSTRUMENTS LTD

CEL 500 Analyser Series

CEL Instruments Limited have announced a new series of their popular range of CEL-500 real-time sound level analysers.

The Digital Signal Processing technology used in the Series 3 500 analysers has been developed by CEL to add new functions, extend the memory storage capacity, restyle the user-interface and create new models.

The DSP technology permits the CEL-500 series to carry out simultaneous measurement of multiple time, frequency and amplitude weighted sound level data and there are options for real-time octave or one-third octave band frequency data.

The Series 3, available in three models, will now perform more functions than the Series 2 but, say CEL, are even easier to operate and users can also select their choice of language from English, French, German, Italian or Spanish.

The Sound Level Meter – (SLM) program module contained in the first model (CEL-553) provides the functionality of a 'classic', manually operated instrument together with some automatic run-time operations which make it ideal for many acoustic investigations including noise exposure risk assessments and sound power determination.

The CEL-573 also includes the Environmental-ENV program to add extensive timing functions that fully automate the collection of data, record time history data and perform statistical analysis. Simultaneous measurement of overall interval and period interval statistics, time average levels as well as a complete time history profile of the measured sound level data have also been added to the functions found in the Series 2 instruments.

The Event-(EVT) program added to the third module (CEL-593), provides extensive triggering facilities. These can activate data collection routines (which include a remote trigger option), a user-set limit level, or enable manual operation using the instrument's keypad. The program can also control external devices including Digital Audio Tape (DAT) recorders and can act as the controlling device for other CEL-500 series meters.

The CEL-593 model is provided with the full Sound Analyser application set of SLM, ENV, Event (EVT) and Fastore application program. It also has a memory equal to four times that provided in the other models which is capable of storing over one million data points.

Optional upgrade programs for all of the CEL-500 series include Fastore that records complete one third octave spectra every 10 milliseconds; Building Acoustics for evaluating the acoustic performance of buildings and auditoria and Loudness, a program which calculates psychoacoustic parameters in accordance with the ISO 532B standard. All optional programs and functions are added by reprogramming from a PC, minimising the delay caused by hardware changes and all models include a PC interface, PC control and download software.

The Windows™ compatible CEL Soundtrack library of application software is also available for post processing and for detailed report generation.

For further information on the range of Ono Sokki analysers or CEL-500 series of real-time analysers contact CEL Instruments Ltd, 35-37 Bury Mead Road, Hitchin, Herts SG5 1RT Tel: 01462 422411 Fax: 01462 422511 Email: sales@cel.ltd.uk. Website: http://www.cel.ltd.uk

CEL Instruments is a Key Sponsor of the Institute.

News Item

CEL INSTRUMENTS LTD

Company Ownership

CEL Instruments Ltd announces that ownership of the company has been transferred to the UIG/Casella group of companies, a leading UK environmental equipment and consulting services group effective October 6th 1998.

The Casella group is stated to be the market leader in the supply of instrumentation systems and consulting services for occupational health and safety, and the environment. Casella, has enjoyed strong recent growth, from its 'one-stop shop' policy for serving the environmental monitoring market. CEL fits extremely well into the strategy with its mix of occupational health and safety and community noise monitoring equipment.

The Casella companies, were formed in 1799: one of the earliest scientific instrument suppliers. Originally based in London, the company relocated to Bedford in 1988 and was acquired by new management in 1996.

CEL Instruments has designed and manufactured noise measuring instruments since 1972. Several 'industry firsts' have been reported by the company, most recently in 1994 with the introduction of Digital Signal Processing (DSP) technology to sound level meter applications.

Both companies have significant export sales, with collectively over 60% output destined for overseas customers. Casella Espana is a group subsidiary serving the Spanish market and CEL Instruments Inc serves the continental Americas.

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

Inaudibility

From Ian Watson FIOA, Glasgow

The Editor

Dear Sir,

The Best Way To Combat Noise. An Urgent Plea to Relax the Flawed Inaudibility Criterion.

There are more complaints about noise than the sum total of all other forms of environmental pollution. Noise from aircraft, trains, road traffic, industry, farming, road works, construction, quarries, clay target shooting, dog kennels, outdoor concerts, too loud radios and television sets, parties, music nights in pubs and hotels, etc upset many people and must be adequately controlled. This requires clearly defined, unambiguous and easily enforced rules. There must be a balanced and fair approach which takes into account the essential and recreational needs of our society.

The use of an inaudibility specification is becoming more common in Scotland in a misguided attempt to reduce noise pollution.

Many years ago the inaudibility criterion was applied to wind farms by some local authorities in England. It is incredible that some Environmental Health Officers and Planning Officials were able to slow down the introduction of a clean source of electrical power in the UK, thus giving our foreign competitors in wind turbine manufacture, the edge on this vital source of renewable energy. No one dared to suggest an inaudibility specification for fossil fired power stations! Thankfully this temporary deviation from common sense and a balanced approach to energy generation and noise has passed, but too late to save UK wind turbine manufacturers.

Satisfactory resolution of two of my current projects has been made much more difficult by either Environmental Health Officers or Licensing Boards stipulating an inaudibility condition.

The proprietor of a hotel has been questioned more than fifty times by the police and charged several times for breaching 'inaudibility' in a bedroom with wide open windows in the adjacent hotel. In some cases the police admitted that they found it very difficult to hear the music! In a few cases they could not hear the music at all! Most would agree that the police have more important work to do.

Two nearby residents of a new church hall have used an 'inaudibility' specification to curtail music evenings for young people, ceilidhs, dancing for the not so young, etc.

An 'inaudibility' criterion has aggravated these noise disputes and made them much more difficult to resolve in a fair and reasonable way. The use of an 'inaudibility' condition is fundamentally flawed for the following reasons:

- it cannot be measured;
- the hearing threshold of people vary;
- it is very dependent on large variations in the background noise;
- it is not fair to music lovers;
- it is a zero tolerance and extreme policy;
- it is not the correct balance between the rights of people to enjoy their recreation and the rights of home owners to low levels of noise;
- it does not comply with the guidelines in PPG24 and the noise limits to prevent sleep disturbance recommended by Professors Berglund and Lindvall who were acting for the World Health Organization;
- it wastes valuable police time, brings disrepute to their profession and alienates them from large numbers of law abiding and responsible citizens;
- it makes it much more difficult and expensive to resolve noise disputes in a fair and reasonable manner;
- it could enable devious and unscrupulous people to use noise rules to successfully and unjustly attack competitors, enemies or opponents;
- the increasing use of the flawed 'inaudibility' criterion in Scotland could result in more unnecessary court cases and a greater drain on public finances and resources;
- the reliance on subjective judgement on noise opens the door to corruption and a partisan approach by officials, civil servants and the police;
- it encourages human conflict.

Why not apply the same extreme inaudibility rules to motor cars and planes used for pleasure and holidays after 22.00 hours? Would any politicians who seriously suggested this be elected to Parliament?

If inaudibility after 22.00 hours was the law for all sources of sound energy and rigorously enforced, our country would soon be bankrupt. Being disturbed by low levels of music noise would be rather trivial compared to mass starvation in the UK!

PPG24 gives the best advice for the custodians of our environment. They wisely state that regarding noise created by recreational and sporting activities - 'Local Planning Authorities should balance the enjoyments of the participants against nuisance to other people'.

The World Health Organization has devoted considerable resources to helping to resolve the serious problem of excessive noise in the environment and in dwellings. Professors Berglund and Lindvall were commissioned to research community noise. After listening to the views of many world experts in this field, they concluded that the maximum allowable night-time noise should be controlled to prevent sleep disturbance. They recommend guideline values for inside bedrooms of 30 dB(A) L_{Aeq} for steady continuous noise and 45 dB(A) maximum. {MaxL}. By assuming a reduction across a slightly open window of 15 dB, they concluded that the night-time noise should not exceed 45 dB(A) outside at 3.5 m from the façade. Anyone who has measured an L_{Aeq} of 30 dB(A) will realize that this is a very low sound level indeed, and that the World Health Organization is bending over backwards to protect tenants and home owners.

Have I any supporters for eliminating inaudibility as a condition?

Printed as received. Comments welcome – Editor ❖

Non-Institute Meetings

February 18-20, 1999 National Hearing Conservation Conference, Atlanta, Georgia, USA.
Contact: K. Wojdyla, NHCA, 9101 East Kenyon Ave., Suite 3000, Denver, CO 80237, USA. Tel: +1 303 224 9022; Fax: +1 303 770 1812. e-mail: nhca@gwami. com

March 15-19, 1999 Forum Acusticum and 137th Meeting of the Acoustical Society of America, Berlin, Germany.
Contact: Elaine Moran, Acoustical Society of America, 500 Sunnyside Blvd., Woodbury, NY 11797, USA. Tel: +1 516 576 2360; Fax: +1 516 576 2377. e-mail: asa@aip.org

April 28-30, 1999 Vibration, Noise, and Structural Dynamics '99, Venice, Italy.
Contact: D Hill, Staffordshire University, PO Box 333, Beaconside, Stafford ST18 0DF, UK. Tel: +44 1785 353469; Fax: +44 1785 353552. e-mail: vib99staffs.ac.uk

May 17-20, 1999 SAE Noise & Vibration Conference, Traverse City, Michigan, USA.
Contact: M Asensio, Noise & Vibration Conference, SAE, 3001 W. Big Beaver Rd., Suite 320, Troy, MI 48084, USA. Tel: +1 248 649 0420; Fax: +1 248 649 0425.

June 28-30, 1999 1st International Congress of the East European Acoustical Association, St. Petersburg, Russia.
Contact: EEAA, Moskovskoe Shosse 44, St. Petersburg 196158, Russia. Fax: +7 812 127 9323. e-mail: kryl spb@sovam.com

July 5-8, 1999 6th International Congress on Sound and Vibration, Lyngby, Denmark.
Contact: F Jacobsen, Department of Acoustic Technology, Technical University of Denmark, Building 352, DK-2800 Lyngby, Denmark. Tel: +45 4588 1622; Fax +45 4588 0577. e-mail: icsv6@dat.dtu.dk

November 1-5, 1999 138th Meeting of the Acoustical Society of America, Columbus, Ohio, USA.
Contact: Elaine Moran, Acoustical Society of America

December 2-4, 1999 ACTIVE 99, the 1999 International Symposium on Active Control of Sound and Vibration, Fort Lauderdale, Florida, USA.
Contact: Institute of Noise Control Engineering, PO Box 3206 Arlington Branch, Poughkeepsie, NY 12603, USA. Tel: +1 914 462-4006: Fax: +1 914 462 4006. e-mail: INCEUSA@aol.com.

December 6-9, 1999 INTER-NOISE 99, Fort Lauderdale, Florida, USA.
Contact: Institute of Noise Control Engineering, PO Box 3206 Arlington Branch, Poughkeepsie, NY 12603, USA. Tel: +1 914 462-4006: Fax: +1 914 462 4006.