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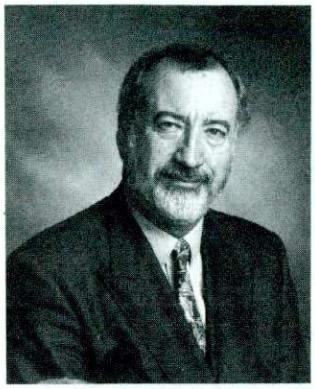

Dear Fellow Member

At the Institute's Annual General Meeting at South Bank University on June 9, I will hand over the Presidency to Ian Campbell. As this is the last President's letter I shall write, this seems a suitable opportunity to reflect on the last two years.

At the start of my term, I set out a number of strategic objectives. I wanted to raise our profile within the scientific community in the UK and also raise general public awareness of the Institute. We have had some success here, with the limited resources at our disposal, including for example, the interview I gave on BBC local radio at the 1997 Autumn Conference in Windermere. I hope that, as Immediate Past President, and through my many contacts, I can continue with this task.

I also aimed to improve our links with acoustical societies in other countries, not just in Europe but also worldwide. Soon after I became President, I was pleased that we were to able to appoint Professor Mark Tatham as Vice President for International Liaison. We are playing an increasingly active and important role in the European Acoustics Association, in the International Institute for Noise Control Engineering, and on the reconstituted Board of the International Commission on Acoustics. The success of InterNoise 96 in Liverpool, the biggest in the 25 year history of the event, with more than 1200 delegates from 45 countries, certainly helped to make the name of the IOA more widely known across the world.

Looking back, when I took over from Alex Burd in May 1996, I knew that the job, taken together with a full-time job as Head of Audiometric and Noise Standards at NPL, was going to be demanding. But, as often happens in life, it has been even more challenging than I expected. We have seen the retirement, as Institute Secretary, of Cathy Mackenzie, after many years of dedicated service, marked recently by the award of Honorary Fellowship of the Institute. We became direct employers of the Head Office staff, and completed a successful search for a new Chief Executive, Roy Bratby. And in recent months we have had to relocate the office within St Albans.

May I use this Letter to record my deep and sincere gratitude to my colleagues on the the Executive Committee, to members of Council, and to Roy Bratby and the Head Office staff who have all supported and assisted me through these difficult but stimulating times. The future of the Institute - your Institute - is secure, and in very good hands.

Sincerely yours

Bernard Berry

Bernard Berry

STRUCTURAL ACOUSTICS AND RELATED HIGH-FREQUENCY VIBRATION ACTIVITIES AT ESA

David C G Eaton FIOA

Introduction

This article describes several of the more typical structural acoustic and high-frequency-vibration problems that can severely adversely affect spacecraft structures and their payloads. It attempts to provide instructive background for the nonspecialist and describes the key tools that have been developed by the European Space Agency – including the ESA Structural Acoustics Design Manual (ESA PSS–03-204) – to combat such problems, as well as some of the practical experience that has been acquired through laboratory testing. Application of some of these tools for in-orbit spacecraft health monitoring is also addressed.

Acoustically Excited Structures

The only difference between mechanical and acoustical excitation of a given structure, with its own particular modal characteristics, is the actual coupling mechanism between these structural modes and the excitation field being applied. In the case of a structure on a mechanical exciter table, the coupling efficiency depends on the forces at the table/structure interface plane. In the case of acoustic excitation, the coupling efficiency depends on how well the sound waves interact with the structural modes.

A simple example of acoustic excitation is provided by a beam subjected to an incident sound field (Figure 1). Considering the lowest-order half-wave structural mode, if the sound is in phase over the structural surface strong coupling occurs. However, in the case of the second-order mode, the energy contents of the vibrating half-waves would 'cancel each other out', so that the mode would not be excited at all. This coupling efficiency is referred to as the 'joint acceptance' and corresponds to the modal participation factor or effective mass found in mechanical vibration synthesis.

An example of reverberant room excitation is given for odd-numbered modes in Figure 2. A number of features that apply to many plate-like structures are in evidence here. The beam is most strongly excited for all modes when the half-wave ($\lambda/2$) is greater than the beam length, but the coupling efficiency drops rapidly with mode number. When $\lambda/2$ is much smaller than the mode size, the 'joint acceptance' is essentially the same, irrespective of structural mode number. A further important aspect is that the lowest-order modes are likely to be efficiently excited whether the sound field is reverberant or directional. This is because the sound pressures are likely to be 'in phase' over the structural surface. Furthermore, a plate in a reverberant sound field will exhibit orthogonal 'joint acceptance' beam properties.

A broad conclusion from the above is that for many classes of structures exhibiting a plate-like vibration behaviour, such as antennas and solar panels, their low-order mode response is likely to be of greatest importance and may well be restricted to one mode. Prediction of their susceptibility to noise-induced damage can often be based on this simplifying assumption. Where the predominant acoustically excited and static modes are similar, assessment of combined acoustical and quasi-static loads is also greatly eased.

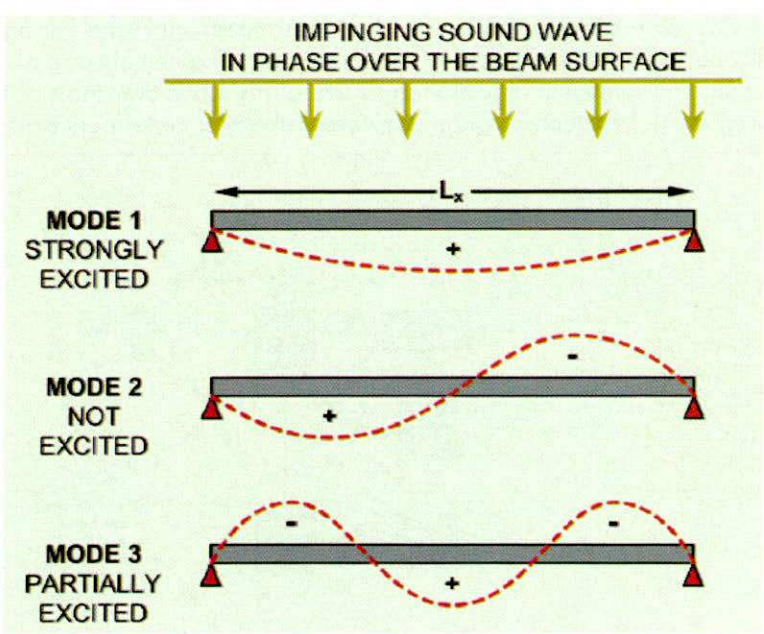

Fig. 1. Excitation of a simply supported beam by a normal-incidence sound wave

Wider Frequency Range Problems

Of course, by no means all noise-excited configurations can be dealt with using single-mode approaches. For example, the responses of platform-mounted equipment may be largely due to the mechanical transmission from the acoustically excited supporting honeycomb panel. The response of the equipment's internal items such as a printed-circuit board will depend on its own resonant modes and the mechanically transmitted vibratory power flowing from the panel. In the case of microvibrations, the

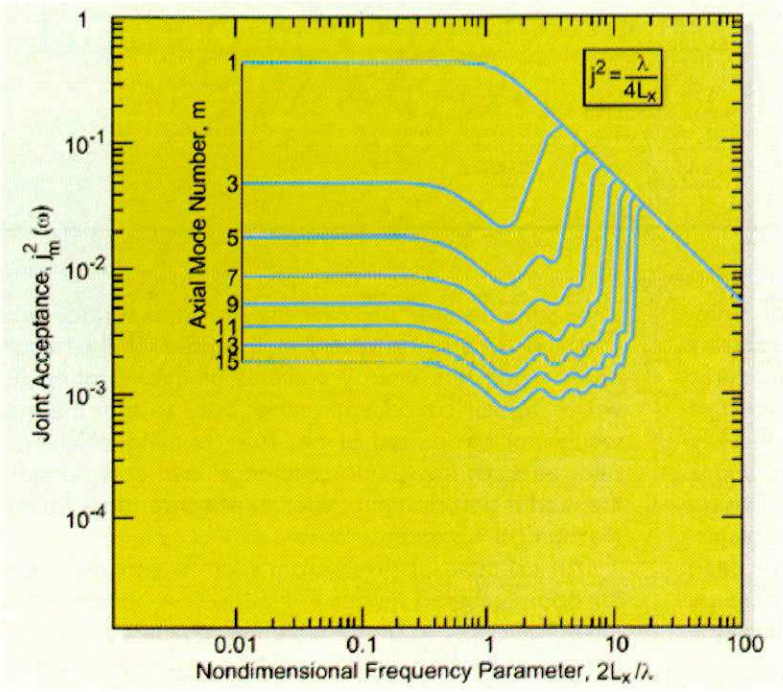

Fig. 2. Joint acceptance properties indicate the coupling efficiency between the sound field and the structure. In most situations, for beams and plate structures efficient coupling occurs when the length of the structure is smaller than the half sound wavelength. It falls rapidly with mode number. At high frequencies, the coupling efficiency is largely independent of structural mode number at a given frequency.

energy is transported from, say, a reaction wheel, around the spacecraft structure, via various mechanical transmission paths, into the jitter-sensitive equipment item. Statistical Energy Analysis (SEA) provides a means of assessing the average plateau of such vibrations and the importance of the routes through which any vibratory power may be transmitted from a remote part of the spacecraft.

Whilst analysis of the detailed behaviour of individual modes is possible using finite-element and classical methods, this becomes impractical and usually not warranted when considering a wide frequency range and the impact of very many modes, as experienced in this class of structural acoustic problem. SEA can be used when the number of acoustic and structural modal resonances in a given frequency band (their modal density) is sufficiently high. It is then possible to consider the average power flow between different subsystems (eg the chamber reverberant sound field, the platform, a central cylinder and its acoustic cavity, the equipment item, etc) and evolve a statistical assessment of their time-averaged response behaviours in both space and time. An example is given in Figure 3.

Some Findings from Acoustic Tests in the LEAF

Commissioning studies using a range of old test structures and payload elements (Figure 4) produced findings which were subsequently confirmed and extended by assessments made during the Ariane-5 fairing acoustic test campaign performed in the new Large European Acoustic Facility (LEAF) at ESTEC in Noordwijk (NL). Sound-pressure levels representative of the lift-off environment were reproduced. The Olympus structural model was first installed inside the Ariane-5 fairing and used to investigate the combined fairing/payload acoustic response with both an air- and a helium-filled fairing. Then Olympus was placed in the chamber alone and exposed to the sound field (Figure 5).

It has been established that the presence of large structures and the near-field effects of the siren horns exciting the LEAF chamber do not significantly disturb the homogeneity of the chamber's sound field, except in the lowest 31.5 Hz centre frequency octave band. Here the rather small number of chamber acoustic modes gives rise to narrow uneven frequency band spectra which increase non-linearly with sound intensity.

Helium is much lighter than air and has a speed of sound which is some three times greater. As a result there is a large mismatch between the impedances of air and helium (a ratio of about 2.5). This means that much less sound penetrates a helium-filled fairing. In addition, because the speed of sound is higher the number of acoustic modes that can be excited within the fairing is reduced (reduced modal density). The nett effect is a significant reduction in structural response over most of the frequency range. However, above a certain critical fre-

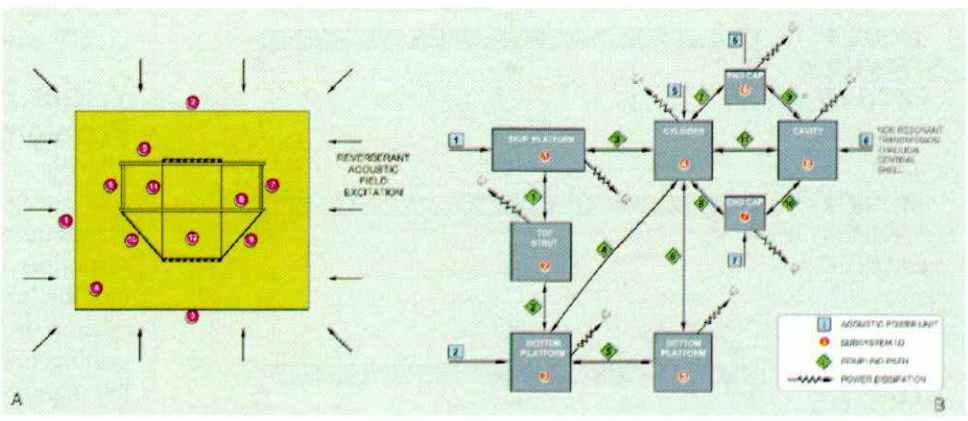

Fig. 3. Statistical Energy Analysis (SEA) can be used to investigate the flow of vibratory energy between different parts of the spacecraft, due either to acoustic excitation or localised mechanical vibration.

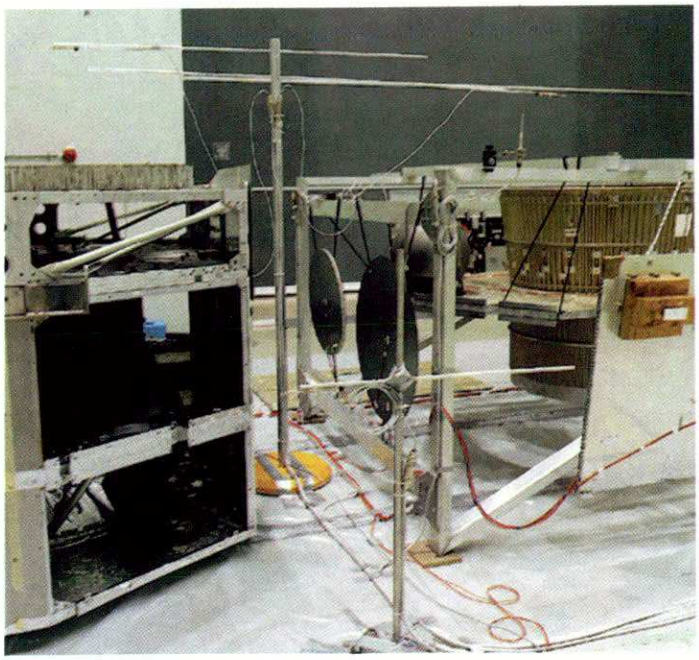

Fig. 4. Miscellaneous development structures and equipment used for early investigations of the acoustics of the LEAF (Large European Acoustic Facility) chamber at ESTEC, and to assess the degree of reverberant behaviour induced within an Ariane fairing.

quency a significant amount of vibratory energy is radiated from the structural surface (acoustic damping). This critical frequency is proportional to the square of the speed of sound of the gas in the chamber. Thus the critical frequency is some nine times higher in helium than in air, which means that the structure becomes much more lightly damped in helium at high frequencies. However, it was found that because of the reduced sound-pressure level and acoustic modal density, there was still some drop in actual structural response compared to those in an air-filled fairing at these frequencies.

Above about 150 Hz, the structural response behaviour is nominally the same both when tested inside the fairing and alone in the LEAF chamber. This implies that the interior of the fairing is truly reverberant above this frequency.

It was also found that the introduction of adjacent structural surfaces had relatively little effect on response behaviour, thought to be due to weak coupling between lightly damped modes. The addition of a large adjacent structure did lead if anything to an overall drop in response levels by way of energy absorption and dissipation.

A further important finding confirmed that most of the internal response of equipment boxes (printed-circuit boards) was due to mechanical transmission from the platform. Only when a box was very heavy and effectively 'killed' the local platform vibration did the airborne sound make significant contributions to the circuit board's response.

It was also possible to demonstrate the validity of zoning concepts. The response of a side panel with equipment mounted on it was found to be little different whether it was mounted in the complete structural model or simply on the service module alone. Subsequent tests demonstrated that a good representation of the integrated spacecraft's behaviour could be realised if the panel was simply attached to a peripheral metal frame and tested on its own (Figure 6).

Active Noise and Vibration Control

An anticipated increase in low-frequency noise within the Ariane-5 payload fairing during launch compared with Ariane-4 led to the successful introduction by Dornier of a passive Helmholtz resonator noise control system, albeit with a sizeable mass penalty. Studies conducted by DASA Dornier with Contraves and TNO have now examined alternative noise-suppression techniques using novel active noise and vibration control. Initial findings substantiated by scale-model testing have shown encouraging results. Means for generating high-intensity 'counter phase' noise and for achieving a better understanding of the distribution of external noise sources require further investigation. Parallel studies are examining the efficiencies of piezoelectric actuators under space conditions.

Turning from the problems of noisy launch environments to the environmental demands of manned spaceflight, the audible background noise environment within the Columbus Attached Pressurised Module (APM) of the International Space Station has to be kept within accept-

Fig. 5. DASA–Dornier (D) and Oerlikon–Contraves (CH) successfully developed the Ariane-5 fairing with its passive noise-control system, shown here with the Olympus test structure used to assess acoustic performance in the LEAF

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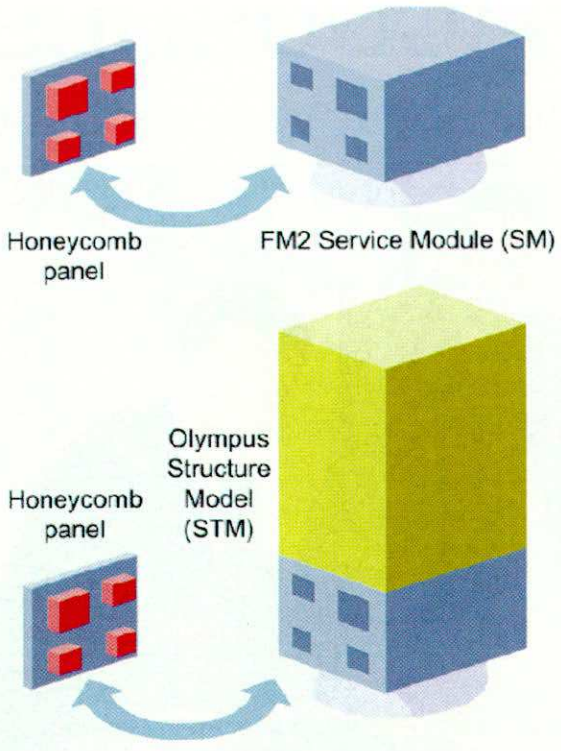

Fig. 6. Example of zoning: the equipment-box responses were reproduced over most of the required frequency range with the panel alone. When the panel was mounted in a metal frame, even greater correlation with the test results for the completely integrated structural model of Olympus was achieved.

able limits to allow the flight crew to execute scientific laboratory work without disruption. Additionally, such unwanted noise must not inhibit communication or induce hearing loss. Such requirements can pose severe restrictions on noise-producing equipment in the APM, given that the internal noise levels should not exceed 55 dBA in the Station's habitable areas if the crew are to be able to work with optimum efficiency whilst in orbit.

There are usually severe constraints in attempting to deal with the noise-generation mechanisms within the individual items of equipment. Investigations are in progress to provide quantitative information about novel noise-reduction tools for the treatment of radiated and transmitted noise. These studies are expected to provide worthwhile improvements over traditional methods.

A typically important problem is the transmission of tonal or near-tonal noise around the cabin-air-loop ducting. This is usually more difficult to eliminate than the general background noise, which can be dealt with by conventional passive means. Active noise- and vibration-control techniques are being studied by a DASA-led team with a view to suppressing noise generated by typical ventilation fans and by any ensuing noise augmentation due to turbulence at bends in, and by structural vibration of the ducting wall.

Microvibrations and their Treatment

Microvibrations can be of concern for microgravity and optical payloads such as the SILEX laser optics telecommunications payload which will be flown on the upper platform of ESA's Artemis spacecraft (Advanced Relay and Technology Mission Satellite). This platform must maintain an incident-beam tracking accuracy of better than 0.2 arcsec. Disturbances may emanate from such sources as momentum and reaction wheels, where dynamic forces and torques can be generated by rotor imbalances and bearing noise. Combinations of transients and more steady-state excitation can be produced by stepper motors as used for solar-array drives, attitude pointing mechanisms and mirrors. Transients can also be expected from relays.

A particular problem is the characterisation of these sources and how to introduce them correctly into any predictions used to assess the validity of the pointing budget. Prediction and testing techniques may also have to be refined if 'line of sight' direct jitter measurements cannot be attempted. These are usually application-specific, but may for example involve the interpretation of instrument mounting-location vibration measurements. The other main difficulties are the characterisation of the spacecraft structure and payload and the impact of ground as opposed to in-orbit conditions in any verification programme.

More than one approach has generally been necessary in order to establish confidence in complying with the requirements at an early stage. Special modelling has been required to represent equipment inputs where local mounting configurations can have significant effects on transmissibility. Finite-element and statistical-energy-analysis models have been used to make predictions. They have often been used to help extrapolate or scale data from ground-based tests. For example, allowance usually has to be made for differences between ground-test and in-orbit configurations. A number of appendages such as solar arrays will not be deployed during ground tests. The importance of the effects of air in ground-based tests, in terms of mass loading at low frequencies and on damping particularly at high frequencies needs to be taken into account. Here the use of a helium tent can largely obviate the unwanted air effects and can also exclude the effects of any extraneous noise in the test area (Figure 7).

Totally satisfactory means of attenuating excessive vibration are hard to find. Viscoelastic damping materials have properties which vary appreciably with frequency of excitation and temperature. They will creep in the presence of quasi-static loads. Electrical damping using piezo-ceramic materials is the subject of a number of investigations. Another novel approach examines the possibility of attenuating vibrations at the locations of isostatic mounts. In many optical payloads distortion due to quasi-static loads is avoided by introducing isostatic mount connections between the spacecraft platform and the equipment, often in the form of flexures. In the absence of airborne acoustic excitation, these provide the sole means of unwanted vibration transmission when in orbit. An investigation is therefore being undertaken to establish if there are ways and means of suppressing the transmitted vibrations at such locations. This could

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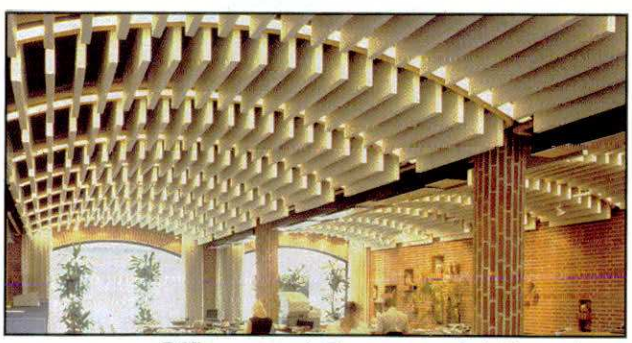

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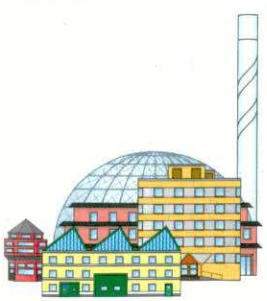

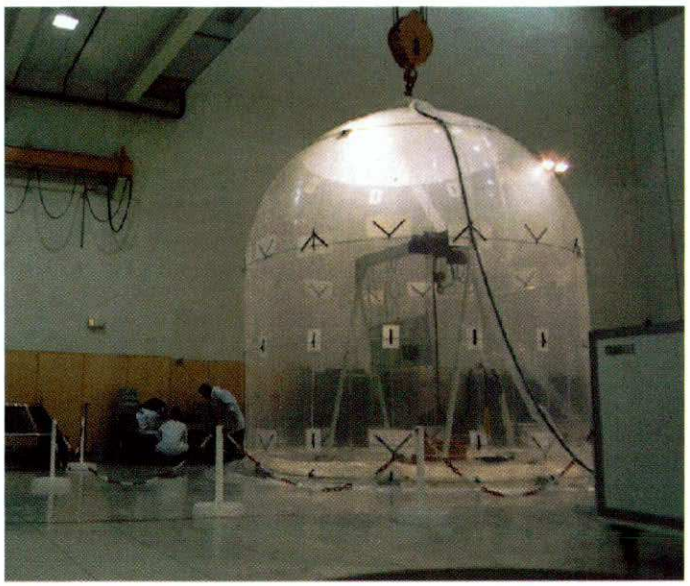

Fig. 7. Helium tent used by Matra-Marconi-Space, Toulouse (F) for microvibration studies.

involve either passive or active damping systems, or both.

A particular approach has been adopted by CSEM (CH) to evolve a flexure in which the incurred microvibrations are magnified in a location where the damping and stiffness is controlled. The stiffness is provided by passive springs and the viscous damping from a linear motor. The use of electrical damping can have a distinct advantage over the use of visco-elastic material whose operational performance, in terms of its behaviour in relation to the effects of temperature and frequency, is less easy to predict.

The current configuration is called the Monolithic Elastic Element for Damping Isolation (MEDI). It effectively handles two degrees of freedom from static load transfer and vibration suppression aspects whilst minimising the stiffness in the other four degrees of freedom. A configuration of three MEDI flexures can therefore provide an isostatic system for the SILEX payload, if required. The MEDI is essentially a flexible structure which transmits and amplifies the relative motion between the interfaces to electromagnetic damping systems (Figure 8).

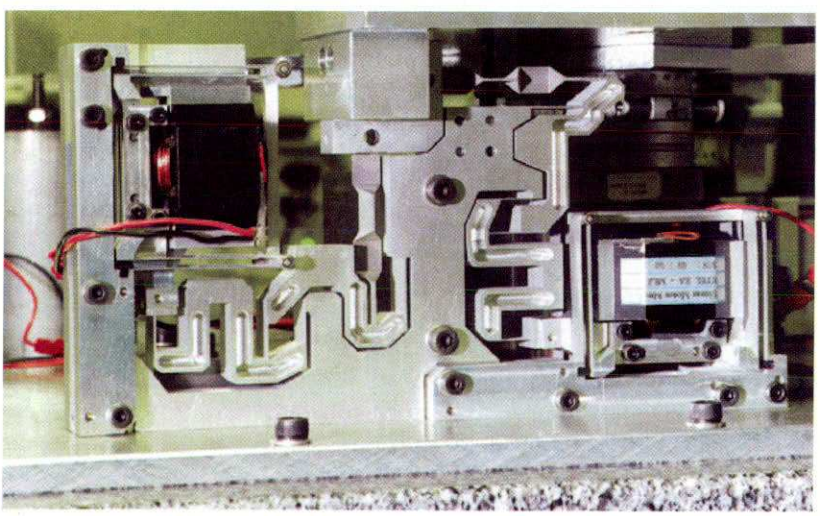

Fig. 8. Monolithic Elastic Element for Damping Isolation (MEDI) developed by CSEM (CH) and Rovsing (DK).

In-orbit Equipment Health Monitoring

The Olympus spacecraft carried a micro-accelerometer system (PAX) designed to measure jitter levels of the type that might be experienced by SILEX on the Artemis spacecraft. It soon became clear that the vibration spectra produced by equipment on board Olympus could also provide data with which to check the health of the equipment items themselves. Any abnormal spectral changes were likely to indicate a deterioration. One of several such examples was the identification of an intermittent change in the behaviour of one of the Olympus reaction wheels, which was subsequently rectified. An automatic signal-recognition system was developed to keep the telemetered signal from PAX under continuous assessment. This in turn has led to consideration of the development of a dedicated system for future satellites, not unlike an aircraft's black-box flight recorder. The main challenge in this respect is to devise a system that makes minimum use of spacecraft resources.

The ESA Structural Acoustics Design Manual (ESA PSS-03-204)

An accumulation of the knowledge gained from the types of problem that have been described here and the development and verification tools used in this field has led to the introduction by ESA of a Structural Acoustics Design Manual. It is intended as a reference source for use by both specialists and non-specialists.

This Manual has been developed for ESA by the Institute of Sound and Vibration Research at Southampton University. It provides information on response prediction tools that can be used for structure, payload and service-equipment items subject to high-frequency vibration environments. Prominence is given to the use of Statistical Energy Analysis (SEA). Information on classical, finite-element and boundary-element techniques is also included. Appropriate empirical data are incorporated together with details of possible scaling and zoning methods. The Manual also addresses the problems of sound transmission into enclosures. Further extensions to cover the particular aspects of high-frequency microvibration and habitation acoustics are in preparation.

This article appeared in the November 1997 issue of esa Bulletin.

David Eaton FIOA is with the Structures and Mechanisms Division, Directorate for Technical and Operational Support, ESTEC, Noordwijk, The Netherlands ❖

VIBRATION ISOLATION FOR RAILWAYS

Richard Greer MIOA & Chris Manning FIOA

Introduction

By comparison to noise, environmental vibration is rarely an issue. However, when vibration is an issue it tends to be a significant one. Mitigation, as with noise, can generally be applied by way of three approaches: treating the source, impeding propagation or treating the receiver.

Railways are the most common source of environmental vibration and therefore this subject area requires careful consideration during the development of new lines. Once the alignment, rolling stock and operational patterns for a new scheme are finalised, the only reasonably practicable opportunity for mitigating vibration is in the design of the track system and the railway formation that supports it. Difficulties associated with design of isolating trackforms, which are exacerbated by a lack of guidance and standardisation, are discussed along with solutions identified by Arup Acoustics during many projects.

Vibration also needs to be considered for new developments adjacent to existing railways. In these cases the only practicable approach is to include isolation in the design of the building foundations. Whilst Arup's project experience includes the design of vibration isolation for many buildings, ranging from small residential to the largest of air-rights developments this topic falls outside the scope of the discussions below although some examples may be found in the literature [1 to 4].

The operation of trains generates vibration at the wheel/rail interface which can pass through the trackform, into the supporting formation or tunnel lining and thence into the surrounding ground and neighbouring buildings. Once in a building such railway vibration may give rise to two types of adverse impact:

(i) Groundborne noise: The vibrating walls, floors and ceilings of the building radiate an audible rumbling sound into the rooms of the building. Groundborne noise is generally associated with higher frequency components of railway vibration, typically those in the range 30 to 250 Hz; and tunnelled sections of railways where receivers are completely shielded from airborne noise.

(ii) Perceptible vibration: This is vibration that one can feel on the surfaces of a building. This is distinct from the vibration giving rise to groundborne noise as it is greater in magnitude and is governed by lower frequency vibration typically occurring in the range 1 to 80 Hz. Perceptible vibration is generally associated with surface sections of railways.

Depending on the magnitude and frequency content of the vibration generated in a building, a railway may give rise to groundborne noise only, perceptible vibration only or both.

The principal, and generally the only realistic, method for reducing groundborne noise and vibration at source is through the design of an appropriate trackform. More precisely, it is the design of a trackform that interacts appropriately with the type of rolling stock under consideration, as it is the proper design of the train/track system, rather than of the trackform alone, that reduces the vibration.

Whilst there are many successful examples, worldwide, of trackforms which successfully reduce groundborne noise and vibration there are equally many failures. The five main stumbling blocks to successful design are:

- the complexity of the systems involved (eg train/trackform/supporting system);
- the absence of validated methods for predicting the performance of the systems;
- the often conflicting requirements of vibration reduction and reliability, accessibility, maintainability and occasionally safety;
- cost; and
- a paucity of guidance and standardisation

Types of Vibration Isolating Trackforms

Railway Trackforms

Railway trackforms have traditionally been formed from rails, fastened to sleepers supported by ballast which in turn is supported by a railway formation. From a vibration perspective, it is the ballast that provides the principle resilience and hence provides some vibration isolation and damping. The drive for higher passenger comfort, reduced whole life cost and improved maintainability has resulted in many changes to the design of ballast track over the years.

One key change, which has reduced both noise and vibration, is the use of continuously welded rail. This has also removed the 'clackity-clack' (or is it 'diddley-pom'?) from the environment around many lines! The same drive has also lead to the development of 'non-ballast' trackforms which are based on a concrete bed with the resilience being provided by elastic/resilient pads or mats. It should be borne in mind that the 'resilience' in a trackform described in this instance is not provided for acoustical reasons but rather to improve passenger comfort and to reduce the wear and tear on the train and trackform. As discussed later the requirements of a trackform designer and an acoustician can often be at odds with each other.

The generic types of ballast and non-ballast trackforms can be categorised in terms of their groundborne noise/vibration reduction and cost as shown in Table 1. Figure 1 presents the principle features of the layout of these different generic designs and the location of the principle resilient component in each case.

Ballast Trackforms	Non-ballast Trackforms	Acoustic Performance	Cost
	Direct fixation with 'hard' rail pads	↓	↓
	Direct fixation with 'soft' rail pads		
Modern & high-speed ballast	'Hard' resilient baseplates	Increasing groundborne noise and vibration** reduction	Increasing cost
Old & low-speed ballast	'Soft' resilient baseplates		
Ballast and sleeper soffit pads	'Hard' booted sleepers		
Ballast and 'hard' ballast mat	'Soft' booted sleepers		
Ballast and 'soft' ballast mat	Light mass-spring systems*		
Resiliently supported ballast trough	Medium mass-spring systems*		
	Heavy mass-spring systems*	↓	↓

Table 1: Categorisation of ballast and non-ballast trackforms based upon ground-borne noise and vibration reduction and cost

Notes: * Also known as floating slab track or floating track slab systems. ** A trackform that reduces groundborne noise may not necessarily reduce perceptible vibration.

Difficulties Associated with Design of Isolation Trackforms

Prediction of Groundborne Noise and Vibration and the Isolation Provided by Trackforms

Arup's consultants have developed a number of models for predicting groundborne noise and vibration and the vibration isolation provided by trackforms [eg, 5 to 9]. Models for predicting the performance of trackforms vary in their complexity from reasonably simple multiple degree of freedom to detailed finite element models. The complexity of the model generally reflects the complexity of the trackform under consideration and particularly of the system that supports it. The frequency range of interest can also influence the most appropriate modelling technique.

For example, the model required to support the design of a trackform to be installed inside a tunnel can be somewhat simpler than the model required to predict the performance of exactly the same trackform installed on a light-weight elevated structure. This is because the performance of the trackform is influenced by the response of the supporting system. In the case of a tunnel, the assumption of an inertial reference may, in some hard rock ground conditions, be reasonable. However, for a light-weight elevated structure detailed consideration of its dynamic response is critical to understanding the performance of a trackform. Figure 2 shows modelling undertaken at Ove Arup for a mass transit system. The figure compares the insertion loss predicted for a given trackform based upon a simple lumped parameter model and that predicted by a detailed FE model of the trackform *and* the supporting structure. It is clear from the comparison that use of the simplified model in this situation would have resulted in an overoptimistic estimate of the reduction in structural vibration, and hence structure borne noise.

Insertion Loss and its Dependence on a 'Reference'

It is impossible to measure the absolute reduction in vibration and groundborne noise provided by a particular trackform. For this reason it is common place to present the reduction provided in terms of an insertion loss or gain. This in itself presents a difficulty because there is no standard approach to defining insertion loss/gain for track systems. This makes comparing the performance for different vibration isolation designs at best difficult and at worst completely misleading. This also makes it difficult to identify trends in the insertion loss/gains presented by other research which in turn hinders the evolution of trackform design with respect to groundborne noise and vibration.

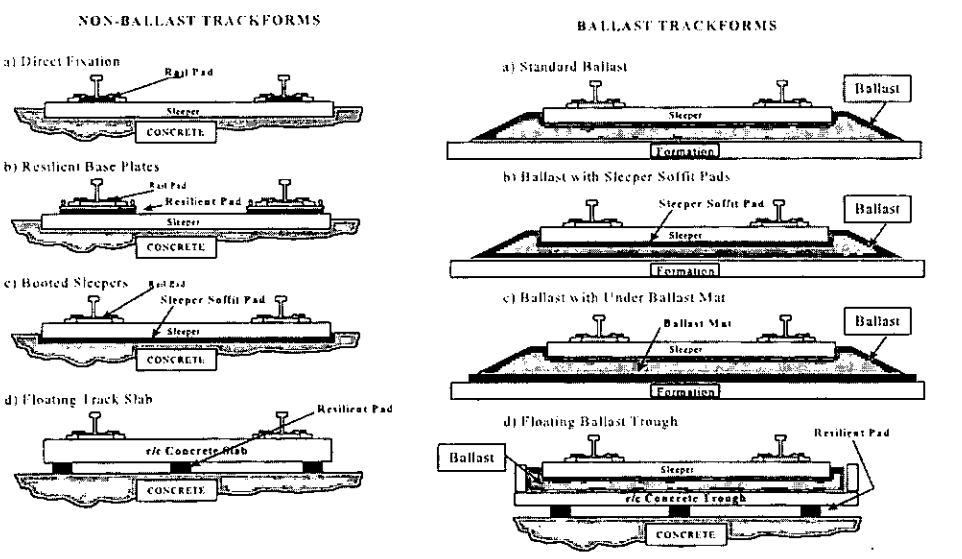

Fig. 1. Diagrammatic representation of generic trackform designs with respect to groundborne noise and vibration.

Figure 3 presents diagrammatically, the process by which insertion loss/gain is

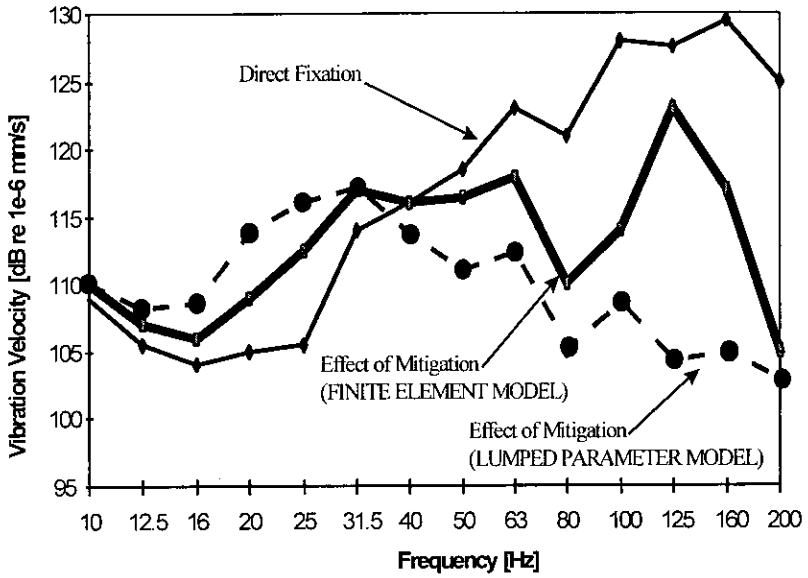

Fig. 2. Vibration reduction predicted using different models

either measured or predicted and, therefore, the dependence of the result on the trackform used as the Reference for the analysis.

Measuring Insertion Loss/Gain and Identifying Conformance with Specifications

The issue of what Reference is used for quantifying insertion loss/gain becomes critical when entering into design and build contracts. These often contain a contractually binding specification for the level of vibration reduction to be provided by the isolation system, and the specifications are often quoted in terms of insertion loss/gain. It is critical, therefore, that the reference for the specification is identified and that the same reference is used when developing the design of the trackforms for comparison against the specification.

Figure 4 presents the insertion gain for a particular trackform product predicted by its supplier. This claimed performance is shown superimposed against a contractual specification which in turn was formulated to ensure, for this particular rail project, compliance with a number of groundborne noise and vibration targets in the buildings set above the new railway tunnel. Based upon this comparison, the supplier claimed compliance with contractual obligations.

However, the predicted performance was relative to a different reference. Figure 4 also presents the predicted insertion gain for the product once it has been corrected to the same reference as the specification. This revised perspective demonstrates that the claim of compliance should be viewed with caution. Whilst this in no way

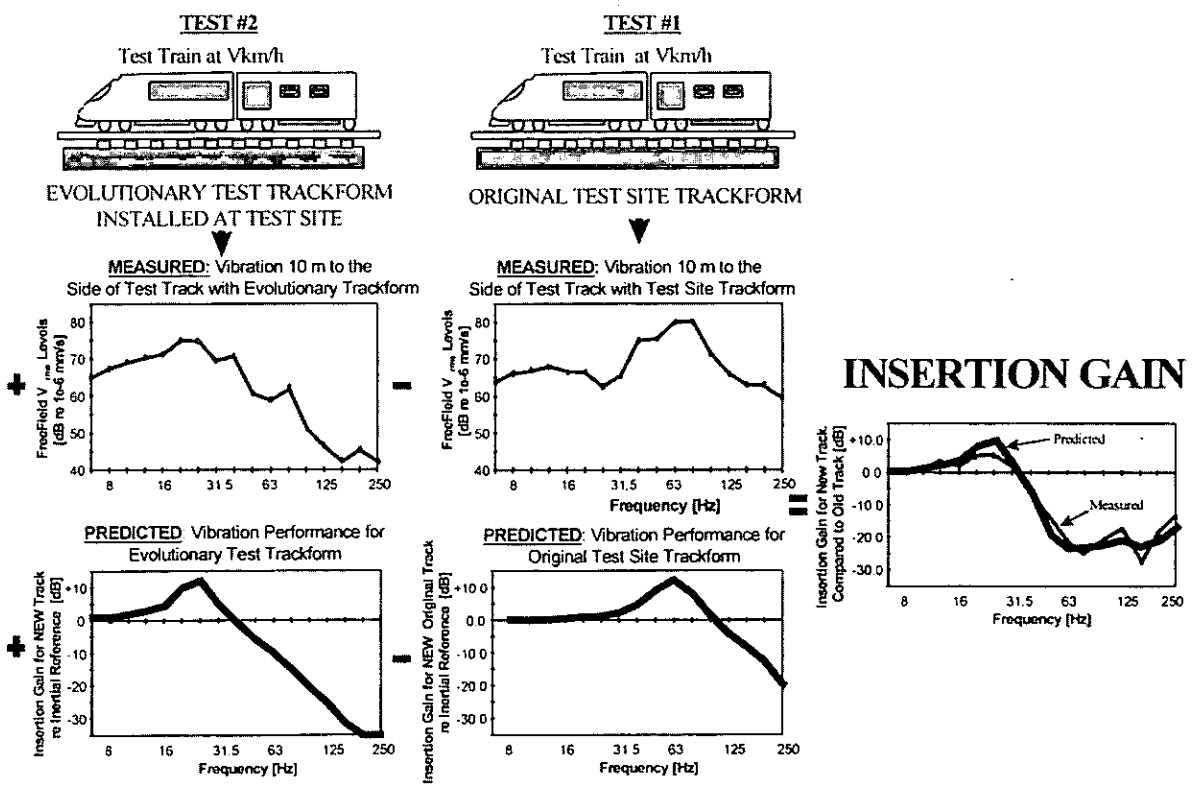

Fig. 3. Calculation and measurement of insertion loss/gain

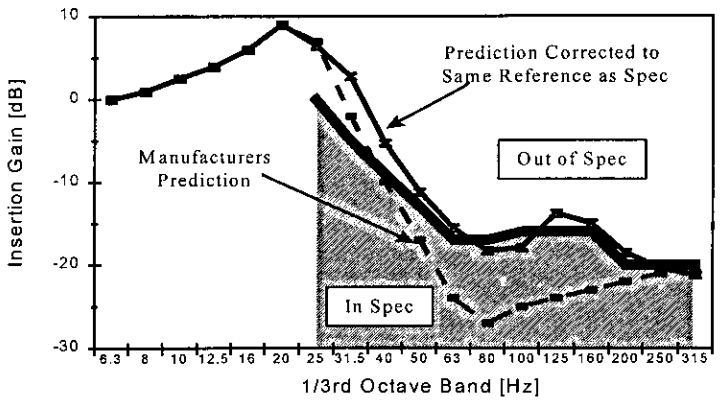

Fig. 4. Influence of the 'Reference' on insertion loss/gain

reflects on the efficacy of the trackform product itself, it highlights the importance of a clear understanding of these issues when assessing the cost and risks faced by railway projects in meeting particular environmental targets.

Component Specification

The insertion loss/gain for a trackform is dependent on many parameters. The most critical of these are:

- static stiffness;
- dynamic stiffness;
- variation of dynamic stiffness with load and frequency;
- effective mass of the train/track system acting on the resilience of the trackform.

Figure 5 shows a typical rail deflection curve under the load of a train's axles. From a wear, rail stress, passenger comfort and safety perspective, it is critical to control the degree of rail deflection, and particularly inter-rail deflection. This requires a high vertical modulus for the trackform as seen at the rail head, whereas the reduction of groundborne noise requires a low modulus. The first part of optimising the trackform design is therefore to reach a compromise between these conflicting requirements. This compromise will determine the static modulus (stiffness) of the resilient elements in the trackform. However, this is only part of the story.

It is also essential to specify other parameters particularly the dynamic stiffness of the same resilient elements. Figure 5 compares two nominally identical trackforms with the same rolling stock and revenue service patterns. The only difference between the two situations was the degree of vibration reduction provided. Both systems had the same static characteristics, as shown in the figure, with maximum static deflections of approximately 1.2 mm under each axle. However, despite the similarity in the static performance under the same train, the reduction in groundborne noise provided by one trackform was over 10 dB greater than the other.

On closer examination of the two systems it transpired that this difference in groundborne noise performance resulted from the resilient pads for the respective trackforms being procured from different suppliers

based upon a specification for the static stiffness only. Whilst both pads met this specification, one had a ratio between static and dynamic stiffness of approximately 1.5 whilst the other had a ratio of approximately 5. This was sufficient to retune the primary natural mode of the train/track system from the 50 Hz to the 80 Hz 1/3 octave band, which accounted for the dramatically different reductions in 'higher' frequency vibration identified.

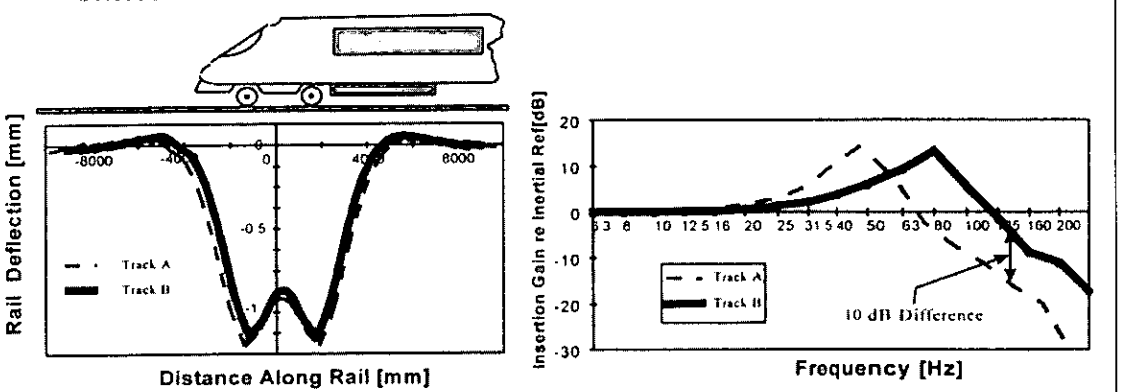

Fig. 5. Influence of dynamic stiffness to insertion loss/gain

Testing and Procurement

Component Testing: The essential part of the procurement process for the isolation system is to provide a tight, well defined specification for each of the components that are critical to the system's performance. It is also essential to require detailed quality assurance and pre-delivery testing to ensure that the components supplied meet the required specification.

For individual components conformance tests are generally undertaken on test rigs. In this situation it is important to ensure that the test conditions reflect, as accurately as possible, the actual conditions under which the components will operate.

The most critical component of the trackform is generally the main resilient element; ensuring its dynamic stiffness meets the required specification is the most important parameter to focus on.

Testing the Complete System: Whilst modern test rigs will allow a reasonable approximation to the operational conditions, the approximation is still at variance with the complex transient load conditions that actually occur in reality. For example, in practice the resilient element in a trackform will be loaded simultaneously by both totally transient and quasistatic loads (pre-loads of possibly 3000 kg but a dynamic load of perhaps only 400 kg), at frequencies between 10 and 250 Hz. This is too complicated a situation to be realistically reproduced in the laboratory. Hence, the only method of improving confidence that the *in situ* performance of the trackform will meet the predicted performance is to test a prototype of the complete system on a representative railway. Testing the complete system is also sometimes necessary because the way in which it responds may differ from the response estimated from the measured behaviour of each of the component parts considered in isolation.

Conclusions

- Developing trackforms that are cost effective and are successful in reducing groundborne noise and vibration requires robust validated prediction models.
- The vibration isolation provided by a trackform is generally measured in terms of an insertion loss or gain. By definition this is relative to a 'reference' and currently there is no standard reference defined in the railway industry.
- Because no 'standard' reference exists

(a) the vibration reduction quoted from different sources and promotional material must be compared with caution; and

(b) it is essential that when comparing predicted insertion losses against contractual specifications, the prediction and the specification are relative to the same reference.

- Ensuring that the track will perform *in situ* requires

(a) detailed specifications for every component; and

(b) testing of each component and, where practicable, the complete system.

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This article is based on a paper presented at the Institute's 1997 Autumn Conference at Windermere.

Richard Greer MIOA and Chris Manning MIOA are with Arup Acoustics ❖

EUROPE COLUMN

Mark Tatham FIOA

Introduction

In this new feature for Acoustics Bulletin we shall be bringing you news of what is happening in our sister organisations in Europe. We shall be doing this using the resources of the European Acoustics Association, and it is the EAA itself which is the subject of this first article.

The European Acoustics Association

The EAA describes itself as a 'service provider' to just under 30 acoustical societies across Europe which jointly have around 8000 members. Largest among these is probably our own IOA (with just under 2600 members) followed very closely by the German Society, DEGA (the Deutsche Gesellschaft für Akustik) and the French Society, SFA (the Société Française d'Acoustique). The EAA was founded in 1992 by eleven societies and is organised in the form of a European Economic Interest Grouping (EEIG), which is a European Union formally established organisation with a Constitution and Articles of Association. The EAA collects a membership fee from each of its full member societies on an annual basis in order to support its collective activities.

EAA Products

Foremost in the activities of the EAA is the promotion of what are known as 'Products' – these are at the moment seven services variously available to member societies. These are the Products (it helps if you speak Latin!):

1. Acta Acustica united with Acustica. This is the EAA flagship academic journal published by Hirzel Verlag in Stuttgart and made available to members at reduced subscription rates. AAA has grown in stature over recent years and from the point of view of coverage (every aspect of acoustics is included) and academic depth succeeds in joining the Journal of the Acoustical Society of America as one of the leading acoustics journals in the world.

2. Forum Acusticum. The Convention of the European Acoustics Association. The last FA took place in Antwerp in April 1996 and was attended by nearly 700 participants. The next Convention will take place in Berlin in 1999 and is expected to attract up to 1000 participants from all walks of acoustics and many countries, including those way beyond Europe. FA is widely regarded as one of the major acoustics meetings worldwide.

3. EAA Symposium. A product which brings scientific meetings together under the aegis of EAA and which focus on specialised fields. These meetings are organised by member societies and designed to extend interest beyond national frontiers. IOA recently provided one such Symposium, the Musical Acoustics meeting last summer in Edinburgh.

4. EAA Tutorium. These Tutoria are meetings, once again organised by members societies rather than by EAA itself, but unlike Symposia their focus is on a tutorial or educational component especially, of course, continuing education in acoustics.

5. Documenta Acustica. Documenta is the literature distribution system of the Association. A number of documents are currently available to members at reduced rates, including copies of meetings proceedings and other important records of member society activities. Back copies of our own Proceedings of the IOA are among the growing list of materials.

6. EAA Index. This is the Association's equivalent of our IOA Register. It contains an alphabetical list of the individual and corporate members of the member and associate-member societies of EAA, together with the affiliations and contact details. The index contains in addition valuable information about the bylaws and official policies of EAA, a listing of EAA Officers, listings of member societies and information about Acta Acustica.

7. Fenestra Acustica. This is the EAA worldwide web 'shop window'. Like our own IOA website it provides a constantly changing information resource available across the internet in all countries of the world. Here you will find information about EAA products and services, as well as 'hotlinks' to websites of member societies and to the European Commission's site.

EAA Personnel

The EAA is managed by an Executive of three professionals: the Chairman of the Board – Professor Jens Blauert of the Ruhr-Universität of Bochum in Germany, the Managing Director – Dr Manell Zakharia of CPE Lyon in France, and the Financial Controller – Professor Mark Tatham of the University of Essex in the UK. Each EAA Officer is elected for a three-year term.

The EAA is effectively governed by a General Assembly of Presidents of all of the Member Societies. This meets annually (the next meeting is in Munich in the autumn) and votes on matters of policy on behalf of all members.

Future Articles for the Europe Column

Besides items and announcements of topical interest, we hope to be discussing each of the EAA products in a series of dedicated short articles. We shall also be featuring profiles of the various member societies. In general we shall be bringing to Acoustics Bulletin a flavour of how our friends and colleagues across the Channel and North Sea (or at the other end of the tunnel, if you prefer!) conduct their affairs and how we are all getting together to mould the future of acoustics in Europe.

How to Find Out More

The best way of finding out more about the European Acoustics Association or any of the Member Societies is to access Fenestra Acustica – the EAA website. The url for this is: http://eaa.essex.ac.uk/eaa/ the site is managed at the University of Essex along with our IOA site: http://ioa.essex.ac.uk/ioa/.

Professor Mark Tatham FIOA is presently the Institute's Vice President for International Liaison.

CULLUM DETUNERS' CENTENARY

Andrew Dodd AMIOA

21 April 1998 represented the centenary of the Cullum name in the world of industrial acoustics and noise control. This article offers a brief history and background to one of the oldest established acoustic companies in the world.

Cullum Detuners started life under the guise of Horace W Cullum, the originator and founder of the Cullum organisation, and was a specialist building supplies business based in London. Products included light weight partitions manufactured from pumice, cork floor tiles and hollow concrete block flooring systems. The range of building products offered by Horace W Cullum was considered extremely innovative in the early 1900's.

Douglas Jack W Cullum joined his father's company at the age of eighteen in 1928. He initially showed little enthusiasm for the business and found it hard to settle down, but in 1929 Jack approached his father with the idea of spending one year in the United States of America to study the science of acoustics under the umbrella of the Johns Manville company, from whom Horace W Cullum was importing cork insulating tiles. Jack Cullum returned from the United States one year later fired with enthusiasm from his new-found knowledge and with a strong desire to develop the acoustic side of the company. During a brief and productive period Jack Cullum developed several new architectural acoustic products including some absorptive wall systems and floating isolated floor systems.

With the sudden popular rise of the Cinema as a mainstream entertainment media and in particular the introduction of the 'Talkies', Cullum's started to import the first generation of mineral wool products from the USA. Through innovation, Cullum's developed a sandwich construction using mineral wool between timber framework to produce early examples of effective sound insulators.

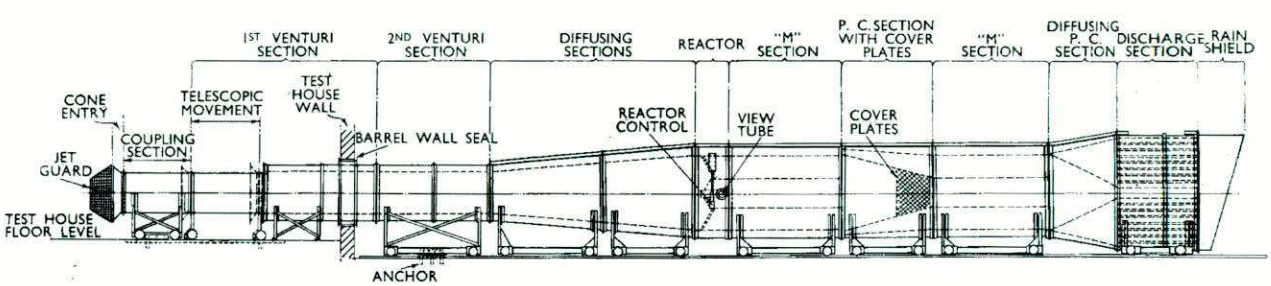
In 1939 Cullum's conceived the idea of a metal suspension system for ceilings which could be directly fixed or suspended to form a false ceiling; this system was developed and marketed as The Cullum Channel Fixing System and became the fore-runner of the suspended false ceiling system now in use in virtually every office block in the world.

Development of innovative building products led to the award of several prestigious building contracts for the supply and installation of acoustic treatment, including London Film Studios in Denham, the Royal Albert Hall, the Royal Festival Hall, Madame Tussauds and the Adelphi Hotel, Liverpool.

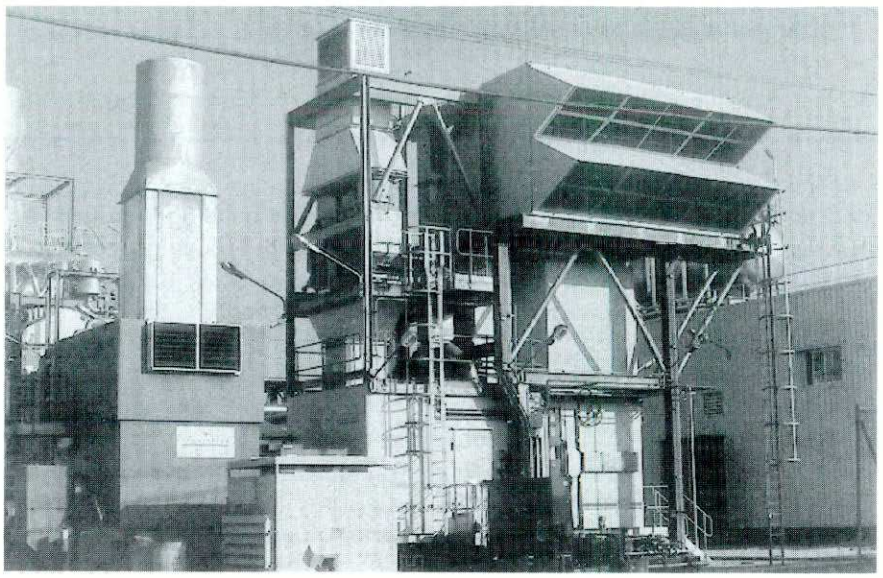
During 1936-37 Jack Cullum undertook a period of studied research into the attenuation of noise generated by the reciprocating engines and propellers used in aircraft propulsion. Just prior to the second world war there arose a need to test aircraft engines at maximum power output whilst maintaining reasonable ambient noise levels. As a consequence of Jack Cullum's contacts from his research and the company's experience in the field of noise control, the Air Ministry placed an order with H W Cullum Ltd in 1938-39 for six test cells, including intake and exhaust silencing and acoustic wall linings.

As a point of interest, early absorptive intake splitters were formed from timber frames and packed with mineral wool, the technology used being a direct spin-off from the development of the acoustic wall systems developed for cinemas. Early customers for H W Cullum Ltd aero engine test cells include some well-known names, sadly not all of which exist today, including the Air Ministry, the Royal Air Force, Napiers, DeHavilland, Rolls-Royce, Fairey Aviation, Bristol Aircraft Company and Armstrong Siddeley.

During 1943 Jack Cullum was asked to design a silencer for a 'supercharger'; it was later to become apparent that this was the code name for the W2 700 jet engine being developed by Sir Frank Whittle and his team at Power Jets Ltd in Lutterworth. H W Cullum Ltd were approached because of their knowledge and experience gained in the attenuation of noise from the reciprocating engine test cell work. It is not clear where the term 'retuner' came from but it was clearly borne out of the development of the silencer for the W2 700 jet engine and was used to describe the silencing effect achieved. It has been synonymous with jet engine silencers and the Cullum name to this day. H W Cullum Ltd manufactured and installed their first commercially



A cross-section of a typical jet test-bed Detuner showing the various sections



Acoustic package of GE LM1600 gas turbine

ordered Detuner for the DeHavilland Engine Company, Hatfield in 1943, which subsequently proved to be for the test bed for the forerunner of the Goblin jet engine.

Detuners Ltd was formed by the parent company H W Cullum Ltd in 1951 to concentrate and capitalise on the growing market for jet engine test cells based on the knowledge and experience gained in the work expedited in the previous twelve years.

With the explosive growth and development of the jet engine came ever more vigorous technological demands, in particular for test cell exhaust systems (retuners) which had to be designed for ever-increasing thrust levels and temperatures. Accordingly it was decided to form a separate company in 1959 to concentrate solely in this field; the new company was named Cullum Detuners Ltd, which has remained the company name to this day.

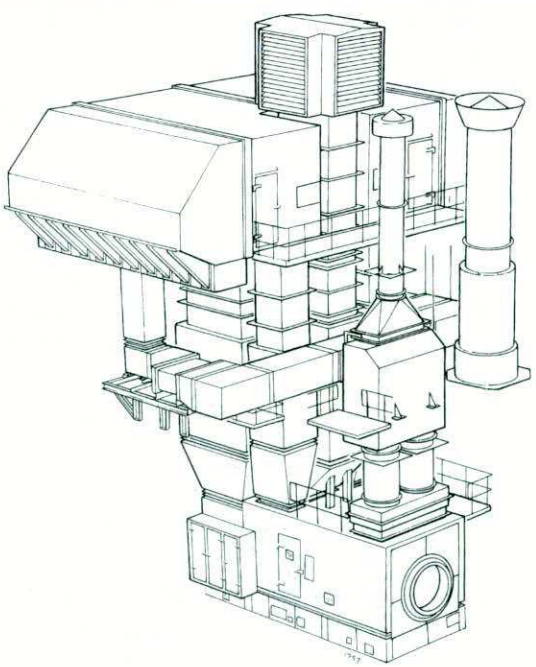
The progression from the aeronautical world to the acoustic packaging and treatment of gas turbines for power generation and mechanical drive applications started in 1972, when Cullum Detuners won a contract for the supply of acoustic packaging for two Cooper Bessemer gas compressor sets for British Gas. During this period Cullum Detuners Ltd won a contract to design and build, what was at the time, the biggest anechoic chamber in the world for the National Gas Turbine Establishment at Pyestock. Rolls-Royce of Derby was, at that time, Cullum Detuners Ltd's biggest customer and as it became evident that a manufacturing facility was required for the Pyestock project, it was decided to purchase a factory unit in Heanor, Derbyshire. The company gradually moved from London to there, where it is now wholly based.

Since the pioneering days the company has been a leading supplier of noise control equipment to the aero and gas turbine industry. Over the years the company has supplied hundreds of facilities including, engine test cells, aircraft mufflers and run-up pens for ground testing aircraft as large as the Boeing 747 and Concorde. The list also includes hush houses to limit the noise emission of a wide range of combat aircraft during ground operation.

More recently the nature of Cullum Detuners Ltd's core business has changed as a result of two major factors. These are, on the one hand, large scale global demilitarisation and, on the other, the rapid escalation of oil and gas field developments and power generation by gas fired turbines. This has meant that since 1972 a gradual shift in emphasis of the core business has taken place and Cullum Detuners Ltd have become one of the world's leading suppliers of full acoustic and filtration packages of gas turbines from 3 MW to 220 MW, for power generation and mechanical drive applications. In total, for industrial applications, equipment has been provided for some 550 installations in the UK and to 41 countries around the world.

Over the past 100 years CDL have grown up alongside six monarchs, survived two world wars and lived and learned through the greatest technological revolution in history. Throughout this time of technical sophistication and commercial change Cullum Detuners Ltd has sought to sustain traditional high standards of engineering excellence, quality and service, and it is believed to be this factor, more than any other, which has earned the respect which the company reputedly enjoys in the industry today.

Andrew Dodd AMIOA works for Cullum Detuners ❖



Acoustic package of GE LM6000 gas turbine

MEETING NOTICE

One-Day Meeting

Good Practice In Acoustical Measurements: Six Hands-On Tutorials

(Organised by the Measurement and Instrumentation Group)

9 June 1998

South Bank University, London

This meeting comprises six workshop tutorial sessions, three in the morning and three after lunch, that will be led by representatives of the National Physical Laboratory, Gracey & Associates, Brüel & Kjær (UK), CEL Instruments Ltd, AcSoft and Cirrus Research plc, on the following topics:

- *Calibration techniques for measurement microphones, and the use of the sound calibrator in calibrating sound level meters and analysers.*
- *Statistical indices, including percentile spectra, and their measurement methods.*
- *Sound power level determinations - various methods and when to use them.*
- *Use of DAT recorders for measurement applications.*
- *FFT analysers for noise measurements - synthesis errors and how to avoid them.*
- *Environmental noise measurement and unattended monitoring - wind noise and windshields, self-noise, and care of microphones.*

Certificates of attendance will be available for CPD purposes.

Meeting Organiser:

Richard Tyler FIOA (Chair, Measurement & Instrumentation Group)
CEL Instruments Ltd, Tel: 01462 422411 Fax: 01462 422511 Email: richardt@cel.ltd.uk

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GOOD PRACTICE IN ACOUSTICAL MEASUREMENTS: SIX HANDS-ON TUTORIALS: 9 June 1998

Name:

Organisation:

Address:

Tel: Fax: email:

☐ Please register me as a delegate to the one-day technical meeting and invoice me for the meeting fee which includes lunch & proceedings

☐ Members £95.00 + £16.63 VAT = £111.63 ☐ Others £125.00 + £21.88 VAT = £146.88

Please return this registration form to:

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

MEETING ANNOUNCEMENT

Musical Acoustics Group

Visit to Loughborough University

and the

Bell Foundry and Museum in Loughborough

Tuesday 16 June 1998

Loughborough, UK

The Musical Acoustics Group is reviving its tradition of meetings and visits to places, organisations and people of general interest to Group members with a one-day meeting at Loughborough. The outline programme is as follows:

10.30 Loughborough University
Dr. John Tyrer: Laser interferometry applied to musical instruments. Demonstrations and participatory workshop. You are invited to bring a musical instrument for analysis and take home a picture of its good vibrations.

13.00 Lunch

14.30 John Taylor Bell Foundry and Museum
The most up-to-date and advanced bell foundry in the UK, dating from 1784. But not all the old established technology has been discarded - look out for the mediaeval hazel stick.

16.30 Go Home

This visit will be entirely free of charge, and non-members are welcome (but may be browbeaten into joining), but please register your intention to attend with the organiser by Tuesday 9th June 1998.

Further information, registration, and travel details from the organiser:

Dr Peter F Dobbins FIOA
Hiron Cottage, Aust, South Glos., BS35 4AY
Tel: 0117 918 8056 (Day), 01454 632306 (Eve).
E-mail: InstAcoust@aol.com

or the Musical Acoustics Group web site:
http://members.aol.com/InstAcoust/Music/

or the Institute website:
http://wrangler.essex.ac.uk/ioa/

MEETING NOTICE

Environmental Noise Group

Half-day Meeting

PPG24 – Where to Now?

Wednesday 17 June 1998

Aston Science Park, Birmingham

Following Rupert Taylor's study for the DoE (now DETR), it is now time for the Institute to review the aims and objectives of PPG24, and to consider the details in it.

- Are the NEC categories really understood?
- Should NEC levels be based on WHO criteria, whatever they say?
- Should a site be classified on its ground floor noise level, whatever the proposed use, and should the effect of barriers be considered?
- Is the guidance on assessment of new sources any use at all?
- If there is one thing you would change, what would it be?

Following registration and buffet lunch at 1pm, Rupert Taylor will present a paper reporting his work for the DETR, and Bernadette McKell will present a paper outlining her concerns.

These papers will be followed by discussion in groups ending with a summary of the group discussions to establish your views. If there is a consensus of opinion that there is scope for improvement, the IOA will take up the issue with DETR.

Numbers are limited and Certificates of Attendance will be available for CPD purposes.

Meeting Organisers:

Ken Collins MIOA (Chair, Environmental Noise Group) Ashdown Environmental Ltd
Tel: 01892 770881 Fax: 01892 770885 email: kmc@ashdown-environmental.co.uk
John Hinton MIOA, Birmingham City Council, Tel: 0121 384 9030 Fax: 0121 384 9054

PPG24 – Where to Now?
17 June 1998

Name:

Organisation:

Address:

Tel: Fax: email:

☐ Please register me as a delegate to the half-day technical meeting and invoice me for the meeting fee which includes lunch & proceedings

☐ Members £52.87 inc VAT ☐ Others £64.62 inc VAT

Please return this registration form to:

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

INSTITUTE TUTORIAL

Organised in conjunction with the Building Research Station

Measurement of Sound Transmission in Buildings

Wednesday, 9 September 1998

The Building Research Station
Garston, Watford, Hertfordshire

A full day session comprising a series of lectures covering the basic theory of sound transmission, both air and structure borne, along with the British Standards that control their quantification. These will be followed by practical sessions supervised by BRE staff to allow delegates to undertake measurements and perform the calculation of the single quantities and the spectrum adaptation terms. The tutorial is intended for those having an understanding of acoustics who need to update and practice their skills.

The objective of the Tutorial is to revise the understanding of the transmission paths within both new constructions and conversions with a particular emphasis on the methods of quantification. A review of the regulations including the current status of the relevant parts of the DETR Approved Document E and the British and International Standards that it refers to will also be included.

After the lectures delegates will split into small groups to undertake a measurement sequence under real world conditions using BRE equipment. Each group will have the opportunity to make its own decisions on microphone and sound source placement and assess the impact of background noise. They will then undertake both source and receive room measurements, establish reverberation times and then return to the lecture room to use this data in the calculation of the noise rating indices.

Because of the highly practical nature of the programme numbers will have to be limited to enable each to receive the degree of support necessary to allow them to get the best out of the day. Early registration is therefore advised.

Meeting organisers are John Seller and Ian Campbell. For further information please contact the IOA headquarters or use the registration form below. Delegates will be expected to have access to copies of the relevant British Standards, details will be advised on registration.

IOA - BRE Tutorial: Measurement of Sound Transmission in Buildings: 9 September 1998

Name:
Address:

Tel: Fax: E-mail:

Please register me as a delegate and invoice me for the tutorial fee, which includes lunch. Members (including those of associated Institutions) £125 and others £130 all excluding VAT.

Please return this form to:

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

CALLS FOR PAPERS

One-day Meeting

Building for a Sound Education

(Organised by the Building Acoustics Group)

Wednesday 23 September 1998

London Venue

This one day meeting will focus on present and future standards for education buildings and their implications. It is intended to be wide ranging, covering design criteria and the effects of the acoustic environment on teaching and learning. Specific types of buildings will be discussed including music schools and schools for the hearing impaired. A presentation will be given of the new DfEE Building Bulletins 86 and 87, *Music Accommodation in Secondary Schools* and *Guidance for Environmental Design in Schools*, together with current research on classroom acoustics.

Offers of contributions covering issues described above are invited. These should be sent in the form of a brief abstract (100 - 200 words) before 12 June 1998.

Please send abstracts to and for further information please contact:

Stephen Chiles Tel: 0171 636 2853 Fax: 0171 465 3665 email: stephen.chiles@arup.com or Raf Orlowski Tel: 01223 355033 Fax: 01223 61258 email: raf.orlowski@arup.com

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14th Residential Week-end Conference

Reproduced Sound 14

'Surrounded by Sound'

22 – 25 October 1998

Windermere Hydro Hotel

Offers of papers are invited on topics relating to the following:

• Broadcast • Studio Design • Control Rooms • Audio in Themed Venues • • Internet Audio • Monitoring Loudspeakers • Audio Processing •

Please send abstracts of not more than 200 words to the Institute office by 26 June 1998. Notification of acceptance will be mailed by 27 July.
Papers which the authors wish to have refereed must be submitted by 7 August. Final papers for the proceedings must be received by 21 September 1998.

Technical Programme Committee Chairman: Julian Wright FIOA

Organised in collaboration with APRS, AES, ISCE & PLASA

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

CALL FOR PAPERS

1998 Autumn Conference

Speech & Hearing

12 – 15 November 1998

Windermere Hydro Hotel

Offers are invited of papers on topics relating to speech and hearing including:

Phonetics
Speech Analysis
Auditory Models
Speech Synthesis
Speech Perception
Human-Computer Interaction
Speech Aids for the Handicapped
Speech, Speaker and Language Recognition

There will be keynote lectures, oral and poster sessions, and a special young researcher session with a prize for the best presentation.

Please send abstracts of not more than 200 words to the Chairman of the Organising Committee as soon as possible.

Papers which the authors wish to have refereed must be submitted by 15 June. Final papers for printing in Volume 20 of the Proceedings of the Institute of Acoustics (1998) must be received by 14 September 1998; word processing layout instructions will be provided for this purpose

Chairman of the Organising Committee:

Professor W A Ainsworth FIOA
Department of Communication and Neuroscience
Keele University
Keele, Staffs ST5 5BG
Tel: 01732 533056
Fax: 01782 583055
email: w.a.ainsworth@keele.ac.uk

CALL FOR PAPERS

International Conference on

Sonar Signal Processing

(Organised by the Underwater Acoustics Group)

Weymouth, UK

21 – 23 December 1998

This will be the fifth in a series of conferences on Signal Processing in Sonar. Much of what was said in the previous Calls for Papers is equally true today – the rapid development in hardware, the reduced size and increased power of processors, and the insatiable demands of the engineers designing the signal processing systems. The purpose of the conference will be to review the present state of this rapidly-developing subject and to report on new developments and future trends. Particular themes of the conference include, but are not restricted to:

• modelling •
• image processing •
• time-frequency methods •
• synthetic aperture sonar •
• arrays, beamforming and high resolution techniques •

As previously, the presentation of practical systems and results will be encouraged and a poster / demonstration session will be a key feature of the conference. Prospective authors should indicate whether their proposed paper is better suited to oral or poster presentation.

Prospective authors are invited to submit a 200-word abstract as soon as possible. Successful authors will be notified by mid-June 1998. Complete manuscripts may be up to 8 pages long, including diagrams, and must be prepared in the correct camera-ready format (a WORD template file will be available). Manuscripts must be in the hands of the conference secretary by 30 October 1998; those arriving after this date will not be printed. The conference proceedings will be published in book form in Volume 20 of the Proceedings of the Institute of Acoustics (1998), and copies will be available at the beginning of the conference.

The conference will take place at the Prince Regent Hotel, which is situated on Weymouth seafront. Full board and accommodation will be available.

For further information, and the address to which abstracts should be sent:

Professor Hugh Griffiths FIOA
Department of Electronic and Electrical Engineering
University College London
Torrington Place
London WC1E 7JE, UK
tel: (44) 171 380 7310 fax: (44) 171 387 4350

MEMBERSHIP

The following were elected to the grades shown at the Council meeting on 14 May 1998

Fellow
Shield, B M
Trevor-Jones, D

Member
Brennan, E
Budd, R W S
Dolling, R
Dowdall, M
Gandy, S J
Gentle, A E
Kelly, R O
Deters, D I
Paris, D M
Sharp, D B
Shepperson, A W
Wong, F M A

Associate Member
Fell, A D
Gregson, M R
Heffer, T A
Hill, G
Owen, C J
Parker Harding, R A
Smith, J
White, S

Associate
Cooper, R S
Norris, H

Student
Anderson, G A L
Gilbey, S G
Hubbuck, E R
Phillips, P G
Songer, H J

Sponsoring Organisation
Castle Group Ltd

INSTITUTE DIARY 1998

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

9 JUN
Instrumentation & Measurement Group One-day Meeting
Good Practice in Acoustical Measurements and **1998 Institute AGM**
London

10 JUN
Midlands Branch Evening Meeting
Motor Sport Noise
Donnington Park

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

16 JUN
Musical Acoustics Group
Visit to Loughborough University and Bell Foundry and Museum
Loughborough

17 JUN
Environmental Noise Group
Half-day Meeting
PPG24 - Where to Now
Birmingham

17 JUN
London Branch Evening Meeting Industrial Noise: Power, Screech and Bang
NESCOT

18 - 19 JUN
Diploma examinations
Accredited Centres

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

20 - 21 JUL
Underwater Acoustic Calibration and Measurements Symposium
Underwater Acoustics Group
National Physical Laboratory

9 SEP
IOA Tutorial Meeting
Measurement of Sound Transmission in Buildings
BRE, Watford

17 SEP
IOA Publications, Meetings Committee
St Albans

23 SEP
Building Acoustics Group Meeting
Building for a Sound Education
London

24 SEP
IOA Membership, Education Committee
St Albans

1 OCT
IOA Medals & Awards, Council
St Albans

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

22 - 25 OCT
Reproduced Sound 14
Electroacoustics Group Conference
Windermere

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

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

10 NOV
Instrumentation & Measurement Group One-day Meeting
Measurement Protocols: Noise Measurement in Buildings
London

12 NOV
IOA Publications, Meetings Committee
St Albans

12 - 15 NOV
Autumn Conference: Speech & Hearing
Speech Group
Windermere

3 DEC
IOA Membership, Education Committee
St Albans

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

10 DEC
IOA Medals & Awards, Council
St Albans

21 - 23 DEC
Sonar Signal Processing
Underwater Acoustics Group Conference
Weymouth

1998 Membership Fees

Members who have not yet paid their 1998 membership fees are asked to do so without further delay.

1998 Institute AGM

5pm Tuesday 9 June 1998

South Bank University, London

Sale of IOA Proceedings

Over the years a considerable stock of Proceedings has built up. In order to reduce this stock, prices have been reduced considerably.
Use the order form enclosed or contact the office for further details.
Fax: 01727 850553

Branch News

North-west Branch

On 21 January Cliff Inman FIOA of the Cliff Inman Consultancy spoke at the Branch evening meeting on the subject of *Recent advances in glazing technology*. He started by pointing out that most sound insulation packages are based on the Noise Insulation Regulations and hence are designed specifically with road traffic noise in mind. Accordingly he warned the audience to take the spectral characteristics of the source being treated into consideration when designing a sound insulation package. The level of insulation, he pointed out, is often determined by resonances which can be panel resonances, that is to say low frequency resonances dependent on panel size, or a coincidence resonance which is a higher frequency effect dependent on panel thickness. Having presented some basic groundwork Cliff went on to describe the characteristics of laminated glass which, by providing an energy absorptive layer, can reduce the adverse effects of coincidence resonance.

A recent advance that he described uses a resin-filled unit which shifts the resonance to higher frequencies and, hopefully, out of harms way. Whilst there are definite advantages in using glass of different thickness in a double glazed unit, he quoted results that showed that the type of frame made no real difference to the resulting sound insulation, an observation that appeared to fly in the face of popular belief. He also showed results that reminded the audience of the catastrophic effects that can arise from even small air gaps around the glazing. A 1% gap, for example, could cause a reduction of 10 dB in the overall insulation.

Moving on to the latest technology, Cliff referred to sulphur hexafluoride (SF6) as a gas filling which gives improvements of about 10 dB in the middle frequencies. He pointed out that problems can occur at the lower frequencies and that combinations with that filling can be very poor in the region of 200 Hz. More problematically, because of the way sound insulation is rated using BS 5821, the resulting single figure rating, R_w, could disguise that fact. He concluded a very interesting and informative talk by saying 'A straightforward 10/12/6 unit is a damn good unit'.

Paul Freeborn FIOA

Midlands Branch

The Midlands Branch started its 1998 programme with an evening meeting on Thursday 19 March. The Branch was a guest of The Convent Hospital, Sherwood in Nottingham where Rosie Hayes gave a stimulating presentation on *Hearing tests in the workplace* which prompted a wide ranging question and answer session. Rosie is the Head Audiologist for Hear and There, an independent audiometric testing company. PC Werth sponsored an excellent and generous buffet and demonstrated both state-of-the art audiometers and the range of Quest Sound Level Meters.

The next Branch meeting will be another evening meeting on 10 June; this time at Donington Park Motor Racing Circuit. Mike Fillery will be explaining the background to the drive-by noise control system that has proved its worth since it was introduced in 1993. As the circuit will be in operation the on-line drive-by monitoring system will be seen in action plus the chance to see some track action for free. Cirrus Instruments, who provided the drive-by monitoring system, have promised to provide the buffet. All this plus two hours CPD – an evening not to be missed.

Mike Fillery MIOA

Eastern Branch

The Branch is now in its tenth year of operation, and the fifth annual dinner took place on 24 April at the Conference Centre of the University of Essex in Colchester. Some 30 people sat down to dinner in the grand surroundings of Wivenhoe House.

The Branch were very pleased to welcome the President Bernard Berry, the President-Elect Ian Campbell, and Chief Executive Roy Bratby accompanied by their wives.

The guest speaker, Bernard Berry, gave an amusing account of his experiences over the last two busy years as President, not least in being involved in three Inter-Noise events in different parts of the world.

The evening extended into the night with jovial gatherings in the well appointed bar, to round off a very happy occasion.

David Bull FIOA

Citations

Jim Griffiths Tyndall Medal 1998

Jim Griffiths obtained a Higher National Certificate in Applied Physics, to which he added endorsements in Instrumentation, Solid State Physics and Electronics. He later studied for, and was awarded, the Institute's Diploma in Acoustics and Noise Control.

Between 1974 and 1988, Jim was employed by the Greater London Council's Scientific Branch which later became London Scientific Services. During this period of employment, Jim attained the grade of Senior Consultant in the Acoustics Team and progressed his career in consultancy. In addition to handling a wide range of projects in the fields of road traffic and aircraft noise, health and safety, building acoustics and vibration condition monitoring, it was at the GLC/LSS that Jim developed his special expertise in the subject of entertainment noise. Whether or not this interest resulted from his own pastime as a noisy lead guitarist is a matter for conjecture! This new field included the monitoring and control of some of the largest pop concerts held in the United Kingdom, such as at Wembley Stadium, Knebworth, and various football stadia. He designed noise control procedures, including the 'Shaped Spectrum' which was used to determine the sound propagation characteristics

of a venue. He was retained by promoters such as Harvey Goldsmith and artistes such as David Bowie.

Jim joined Travers Morgan Ltd, now Symonds Travers Morgan, in 1988 as a Senior Consultant. He has since been promoted to Associate Director and in 1992 to Director of Acoustics, with full responsibility for the acoustics team based in East Grinstead. His management duties include the planning of technical and business development strategies and the preparation and presentation of major bids to prospective clients. He has continued his direct involvement in all technical aspects of consultancy work in acoustics, noise and vibration. This has included the management of numerous innovative projects, as well as presenting expert evidence at legal proceedings, public inquiries and House of Commons Select Committees. One of many such projects was the co-ordination of rail noise and vibration advice for seventeen local authorities affected by the proposed route of the Channel Tunnel Rail Link. Over the last three years, he has also been heavily involved in the Heathrow Terminal 5 public inquiry. Jim's specialisation in the control of entertainment noise has continued, and he has now built up an international reputation in this field. In 1990 he was responsible for the design of the Wembley Stadium sound system, which cost £1,000,000 and has been used by all artistes who have performed there since. Major artistes with whom he has worked in recent years include the Rolling Stones, Oasis, Michael Jackson and Madonna, with whom Jim apparently has a mutual understanding! He is also a specialist adviser to the Noise Council.

Jim Griffiths has lectured on subjects such as vibration, entertainment noise and health and safety at seminars organised for Environmental Health Officers, Civil Engineers and the Home Office. Since 1985 he has written over 20 technical papers which have been presented in the UK and overseas. Jim is a Fellow of the Institute of Acoustics and a Member of the Institute of Safety and Public Protection.

The Institute of Acoustics is pleased to award the Tyndall Medal for 1998 to Jim Griffiths for his outstanding contributions to the assessment of noise impact from aviation and rail transport, and to the control of entertainment sound and noise.

Cathy Mackenzie Honorary Fellowship 1998

Most Honorary Fellows are well known within their particular disciplines; Cathy Mackenzie enjoys the distinction of being famous to all members of the Institute of Acoustics, having served as the Institute's Secretary from 1979 to 1997. Cathy's impact has been such that, for many, she and the Institute have become synonymous.

Prior to joining the Institute, Cathy had obtained her Bachelor of Art degree in Business Administration. She had worked for the Co-operative Insurance Society and held the post of Treasurer of the Edinburgh branch of the Union of Insurance Officials. Cathy had also carried out research in the field of acoustics which led to the award of her Master of Science Degree.

Cathy's appointment came at a time when the Institute

Material for the Bulletin

The editor is always pleased to receive offers of contributions to the Bulletin, particularly under the following headings:

Technical contributions
(3000 to 5000 words plus artwork)
Technical notes *(Perhaps 1000 words)*
Commentaries on conferences attended
Consultancy spotlight
Letters to the editor
News of research projects and grants
Personnel changes

Also offers are invited for a new section entitled *What would you have done?* In this members describe acoustic situations where they have been uncertain about the line they or others have taken. This could be, for example, in respect of measurement procedures or legislative aspects.

was experiencing serious financial difficulties, only five years after it had been founded and three since becoming a fully professional body. Her immediate tasks were to set up a new home for the Institute's headquarters, at Heriot Watt University, and to set about stabilising the Institute's finances. Whilst getting to grips with these matters, Cathy commenced the process of guiding the expansion of activities and services. These included the organisation of meetings and conferences and the development of educational programmes. Perhaps worthy of special note, amongst many achievements, were the organisation of Inter-Noise 83 in Edinburgh, the introduction of the annual Autumn and Reproduced Sound Conferences at Windermere, and managing the expansion of the Institute's Diploma in Acoustics and Noise Control.

In 1989, she supervised the transfer of the Institute's headquarters to St Albans. By now the membership had grown substantially, and the process of expansion was continuing unabated. The meetings programme was ever more varied and popular, educational initiatives were being implemented such as the Certificates of Competence and the Tutored Distance Learning Programme, Acoustics Bulletin was modernised and increased in size and frequency, the Institute Register was introduced as an annual publication, links were being forged with outside bodies such as the Engineering Council and the European Acoustics Association, and the Institute's CPD scheme was inaugurated. In 1996, she coped with one of the most demanding tasks ever undertaken by the Institute, namely the organisation of the Inter-Noise 96 Congress which has been acknowledged as the best ever to that date. Meanwhile, the efficient running of the Institute office has continued, the many needs of the extensive network of committees have been attended to, and the membership has now reached about four times that which she inherited in 1979.

Cathy will be the first to acknowledge the help of others in the achievements which have been made. These notably include the tireless support of Roy Lawrence and the assistance of the dedicated staff which Cathy has built up at the St Albans office. The voluntary help provided by members of Council and the many Committees have also played their part. Nonetheless, it is Cathy's farsightedness and her ability to cope with whatever has been thrown at her which form the foundations upon which the Institute's success has been built.

It is with especial pleasure that the Institute of Acoustics awards an Honorary Fellowship to Cathy Mackenzie for her outstanding service to the Institute.

IOA Tutorials

The traditional pattern of meetings organised by the Institute has been predominantly of a scientific nature that are designed to give researchers a chance to present new work and for their colleagues to keep abreast of developments in the various fields that interest them. In parallel with these we have seen the growing popularity of workshops. These are less formal and are structured in such a way as to allow members to come along to either practice new techniques or to contribute to general discussion; these discussions often relate to the development of standards, codes of practice or similar documents. All of this activity is an overlay to the education activities undertaken by the Institute and is of course seen as an important part of post-qualification activity, all of which is becoming more established through the Institute's CPD programme.

A need has been recognised for an additional activity that fits in between the formal qualification process and the current meetings programme. This stems from the fact that acoustics is a multi-disciplinary profession and staff move from one specialisation to another and will need to bring themselves up-to-date in different facets of the subject. It is not formal re-qualification, nor is it assimilating new work that will meet this need. The midground is seen as IOA Tutorials, presented by acknowledged experts in various aspects of acoustics in which there is rapid growth or interest among the membership.

The first session will be very much a trial; it will be based upon the growing need for the measurement of sound transmission in buildings and has been commissioned from the Building Research Station. Those who are completely new to the topic would naturally be best served by following the proposed new Certificate of Competence in the Measurement of Sound Transmission in Buildings. For those returning to the subject the one-day Tutorial may be more appropriate. A meeting notice for the first IOA Tutorial is included in the blue pages of this issue of the Bulletin.

The full day session will comprise a series of lectures covering the standards and theory of sound transmission, both airborne and structure borne. This will be followed by practical sessions supervised by BRE staff to allow delegates to undertake measurements and perform the calculation of the single number quantities and the spectrum adaptation terms. The objective of the Tutorial is to revise the understanding of the transmission paths within both new constructions and conversions with a particular emphasis on the methods of quantification. A review of the regulations including the current status of the relevant sections of the DoE approved document E and the British Standards that it refers to will be included.

After the lecture sessions the delegates will be split into small groups to undertake a measurement sequence under real world conditions using BRE equipment. Each group will have the opportunity to make its own decisions on microphone and sound source placement and assess the impact of background noise. They will then undertake both source and receiving room measurements, establish reverberation times and then return to the lecture room to use this data in the calculation of the noise rating indices.

If the format proves to be successful a number of other topics have been identified and the programme can easily be expanded as part of the development of services that the Institute is undertaking for its members.

Ian Campbell MIOA ❖

Hansard

9 February 1998
Vehicle Stereo Systems: Excessive Noise
Viscount Tenby asked Her Majesty's Government:
What action they propose to take to curb the noise stemming from the use of excessively loud stereo sound systems in vehicles.
The Parliamentary Under-Secretary of State, Department of the Environment, Transport and the Regions (Baroness Hayman): Excessive noise from vehicle stereo systems is a small, but growing problem causing unnecessary and annoying noise nuisance. The department is in the process of preparing amendments to Regulation 97 of the Road Vehicles (Construction & Use) Regulations 1986, relating to excessive noise from road vehicles, to address this issue.

17 February 1998
Ashley Heath
Mr Chope: To ask the Secretary of State for the Environment, Transport and the Regions (1) what additional cost has been incurred compared with budget forecasts as a result of errors made in the calculation of noise predictions in respect of the A31 road improvement at Ashley Heath; (2) what were the noise predictions made before construction started on the A31 Ashley Heath improvement in respect of the impact upon properties in St Ives Wood; and what were the noise levels recorded after construction was complete; (3) how many claims for purchase or compensation have been made by householders in respect of the impact of the A31 Ashley Heath improvement; and how many have so far been settled, and at what cost; (4) what forecast was made prior to construction of the cost of claims for purchase or compensation for landholders affected by the A31 Ashley Heath improvements.
Ms Glenda Jackson: I have asked the Chief Executive of the Highways Agency to write to the hon Member.
Letter from David York to Mr Christopher Chope, dated 17 February 1998:
The Transport Minister, Glenda Jackson, has asked the Chief Executive of the Highways Agency to reply to your recent Parliamentary Questions about the A31 Ashley Heath junction improvement. In his absence I am writing on his behalf. Estimates provided by the District Valuer before construction began for the cost of acquisition of property and compensation arising from construction of the scheme amounted to £130,000. This did not cover the cost of buying under discretionary purchase rules property which was considered to be seriously affected by traffic using the new scheme.
To date 9 interests in property needed for construction have been acquired at a cost of approx £125,000 and 95 claims for compensation for loss in value of property have been received which could cost £150,000. Property to the value of £2.6 m has been acquired because it was considered to be seriously affected but will be resold and it is expected that a large part of that sum will be recouped.
Revisiting calculations of predicted noise levels from traffic using the junction improvement led to applications for purchase of property which had previously been refused being accepted. Additional costs of about £100,000 resulted.
In accordance with the Noise Insulation Regulations, predictions of future noise levels in the vicinity of the junction were published in 1991. I will arrange for a copy of this report to be placed in the House of Commons library. No comprehensive measurement of noise levels has been made since the junction improvement has been completed although the local authority has taken several spot readings.

2 March 1998
Noise Warnings
Dr Vis: To ask the Secretary of State for the Environment, Transport and the Regions if he will introduce legislation (1) to provide for noise warnings to be displayed on (a) ghetto blasters, (b) hi-fi equipment and (c) personal stereos and (2) for dance events to be prohibited from playing music at levels above 85 decibels.
Mr Meacher: Risks from noise exposure to people who work at music events are covered by the Noise at Work Regulations 1989, while the health and safety of members of the public who attend is governed by the general requirements of the Health and Safety at Work etc Act 1974. In 1993 the Health and Safety Commission, the Home Office and the Scottish Office published a *Guide to Health, Safety and Welfare at Pop Concerts and Similar Events*. That guidance recommended that audiences should not be allowed within 3 metres of any speaker at outdoor events and that audiences should be advised in advance if the sound level is likely to exceed 96 dB(A).
The Government do not consider it appropriate to extend legislation to provide warnings on music equipment that is for personal use.

Highways (Noise Pollution)
Mr Letwin: To ask the Secretary of State for the Environment, Transport and the Regions what is his Department's policy in relation to (a) increased levels of noise from existing highways and (b) compensation for living near to such highways.
Ms Glenda Jackson: There is no legal obligation to take measures to mitigate the impact of increased levels of noise from existing highways. Nor is there any requirement to provide compensation in such cases.
Problems arising from traffic noise are among the many issues being considered as part of the current transport policy review.

3 March 1998
Roads (Noise Pollution)
Mr Randall: If he will make a statement on his Department's plans to limit noise pollution on major trunk roads.
Dr Strang: Noise pollution is being addressed in the review of the role of trunk roads in England and is being

considered with other matters in the preparation of the White Paper on integrated transport.

Mr Randall: I thank the Minister for his reply. What assurances can he give my constituents, particularly those living in Ickenham close to the A40, about measures to alleviate the misery of noise pollution there?

Dr Strang: The hon Gentleman is right to focus attention on that. I know how important the issue is for many of his constituents. Under the policy of previous Governments, there has been no specific provision for tackling the problem once a road has been constructed. We are considering the matter, and we will announce our decision when we publish our White Paper on integrated transport.

Fiona Mactaggart: I am glad that the matter will be covered in the White Paper. Is there any prospect that the paper will include proposals to protect people who live near existing roads, such as the A40 and M4, that have had increasing traffic in recent years and become very noisy for people nearby? If there were to be some alleviation, it would be for the first time for many years, which would be welcome to those of us who have campaigned on the matter for a long time.

Dr Strang: My hon Friend is right to point up the problem. As she knows, there is an excellent chapter on the subject in the report on transport of the royal commission on environmental protection. It is an issue of growing importance for many people and we intend to address it.

23 March 1998

Aircraft Noise

Mr Ottaway: To ask the Secretary of State for the Environment, Transport and the Regions (1) if he will make a statement on his policy on aircraft noise nuisance; (2) if it is his policy to continue to reduce aircraft noise after 2002.

Ms Glenda Jackson: The Government's policy is to minimise the impact of airports on the environment while ensuring that land use planning and conservation policies take account of the economic benefits of maintaining a strong and competitive British airline industry and providing sufficient airport capacity where it is economically and environmentally justified. This necessarily involves striking a balance between the needs of an efficient aviation industry, providing jobs and serving the local, regional and national economy and the need to minimise the impact on the environment and the communities around airports. There has been a substantial improvement in the noise climate around Heathrow over the past two decades, which has been accelerated since 1990 by the compulsory progressive phase-out of Chapter 2 jet aircraft, a process due to be completed by 31 March 2002. While this makes the securing of further improvement all the more challenging, the Government are committed to doing everything practicable to ensure that the noise climate around the airport continues to improve after 2002. We have given local people around Heathrow an additional commitment to take all practicable steps to prevent a deterioration in the noise climate after the Chapter 2 phase-out is complete.

Mr. Ottaway: To ask the Secretary of State for the Environment, Transport and the Regions how often he meets the BAA and airline representatives to discuss aircraft noise from planes using Heathrow Airport.

Ms Glenda Jackson: DETR Ministers meet with airline representatives and BAA plc from time to time to discuss a wide range of matters, including the nuisance caused by aircraft landing and taking off at Heathrow.

8 April 1998

Noise

Dr Starkey: To ask the Secretary of State for the Environment, Transport and the Regions what regulations are in place for limiting noise levels in public places with particular reference to places of entertainment.

Angela Eagle: Whilst there is no legislation setting specific noise limits for audience exposure to loud sound, employers and self employed persons are required under Section 3 of the Health and Safety at Work, etc Act 1974 to ensure, so far as is reasonably practicable, that their business activities do not expose persons not in their employment to risks to their health and safety. This would include protection against risk of damage to their hearing.

BSI News

New and Revised British Standards

BS 5839: Fire detection and alarm systems for buildings.

BS 5839-8:1998 Code of practice for the design, installation and servicing of voice alarm systems. Provides recommendations for the planning, design, installation and servicing of voice alarm systems in and around buildings. This standard should be read in conjunction with BS 5839-1: 1988, BS 6259 and BS 7443. No current standard is superseded. *(Underscribe indicates the correction)*

BS EN Publications

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

BS EN ISO 140-1:1998 Requirements for laboratory test facilities with suppressed flanking transmission (ISO 140-1:1997) Supersedes BS2750-1:1980.

BS EN ISO 140-8:1998 Laboratory measurements of the reduction of transmitted impact noise by floor coverings on a heavyweight standard floor (ISO 140-8: 1997) Applies to all floor coverings, whether single or multi-layered, as installed on a standard floor. Supersedes BS 2750-8:1980.

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

BS EN ISO 389-7:1998 Reference threshold of hearing under free-field and diffuse-field listening (ISO 389-7:1996). No current standard is superseded.

BS EN ISO 8253: Acoustics – Audiometric test methods.

BS EN ISO 8253-1:1998 Basic pure tone air and bone conduction threshold audiometry (ISO 8253-1:1989) No current standard is superseded.

BS EN 60704: Household and similar electrical appli-

ances – Test code for the determination of airborne acoustical noise BS EN 60704-2-7:1998 ≡ IEC 60704-2-7:1997. Particular requirements for fans No current standard is superseded.
BS EN 60942: 1998 ≡ IEC 60942:1997 Electroacoustics – Sound calibrators. Specifies performance requirements for class 0, class 1 and class 2 calibrators under specified conditions. Supersedes BS 7189:1989, which will be withdrawn on 1 October 1998.
BS EN 61595: Multichannel digital audio tape recorder (DATR), reel-to-reel system, for professional use.
BS EN 61595-2:1998 ≡ IEC 61695-2:1997
Format B Defines the mechanical and electrical characteristics, recorded as digital audio signals on magnetic tape, to ensure programme interchangeability in professional industries. No current standard is superseded.

British Standards Withdrawn

BS 2750: Measurement of sound insulation in buildings and of building elements.
BS 2750-1:1980 Recommendations for laboratories. Superseded by BS EN ISO 140-1:1998.
BS 2750-8:1980 Laboratory measurements of the reduction of transmitted impact noise by floor coverings on a standard floor. Superseded by BS EN ISO 140-8: 1998.

New Work Started

BS EN 60076-10 Power transformers – Part 10: Determination of sound levels. Will define the sound pressure and sound intensity measurements by which sound power levels of transformers, reactors and their associated cooling auxiliaries may be determined.

International New Work Started

ISO 7235 Acoustics – Measurement procedures for ducted silencers – Insertion loss, flow noise and total pressure loss. Will revise ISO 7235.
ISO 9295 Measurement of high-frequency noise emitted by information technology and telecommunications equipment. Will revise ISO 9295.
ISO 9296 Declared noise emission values of information technology and telecommunications equipment. Will revise ISO 9296.
ISO 11205 Determination of emission sound pressure levels using sound intensity.
Acoustic insulation for pipes, valves and flanges.
Recommended practice for noise control procedures in open plant during project execution.
ISO 15762 Road vehicles – Test procedures for measuring noise generated by a deploying air bag system.
IEC 61973 Ultrasonics – Field characterisation – Test methods for the determination of thermal and mechanical exposure for the purpose of defining the safety classification of medical diagnostic ultrasonic fields.

Drafts for Public Comment

98/230265 DC Draft IEC 60076-10 Power transformers and reactors – Part 10: Determination of sound levels. (Possible new British Standard) (IEC 14/308/CD).
98/560765 DC prEN ISO 7089 Acoustics – Statistical distribution of hearing thresholds as a function of age. (Revision of ISO 7029:1994) (ISO/DIS 7029).

CENELEC Publications

EN 60942: February 1998 (IEC 60942:1997) Electroacoustics – Sound calibrators. Supersedes HD 556 S1:1991 NOTE: Implemented as BS EN 60942:1998.

DIN Publications

DIN 18165-2: 1997 Fibre insulating building materials – Impact sound insulating materials.

IEC Publications

IEC 60849: February 1998 (Edition 2) Sound systems for emergency purposes.
IEC 61161: Ultrasonic power measurement in liquids in the frequency range 0,5 MHz to 25 MHz Amendment 1: January 1998 to IEC 61161:1992.
IEC 61847: January 1998 Ultrasonics – Surgical systems – Measurement and declaration of the basic output characteristics.
This information was announced in the March and April 1998 issues of BSI Update.

Book Reviews

Audio Power Amplifier Design Handbook
Doug Self
Newnes 1996, 312pp
ISBN 0 7506 2788 3 £25.00

High Performance Audio Power Amplifiers
Ben Duncan
Newnes 1996, 456pp
ISBN 07506 2629 1 £40.00

These books are very different in character. One approaches the topic of audio power amplifier design from an analytical point of view and attempts to tie the measurable and audible defects to explicable and quantifiable physical factors. The second relates a wider range of amplifier design solutions to the heuristic and oftentimes highly subjective requirements imposed by working at much higher powers. The relative rigour of Doug Self's text is set against the more narrative approach adopted by Ben Duncan. The latter provides information about the history and success of various manufacturers and their design approaches and is very light on the analysis of cause and effect within the wide range of design approaches which are referred to. The former provides researched and documented results which could instruct competent design although this is limited to relatively modest power levels using linear amplifiers.

In the design of a blameless amplifier Doug Self justifies the approaches taken by recognising the physics of practical components. From an objective point of view a blameless amplifier is characterised by a freedom from distortion and aberrations imposed on audio signals irrespective of any load. Reliability and consistency of pro-

duction are every bit a requirement even if the power output levels required are modest, and these topics are well covered. By contrast the power output requirements for high power live music amplifiers are at least an order of magnitude greater but the design challenge remains that of attaining performance perfection whilst retaining the highest reliability.

The authors approach the topic from the opposite ends of the objective/subjective divide. The reader should read well the objectively based text whilst bearing in mind that the somewhat subjectively based approach offers gems of practical advice which only experience in the field can provide. The design of complex high power switching systems requires that the design is carefully justified. This is a topic which really requires insightful analysis but unfortunately this is not attempted by either author. Throughout the design the engineer must bear in mind not only the audio performance needs but also the legislative EMC and safety requirements and rigorous documentation of the rationale of a design forms an essential part of this process.

The reader should note that since the books went to press the relevant standards for EMC and safety have been affirmed. In addition to the global product standards which apply to mains waveform disturbances the family product standard for EMC is EN 55 103 and the applicable safety standard is EN 60 065. The safety standard quite explicitly notes that the use of 4 mm plugs – so called banana plugs and terminal binding posts – do not satisfy the safety requirements. The output terminals of high power amplifiers may readily achieve live voltages and this does limit the choice of connectors which will allow conformity to standards. Note that where the rated current taken from the mains exceeds 16 Amps permission is, in principle, required from a local electricity generating supply company before connection is attempted!

The continuing debate over audio power amplifier design has resulted in a challenge on engineers to improve the technology to the point where further gains in performance, while representing a creeping advancement of engineering skill, are arguably of infinitesimal auditive value.

In summary a good read which should inform a competently educated design engineer and which will not require significant mathematic fluency. Both should be read together and, at least from the stand point of the reviewer, a critical questing awareness of physical realities should be engaged throughout particularly during the more anecdotal sections. This is essential as the reader will often be the only person who will be able to accurately differentiate between a truth and misinformation. The truth is out there and it can not be blamed for poor sounding music.

Allen Mornington-West FIOA

Report

International INCE Working Party

Technical Assessment of the Effectiveness of Noise Walls

Executive Summary

At the INTER-NOISE 94 Congress in Yokohama, Japan, the International Institute of Noise Control Engineering (I/INCE) decided to undertake a study with the objective of obtaining a review of the technical aspects of the acoustical performance afforded by noise barriers for transportation noise sources. This initiative deals with the important physical phenomena and how to model them.

The study started in 1995 April, when members of a Working Party on the Effectiveness of Noise Walls were appointed by the Member Societies of I/INCE, and was completed in 1997.

- The main points determined by the Working Party are summarized below:
- There is a strong body of evidence to support the use of barriers as an effective method of abating transportation noise.
- The best descriptor of barrier performance is its insertion loss, which is the difference in the noise environment before and after the barrier is constructed.
- It is the collective experience of the Working Party that the most common values for A-weighted insertion loss range between about 5 to 12 dB.
- Barrier height is of fundamental importance to the effectiveness of a barrier. Proximity of source/receiver relative to the barrier is also of fundamental importance to the insertion loss provided by a barrier.
- The material used to construct barriers must be such that there is sufficient transmission loss of sound through the wall. It is also important that there be no significant air gaps in the structure nor between the barrier and the ground.
- Sound-absorbing material may be important in reducing noise between parallel reflective walls.

Reprinted by permission of I/INCE. The full text of the draft report for comment, which amounts to 22 pages and of which the above is an executive summary, appears in Noise/News International Volume 6 No 1, March 1998, published by the International Institute of Noise Control Engineering, PO Box 2469 Arlington Branch, Poughkeepsie, New York, USA. ❖

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ACOUSTICS 98 – 1998 SPRING CONFERENCE
Transportation Noise – Noise on the Move
Cranfield University, 31 March – 2 April 1998

Introduction

This was the first IOA Spring Conference since 1995 (Inter-Noise 96 accounted for the years 1996 and 1997). The venue, the university campus at Cranfield seemed strange after so many autumn conferences at the Hydro Hotel at Windermere. The main disadvantage, true of most university locations, was the open air trekking between lecture hall, catering facilities and accommodation, made somewhat more trying because of road repairs on the site. However, in spite of dull, misty, damp weather, the conference went well and the Mitchell Hall accommodation was of a high standard.

The conference was organised in collaboration with the Association of Noise Consultants (ANC) and the programme of lectures and workshops was varied and interesting, encouraging an enthusiastic participation in discussions and the workshops. As usual there was a splendid exhibition of products, on this occasion presented by AcSoft Ltd, Brüel & Kjær UK Ltd, CEL Instruments, Cirrus Research plc, Gracey & Associates, Larson Davis, LMS UK, Neutrik UK Ltd and URBIS Acoustic Products.

Special events of this conference were the awards of the Tyndall Medal to Jim Griffiths, who gave the Medal Lecture, Honorary Fellowships to Cathy Mackenzie and Frank Fahy, the 1997 Diploma Prize to Mark George and a book token to Carol Murray of the RAF Institute of Health for the best effort in the poster session.

Tyndall Medal

In something of a 'change from tradition', the 1998 Tyndall Medal was awarded to an acoustic consultant, Jim Griffiths of Symonds Travers Morgan. In his medal lecture, *Acoustic performance of entertainment venues for the millennium*, Jim reviewed the wide range of acoustic parameters and the interrelated disciplines which need to be considered when dealing with sporting and entertainment venues, particularly with large stadia. He illustrated his review with fascinating examples not only from the UK, such as Wembley Stadium and the Millenium Stadium in Cardiff, but also Hong Kong where proximity to high rise dwellings presents particular demands. He concluded a highly entertaining and informative lecture with unique visual commentary on some of the performers with whom he has worked, such as the Rolling Stones and Michael Jackson.

Technical Sessions

The following detailed descriptions of the technical sessions were largely provided by the chairmen, to whom thanks are due, with some gap filling by the reporter.

After registration and a welcoming address by the President, Bernard Berry, the conference started with a session, chaired by him, on Environmental Noise.

The opening paper entitled *The assessment of environmental noise: ISO 1996* by Ian Flindell of the University of Southampton and Nicole Porter, lately of NPL, now with Air Traffic Services Ltd, concerned progress with the complete revision of International Standard ISO 1996 *Description and measurement of environmental noise*. Nicole opened the presentation with a review of the background since the formation of the Working Group in 1996 and a summary of past activities. Ian then outlined the new approach which the UK delegation to the Working Group is developing to provide a framework of methods of assessment to be incorporated into the major revision. Nicole concluded with an introduction to the workshop session which followed later and which was planned to elicit a wide range of views on the approach which could be fed back into the Working Group's deliberations.

Wing Commander Brian Ludlow, who is Command Medical Officer (Occupational Health) at HQ Personnel and Training Command, RAF, in his interesting contribution *Are the benefits of modern transport outweighed by the health effects caused by noise?* then outlined the main health effects which are attributed to noise exposure and stressed the importance of balancing the measurable physiological outcome against the clinical significance of that outcome, before claiming the result as a health effect. He concluded that the answer to the question he posed was 'Not Yet'.

After coffee and a damp walk, the conference addressed road noise with three papers in a session chaired by Jeff G Charles of Bickerdike Allen Partners.

The first was entitled *A common European calculation standard for traffic noise, Utopia or reality?* by Doug Manvell of Brüel and Kjær and H J A Leeuven from dgmr consulting engineers bv. Doug considered the possibility of a pan-European standard for the prediction of road traffic noise. He reviewed the currently available models adopted in European countries, noting that all predicted the equivalent continuous sound level, as opposed to the UK where the CRTN computed the dB $L_{10,18h}$ value. He noted that most methods include common features and suggested that the way forward was to use ISO 9613 to compute noise propagation and incorporate the vast quantity of measured data on source noise levels. He felt we needed a common European approach and his way forward should produce a good engineering method. During questions Keith Attenborough queried the wisdom of relying on ISO 9613.

Professor Victor Krylov of Nottingham Trent University

then discussed traffic calming and the associated ground vibrations. Victor noted that there was clear road safety improvement from the use of 'speed bumps', and described his development of a theoretical method to predict the resultant groundborne vibration. The model was described and it was noted that the resultant predicted relationship between vibration and vehicle speed related well to the TRL results on speed control humps and cushions. He concluded with a review of the critical factors which determine the resultant vibration and noted how a bump with a bell-shape configuration was 20 dB lower than for other shapes.

The third paper in the session was entitled *Natural gas vehicle* and was presented by Steve Murkett. Steve described his study on a natural gas powered heavy articulated lorry for BOC/Marks & Spencer. He explained that the work derived from environmental disturbance problems experienced at night when heavy vehicles were reversing into a Marks & Spencer store in an urban location. The 320 BHP natural gas engine was designed by Varity Perkins and, when installed in an ERF tractor unit, produced in a stationary test at least 4 dB(A) less than an equivalent diesel engine. At tick-over the improvement was 7 dB(A). He showed that the frequency spectra of the gas engined vehicle contained less tonal low frequency noise. Another advantage of the natural gas engine was its greatly reduced emissions. However, a disadvantage at the moment is that the gas powered vehicle costs about £20,000 more than the standard diesel engined version. In spite of this cost penalty, because of the good noise improvements, the operator had ordered 10 more of these units. The development will be highlighted at the Millenium Show.

Dr Mike Fillery chaired a second session on road noise. This opened with a paper entitled *An investigation of vehicle accessory noise using the principle of acoustic reciprocity*. This was given by I Robinson of Ford Motor Company, SVC, S J Walsh from Loughborough University and G Stimpson from ISVR. The paper involved a a lucid account of the use of reciprocity applied to an investigation of the effect of alternator noise upon interior noise levels. The findings point towards the alternator as a significant source of mid- to high-frequency noise at higher engine speeds. The work showed that the principle of reciprocity can be used successfully for this type of investigation, although for accurate results, particularly at high frequency, care has to be taken in the positioning of the microphones.

G Harris presented a contributed paper, co-authored by Paul Nelson, both from TRL, with the title *Control of body noise from commercial vehicles*. The paper described work carried out at TRL into commercial vehicle body noise and described the background to the work with an interesting summary of the principal body noise sources from various types of commercial vehicle when travelling over uneven road surfaces, derived from both roadside studies and tests on the TRL track. A consultation draft of a guide to best practice for controlling this type of noise nuisance has been distributed to an advisory group comprising representatives from the vehi-

cle and body manufacturers, operators associations and operating engineers. Once published, hopefully in 1998, the Guide will provide advice on the control of vehicle body noise for all those responsible for the design, manufacture, maintenance and use of commercial vehicles.

After tea, conference divided into two parallel general sessions. The first, was chaired by Ralph Weston of the RAF Institute of Health. The three papers in this section provided some interesting contrasts to the main theme of the conference.

The first was presented by N Qi of Liverpool University and tackled the problem of small circulation water pumps as a source of structure-borne noise, using a domestic central heating system as an example. As was highlighted by the questions session following the presentation, structure-borne noise is a continuing problem and, as pointed out by one consultant, without a standard method of rating pumps it is difficult to lay down specifications for construction projects. The author reviewed three possible rating methods; room simulation, reception plate and free velocity. The practical aspects of the various methods were discussed and compared. Ideally, a standard test should be capable of comparing different pumps, comparing pumps with set limits, predicting the sound level when installed and assisting in the design of quieter pumps. Correlation between the methods and between the pump rating was shown to be poor. However, the authors favoured the free velocity method since it can be used to obtain details of the internal noise generating mechanism.

The second paper, *Predicted and measured low frequency response of small rooms* by S Maluski, H Bougdah, both of Sheffield Hallam University, and Professor Barry Gibbs from the University of Liverpool, was given by Stephanie Maluski. This presentation was part of work being carried out towards improving the low frequency sound insulation (below 100 Hz) of rooms. The main problem remains the poor reproducability of measurements. Some recent investigations showed that sound insulation of party walls could be dependent on the modal characterisation of the sound fields of the separate rooms. The paper reports on work to validate a simulation of the modal characteristics of a room as a prelude to an investigation of sound transmission between walls. The validation, which was carried out on a 1:4 scale model, showed promising results and indicated the choice of mesh number to model the rooms and party walls.

The third paper in this session, presented by Colin McCulloch and co-authored by J P Coyette, C Lecompte, and J L Migeot, all of LMS International, was on the use of numerical techniques for solving acoustic transparency problems. Acoustic transparency is defined as the assessment of the transmissibility of sound by vibro-acoustic interactions from one side of a structure to the other. This kind of problem is encountered in the design of all major transportation systems, including ground vehicles, aircraft and spacecraft. The presenter introduced this paper by explaining the wide range of applications and emphasised that carrying out experimental tests is expensive, especially if information on performance is required at the design stage. The paper presented a prediction transparency analysis technology using numerical modelling. The mathematical process was explained in some detail and several examples using baffled plates were shown. The methodology has been embodied in software which will be added to a general purpose FE/BE programme and will be very useful to both designers and engineers in this field.

The President chaired the second parallel session. This began with a paper on *Localisation of sound sources with sea-bed geophones*, by R J Brind, N J Goddard, both of DERA, Winfrith Technology Centre and R B Whitmarsh from the Southampton Oceanography Centre. Recent work on the use of geophone sensors on the sea bed for detecting and localising noise sources in the ocean was described in which an array of deployable sensor units for use in shallow water environments was designed, produced and tested. For the estimation of the bearing of weak sources, this work showed that the directionality of the individual sensors can be combined with that of the array to produce superior performance to an equivalent array of omnidirectional hydrophones.

Characterisation of acoustic devices for apertures, was the subject of the second paper and this was by R Lyons, R H Brown, J L Horner and B A T Petersson, all of Loughborough University. The authors presented some preliminary results from research into the characterisation of acoustic devices for apertures such as louvres.

Presentation of the 1998 Tyndall Medal to Jim Griffiths by the President, Bernard Berry

Presentation of Honorary Fellowship to Cathy Mackenzie

The work so far has provided normalised and condensed transmission data in the wave number domain which enabled qualitative and partially quantitative comparison of devices.

Following a poster session, a Workshop Session – *The assessment of environmental noise (ISO 1996)* – referred to above, was held. Ian Flindell reports that following on from the morning presentation on the current revision of ISO 1996, around 45 delegates took part in a late afternoon discussion workshop on the same topic. Steve Turner introduced a number of issues relating to the interface between the revised ISO 1996 and the prospective Institute of Environmental Assessment guidelines document to which the IOA Environmental Noise Group are making a major contribution. Steve Turner, Andy McKenzie, Bernadette McKell, Philip Wright, Brian Ludlow and Ken Collins then led discussion groups using a list of key questions prepared by Ian Flindell and Nicole Porter.

A large number of very useful points emerged from the discussions; perhaps chief among these was the need to carefully balance the degree of prescription included in the revised standard against the need to retain flexibility to deal with unique situations.

The workshop concluded with a short presentation by Bernard Berry showing how the current revision of ISO 1996 sits within the forthcoming EC noise policy working groups.

The first day concluded with a sherry reception, hosted by the exhibitors, and dinner in the Mitchell Hall.

The second day opened with Bill Stubbs chairing a session on aircraft noise. The first paper *New airport noise monitoring system at Oslo airport – Gardamoen,* by O H Bjør and G B Ese of Norsonic A/S, Lierskogen, Norway, R Gerber from Topsonic, Würselen, Germany and K H Liasjo of the Civil Aviation Administration, Oslo, Norway, was presented by G B Ese. He reported that eight fixed and three mobile terminals will give continuous information on noise levels which will be correlated with aircraft identified by radar. A dynamic trigger threshold will be used and $^1/_3$ octave levels will be obtained as well as dB(A) values.

In a paper entitled *Heathrow departures noise study* by I H Flindell of Flindell & Associates, A R McKenzie from the Hayes McKenzie Partnership, A Knowles of Heathrow Airport Ltd and K Morris from British Airways, Environment Branch, Ian Flindell described a study undertaken by Heathrow Airport and British Airways to investigate possible noise reduction from B747 departures consistent with power settings, aerodynamics and rate of climb. The study showed that small but significant improvements were technically feasible and could be programmed into the flight computer for future use.

Professor Keith Attenborough from the Open University presented a paper on the prediction of A-weighted noise levels from airport ground operations. Measurements of noise from a fixed jet engine at Hucknall and Hatfield were used as a basis for a noise pre-

The Environmental Workshop: Groups in session

diction system which was put forward at the Heathrow Terminal 5 Enquiry. Distance attenuation rates were established for acoustically neutral conditions and downwind. A comparison with CONCAWE and ISO 9613 systems was made. The paper was co-authored by Colin Cobbing and Mike Rickaby from the Environmental Services Division, London Borough of Hillingdon, Jim Griffiths and A Thompson both of Symonds Travers Morgan.

Ralph Weston then chaired a second session on aircraft noise in which there were two presentations.

The first, by Mike Lucas, was almost a keynote talk having been specially invited. Mike Lucas works for Wyle Labs in Arlington, Virginia and is carrying out aircraft noise modelling for NASA. His paper on the Rotocraft noise model shows the progress that has been made in developing a helicopter noise impact model for helicopter manufacturers, legislators and those concerned with 'noise on the ground'. The acoustic properties of the sound source are defined by two sound pressure hemispheres providing broadband and narrowband data. The model gathers together operational data, atmospheric modules, flight track data and a propagation module and uses them to output noise contours on the ground, which are suitable for inclusion in environmental impact statements or environmental assessments. The output can be presented in a wide range of recognised metrics to suit whatever local legislation is in force. The paper showed the results of a validation exercise with the XV-15 tilt rotor aircraft. Further validation is planned in conjunction with a NATO CCMS international trial in Canada in June 1998, at which the RAF Institute of Health and DERA will be contributing measurement teams on behalf of the UK. When the model has been proven, it is planned to make it freely available to all, on the Internet, and it should become a powerful tool for planners and consultants as city to city helicopter routes and landing sites are developed across Europe in the next millennium.

The second paper in this session was presented by Stephen Mitchell from NATS. The paper explained the DORA Aircraft Noise Contour Model (ANCON) and how it could be used to assess the merits of noise mitigation measures around smaller airports and allow airfield operators to embark on pro-active noise management. Noise contours at 57, 63 and 69 dB $L_{Aeq,16h}$ were presented for a theoretical airfield with towns, villages and other population concentrations illustrated by triangles and squares. The authors had shown how, by altering departure routes and operational take off procedures, the shape and areas exposed can be compared and allow mitigation to take place.

The third session on aircraft noise saw the chair switch to Paul Freeborn.

In a paper entitled *Eurofighter 2000 – health and safety considerations* by D Humpheson from the RAF Institute of Health, the author described the history of the development of the Eurofighter 2000 and looked at the differences between military and civil aircraft. He described the programme of noise measurements to be carried out, when the aircraft is operational, to assess potential hearing damage to ground crew. Noise level exposures of 135 to 140 dB(A) are anticipated. In most operational conditions the Eurofighter is expected to be no noisier than the Tornado, while the environmental noise on the ground is expected to be less than the Tornado.

In the penultimate paper, *Noise monitoring of a military training field*, by O K O Pettersen of SINTEF Trondheim, Norway, the author explained the background to a new military training field in what was previously a quiet area. He described the difficulties in meeting the noise regulations set by the State Pollution Agency. Regulatory levels have been set for various weapons and combat vehicles. Fixed, continuous noise monitoring is carried out to ensure the regulatory levels are met. The measurement system stores noise levels in a database together with met data, activity on site and any complaints received. Future developments will include neural network detection systems.

The environmental noise impact of light aircraft; a method for comparing different light aircraft types, was authored by Ralph J Weston and D Humphesen from the RAF Institute of Health. Ralph introduced the traditional methods of noise level assessment of aircraft together with WHO guidelines for people seriously affected. He emphasised the disproportionate level of complaints due to light and micro-light aircraft. The RAF use light aircraft for training and air familiarisation purposes. This involves a lot of circuit flying which can be very intrusive. He described a measurement procedure with a line of microphones running perpendicular to the flight path out

Presentation of the 1997 Diploma Prize (left to right the President, Mark George and Mike Fillery – Mark's tutor at the University of Derby)

to 300 m. These data have been used as part of the assessment process for the purchase of new, replacement, light aircraft for the RAF.

There followed the second Workshop Session of the conference which treated general aviation noise. It was led by Vernon Cole of Vernon Cole Associates, Mike House who is a consultant and Geoff Kerry from the University of Salford.

The day closed with a sherry reception hosted by the Association of Noise Consultants and the Conference Dinner at which the various presentations were made.

The third day began with a session on rail noise and this was chaired by Chris Manning of Arup Acoustics.

In his paper *Railway wear and noise*, Gunnar Rasmussen from W T Gracey & Associates, gave an interesting presentation on the monitoring of the noise from rail-wheel interaction on a train set operated by the British Columbia Rapid Transit Co Ltd. He described the track-side measurement set-up for monitoring the condition of rolling stock in a pass-by situation and outlined the effects of wheel flats and track irregularity on noise levels. A preset value of 74 dB(A) was used to determine when the train should be sent for maintenance. He discussed the use of special wheels in the effort to reduce wheel/rail noise.

Ken Ratcliffe from ISVR followed with a contribution entitled *Noise from steam trains: the Welsh Highland Railway*. In a refreshingly undemanding and fascinating talk on a subject obviously dear to his heart, Ken gave us the history of the original Ffestiniog Railway Company and its line linking Porthmadog and Blaenau Ffestiniog to service the slate industry. The current aim of this company is to re-open the Welsh Highland Railway, using steam trains, which connects with the Ffestiniog Railway in Porthmadog and passes Snowdonia on a 25 mile route to Caernarfon; trains were operated on this line until 1937. The author is involved in the Public Inquiry resulting from this proposal and he explained the background and the noise measurements made on the existing three mile section of the Welsh Highland Railway which was opened in November 1997 to serve the 1998 tourist season. One of the main worries of the local residents, who have raised the objections to the plan, is the proposed use of 61 tonne Beyer Garratt locomotives rather than the 15 tonne Alco 'Mountaineer' as used on the existing line. One of the reasons for the noise measurements was to demonstrate that, for various reasons, the heavier train was in fact quieter, thus removing this particular objection. It was shown in the evidence to the inquiry that the noise levels generated by the railway will generally meet the recommendations of the WHO and the Planning Guidance for Wales.

In the second session on rail noise Bryan Hemsworth took the chair.

Predicted acoustic effects of railway ballast was presented by P Boulanger and Keith Attenborough of the Open University and H A Holties from M + P Raadgevende ingenieurs bv, The Netherlands. This presentation

dealt with the noise generated by the rail wheel/track source and the effects that the characteristics of the ballast bedding material has on the attenuation of this noise source. A mathematical model was described which allowed the effect that modification of the acoustic properties of the ballast has on the reduction of railway noise. The study concluded that the design of the ballast can be improved but the improvement is limited due to the intrinsic sound absorbing nature of ballast. Larger porosity and larger flow resistivity can lead to lower noise levels. Further reduction of railway noise can be achieved by ballast profiling (raising a protrusion of ballast material parallel with each rail) without the need of modifying the ballast material.

This was followed by *Criteria for the environmental assessment, planning and mitigation of railway noise* given by Chris Manning of Arup Acoustics. With the renewed interest in new railways as diverse as the high speed Channel Tunnel Link, new freight depots and numerous light rail and tram systems, various criteria have been proposed for the assessment, planning and mitigation of railway noise. In this paper, Chris reviewed the approaches that have been adopted in recent years and posed a number of questions in the light of experience in attempting to apply these to actual projects. The projects he exemplified included Strathclyde CrossRail, Thameslink 2000 and the Sunderland Metro.

Victor Krylov of Nottingham Trent University then presented a paper *Generation of ground vibrations by high-speed trains travelling on soft soil.* He discussed the effects of soft soil on the ground vibrations generated by high speed trains and compared theoretical predictions with recent measurements of railway-generated ground vibration on the West-coast Main Line in Sweden. He introduced the concept of a vibration boom, analogous to an aircraft sonic boom, which he predicted should take place if train speeds exceeded the velocity of Rayleigh surface waves in the ground. The Swedish results support this theory. He suggested that the builders and operators of high speed railways should be made aware of the possible consequences of a ground vibration boom.

Ken Ratcliffe took the chair for a series of papers on Transportation Noise.

The content and purpose of *Hearing the noise you want, by design: geometrical acoustics for speech intelligibility and auralisation* by Colin F McCulloch and E de Geest of LMS International, Belgium was demonstrated very clearly at the outset by a recording of an emergency message broadcast by a PA system. In the first part of the recording the message was blurred and in the second it was clearly audible. The paper was concerned with the intelligibility of speech in enclosed spaces such as stations and airports and discussed the theoretical basis, modelling approaches and practical techniques used. After an interesting outline of the factors to be taken into account, such as coherent and incoherent sources, diffuse reflections and the transmission of sound through structures, the reasons for loss of speech intelligibility, and the

use of auralisation in models, Colin summarised his conclusions. Geometrical acoustic modelling, using beam-tracing methods, offers a powerful tool for the assessment of the acoustic performance of architectural, structural and vehicle designs, at the development stage of a project. Not only sound levels but also quality parameters can be predicted. Auralising the sound received in the 'virtual space' adds a useful subjective tool to the objective results.

Rupert Thornley-Taylor of Rupert Taylor Ltd began his presentation, *Predicting the propagation of ground vibrations from underground railways,* by summarising the calculation methods for predicting vibration propagation from underground railway tunnels to nearby receptors using both theoretical and numerical modelling means. He categorised the methods as; calculation of levels of vibration using algebraic expressions for propagation; application of empirical methods, by adapting results of measurements in similar circumstances; numerical modelling of vibration propagation. This was done taking full account of all relevant physical properties of the soil, source and receiving structures. He concluded that the appropriate method is dependant on the complexity of the site and the purpose for which the predictions are to be used.

FEM and FDM methods were recommended where geological conditions were not too complex for algebraic predictions. Numerical models, it was noted, should be validated against cases that can be solved analytically and, where possible against actual data from underground railways.

Colin Cobbing and Mike Rickaby, from the London Borough of Hillingdon, presented a contribution entitled *Perception and significance of transportation noise changes.* This included some of the opinions offered by witnesses at the Heathrow Terminal 5 Inquiry as Colin considered the terms *perception* and *significance* as related to transportation noise change. The question was also raised about whether a perceptible change for simple sounds would translate directly to noise indices. Evidence at the T5 Inquiry suggests that most people would discern a difference of 3 dB and possibly less between successive aircraft. It was also noted that the reference to the change of 1 dB in the glossary to PPG24 does not make it clear that it applies to sound levels or to noise indices as well.

A simplified example of the spreadsheet calculations from HIL/607 relating to aircraft was shown. The B747 Chapter 3 was about 3 dB quieter than the Chapter 2 aircraft in terms of SEL but resulted in a reduction of only 0.7 dB in terms of $L_{Aeq,16h}$. The authors examined the fact that strong representations at the T5 Inquiry were made to show that the noise climate had deteriorated despite reductions in the $L_{Aeq,16h}$ contour area. It was argued that reductions in event sound levels and number of events are not interchangeable.

The question was presented as to whether a change in noise from traffic due to a change in flow would give the same prediction, in terms of people bothered, as a change due to some other factor. An example was that of the effect of noise barriers compared with a reduced flow. It was concluded that there was some misunderstanding of the assessment of noise changes and that surveys based on steady state surveys are not adequately representing public perception.

The conference closed with the Workshop Session on *BS 6472 – evaluation of human exposure to vibration in buildings – experience and problems with measurements.* This was led by R Pierce, D Nicholl and David Fleming.

John W Tyler FIOA

Non-Institute Meetings

June 8–10, 1998: Joint EAA/EEAA Symposium Transport Noise and Vibration, Tallinn, Estonia
Contact: East-European Acoustical Association, 196158, Moskovskoe shosse 44, St Petersburg, Russia; Fax: +7 812 12 79 323; e-mail: krylspb@sovam.com

June 20–26,1998: Joint Meeting of the 16th International Congress on Acoustics (ICA) & 135th Meeting of the Acoustical Society of America (ASA), Seattle, Washington, USA
Contact: ICA/ASA '98 Secretariat, Applied Physics Laboratory, Univ of Washington, 1013 NE 40th Street, Seattle, WA 98105-6698, USA; Tel: +1 206 543-1275, Fax: +1 206 543 6785, E-mail: ICA/ASA98@apl.washington.edu

June 26–July 1, 1998: International Symposium on Musical Acoustics – ISMA 98, Leavenworth, Washington State, USA
Contact: ISMA 98 Secretariat; The Catgut Acoustical Society; 112 Essex Av, Montclair, NJ 07042, USA; Tel: +1 201 744 4029 (Thursday only); Fax: +1 201 744 9197 e-mail: catgutas@msn.com; http://www.boystown.org/isma98

September 7–9, 1998: Nordic Acoustical Meeting 98, Stockholm, Sweden
Contact: Swedish Acoustical Society, c/o Ingemansson AB, Box 47321; S-10074 Stockholm, Sweden; Fax: +46 818 2678; e-mail: nam98@ingemansson.se

October 12–16, 1998: 136th Meeting of the Acoustical Society of America, Norfolk, VA, USA
Contact: Elaine Moran, ASA, 500 Sunnyside Blvd, Woodbury, NY 11797 USA; Fax: +1 516 576 2377; e-mail: asa@aip.org

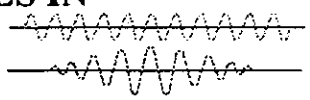
November 16–18, 1998: Inter-Noise 98, Christchurch, New Zealand
Contact: NZAS, PO Box 1181, Auckland, New Zealand, Fax: +64 9 309 3540 hhtp://www.auckland.ac.nz/internoise98/

November 20, 1998: Recreational Noise, Queenstown, New Zealand
Contact: G Morgan, ECS, PO Box 76-068, Manukau City, New Zealand, Fax: +64 9 279 8833 e-mail: grantm@ bitz.co.nz

November 22–26, 1998: Noise Effects '98, 7th International Congress on Noise as a Public Health Problem, Sydney, Australia
Contact: GPO Box 128, Sydney NSW 2001 Tel: +61 2 9262 2277 Fax: +61 2 9262 3135 e-mail: noise98@tourhosts.com.au ❖

WS ATKINS SCIENCE & TECHNOLOGY

OPPORTUNITIES IN

VIBRATION ENGINEERING 

WS Atkins PLC is one of the World's leading providers of professional, technologically based consultancy and support services with more than 8000 employees. We act for clients in a wide range of industries, including "blue chip" UK companies, the public sector and overseas organisations.

Science & Technology business unit comprises 200 staff who provide consultancy services in vibration engineering, structural analysis and mechanical integrity, safety and reliability, fluid mechanics, software engineering and other related disciplines.

In vibration engineering, we are involved in prediction, design, analysis and field investigation of vibration associated with railways, machinery, building structures, power stations, sensitive optical/microelectronic/aerospace facilities, building services, ships, shock/blast effects and much more. If it moves, we can investigate analytically or by measurement to understand, define or control the motion. Adaptability, initiative and a capacity for applying fundamental principles and developing practical solutions in a range of industries are called for.

We are seeking an additional vibration specialist to help with an increased workload at our Leatherhead Office. The qualifications and experience required for this position are as follows:

* A good degree in mechanical engineering or engineering sciences
* Two or more years experience in analysis and measurement in either

Structural dynamics		Machine vibration
Structural vibration		Vibration isolation
Environmental vibration	or	Foundation dynamics

* Ability and motivation to develop new application areas
* Commercial awareness - preferably from consultancy experience

The remuneration and benefits are commensurate with a large growing International organisation, including a profit related bonus scheme, free life assurance and assistance with re-location where appropriate.

If you are interested to find out more, please telephone David Malam, Chief Engineer, Vibration Engineering on 01372 726140 ext 4625 for an informal discussion, or alternatively write, enclosing your CV to:

Chris Munnery, Personnel Department, WS Atkins Science & Technology, Woodcote Grove, Ashley Road, Epsom Surrey, KT18 5BW.

New Products

NEUTRIK UK LTD

NC10 Digital Sound & Noise Analyser

Following the successful Audiograph and A-Series Test Sets, Neutrik have added a new unit to their range of high density quality test instruments. Utilising the latest in DSP technology, the new NC10 is one of the most versatile class one noise analysers.

Available as a single or two channel unit, the NC10 offers the complete range of level measurements including Percentiles, L_{eq}s, Impulse and Peak levels and comes equipped with A, B, C & D weighting filters.

As well as being a complete level meter the standard NC10 also offers real time third octave analysis and psychoacoustic loudness analysis. Standard features include the facility to log measurements, and an easy to use communication package allows the operator to download data to a computer for further analysis and reporting. Optional features include, 2-channel third octave FFT, RT60 and building acoustic analysis. Later this year Neutrik will be releasing further optional packages such as vibration and sound intensity analysis.

This light, rugged unit has a range of display features on its high resolution LCD or external monitor including waterfalls, and the NC10 supports industrial standard printers for immediate hard copy.

For further details contact Steve Wakelin at Neutrik (UK) Ltd, Columbia Business Park, Sherbourne Avenue, Ryde, Isle of Wight, PO33 3QD Tel: 01983 811441 Fax: 01983 811439.

TARMAC TOPBLOCK LTD

Echomaster Range

The specially developed Echomaster range sound absorbing blocks, featuring a distinctive slot in the front face, are expected to find applications in projects ranging from swimming pools and sports centres through to commercial premises, institutional buildings and locations such as lecture theatres or plant rooms.

Pivotal to their performance which is said to be five times better than ordinary dense concrete masonry, is a voided structure connecting to the slots in the face.

Pre-filled with mineral wool, Echomaster's construction allows sound waves to enter the body of the block, reducing reflection and cutting reverberation across a wide band of frequencies. Tests carried out at a NAMAS laboratory also show a measured sound reduction in excess of 40 dB.

Although all the blocks have a standard face dimension of 440 x 215 mm, specifiers can choose between the 100 mm thick Echomaster featuring a cellular construction (closed at one end) and the 140 mm hollow version where the void is continuous.

Echomaster blocks are manufactured in accordance with BS 6073 under an ISO 9002 Quality Assured production process. The blocks themselves are non-combustible with a Class 0 rating for the surface spread of flame while the mineral wool infill offers very good resistance to high temperatures.

With weights of 14.5 and 17 Kg for the two thickness the Echomaster blocks will normally be laid within loadbearing or internal partition walls above two metres from the ground. The colour is either buff or light grey depending on the factory of origin, while the close textured face is an ideal background for decoration with emulsion paints.

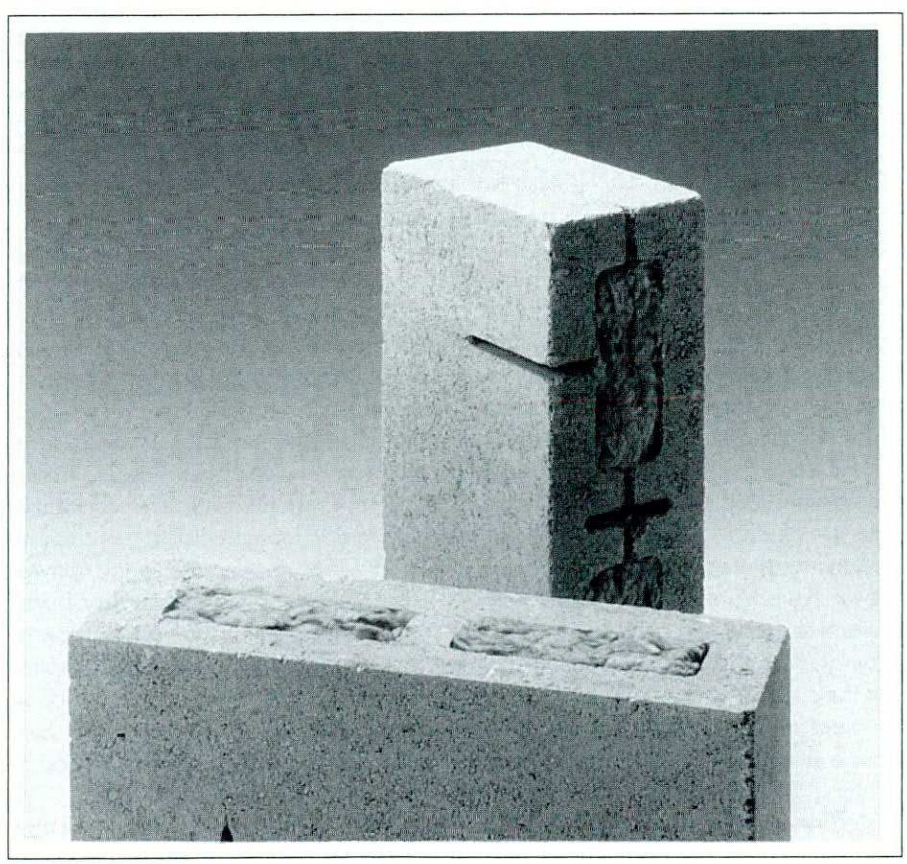
For further information contact Lindsey Willetts of Tarmac Topblock Ltd, Wergs Hall, Wergs Hall Road, Wolverhampton WV8 2HZ Tel: 01902 774151 Fax: 01902 747236.

LEADERFLUSH DOORS LTD

Audiodor Range of Acoustic Doorsets

A new slimline range of acoustic doorsets is set to replace the traditional heavyweight solution to noise reduction. Hitherto, average acoustic performance has been achieved but only at a price: by using bulky, rather unsightly doors which are cumbersome to fit and awkward to use.

Leaderflush claim that their Audiodor range offers substantially



better sound reduction capabilities of between 32 and 47 dB R_w while few doorsets today can provide in excess of 40 dB R_w and also offers a composite core that is on average 25% thinner than conventional constructions.

The 44 mm slimline profile is thus commensurately lighter, ensuring both ease of installation and operation; while its improved aesthetics are further enhanced by simple concealed sealing details.

All six doorsets in the range are tested to BS ISO 140-3 and R_w rated in accordance with ISO 717/1; they are also certified fire resistant to BS 476: Part 22.

Stated to be priced competitively, Audidor has been designed for a wide range of high traffic environments seeking to combine performance with visual appeal, such as theatres, cinemas, schools, hotels, offices and police stations.

All relevant information and technical data is contained in the new Extended Performance specification brochure.
For further information contact David Elvey, Marketing Manager, Leaderflush Doors Ltd, Langley Mills, Nottingham, NG16 4AZ Tel: 01773 536724.

NEWS

EUREMICA LTD

New UK Representative for Larson Davis Sound Level Meters

Euremica Ltd of Guisborough, Cleveland, are pleased to announce that with immediate effect, they are the new representative for the Larson Davis range of personal noise dosimeters and sound level meters.

Having secured an exclusive agreement to provide selected items into the Health, Safety and Environmental markets, and the services of Dave Neil from Larson Davis Ltd, Euremica have already begun providing customers with instruments for their needs.

Euremica can now offer the range of DSP80 Type 1 Sound Level Meters, 700 series dosimeters, including the miniature 705 Noisebadge. The 812 and 820 Type 1 Environmental meters are complete with outdoor enclosures. And finally Euremica will continue to provide the ever popular Night Nurse noise monitoring system for neighbour nuisance noise. Euremica have been established for over 30 years and will continue to offer Larson Davis customers a complete service of sales, hire, service and calibration.
For further details contact David Neil, Euremica Ltd, Instrument House, Morgan Drive, Guisborough, Cleveland TS14 7DG Tel: 01287 639266 Fax: 01287 638832.

PROSCON ENVIRONMENTAL LTD

New UK Representative for Larson Davis Analysers

ProsCon Environmental Ltd have recently been appointed to represent Larson Davis Instruments in the UK taking over from Larson Davis Instruments with immediate effect. Through ProsCon a wide range of Larson Davis products and services will continue to be available including technical support, service, repair and calibration. They also offer an extensive noise and vibration monitoring instrument hire service.

ProsCon will concentrate on the extensive range of Larson Davis real time analysers, environmental noise analysers, sound level meters and accessories, including replacement microphones and pre-amplifiers interchangeable with other leading manufacturers.

In addition to this, the continued expansion of the Larson Davis product range means that many new products are now available with many more planned for the near future. For further details on real time analysers and sound level meters, environmental noise monitoring systems with the capability for remote communications (landline and GSM modems), sound power using either sound pressure or intensity measurements or microphones, accelerometers and power supplies please contact Peter Clark, ProsCon Environmental Ltd, Abbey Mill, Station Road, Bishops Waltham, Southampton, Hants SO32 1GN Tel: 01489 891853 Fax: 01489 895488.

CAPE BOARDS LTD

Pyrok at the Royal Opera House

The acoustic performance of Pyrok cement particle panels from Cape Boards will soon be put through its paces at the redeveloped Royal Opera House in London's Covent Garden. Over 2,000 m² of the high performance panels have been incorporated into what is described as a meticulously designed cladding system which will provide exceptional sound and thermal insulation for buildings presently under construction at the world famous site.

Devised by architects Dixon Jones BDP in conjunction with Arup Acoustics, it is claimed that the external cladding will ensure outstanding sound and thermal insulation to the building envelope, allowing ballet rehearsals and performance to be held in a quiet internal environment. The acoustic performance of the new cladding system was exhaustively tested at the AIRO laboratories, with weathering tests and impact resistance established at the Taywood facility in London.

Pyrok's density of 1250 kg/m³ is higher than conventional wood based panels, which points to superior sound reduction qualities. Its acoustic capability has been proven on prestige projects as diverse as the Newcastle Arena and Hong Kong's new Chek Lap Kok airport.

Pyrok is described as a smooth, flat, highly durable and rot resistant Class 0 board for use in load-bearing applications, offering high acoustic performance together with moisture resistance, good performance in fire and excellent impact resistance.
For further information on this product contact: Jacky Holder at Cape Boards Ltd, Iver Lane, Uxbridge, Middlesex UB8 2JQ Tel: 01895 463000 Fax: 01895 259262.

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

Institute of Acoustics

BUYER'S GUIDE
FOR
ACOUSTIC MEASUREMENT INSTRUMENTATION & ACOUSTIC PRODUCTS

The Institute of Acoustics intends to publish a **Buyer's Guide for Acoustic Measurement Instrumentation and Acoustic Products** in early November this year.

The first edition, of what is expected to be an annual publication, will be approximately 100 to 120 pages in length and will be free to all members of the Institute of Acoustics. It will also be available to members of the public or other organisations who contact the Institute office for assistance regarding the possible purchase of acoustic measurement instrumentation or other acoustic products.

The Buyer's Guide is intended to be as comprehensive a document as possible and will be divided into three sections with the first two listing some 118 categories of acoustic measurement instrumentation or other acoustic products, many of which will be sub-divided into more detailed listings. Each category or sub-division will be identified numerically. The third section will provide the details of the addresses etc of the manufacturers or suppliers of the various items listed in the first two sections, with the numerical identification being used to provide a cross referencing system. This will enable a reader not only to identify and contact a firm from the numerical identification, but also to find out what other instruments or products a firm may market without reading through the whole publication.

An entry fee of £100 plus VAT will be levied per company address for companies wishing to participate in the publication.

For further information, please contact:

Keith Rose, Associate Editor, Brook Cottage, Royston Lane, Comberton, Cambs, CB3 7EE
Tel: 01223 263800 Fax: 01223 264827