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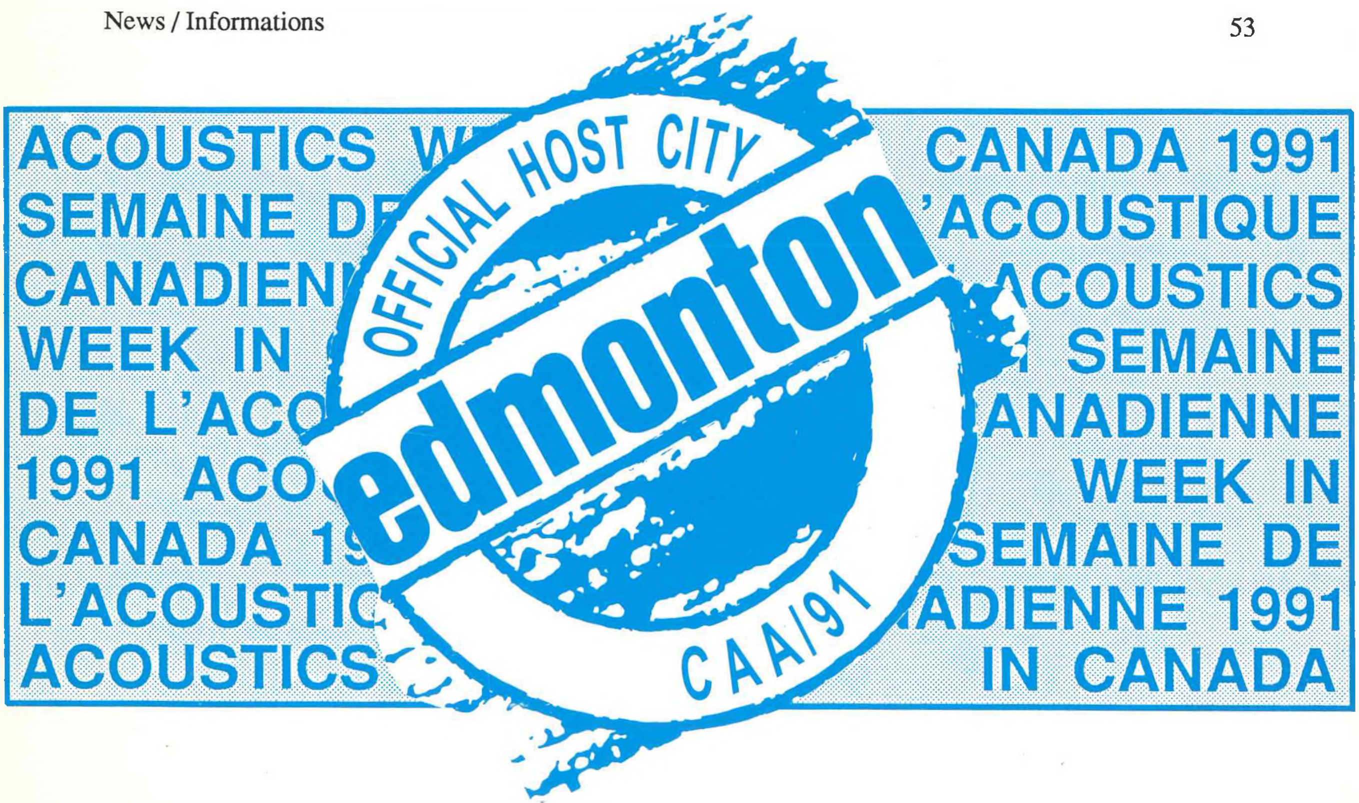

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EDITORIAL

Dans ce numéro, nous publions la seconde partie du rapport sur les vibrations des bâtiments induits par le trafic routier, un article sur l'acoustique de salles de concerts de grande renommée ainsi qu'un point de vue relatif à la surdité professionelle. Est-ce que certains d'entre vous ont noté qu'il s'agit du cinquième numéro successif dans lequel un article émanant de l'Institut de Recherche en Construction - où il semble que tout se passe - est publié? Des détails sont aussi donnés sur la Semaine Canadienne de l'Acoustique 1991 qui se tiendra à Edmonton. Soyez-y!

Dans le dernier numéro, nous avons sollicité de votre part des informations sur les programmes de formation en acoustique et vibrations au Canada, et où pourrait se trouver les divers actes et publications de l'ACA. Le taux de réponse ayant été très faible, nous réitérons notre demande (voir page 47). S'il vous plait, prenez un moment, si vous le pouvez, pour nous transmettre cette information.

Nous désirons vous informer de changements majeurs à l'Acoustique Canadienne. Tout d'abords, nous proposons de devancer d'un mois les dates de publication du journal (à mars, juillet, septembre, decembre) en débutant des le mois de septembre qui vient. Le second changement concerne la publication des actes du congrès annuel. Historiquement, cette publication a connu un succès mitigé. Nous proposons de consacrer un numéro par année (septembre - l'annuaire des membres de l'Association paraîtra dans le numéro de decembre) de l'Acoustique Canadienne en tant que 'cahier des actes'. Dorénavant, les personnes qui soumettrons un résumé pour présentation au congrès annuel seront aussi incitées à fournir un article prêt-à-copier pour publication dans ce numéro. Quant au contenu technique, ce numéro contiendra seulement ces publications, qui ne seront pas revisées. Les détails concernants la présentation spéciale de cet article de deux pages sont présentés à la page 43; ceci a été conçu afin de permettre aux auteurs de présenter le plus d'information possible d'une manière efficace et facile à lire. En guise d'exemple, vous trouverez, tel que promis récemment, trois articles d'étudiants qui se sont mérités des prix - présentés dans le nouveau format des actes. Transmettez-nous connaître vos commentaires sur ces nouvelles idées.

In this issue we publish the second part of the report on traffic-induced building vibration, a paper on the acoustics of famous concert-halls and a viewpoint related to noise-induced hearing loss. Has anyone else noted that this is the fifth issue in a row in which a paper originating from the Institute for Research in Construction - where it's apparently all happening - has appeared? Also presented are further details of Acoustics Week in Canada 1991 to be held in Edmonton. Be there!

In the last issue we requested information from you on acoustics and vibration courses in Canada, and on the whereabouts of CAA publications. The response has been poor, so we repeat our request (see pages 10 and 47). Please take a moment to provide us with this information if you can.

We would like to announce further big changes to Canadian Acoustics. First, we propose to bring forward the dates of publication of the journal by one month (to March, July, September and December), starting this September. The second change relates to the publication of proceedings of the annual conference. Historically, this has occurred with mixed success. We now propose to dedicate one issue (September - the Association membership list will appear in December) of Canadian Acoustics each year as a 'proceedings issue'. From now on, persons submitting abstracts for presentation at the annual conference will also be expected to provide a camera-ready paper for publication in this proceedings issue. As far as technical content is concerned, the issue will contain only these papers, which will not be reviewed. Details of the special two-page proceedings format to be used are presented on page 43; it is designed to allow authors to present as much information as possible in an efficient and readable manner. By way of example, this issue also publishes, as recently promised, three award-winning student papers - in the new proceedings format. Let us know if you have any comments on these new ideas.

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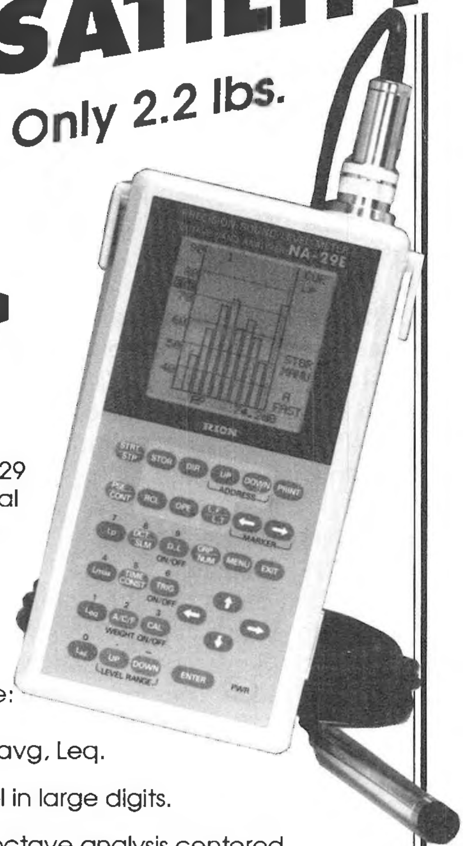

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COMPARISON OF A MULTI-PURPOSE HALL WITH THREE WELL-KNOWN CONCERT HALLS

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ABSTRACT

The results of detailed measurements are used to compare acoustical conditions in a multi-purpose hall with those in three famous concert halls. The values of five modern acoustical measures are presented for each hall. Significant differences are expected and found between the multi-purpose hall and the dedicated concert halls. The paper is intended to demonstrate the value of using extensive modern measurements to more reliably evaluate acoustical conditions in auditoria.

SOMMAIRE

Les résultats de mesures exhaustives sont utilisés pour comparer les conditions acoustiques d'une salle à usages multiples avec celles de trois salles de concert célèbres. Les valeurs de cinq mesures acoustiques de pointe sont présentées pour chaque salle. L'on prévoyait des écarts importants et on trouvait les différences entre la salle à usages multiples et les salles de concert. La présente communication vise à démontrer que les mesures exhaustives de pointe permettent d'évaluer avec plus d'efficacité les conditions acoustiques des auditoriums.

1. INTRODUCTION

The assessment of acoustical conditions in an auditorium is frequently based on the personal impressions of a single consultant with very limited objective measurement data. The purpose of this paper is to demonstrate the value of comprehensive modern objective measurements to more reliably assess acoustical conditions in large halls. To do this, extensive measurements in the Salle Wilfrid Pelletier, Place des Arts, Montreal, are compared with similar measurements in three famous classical concert halls: Boston Symphony Hall, the Amsterdam Concertgebouw, and the Vienna Musikvereinssaal.

While most would agree that the three classical halls are acoustically excellent concert halls, Salle Wilfrid Pelletier, SWP, is intended to be a multi-purpose hall. Thus, one might wish to compare it with other good multi-purpose halls. However, it is difficult to define or get agreement as to what constitutes a "good" multi-purpose hall, and it was thought to be a more interesting exercise to consider only the performance of SWP as a concert hall. Thus, the paper may be thought of as an exercise to determine why SWP is not a famous concert hall. Of course, it must always be remembered that preferred acoustical conditions in a multi-purpose hall will not be the same as for a concert hall.

The volume and number of seats in each hall are given in Table 1.

Table 1. Hall volumes and numbers of seats.

Hall	Volume, m^3	No. Seats
Salle Wilfrid Pelletier	32,100	2982
Boston Symphony Hall	18,750	2631
Vienna Musikvereinssaal	15,000	1680
Amsterdam Concertgebouw	18,770	2100

2. NEW AUDITORIUM ACOUSTICS MEASURES

The study of concert hall acoustics has made considerable progress over the past 20 years; a small number of newer auditorium acoustics measures are widely accepted as explaining almost all of the variance in subjective assessments of acoustical conditions in halls[1]. There is not complete agreement on which subset of the newer measures should be used, but the quantities that are mentioned in this paper are widely accepted and provide a comprehensive picture of conditions in a concert hall.

Measurements in all four halls were made with our RAMSoft[2] measurement system using a specially modified and calibrated blank pistol as the impulsive sound source. The measurement system consists of a program running on an IBM PC-compatible portable computer interfaced to a Norwegian Electronics type 830 two-channel real-time analyser. The values of 12 different parameters in each of six octave bands are obtained in situ at each position in the hall.

The 0.38 calibre blank pistol was modified so that it was a good approximation to an ideal omni-directional source[3]; black powder blanks are used to ensure that there is adequate energy in all the octave bands from 125 Hz to at least 4000 Hz.

The real-time analyser is used to capture, ensemble average, and filter the pulse responses which are then transferred digitally to the computer. Decay times are calculated from least squares fits to portions of the decay curves obtained by the Schroeder backwards integration technique[4]. Both the classical reverberation time, RT, measured over the decay from -5 dB to -35 dB, and the early decay time, EDT, measured over the first 10 dB of the decay are measured.

Early/late arriving sound energy ratios, C36, C50, and C80 with 36, 50 and 80 ms early time intervals are calculated. C80 values are determined as follows:

$$C80 = 10 \log\{ \int_0^{0.08} p^2(t)\,dt / \int_{0.08}^{\infty} p^2(t)\,dt \},\ \text{dB} \qquad (1)$$

where p(t) is the measured pulse response in the auditorium. The other early/late ratios are calculated in a similar manner, but with different early time limits.

The overall strength, G, is calculated as the ratio of the total measured energy in the pulse response to the energy from the same source at a distance of 10 m in a free field as given in the following equation:

$$G = 10 \log\{ \int_0^{\infty} p^2(t)\,dt / \int_0^{\infty} p_A^2(t)\,dt \},\ \text{dB} \qquad (2)$$

where $p_A^2(t)$ is the response of the source at a distance of 10 m in a free field.

The program calculates two versions of the lateral energy fraction, LF, which is the ratio of the lateral energy received by a figure-of-eight pattern microphone to the energy measured by an omni-directional microphone over the first 80 ms of the pulse response. The sensitive lobes of the figure-of-eight microphone are pointed at the side walls so that the null in the directional sensitivity is directed towards a centre stage source position. LF values are calculated as follows:

$$LF = \int_0^{0.08} p_L^2(t)\,dt / \int_0^{0.08} p^2(t)\,dt \qquad (3)$$

where $p_L(t)$ is the lateral response from the figure-of-eight microphone. The first integration is sometimes started from 0.005 seconds rather than 0.0 seconds. Both variations of LF are calculated but the differences are very small (typically 0.01 or less in the 500 Hz octave band), because the directionality of the microphone eliminates the direct sound energy arriving in the first 5 ms. Only LF values corresponding to equation (3) are included in this paper.

Values of the background noise levels, the centre time[5], and useful/detrimental sound ratios[6] are also obtained but are not discussed in this paper.

In this paper, octave band values of only five parameters are presented because others are either less commonly used or are usually highly correlated with one of these five parameters. These are: RT, EDT, G, C80, and LF. While RT is related to other physical properties of spaces, EDT values are related to subjective judgments of reverberance. G values relate to how loud a given sound source will be in a particular space and hence to the dynamic range that is possible during musical performances. C80 values relate to perceived clarity or the balance between clarity and reverberance, and LF values are related to the subjective sense of spatial impression or envelopment. In this paper, some further parameters are calculated from these five basic parameters to explore in more detail the strength of the sound arriving in the early and late parts of the impulse responses.

In each hall, measurements were made at all the combinations of three source positions and between 10 and 14 receiver positions distributed over all audience seating areas. Each measurement was calculated from an ensemble average of four pulse responses, and all measurements were for unoccupied conditions.

3. HALL MEAN VALUES

3.1 Reverberation Times, RT

Results are first examined in terms of overall mean values. These means are averages over the results obtained from

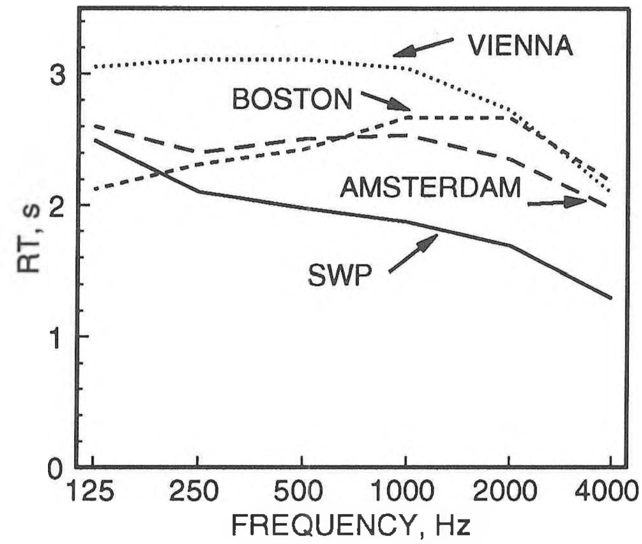

Figure 1. Comparison of hall-average RT values versus octave band frequency.

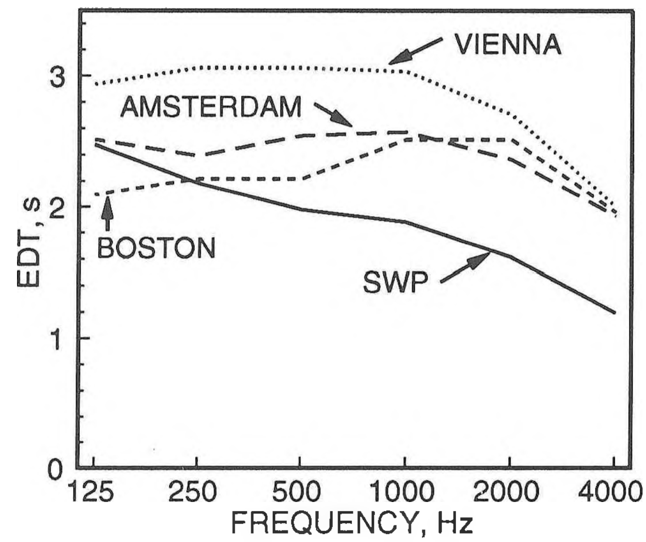

Figure 2. Comparison of hall-average EDT values versus octave band frequency.

between 30 and 42 combinations of source and receiver position in each hall. Figure 1 compares hall-average RT values for SWP and the other three halls. There are differences among the hall-mean RT values; SWP has the lowest RT values in all but the lowest octave band. At 1000 Hz, SWP is almost 1 second less reverberant than the average RT of the other three halls. This is a large difference, and SWP is less reverberant than is normally considered optimum for orchestral music. (A mid-frequency RT of approximately 2 seconds is usually considered optimum for orchestral music).

These measurements were for unoccupied conditions; it would clearly be desirable to have similar results for the occupied halls. Unfortunately, reliable RT values for occupied conditions are not available and the effect of an audience can not be calculated very accurately. Since all of the halls were unoccupied during measurements, one might assume that comparisons are completely valid. This is not strictly true because the three classical concert halls all have seats that are not very absorptive, and SWP has quite absorptive seats typical of most modern halls. Thus, the effect of an audience on RT values would be greater for the classical halls than for SWP, and one would expect that occupied RT values for SWP would be a little closer to those in the other halls. Precise corrections for the effect of an audience would have to consider the different absorptive properties of the seats. Because this information is not available, estimates of acoustical parameters for occupied conditions, which would at best be approximations, are not included in this paper.

3.2 Early Decay Times, EDT

The hall-average EDT values are shown in Figure 2. Comparison of Figures 1 and 2 shows that in these halls, mean EDT values are very similar to mean RT values. Thus, in all of these halls the perceived reverberance, as indicated by EDT values, would be very similar to that indicated by the conventional reverberation time. This is not always true and in some halls decays are markedly non-exponential, leading to differences between RT and EDT values.

The variation with frequency of EDT and centretime values has been related to perceived timbre[7]. The mean EDT values of Figure 2 show relatively lower high-frequency EDT values in SWP. However, the effects of an audience would be expected to decrease EDT values in the other three halls more at higher frequencies because of their less absorptive seats. Thus, timbre differences cannot be precisely determined from this data.

3.3 Overall Strength, G

Figure 3 compares hall average G values. Mean G values in SWP are distinctly lower than in the other halls. Mid- and low-frequency G values in SWP are approximately equal to 0 dB while in the two European halls they are close to 6 dB. Thus, the same sound source would be as much as 6 dB louder in the European halls than in SWP. Barron[7] has found that subjects respond to level differences of only a few decibels. Six decibels corresponds to a fourfold

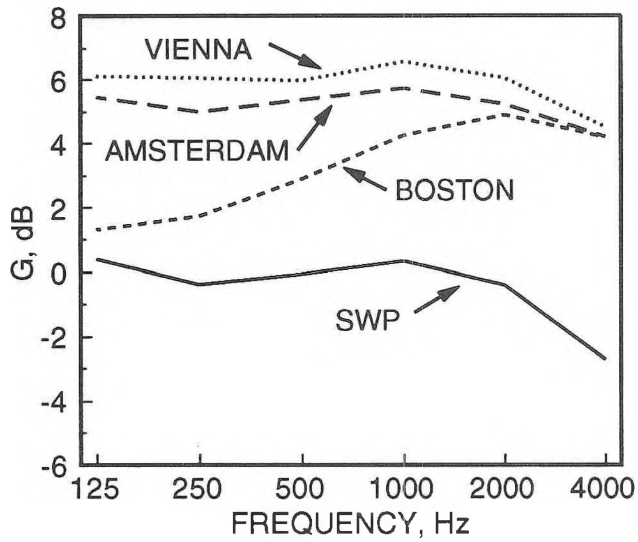

Figure 3. Comparison of hall-average G values versus octave band frequency.

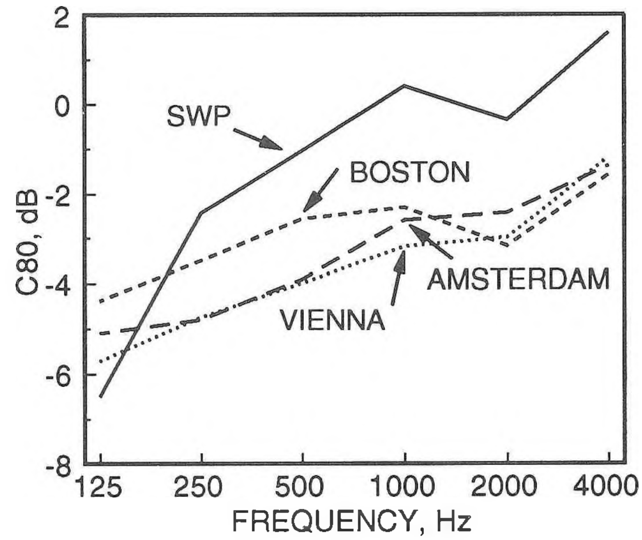

Figure 4. Comparison of hall-average C80 values versus octave band frequency.

increase in sound energy and so it can be thought of as the same as having an orchestra four times as large. Such a difference is very significant and would enable a much greater dynamic range in the music performed in the two European halls.

The Boston hall-mean G values are intermediate to those of the other halls and they vary more with frequency. Since the Boston Symphony Hall is considered one of the world's best concert halls, this may indicate that this range of G values represents what is acceptable in a good concert hall. It is also possible that G values in the Boston hall are less than optimum but other factors compensate to make this hall famous for its fine acoustics.

3.4 Early/Late Ratios, C80

The hall average C80 values in Figure 4 also show interesting differences between SWP and the other halls. In all but the lowest octave band, C80 values are largest in SWP. Thus, the sound in SWP will have more clarity than the famous concert halls. This higher clarity in SWP is probably more than is optimum for orchestral music, but perhaps is more appropriate for a multi-purpose hall.

Mean C80 values also vary with frequency more in SWP than in the other halls. The SWP mean C80 values are characterized by a prominent minimum in the 125 Hz octave band. This is due to the grazing incidence attenuation of low-frequency sound by audience seating. Although this phenomenon was discovered some time ago[8,9], its dependence on the details of an auditorium are not well understood. New results[10] suggest that the seat dip attenuation is less in halls with strong ceiling reflections. SWP has a very high reflective ceiling that is behind an acoustically transparent ceiling and various duct work. Thus, strong ceiling reflections do not occur at most seats in SWP and the low frequency seat dip attenuation is particularly pronounced.

3.5 Lateral Energy Fractions, LF

The hall-average LF values in Figure 5 show that these values are lowest in SWP. The values of this ratio in the other halls are approximately double the SWP values. Thus, the fraction of the early energy that arrives at listeners from the side is much less in SWP. Consequently, spatial impression or the sense of being immersed or surrounded by the music will be much less in this hall. Spatial impression is known to be a very important attribute of a good concert hall. The narrow rectangular shapes of the classical concert halls naturally produce relatively strong early side wall reflections. The wide fan-shaped plan of SWP makes it almost impossible to provide strong early reflections to all members of the audience. However, this plan does make it possible to seat more audience members closer to the stage, which again may be more important in a multi-purpose hall.

3.6 Early and Late Energy Levels, G80, GEL, and G(late)

The mean overall G values in Figure 3 indicated substantial differences between SWP and the other halls. It is therefore of interest to consider these differences further by

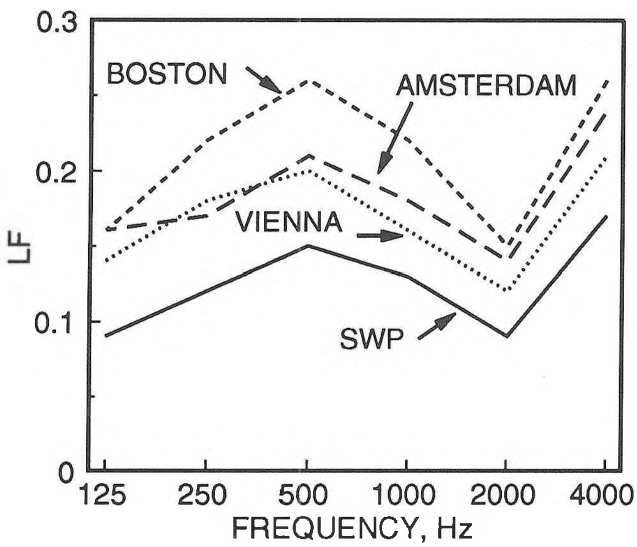

Figure 5. Comparison of hall-average LF values versus octave band frequency.

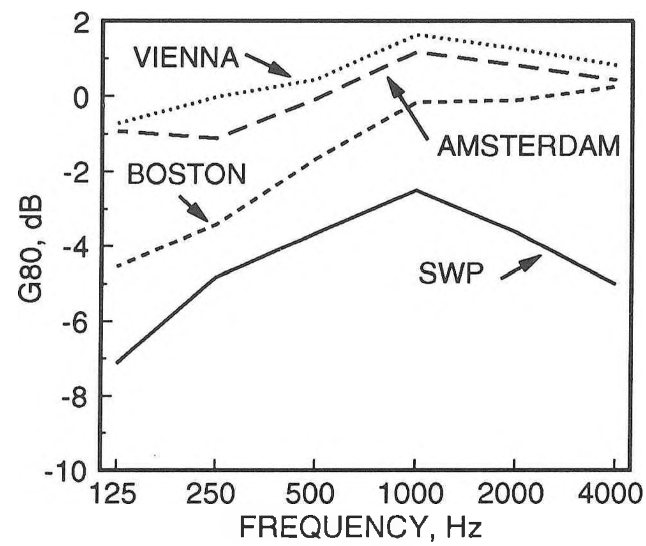

Figure 6. Comparison of hall-average G80 values versus octave band frequency.

examining the separate temporal components of the sound energy in each hall. Thus, the early, the late, or the early lateral energy are considered separately in terms of G values. G80 is the G value of the sound energy arriving within the first 80 ms after the direct sound. G(late) is the G value of the sound energy arriving more than 80 ms after the direct sound, and GEL is the G value of the early lateral energy arriving within the first 80 ms after the direct sound.

Figure 6 compares hall-average G80 values for all four halls. These early sound levels are lowest for SWP and approximately 4 dB lower than in the two European halls at mid-frequencies and even more different at lower frequencies.

Hall average GEL values in Figure 7 show that the early lateral energy is considerably smaller in SWP than in the other halls. At mid-frequencies, the mean GEL values for SWP are approximately 5 dB lower than those in the other halls. This lack of early lateral energy is a major cause of the lower LF values in this hall. GEL values were particularly low at 125 Hz where they are more than 8 dB less than in the two European halls.

Spatial impression depends on having an adequate portion of the early energy arriving from the side and also on having relatively high sound levels. Low-frequency lateral energy is particularly important for a good sense of spatial impression. Having low GEL values is evidence of a lower portion of early lateral energy, as well as having lower levels of this sound. Given that this is particularly true at lower frequencies, it is clear that the sense of spatial impression will be much less in SWP than in the other halls.

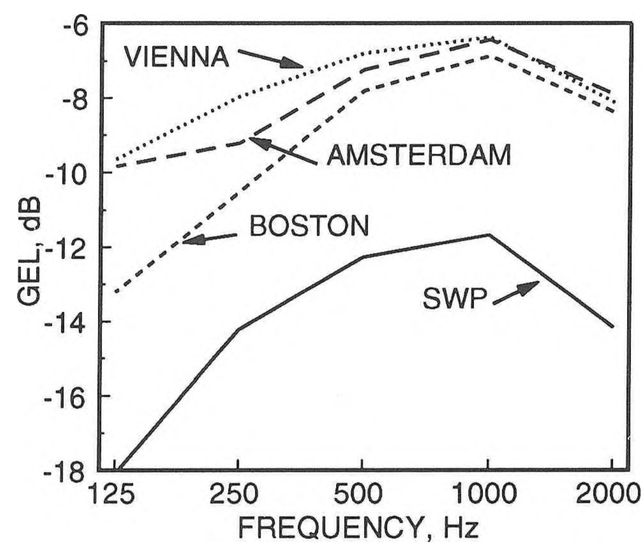

Figure 7. Comparison of hall-average GEL values versus octave band frequency.

The mean G(late) values are compared in Figure 8. These values are quite similar to the overall G values in Figure 3, indicating that the late arriving energy makes up most of the overall G values. The mean mid-frequency late energy is approximately 7 dB lower in SWP than in the two European halls. One might therefore expect a much smaller sense of reverberance in SWP than in the two European halls. It is unlikely that the added effect of audience absorption would greatly diminish this difference. Again, the Boston hall results are intermediate to the others, suggesting that lower

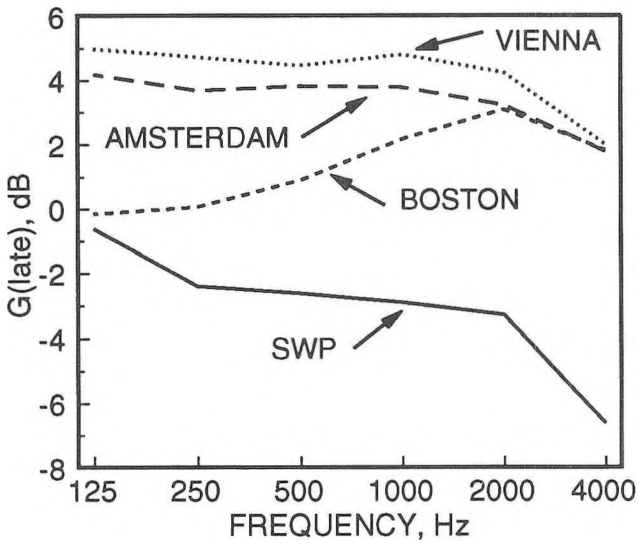

Figure 8. Comparison of hall-average G(late) values versus octave band frequency.

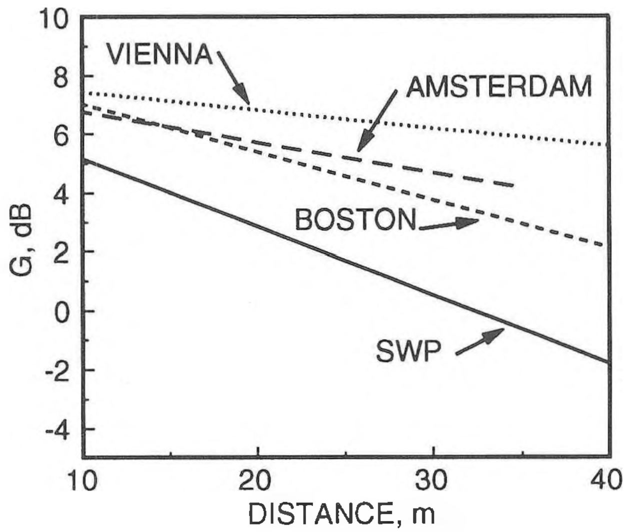

Figure 9. Linear regression lines for 1 kHz G values versus source-receiver distance.

late energy levels are, at least in some combinations of conditions, acceptable.

4. VARIATION OF LEVELS WITH DISTANCE

It is of interest to examine the variation of measured values from position to position within each hall. Some halls have larger seat-to-seat variation which is assumed to be less desirable than uniformly good conditions. In all of these halls, the within-hall variation of RT, EDT, and C80 values were all quite small. LF values tend to vary more from seat-to-seat than the other parameters and these four halls were no exception. The within hall variation of the overall sound levels was examined further by plotting G values versus source-receiver distance.

Figure 9 compares 1 kHz G values versus distance in all four halls. Only the best fit linear regression lines to the measured data have been included to simplify the comparison. In all cases, the data were well represented by the regression lines with associated standard errors of between 0.6 and 0.8 dB. As observed earlier, G values were lowest for SWP. They also decrease more rapidly with distance in SWP. The regression lines indicate that, on average, 1 kHz G values decrease at 2.3 dB/10 m in SWP, while in the Vienna hall, 1 kHz G values decrease at only 0.6 dB/10 m. These two values are close to the two extremes of decay rates that we have measured in halls. Closer seats in SWP may have G values that are 2 to 3 dB lower than the other halls, but the farthest seats have G values that are 5 to 6 dB lower. Thus, the weaker sound in SWP would be most noticeable at rear seats.

The observed decreases of overall G values with distance are in contradiction with simple diffuse field theory. In an ideal diffuse field, sound levels are essentially constant with distance in the reverberant field where the contribution of the direct sound is not significant. Although such diffuse conditions rarely occur in real rooms, diffuse field G values can be predicted by the following equation:

$$G = 10 \log\{ Q/(4\pi r^2) + 4RT/(0.161V) \} + 31, \text{dB} \qquad (9)$$

where:

V is the room volume, m^3;

Q is the directivity factor of the source and is 1 for an omni-directional source;

r is the source-receiver distance, m.

Barron and Lee[11] have developed an improved technique for predicting sound levels in concert halls that better correlates with measurements. Their procedure sums separate estimates of the contributions of the direct, early, and late arriving sound energy. All three components vary with source-receiver distance, causing predicted G values to decrease with increasing source-receiver distance. Figure 10 plots measured 1 kHz G values versus source-receiver distance in the Vienna hall. For comparison, the predictions of simple diffuse field theory and Barron and Lee's revised theory are also included. While the diffuse field theory does not agree well with measurements, Barron

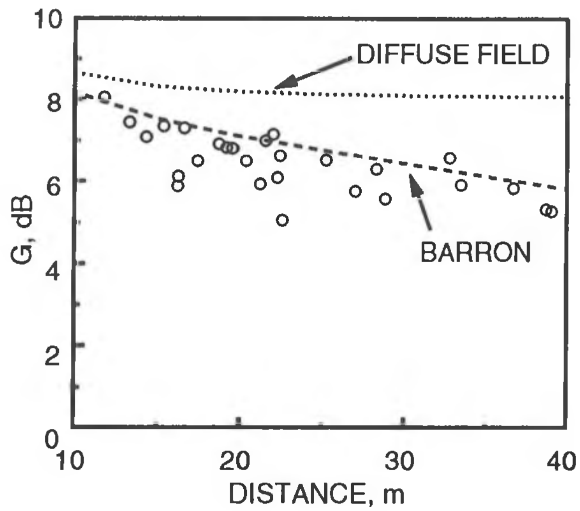

Figure 10. Comparison of measured 1 kHz G values with predictions of diffuse field theory and Barron's revised theory for the Vienna Hall.

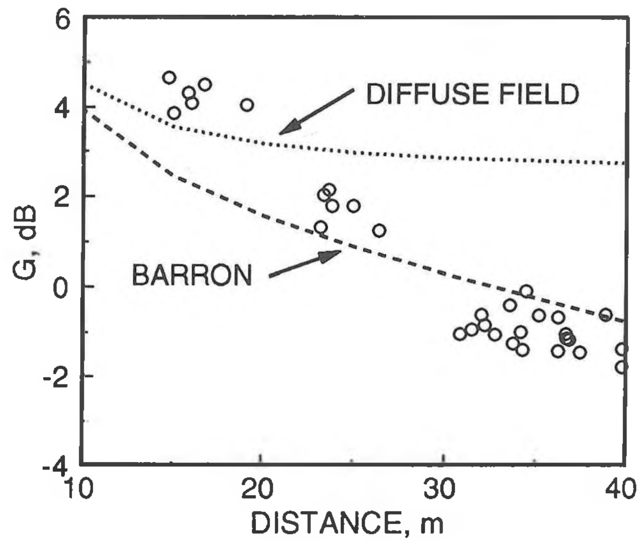

Figure 11. Comparison of measured 1 kHz G values with predictions of diffuse field theory and Barron's revised theory for SWP.

and Lee's predictions do agree well with these measurements. Similar improved agreement has been obtained with measurements in other halls.

Figure 11 shows similar comparisons for the SWP. Again, the diffuse field predictions are not acceptable, but the measured values do not agree as well with Barron and Lee's predictions for this hall. For seats closer to the stage, measured values exceed predictions by approximately 2 dB. At the farthest seats from the stage measured, values are less than predicted by about 1 dB. Conditions in SWP are less diffuse than found in many auditoria and show more variation with distance than predicted by Barron and Lee's revised theory.

5. CONCLUSIONS

In comparison with the three famous concert halls, SWP is seen to be lacking as a concert hall. The sound in SWP is first of all weaker; G values are lower by up to 6 dB. Thus, the same sound source in SWP would be weaker than in the other halls, and the dynamic range available to musicians would be less. Secondly, the sound in SWP is lacking in spatial impression compared to the other three halls. The sense of being immersed in, or surrounded by the music, which is essential to a fine concert hall, is much diminished in SWP. This was identified by lower LF and GEL values. The clarity of the sound in SWP is higher than in the other halls and there is stronger evidence of the attenuation of low-frequency early energy due to grazing incidence propagation over audience seating. Conversely, the sense of reverberance is less in SWP. EDT and RT values are generally lower, and late arriving sound levels are as much as 7 dB lower than in some of the other halls.

The geometry and materials of SWP are largely the cause of these differences. The much larger volume would relate to lower G values. The wide fan-shaped plan naturally leads to weaker early lateral reflections. The lack of strong ceiling reflections would lead to the greater decrease of sound levels with distance and to the stronger attenuation of early low frequency sounds in SWP.

These differences probably explain the major acoustical reasons why SWP is not generally considered to be a famous concert hall. However, while the other three halls are single purpose concert halls, SWP is a multi-purpose hall. The acoustical requirements for a multi-purpose hall must be a compromise between the needs of the various types of performances. Thus, at least some of these differences make the hall more suitable for other types of performances. For example, less reverberant conditions would be preferred for amplified performances and strong side wall reflections would not be needed. Seating the audience closer to the stage, for visual reasons, would then be more of a priority than lateral reflections. Although higher G values might be preferred for almost all types of performances, the smaller hall volume that this would require would again conflict with the needs of other types of performances.

A multi-purpose hall must be a balance between the needs of the various intended uses. It can be more or less acceptable as a concert hall depending on how important this particular type of use is seen to be. An optimum compromise (which is perhaps a contradiction) can only be decided in terms of the priorities of the owners and users.

The results in this paper consider only the major differences between SWP and the three classical halls. It is possible to go into much more detail in examining the within-hall variation of these properties. This can lead to a better understanding of acoustical conditions in each hall but is beyond the scope of this paper. It is also possible to evaluate the influence of particular aspects of the hall such as the removable orchestra shell. Measurements for this purpose were made and will be reported in a future paper.

Of course, the results of this paper relate only to unoccupied conditions. The addition of an audience would change conditions in these halls and the changes would be larger in the three classical concert halls because of their less absorptive seats.

The quite obvious differences that were found very clearly demonstrate the value of using thorough modern measurements to evaluate acoustical conditions in auditoria. The differences are unambiguously described in terms of objective quantities. This systematic objective assessment leads to a better overall understanding of acoustical conditions in each hall. The alternative, of largely unsubstantiated individual opinions, is simply not reliable and not acceptable.

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INVENTORY OF ASSOCIATION PROCEEDINGS AND PUBLICATIONS

The association has recently received several requests to purchase CAA proceedings and publications. These, it seems, are scattered all over the country, mainly in the hands of past conference organizers. We would now like to locate all of these documants in order to offer them for sale. We would therefore appreciate if anyone in possession of CAA proceedings and publications would get in touch with Murray Hodgson. Tel: 613-993-0102 Fax: 613-954-5984.

Canadian Acoustics / Acoustique Canadienne 19(2) 11-20 (1991) ***Research article / Article de recherche***

REMEDIAL MEASURES FOR TRAFFIC-INDUCED VIBRATIONS AT A RESIDENTIAL SITE. PART 2: FEM SIMULATIONS

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Abstract

This is a companion paper to an experimental investigation, reported earlier, of traffic-induced vibrations at a site where several complaints were lodged by homeowners residing near a roadway. The objective of the previous paper was to investigate experimentally the factors influencing the level of these vibrations and their relative quantitative importance. The present paper reports on the results of the analytical part of the study in which the role of pavement/subbase characteristics, effectiveness of vibration screening by concrete walls and soil improvement were investigated using finite element simulations.

Résumé

Ce document décrit le second volet d'une étude, signalée plus tôt, sur les vibrations produites par la circulation; cette étude avait été menée à la suite de plaintes déposées par plusieurs propriétaires de maisons situées le long d'une route. Le volet expérimental de l'étude portait sur les facteurs qui influent sur le niveau des vibrations et sur leur importance quantitative relative. Ce document fait état des résultats du volet analytique, dans lequel les auteurs ont étudié, à l'aide de simulations par éléments finis, le rôle de la chaussée-couche de fondation, l'efficacité du blocage des vibrations au moyen de murs de béton, ainsi que l'amélioration du sol.

1 INTRODUCTION

Information on the effectiveness of improving pavement/subbase characteristics to reduce traffic-induced vibrations is scarce. In the one study known to the authors, Tholen (1974) reports that ordinary variations in the nature and thickness of the pavement has negligible influence on the level of traffic-induced vibrations. One would tend to believe, however, that a rigid and massive road structure could be a valid remedy to reduce the level of traffic-induced vibrations.

The purpose of the present study is to investigate the influence of pavement/subbase characteristics on the level of traffic-induced vibrations. Screening of vibrations by a concrete wall and the effect of soil improvement using lime piles were also briefly investigated. The study was performed by means of computer simulations using the finite element method. Such an investigation would be theoretically very difficult and experimentally very expensive. Simulation using the finite element method provides a powerful and economical tool.

This study is the second and a companion part of an investigation of the effectiveness of various remedial measure of traffic-induced vibrations at a residential site (Al-Hunaidi and Rainer 1990). A full description of the site is presented there.

2 MODEL DESCRIPTION

2.1 Source

The source of vibrations is modelled as a steady state harmonic vertical point load applied at the center of the roadway. Although this type of load may not accurately represent the moving source of traffic vibrations (which may be said to fall somewhere between a line source and a point source), this approach is considered to provide a sufficiently accurate tool for performing a parametric study of pavement/subbase characteristics as they relate to traffic vibrations. For vibrations originating at a surface crack, the stationary point source is actually quite realistic since it is these vibration components that represent the major part of the induced signal (Al-Hunaidi and Rainer, 1990).

2.2 FEM Model

An axisymmetric finite element model is used to simulate the pavement/subgrade system, unless otherwise noted. Hence, it is implicitly assumed that (i) the subgrade consists of horizontal soil layers and (ii) the propagation pattern of waves generated by a vertical load on the surface of the road is axisymmetric, in spite of the fact that the system is in reality 3-dimensional. The first assumption is usually true for most sites. The second assumption was verified by a set of field experiments.

In these experiments, an electrodynamic shaker was used on a road surface to generate point load vibrations. The induced wave field was measured by a grid of vertical accelerometers placed axisymmetrically with respect to the shaker, as shown in Figure 1. Since the measured ground motion was not purely harmonic due to the presence of ambient vibration at the site, the measured signals were Fourier transformed to obtain the response that corresponds to the frequency of the excitation. For an 8 Hz excitation frequency, the accelerations at measurement stations 1, 2, 3, 4, and 5 at 10 metres from the shaker (see Figure 1) were 0.7, 1.2, 1.4, 0.9, and 1.3×10^{-3} (%g), respectively. While there exists some variation in acceleration amplitudes between these stations which are equidistant from the source, from a practical point of view the wave field could be considered sufficiently axisymmetric. The accelerations of measurement stations at 20 and 30 metres, and results of tests with 12 and 16 Hz excitation frequencies also show a similar trend.

The road section under consideration was simulated using the finite element model shown in Figure 2. The model consists of 31 x 31 axisymmetric 4-node elements. The bottom boundary of the model, located at 13.55 m, is fixed to represent a hard (rock) layer. The lateral boundary located at horizontal distance of 13.55 m from the centre line, is a consistent silent boundary (Lysmer and Waas, 1972) which simulates the infinite dimension of the site in the horizontal direction. The maximum element size in the mesh was chosen to satisfy the condition that it is less than 1/6 the shortest wavelength of interest. The shortest wave length is based on the slowest wave velocity and the maximum frequency of interest which for the present analysis was taken as 28 Hz. Material behaviour was assumed to be linearly elastic and the analysis was performed in the frequency domain. Frequency response spectra were calculated for points at 0.25, 5.05 and 12.05 metres from the source by applying unit point source load starting with an excitation frequency of 4 Hz and then incrementing it by steps of 1 Hz. Calculations were performed in double precision on an IBM 3090 computer.

Table 1
Comparison between experimental and FEM results for point source test

Frequency (Hz)	Force Amplitude (N)	Vertical Acceleration (% g)	
		Experimental	FEM
8	173.35	3.25×10^{-3}	3.73×10^{-3}
12	166.69	4.85×10^{-3}	5.03×10^{-3}
16	148.68	8.30×10^{-3}	7.75×10^{-3}

2.3 FEM Verification

The accuracy of simulations employing the finite element model shown in Figure 2 was verified by comparing numerical FEM results with those of field measurements. The test problem employed is that of a single oscillating vertical harmonic force acting at the centre of the roadway. An electrodynamic shaker was used in the field test. Vertical acceleration was recorded at a point 5.35 m from the center of the road.

The comparison between numerical and experimental acceleration amplitudes is presented in Table 1 for 8, 12 and 16 Hz excitation frequencies. Although it was not possible to reproduce exactly the conditions that prevailed in the field, numerical and experimental results show satisfactory agreement.

3 SOIL PROPERTIES

The subsoil investigation consisted of soil sampling, performing Dutch cone penetrometer test, and carrying out resonant column tests in the laboratory. The dynamic shear modulus profile as determined from the Dutch cone penetrometer test is shown in Figure 3 for the location under consideration (note: The dynamic shear modulus is obtained with the cone penetrometer by correlating the results with those of resonant column tests, using undisturbed high quality samples, as well as with cross-hole tests on Champlain Sea clay (Law, 1990)). The bulk soil density was 1.7 ton/m^3 and damping ratio from resonant column test was found to be 1.6%. At the time of performing FEM calculations, the damping ratio was not available and it was assumed to be 0.1%. Later verification tests with 1.6% showed only negligible difference of amplitude response at the fundamental frequency of the site. Poisson's ratio was taken as 0.45.

Soil layers extended to a depth of 13.5 m, where a firm layer was encountered by the penetrometer. The soil profile from the surface down is approximately as follows: (i) 1.0 m gravel/sand fill, (ii) 4.0 m grey/brown stiff weathered clay, (iii) 8.5 m medium to stiff silty clay. The water table was at 1.0 m below the ground surface.

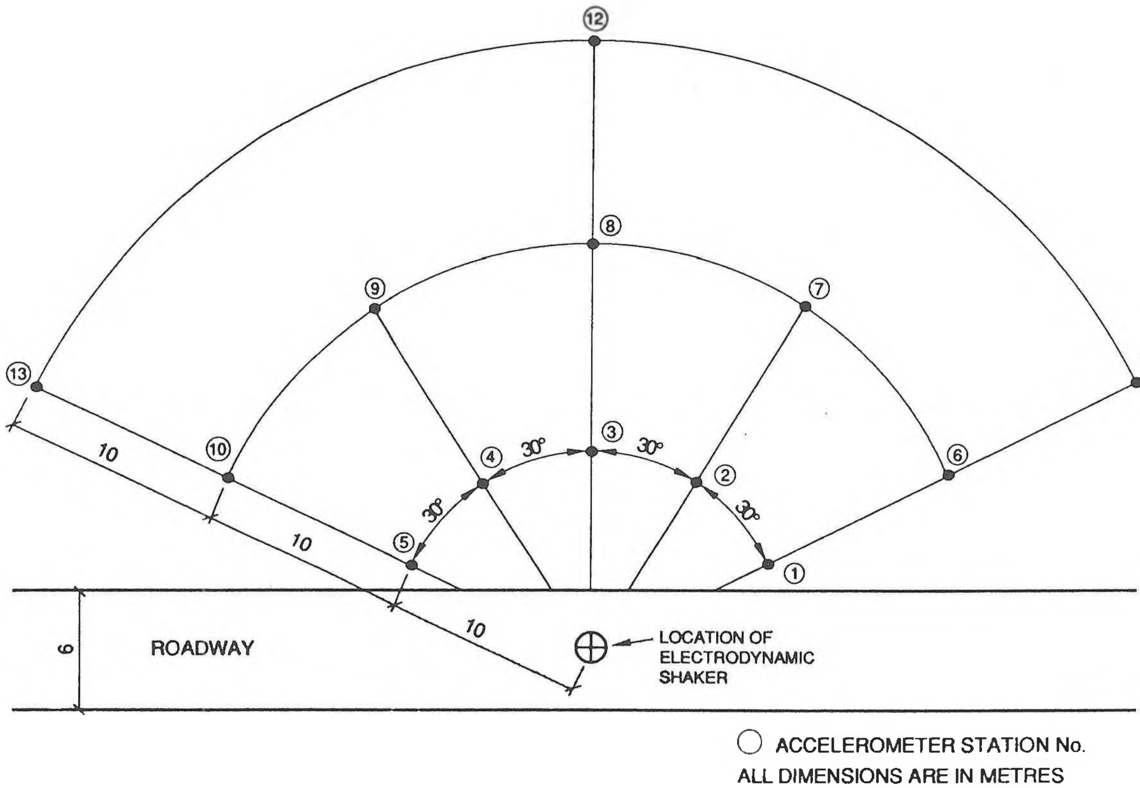

Figure 1 Axisymmetrical layout of vertical accelerometer stations.

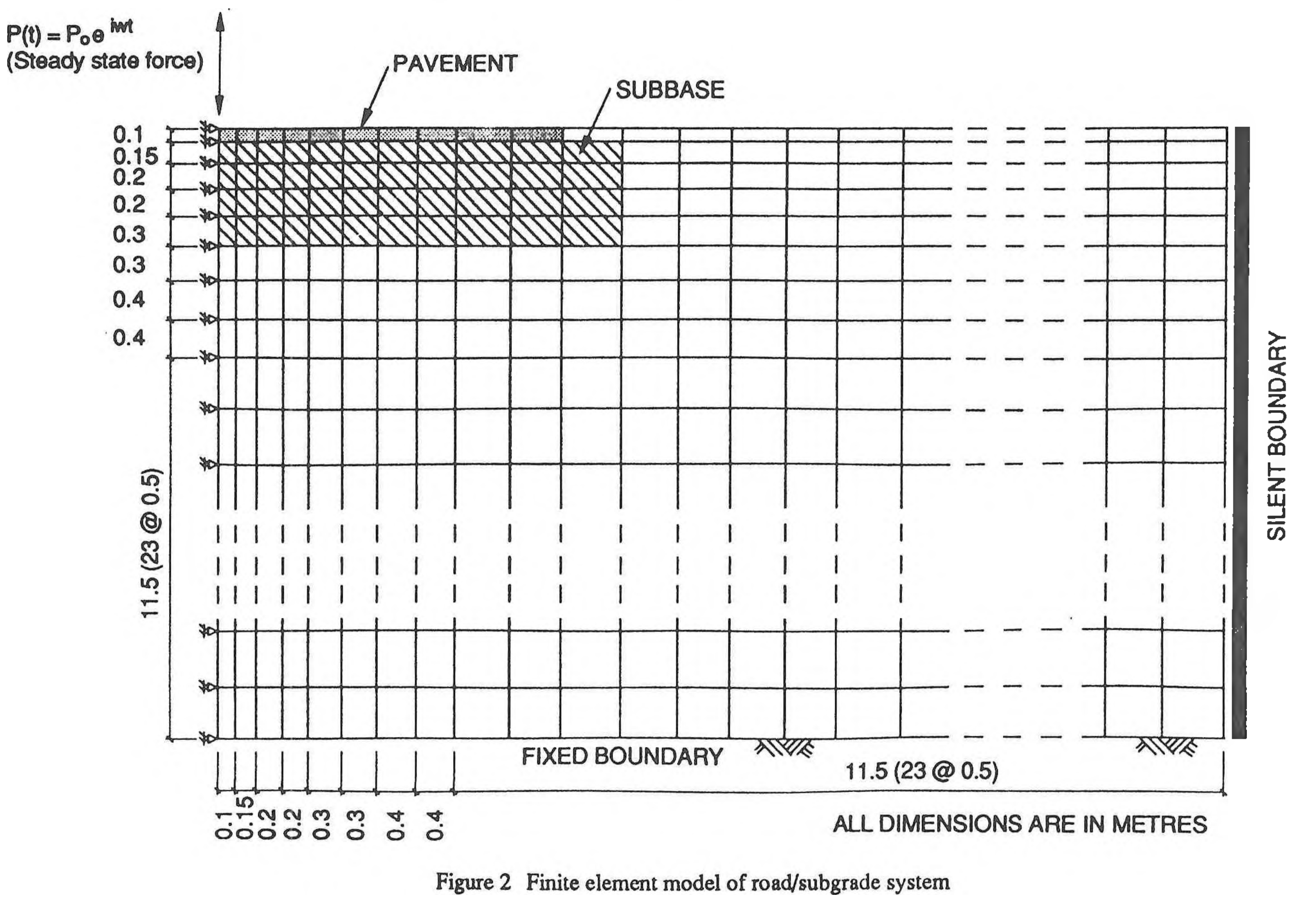

Figure 2 Finite element model of road/subgrade system

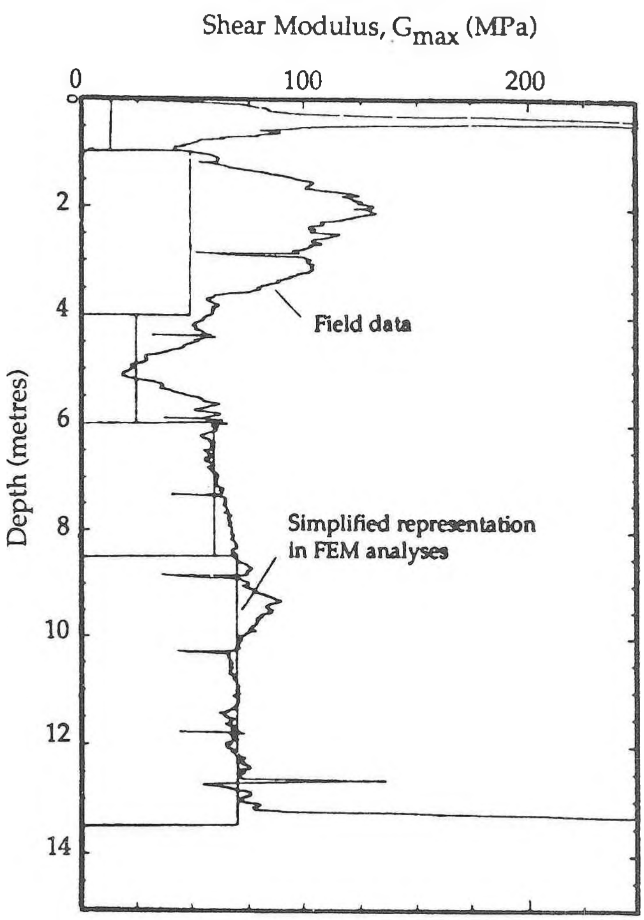

Figure 3 Shear-modulus profile at test location.

Approximate road dimensions and properties of the existing roadway and a modified design (proposed by an independent consultant) are shown in Figures 4 and 5, respectively.

4 DESCRIPTION OF FEM ANALYSES

The following remedial measures for reducing traffic vibrations were investigated using finite element analyses:

- Improving road structure
- Screening of waves by a concrete wall
- Soil improvement

4.1 Effect of road structure

Several FEM tests were performed to evaluate various road designs. Frequency response functions are generated and changes in these functions are taken as indicators of how parameter variation would affect the vibration behaviour of the site. The response spectra of the existing road design were compared with those of the modified design shown in Figure 5. In addition, the following parametric tests were performed in conjunction with the modified design:

- Replace the 10 cm bituminous pavement with 10 cm concrete layer.
- Replace the 10 cm bituminous pavement with 25 cm concrete layer.
- Double the proposed thickness of upper and lower road base.
- Replace the bituminous pavement and upper and lower base foundations by 65 cm concrete road (admittedly an impractical extreme case).

4.2 Screening by a Concrete Wall

Screening of ground vibrations by placing a trench in the transmission path of surface waves is known to be an effective measure to reduce ground vibrations (Richart et al, 1970). The trench can be left open or backfilled with a material that provides a sufficient impedance mismatch with the surrounding soil. It was found that when the ratio between an open trench depth and the propagating wavelength is greater than 0.6, the vibrations amplitudes in the screened area are significantly reduced (Segol et al., 1978). A minimal value of 1/3 is usually set for the ratio between the trench depth and wavelength (Le Houdec & Picard, 1988). Contradictory results, however, are reported regarding the effectiveness of stiff obstacles (Segol et al., 1978). Therefore, finite element analyses were performed to investigate the effectiveness of a concrete wall to reduce ground vibrations for the site conditions in this study. Two wall depths were considered: 5.0 m and 10.0 m, which correspond to roughly 1/3 and 2/3 of the longest wavelengths of interest, corresponding to 8 Hz. The concrete wall is 0.5 m wide and is located at 4.05 m from the center of the roadway. For this analysis, a plane strain model was used in order to realistically simulate the wall in the horizontal direction.

4.3 Soil Improvement

Improvement of soil to increase its stiffness using lime piles is reported to be very effective in improving the bearing capacity of the ground (Broms, 1979) as well as reducing ground vibrations induced by dynamic loads (Taniguchi & Okada, 1981). To investigate the possible effects of this type of soil improvement on the site under consideration, several finite element analyses were performed. Only the soil under the road is assumed to be improved using 0.4 metre diameter piles at 0.9 metre spacing arranged in a rectangular grid. The improved soil's modulus is assumed to be 225% of the original modulus. Density is also assumed to increase by 18%. Calculations were performed for improvement depths of 13.55, 8.55 and 6.05 metres. An axisymmetric FEM model was used.

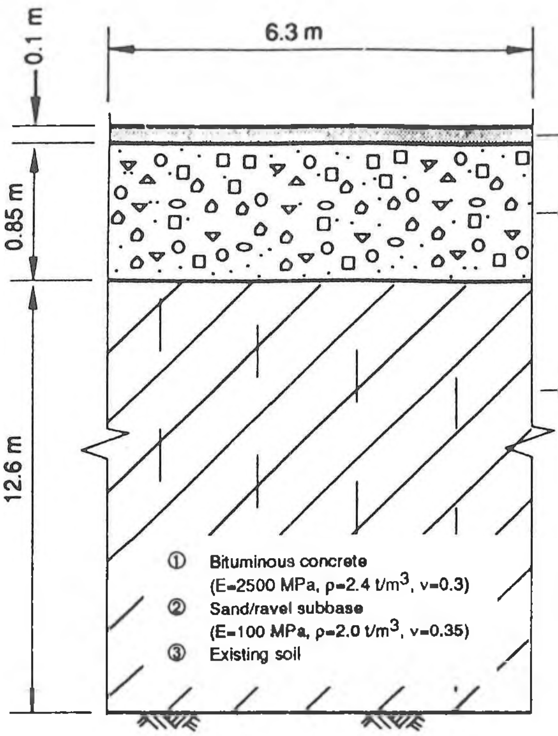

Figure 4 Existing cross-section of road.

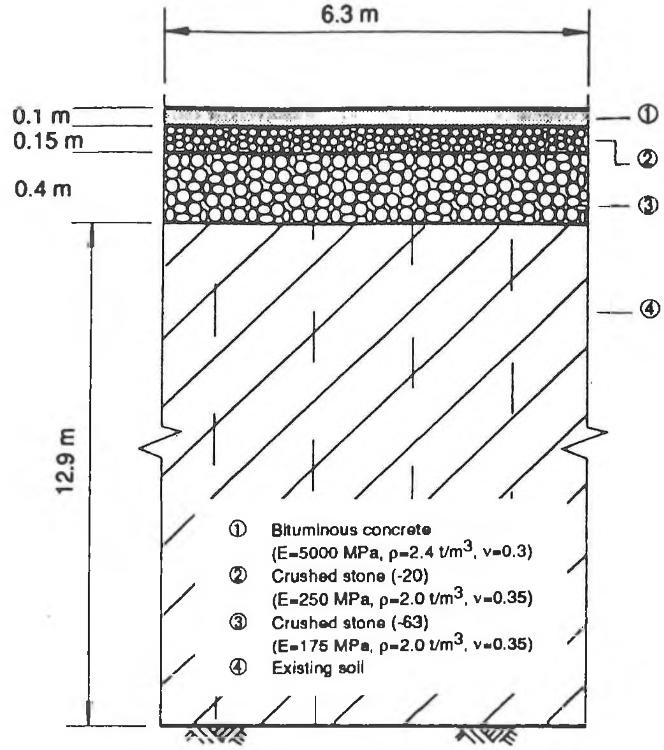

Figure 5 Modified design for road section.

5 NUMERICAL RESULTS

Results of finite element analysis of the road response are graphically presented as frequency response functions at surface points 0.25, 5.05, and 12.05 metres from the source. All results are compared with those of the existing road profile, shown in Figure 4.

5.1 Effect of Road Structure

Comparison between existing design and modified design

Implementing the modified road design, shown in Figure 5, introduces very little or no reduction in vibration levels at points 5.05 and 12.05 metres from the centre of the road as can be seen from the frequency response functions in Figure 6.

Replacing 10 cm bituminous pavement with 10 cm concrete pavement

The increased rigidity of the pavement layer in the modified design has a negligible effect on the level of vibrations at points away from the road (5.05 and 12.05 m), as can be seen from Figure 7.

Replacing 10 cm bituminous pavement with 25 cm concrete pavement

The 25 cm concrete pavement has a more noticeable reduction of vibration amplitudes than for the case of a 10 cm concrete pavement, especially for the horizontal component. However, close inspection of the results in Figure 8 shows that: (i) the reduction occurs generally at high frequencies, and (ii) the amplitude reduction is more pronounced for points closer to the source (compare the results at 5.05 and 12.05 m). Overall, the reduction in amplitudes is negligible.

Doubling the thickness of the upper and lower roadway foundations

In the modified road structure, shown in Figure 5, the thicknesses of the upper and lower foundations were increased from 0.15 and 0.4 m to 0.35 and 0.8 m, respectively. Frequency response spectra of this case (not displayed here) show that the amplitude reduction is slightly more than that gained with the original modified design. The amplitude reduction is comparable to that achieved by replacing the asphalt pavement with 25 cm concrete pavement (Figure 8).

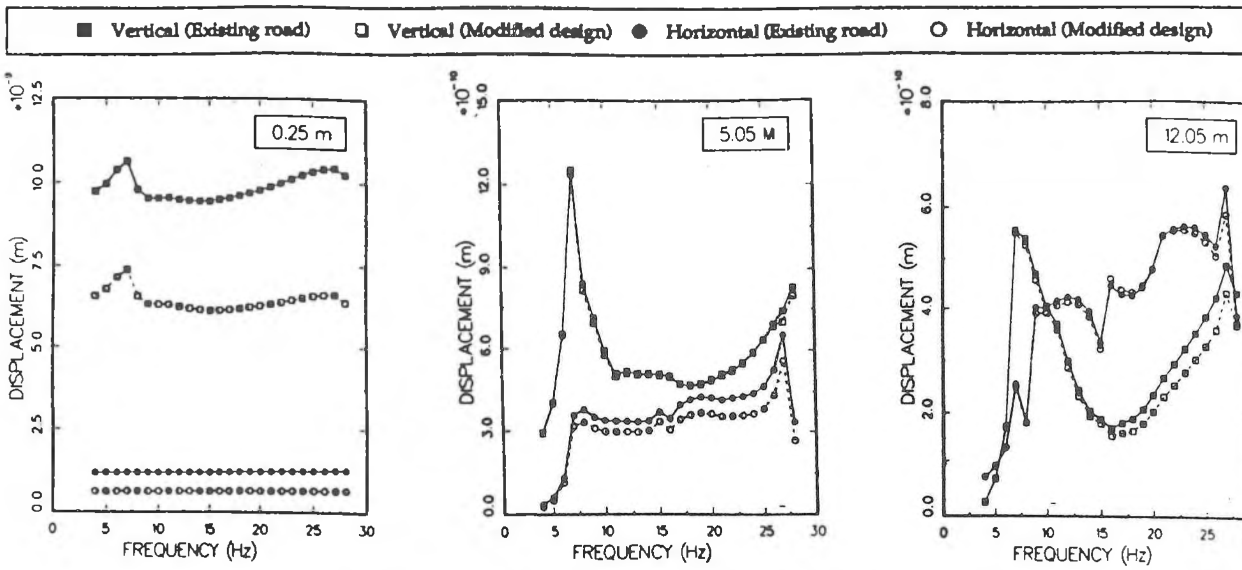

Figure 6 Frequency response functions of existing road design and modified design.

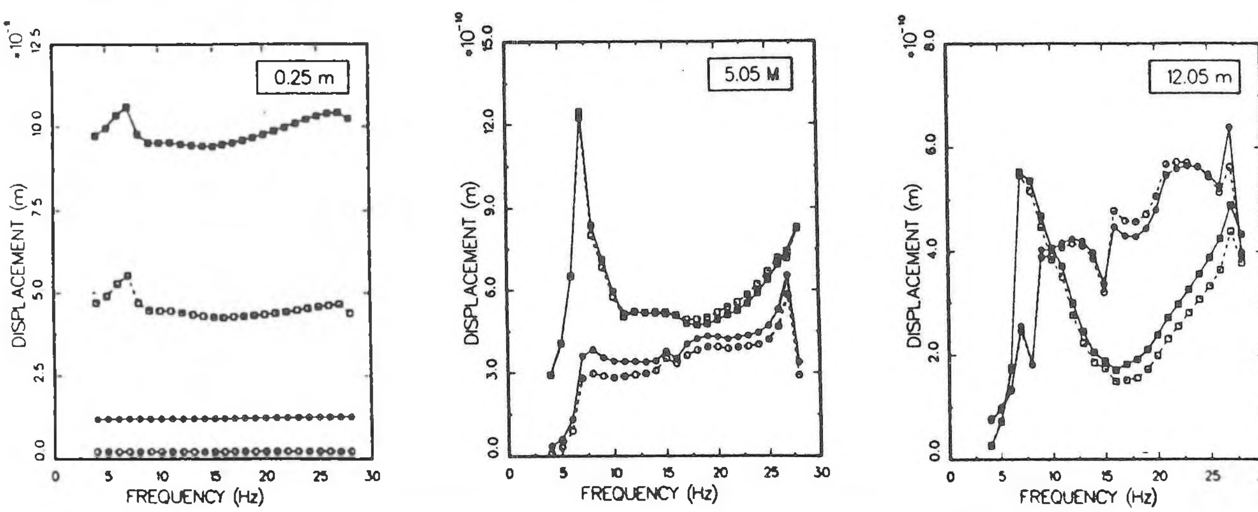

Figure 7 Effect of replacing 10 cm bituminous pavement with 10 cm concrete pavement.

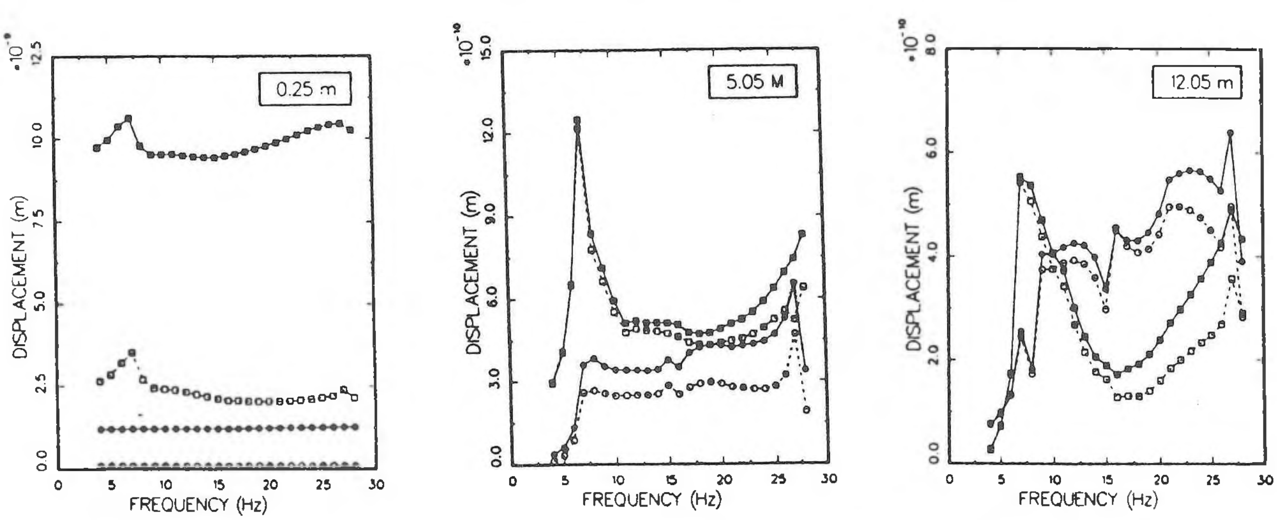

Figure 8 Effect of replacing 10 cm bituminous pavement with 25 cm concrete pavement.

Using a 65 cm concrete pavement

The objective of such an obviously impractical design is to test a hypothetical road structure that is very stiff and massive in comparison with all previous designs so as to detect trends for extreme parameter variations. As can be seen from the response functions of this design, shown in Figure 9, there is a substantial reduction in amplitudes which has not been achieved by any of the previous road structures. The higher the frequency, the higher the reduction. However, amplitude reduction at and close to the fundamental frequency of the road/subgrade system, which is of primary interest here, is not significant.

5.2 Effect of Screening by Concrete Wall

Tests on the effectiveness of vibrations screening by a concrete wall were performed in connection with the existing design of the road section shown in Figure 4.

Using a 5 metre deep concrete wall

From the frequency response functions presented in Figure 10 it seems that the reduction of vibration amplitudes varies from point to point in the screened area. While vibration amplitudes at 5.05 m are moderately reduced by the presence of the concrete wall, there is only a slight reduction at the 12.05 m location.

Using a 10 metre deep concrete wall

As would be expected, a significant reduction of vibration amplitudes occurs in comparison with the 5 m deep wall. As can be seen from Figure 11, there is a substantial reduction especially at frequencies close to the fundamental frequency of the road/subgrade system. However, the reduction of vibration levels at 12.05 m is lower than that at 5.05 m, as was observed with the case of the 5 m wall.

5.3 Effect of Soil Improvement

The calculations for soil improvement were carried out in conjunction with the modified road design, shown in Figure 5. FEM calculations were performed for improvement depths of 13.55 m, 8.55 m and 6.05 m, and the resulting response functions are shown in Figures 12, 13, and 14, respectively. It can be seen that substantial reduction in vibration amplitudes can be attained for almost all frequencies. The greater the depth of the improved area, the greater the reduction in amplitudes, especially for frequencies at or near the fundamental frequency of the road/subgrade system. For frequencies higher than about 15 Hz, the vibration reduction is almost the same for the three soil improvement depths.

6 DISCUSSION

An explanation as to why improvement of the road structure is effective for reducing low frequency vibration levels at points on the roadway itself and not at points away from the road is due to the spreading of the applied load. The stiffer the road the less concentrated is the action of the load. Unfortunately, the effect of this action is local and only points close to the load experience the difference. For points away from the pavement, the loading action seems to be practically unchanged, i.e. the load remains as if concentrated. This can be clearly seen in Figure 15 where a comparison is shown between the wave fields at the surface for the 10 and 65 cm concrete pavements at an 8 Hz excitation frequency. Across the width of the pavement (0 to 3.0 m) the amplitude of the wave field for the case of the 65 cm pavement is much less than that of the 10 cm pavement, whereas outside the pavement width the two wave fields are almost identical.

On the other hand, the fact that improving the road structure is effective in reducing vibration levels at high frequencies may be explained as follows. As the wavelength becomes shorter it approaches the road dimensions, leading to propagation action within the pavement itself. Due to the impedance mismatch between the road materials and the surrounding soil a great proportion of the wave energy is trapped within the pavement (box effect). For long wavelengths, however, the pavement behaves more like a rigid body, i.e. there is no propagation action, and therefore most of the wave energy is transmitted to the soil. As the base of the road becomes thicker, lower frequency components start to propagate in the subbase structure. This would explain the effectiveness of soil improvement below the road since it would create a bigger box of sufficient impedance mismatch with the rest of the soil.

7 CONCLUSIONS

Based on the FEM simulations of the site considered in this study, the following conclusions are reached:

- Increasing the stiffness and mass of the road structure is not effective for reducing traffic-induced vibrations in the frequency range of interest. However, improvement of the road structure would slow road deterioration and hence indirectly forestall vibration problems by preventing cracking and structural damage, which are the major causes for vibration generation.
- The substantial depth necessary for concrete walls to be effective in reducing ground vibrations renders them impractical.
- Soil improvement under the road is an effective remedial measure for reducing traffic-induced

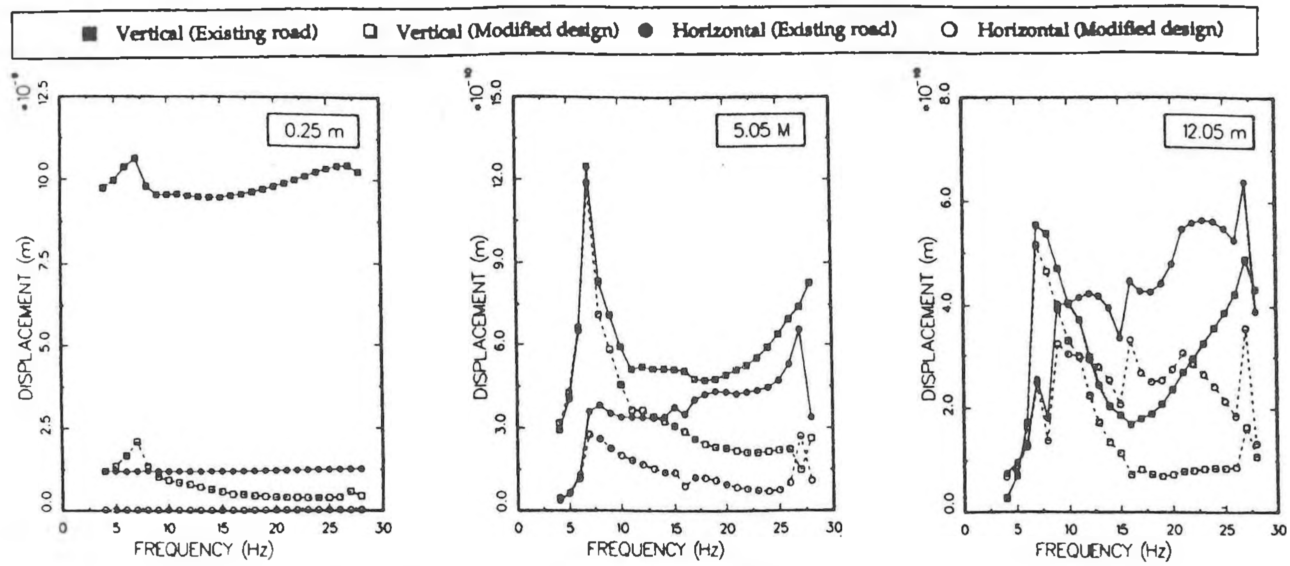

Figure 9 Effect of using a 65 cm deep concrete pavement.

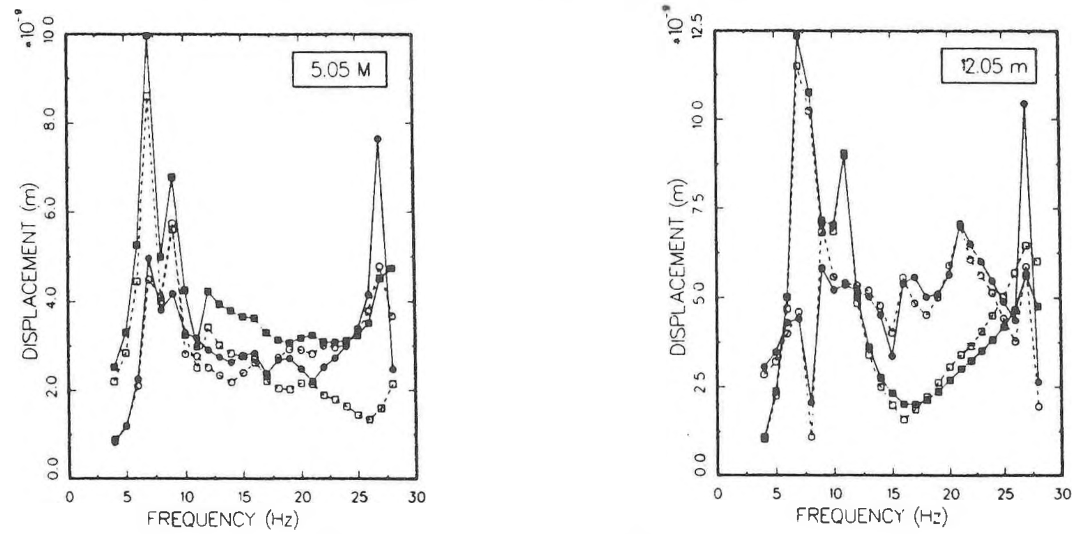

Figure 10 Effect of screening ground vibrations with 5 m deep concrete wall

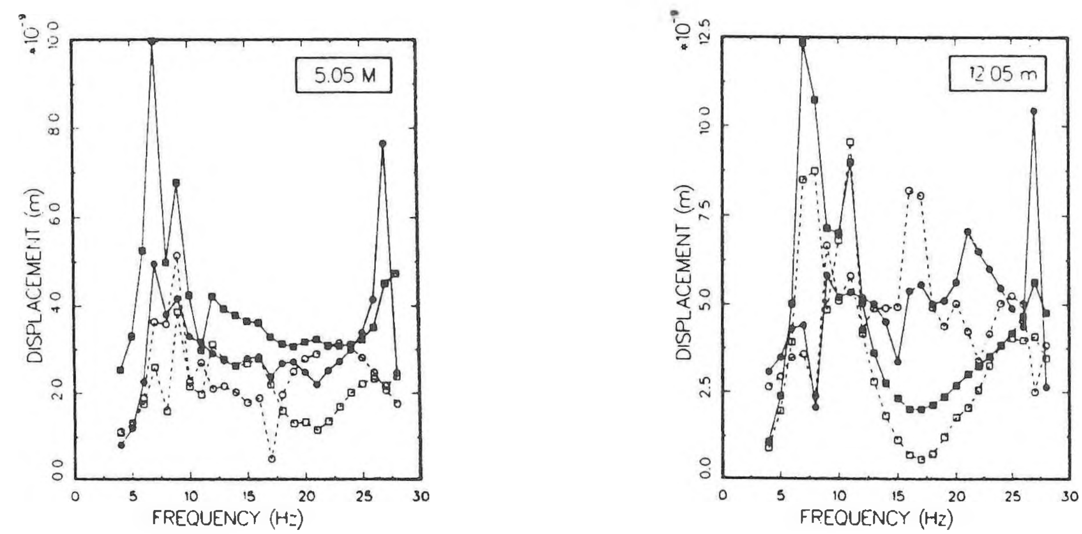

Figure 11 Effect of screening ground vibrations with 10 m deep concrete wall

■ Vertical (Existing road) □ Vertical (Modified design) ● Horizontal (Existing road) ○ Horizontal (Modified design)

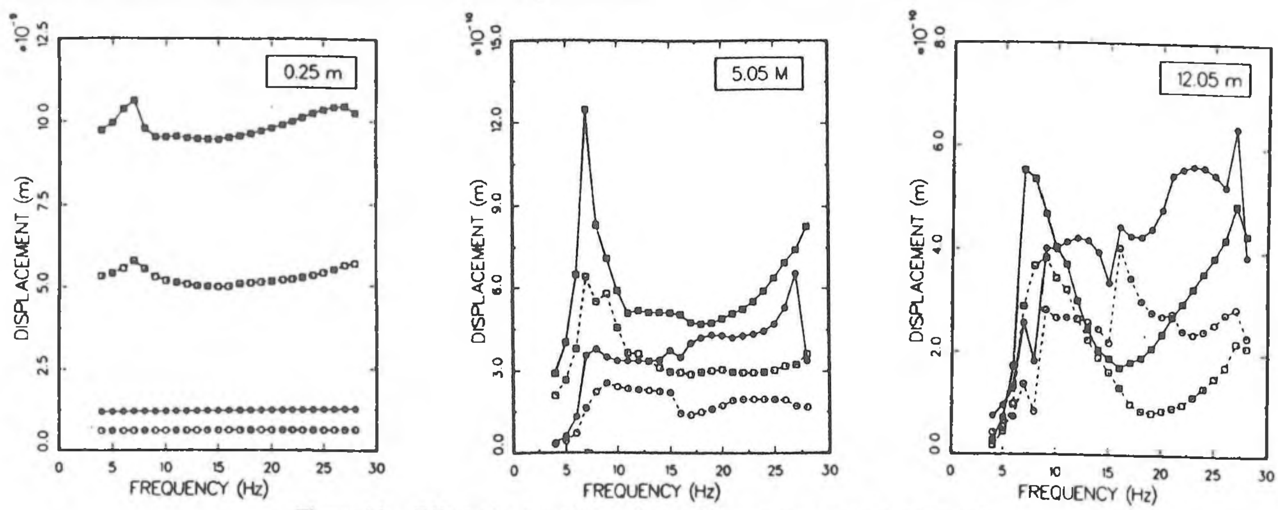

Figure 12 Effect of using 13.5 m deep soil improvement under the road.

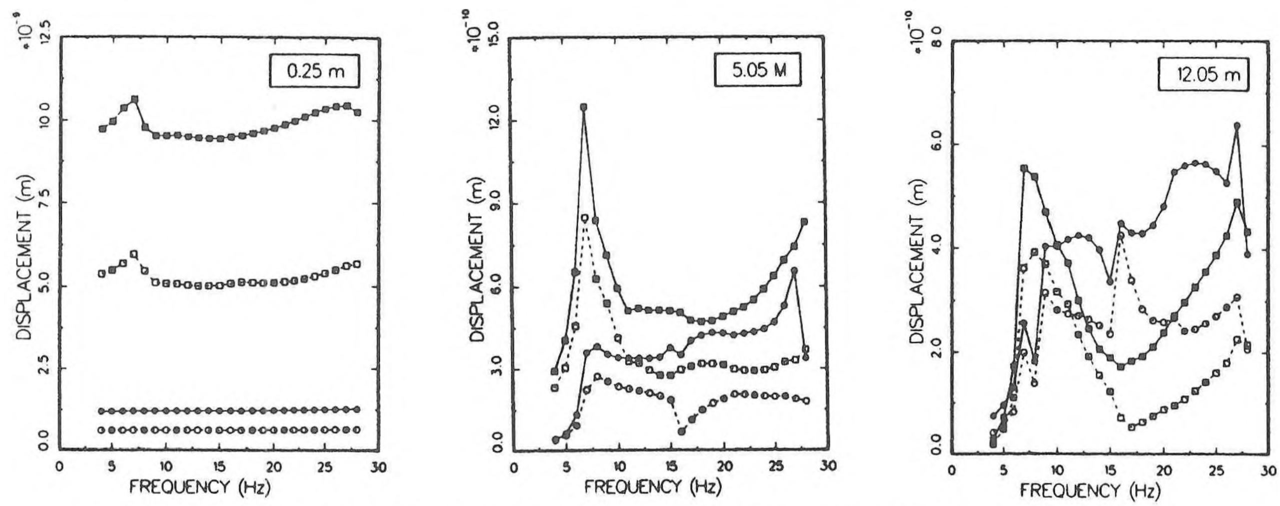

Figure 13 Effect of using 8.5 m deep soil improvement under the road.

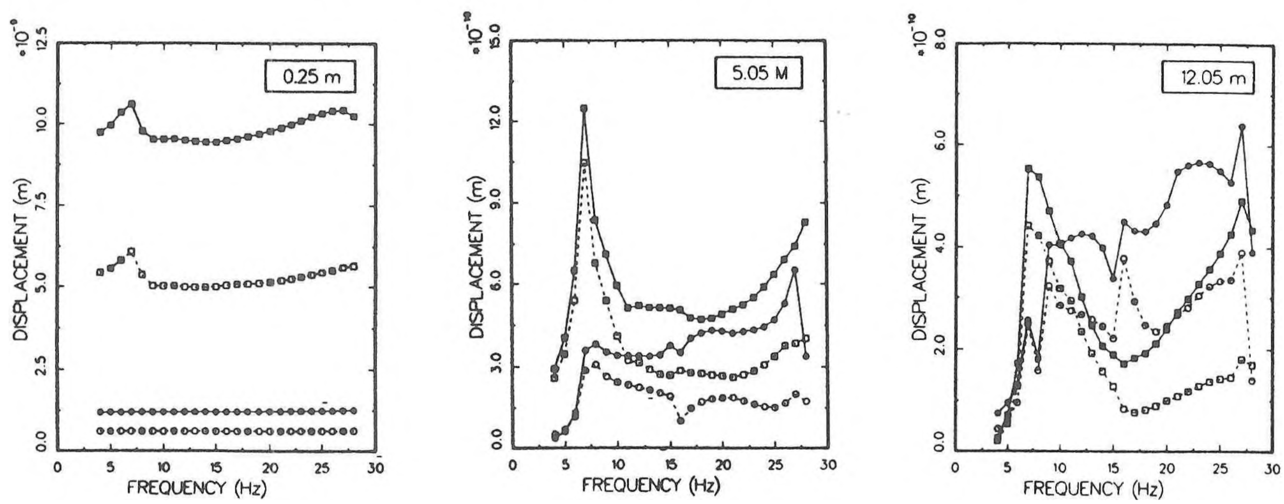

Figure 14 Effect of using 6.0 m deep soil improvement under the road.

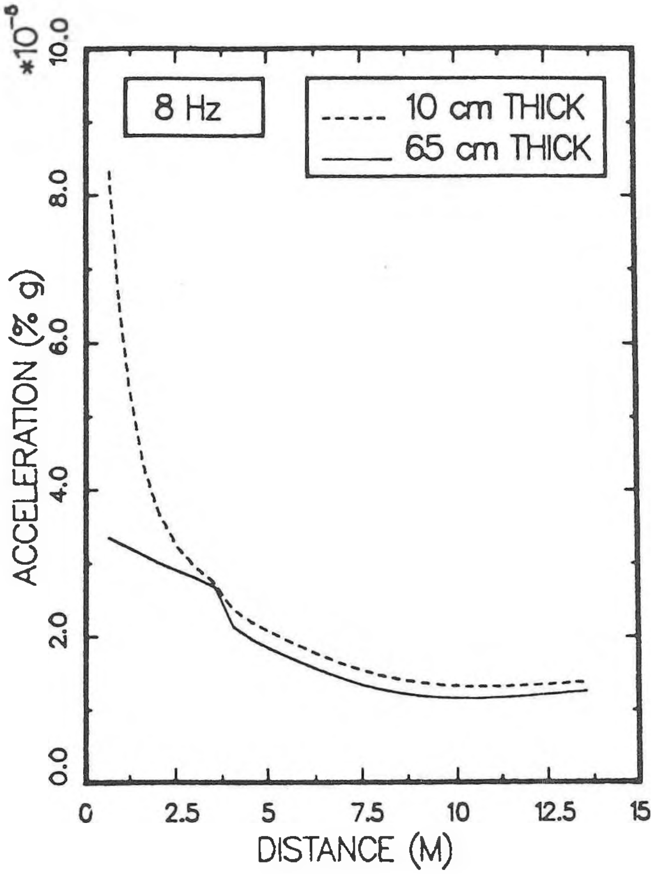

Figure 15 Vertical wave fields at the surface for 10 cm and 65 cm thick concrete pavements.

vibrations. In addition, since the bearing capacity of the soil is also improved, the structural integrity of the road will be further improved, and hence indirectly lead to less vibration generation. The degree of vibration reduction depends on the soil improvement design which is a highly specialized field and beyond the scope of this study. Increasing the soil modulus by at least a factor of 2 and an improvement depth of about 8 m resulted in satisfactory reduction of vibration levels for the site considered in this study.

- The fundamental frequency of the road/subgrade system is governed by the properties and profile of the site. None of the remedial measures that were analysed succeeded in significantly altering it.

ACKNOWLEDGEMENTS

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REVIEW AND CRITIQUE OF EXISTING SIMPLIFIED MODELS FOR PREDICTING FACTORY NOISE LEVELS

Canadian Acoustics / Acoustique Canadienne 19(1) 15-23 (1991)

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In the captions of Figures 1 and 2 of this paper the lines and symbols designating the various curves were omitted. The figure captions should read as follows:

Figure 1. Measured 1000 Hz octave-band sound propagation function in a factory when empty (—✱—), partly furnished (●-●) and fully furnished (-o--o-). Also shown for reference are the functions predicted by diffuse-field theory for the empty factory (— —) and for a point source in the free field (——).

Figure 2. Sound propagation functions predicted by ray tracing in four furnished factories with different length : width : height ratios: (—·—) 1:1:1, (·······) 10:10:1, (— — —) 5:2.5:1, (- - - - -) 10:1:1. The curve for the cubic room is similar to that predicted by diffuse-field theory. Also shown for reference is the function for a point source in a free field (——).

EVALUATION OF DISABILITY AND HANDICAP IN NOISE-INDUCED HEARING LOSS

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In January 1990, a conference was held under the auspices of the National Institutes of Health (National Institute on Deafness and Other Communication Disorders) in Bethesda, Maryland. The topic of the conference was "Noise and Hearing Loss". The conference was planned to be accessible to the public as well as to a professional audience. It was organized around five questions: "What is noise-related hearing loss?"; "What sounds can damage hearing?"; "What factors, including age, determine an individual's susceptibility to noise-related hearing loss?"; "What can be done to prevent noise-related hearing loss?"; "What are the directions for future research?"

The present author was asked to give a paper on the issue of "quantification of handicap" resulting from noise-related hearing loss. The press for quantification arises from the physico-biological orientation of most researchers involved in study of this occupational injury. While my own research endeavours have been affected by that orientation, the question pursued - namely, how to evaluate handicap - has always been seen as qualitative in nature. Thus, opportunity was taken by means of this conference presentation to consider the broader issue of appropriate approach to evaluating disability and handicap arising from this impairment to hearing. Following is the text of the conference paper, as amended consequent to this journal's referees' comments. I acknowledge with thanks their suggestions for amendment and clarification.

The terms "disability" and "handicap" have been used in various ways in literature addressed to the issue of effects of hearing impairment. So as to get definitional problems out of the way, I will start by explaining the usages I rely upon in discussion of such matters. These are the World Health Organization (1980) definitions and, in the context of impaired hearing, the term "disability" refers to loss or reduction in a person's capacity to perform hearing acts, such as the detection or discrimination of audible events in the everyday world; "handicap" is used to refer to the disadvantage in daily life resulting from this disability or impairment.

A question relevant to the aims of the present Conference is with respect to evidence that hearing impairment due to noise injury results in disabilities sufficient to cause handicap, to cause "disadvantage in daily life". One issue raised in this paper concerns what form of evaluation of hearing can furnish evidence of such disadvantage. Flowing from that, and given that evidence of hearing disability and handicap is accepted, then the question of significance is surely: - "What can be done to prevent noise-induced hearing loss?" I would urge this Conference to put that question at the top of its agenda.

One of the earliest systematic investigations of noise-induced hearing loss was by Thomas Barr in 1886. This classic study captures the essence of the issue about how to evaluate disability, on the one hand, and, on the other, how to evaluate handicap. Barr used the tick of his pocket watch to perform functional tests on three groups of workers exposed to distinctly different amounts of noise at work, namely, ship's boilermakers, iron-moulders, and letter-carriers. By using the watch to assess the least amount of acoustic energy detectable, Barr was measuring the comparative extent of disablement of the auditory systems of the three samples.

But Barr also inquired directly of the people studied about handicap, about the disadvantage in their daily life due to disablement of hearing. He asked them to report on their capacity to hear in a public place. Among the boilermakers, not only was there severe hearing impairment compared with the other groups, as revealed by the watch-tick test, but the majority of them reported difficulty hearing at a public meeting or church service, to the point where many said they had ceased attending such gatherings. This finding dramatizes the profoundly handicapping effect hearing disability can produce. It has become clear from subsequent investigation that interference with everyday communication, and not so much hearing at public gatherings, is the major source of handicap suffered by those with injured hearing.

The principal point emerging from mention of Barr's work is that evaluation of impairment may be appropriately carried out by the testing of some aspect of hearing capacity, be that by use of a ticking watch, a whispered voice, an electronic sound maker, or an elaborately devised speech discrimination procedure. But *handicap*, the disadvantage in everyday life resulting from disability, cannot be determined by any such test. It can only be assessed by the person who suffers the disability, because that is the one who experiences any disadvantage; and how such disadvantage occurs is a function of the life the person lives. In evaluation of handicap, the self-assessment of the person affected cannot be avoided.

Of course, impairment and disability are related and both are, in turn, related to handicap. before going on to say more about the self-assessment approach as such, it is appropriate to say something about that relationship, as reflected in the relation between measurements of hearing impairment using various tests, and self-assessed disability scores. I'm focussing my attention on research specifically among people with noise-induced hearing loss. Research such as by Kryter and colleagues (1962), Macrae and Brigden (1973) and Suter (1978) shows hearing capacity at audio-frequencies higher than 2 kHz plays a significant role in affecting the discrimination of speech heard in noisy background conditions. These sorts of conditions, of course, typify the communicative circumstances for most people working in noisy jobs, not to speak of the noisy background conditions we all have to contend with when trying to hear in the street, in the store, at the restaurant, or whatever. So it is predictable, and borne out in results, that self-assessed hearing disability and handicap in people with noise-induced hearing loss correlates more closely with results of hearing sensitivity tests when threshold levels at frequencies higher than 2 kHz are included in the analysis (see, e.g., Parving and Ostri, 1983; Phaneuf et al., 1985).

In subsequent decades following Barr's pioneering work, testing of hearing sensitivity predominated over other methods of evaluation, and the question of a role for self-appraisal in assessment of handicap was never raised. This may be because the issue of compensation in noise-induced hearing loss was not addressed on a large scale until after the second world war. In addition, rehabilitation of people with disorders of hearing also developed more strongly as a practice around that time. It is really only with the emergence of these practices that evaluation of handicap becomes an issue at all.

Over the last 25 years numerous attempts have been made to measure hearing disability and handicap using questionnaires, check-lists, and other self-assessment devices. Some of these have taken the form of devices constructed with attention to principles of psychometric measurement, such as reliability and validity. Insofar as it is considered appropriate to apply a numerical value to self-assessed handicap (or self-assessed disability), then it has made sense, in the construction of scaled questionnaires, to look to their properties as measuring instruments. It is not my purpose to give you a lecture on principles of psychometrics; I merely seek to have you appreciate that there is a difference between a questionnaire got up in half-an-hour on the back of an envelope, and one that attempts to provide stable, meaningful and valid measurement of the property or properties it claims to assess.

So far as I am aware, the first effort to devise a self-assessment questionnaire with attention to psychometric criteria was the Hearing Handicap Scale of High, Fairbanks and Glorig (1964). This device focused on hearing for speech. The second scaled questionnaire on the market, constructed with more elaborate developmental steps, was the Hearing Measurement Scale, by myself and Gordon Atherley in 1970. It covered areas of everyday hearing, such as hearing for speech, non-speech sounds, localization or sounds, speech distortion, and tinnitus. Subsequent to its emergence, I went on to express arguments in some detail (Noble, 1978) about the limitations of tests of hearing impairment for assessment of hearing disability and handicap, and about the rightful place of self-appraisal in the suite of auditory evaluative procedures.

In the last 10 to 15 years, several scaled and unscaled questionnaires have emerged, designed for different used in different target populations. Among these are, for example, The Hearing Performance Inventory, developed originally by Giolas and colleagues (1979), the hearing Handicap Inventory for the Elderly by Ventry and Weinstein (1982), and the Communication Profile for the Hearing Impaired by Demorest and Erdman (1987). By use of these and other questionnaires, the self-assessment approach to hearing disability and handicap has found a significant place in various contexts. Self-assessment has been used historically in census-taking of hearing capacity in the population at large, but the method has lately become more psychometrically refined (e.g., by Lutman et al., 1987). Self-assessment has been used for rehabilitative screening procedures (e.g., by Schow & Nerbonne, 1982), in evaluation of hearing aid benefit (e.g., by Newman & Weinstein, 1988), in counselling for, and evaluation of, rehabilitation programmes of various kinds (e.g., by Giolas, 1982), in evaluation of general problems due to hearing impairment (e.g., by Barcham & Stephens, 1980), in evaluation of specific effects such as those due to tinnitus (e.g., by Tyler & Baker, 1983), as well as in development of schemes for assessment for compensation purposes (e.g., Salomon & Parving, 1985).

It has consistently emerged from application of the self-assessment procedure that the principal disability, and source of the resulting disadvantage experienced by people who suffer impairment of hearing, is interference with occasions of commonplace spoken communication, be that in face-to-face interaction, telephonic conversation, or picking up information from electronic media. Among commonplace sounds that may go undetected, those linked to communication - the telephone or door-bell - are identified by people with impaired hearing as most highly salient (Barcham & Stephens, 1980). Among the difficulties caused by tinnitus, its interference with communication is reported as outweighing its other disturbing qualities (Tyler & Baker, 1983).

Other areas of everyday existence are reportedly affected by impaired hearing. For instance, reduction of the ability to detect the occurrence of various domestic noises (the whistling kettle, the pet dog seeking entry), or of warning signals (a car horn, the neighbour's call) is reported as having a handicapping result. The sounds in question may not be those of spoken speech, but they are still communicative or associated with communication. This underscores my point that the central handicapping disability of hearing impairment is loss or reduction of communicative contact with others.

Of course, it becomes quite understandable that interference with communication is the key handicapping effect of hearing impairment, once it is remembered that the basis of human life is communication. That is the case because human life is essentially, uniquely, and unavoidably linguistic. I want to say more on this point, because an appreciation of it should assist in your appreciation of an issue to be raised in the closing part of my address.

Most people, most of the time, take their communicative ability for granted. In exactly the same way, they take their capacity to see and hear for granted. We only really notice these features of ourselves, in our mundane activities, when something goes wrong. That most of us are engaged in communicative activity almost all of our waking lives can come as something of a surprise. Surely we do other things besides communicate? I don't intend to get into a major argument on this point. I do want to suggest that human beings don't do *much* besides engaging in communicative activity - but I want you to understand that by "communicative activity" I include anything undertaken for the purpose of showing others as well as saying things to others.

Even if we restrict the notion of communication to vocal interchange, the business of *saying* something to someone else is only one of a host of such communicative acts. We *ask* things of others, we answer them, we inform each other, we misinform, we beg, command, tell secrets, tell jokes, gossip, complain, argue, discuss, praise. I could go on at length. All these and myriad other communicative acts are undertaken by humans in virtue of their having access to one ore more natural languages. We chat to each other routinely. And once we recognize this ordinarily taken-for-granted feature of human life, we can see more clearly what it *means* to be human. The things I listed are quite familiar to us all, though I suspect we tend to forget we do all these things when groups of us lock ourselves into conferences to discuss the handicapping effects of hearing impairment. When we break for a coffee or lunch, though, we go into taken-for-granted chat mode with a vengeance. Bringing these familiar, taken-for-granted features of human life to the forefront of attention can surely assist us all in seeing what is so fundamentally damaging about hearing impairment. Interference with communication is interference with the basis of human life.

A recent refinement of the self-report approach to evaluation of the handicaps resulting from noise-induced hearing loss is to be found in the work of Hétu and colleagues (e.g., Hétu et al., 1988). This work tells most strongly as regards the points I have just made. In the work of Hétu's research group, a formal self-report scale is replaced by semi-structured interviewing, and the content of resulting transcripts independently examined to extract themes and descriptors emerging from the discourse of participants. Interviews are typically carried out among hearing impaired workers and their spouses, and a significant outcome has been discovery of the extent to which other family members must adjust *their* behaviour in order to compensate for the difficulties experienced by the workers. These adjustments are, in turn, due to efforts by workers to minimize the display of signs of disability. The upshot is that the disadvantage suffered by the hearing impaired worker introduces a fresh disadvantage, to their family, in coping with the worker's disability. The problem shifts, then, in the conceptualization of Hétu's group, from a clinical disorder affecting individuals, to an issue of *public* health, affecting the families and close friends of those injured.

There are many plausible reasons why people with impaired hearing are reluctant to admit they have problems. If communication is central to human life, as I have just stressed, anything which threatens that will be highly unwelcome and barely acknowledged. Motivation to conceal a reduction in communicative ability will be reinforced by others, who will typically take any signs of *communicative* incompetence as evidence of incompetence *as a member of society*. It does one's standing no good, in the eyes of others, to be so regarded. Hétu and colleagues (1990) have also pointed out to a phenomenon arising from the experience of working in hazardous conditions. They refer to the work of Dejours et al. (1985) which identifies a drive, by those exposed, to diminish perception of the riskiness of occupational hazards, so as to make the matter of working in the hazardous environment tolerable. A further pressure to conceal hearing difficulty is fear of discrimination in employment and promotion chances. Who, after all, is likely to put a hearing impaired person in a position of responsibility; in a position where they *must* be able to communicate effectively with others.

Despite a vast wealth of knowledge about the causes, mechanism, likelihood and incidence of noise-caused hearing impairment, this injury remains one of the most intractable occupational hazards. Risk of damage to hearing continues on an epidemic scale. One part of the reason why this is so is due to the forces I have just described. These serve to keep the pressure low, from among those exposed, as regards taking action to reduce noise levels to safe limits.

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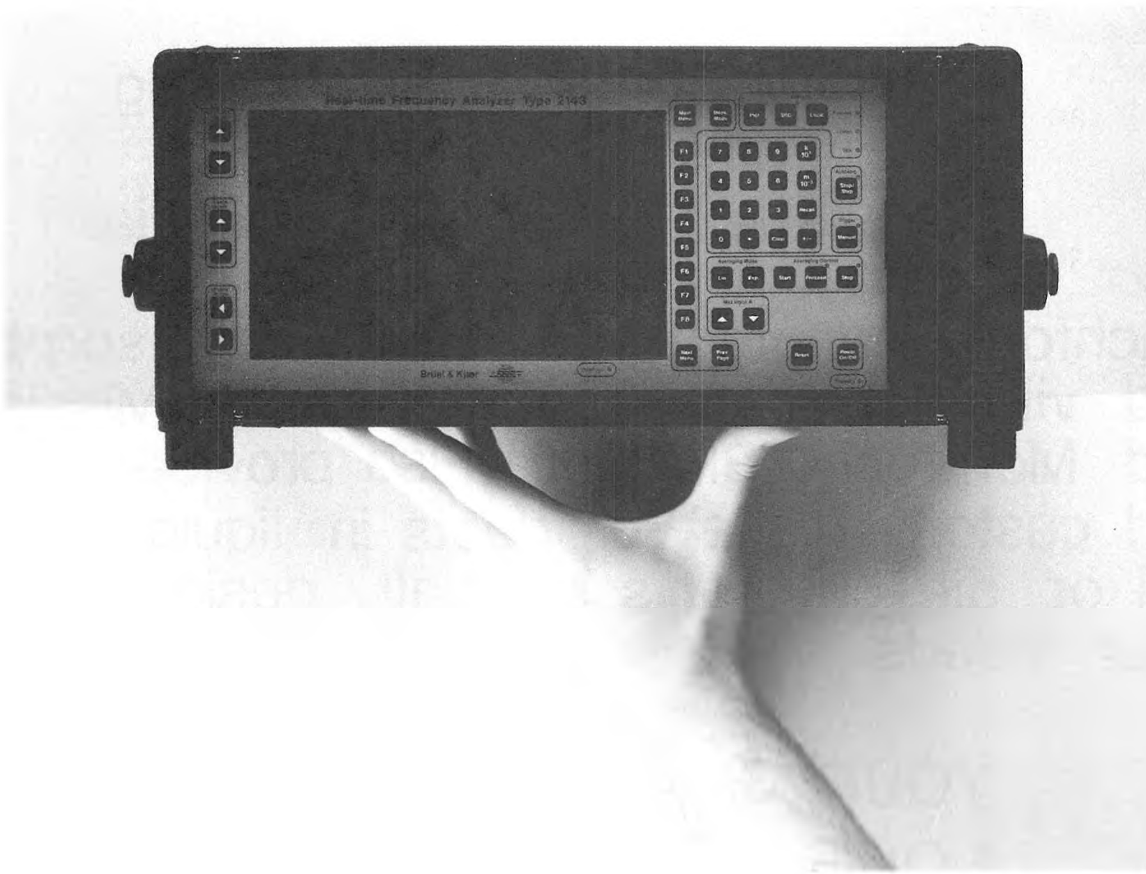

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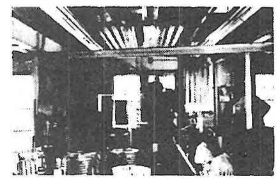

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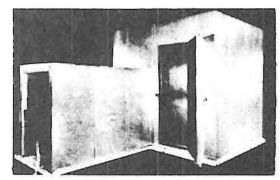

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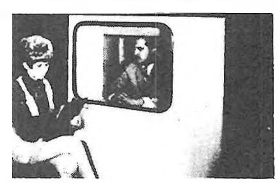

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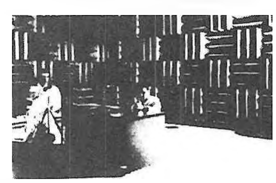

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HARMONOGRAPHICS: PHYSICS OF AN ARTISTIC NOVELTY OF THE VICTORIAN ERA

Rachel Zimmerman
London Central Secondary School, Grade 11

Project Summary

1. Introduction to the Problem

When two pendulums swing at right angles to each other, the combination of their oscillations plotted on paper form intricate patterns called Lissajous figures. A device which makes these patterns is called a harmonograph because it records harmonic motion. I became interested in harmonographs after seeing samples of Lissajous figures and marvelling at their complexity and beauty. I wanted to know how such a simple machine could make such a wide variety of complex designs. I set out to learn about the physics and mathematics of simple harmonic motion which are reflected in the Lissajous figures.

2. Outline of the Experiment

I researched historical designs for harmonographs and built a harmonograph which clearly displayed the relationship between the two interacting pendulums. I modified the design of my harmonograph to minimize friction and wobbling. Using a metre stick to adjust the length of each pendulum and a protractor to measure angular amplitude and phase displacement, I experimented to determine what factors affect the shape of the resulting figures.

Based upon the results of my experiments and research regarding harmonic motion, I derived mathematical formulae to describe the path followed by the pen whose motion is driven by the interaction of two pendulums swinging at right angles to each other.

I developed a computer simulation to plot the x and y coordinates calculated by my mathematical formulae. This allowed me to do three things which could not be done using the physical model: 1) to verify the mathematical formulae by comparing the shapes of the figures generated by the computer program with those generated by the physical model; 2) to test more precisely the effect of varying each factor while holding all others constant and while observing the effect of specific ratios of pendulum length and angular velocity; and 3) to observe the patterns that could be generated by ideal theoretical pendulums in a frictionless system.

3. Summary of Results

a) Two pendulums with the same angular amplitude and same lengths generate a straight line.

b) The lengths of the pendulums affect the outer dimensions of the envelope.

c) The ratio of the angular amplitudes affects the cycling of the curves; e.g. a ratio of 1:4 produces 4 loops.

d) Angular displacement is changing fastest at the bottom of the pendulum's swing and slowest at each end.

e) If the ratio of the angular amplitudes of the pendulum representing the x axis to the pendulum representing the y axis is a rational number, the curve is closed and the motion repeats itself at regular intervals of time.

f) If the ratio of the angular amplitudes of the pendulum representing the x axis to the pendulum representing the y axis is an irrational number, the curve is open and the tracing will gradually fill the area enclosed by the envelope.

g) The motion of the physical pendulum is damped by air resistance and the friction between the moving parts. Thus, the angular displacement of the swing of the physical pendulum gradually diminishes to zero. The motion of the theoretical pendulum is unaffected by friction.

4. Conclusions Reached

The interference pattern generated by two orthogonal oscillations can be represented by a Lissajous figure (x,y), where

$$x = R_x \cos(\omega_x t) \qquad y = R_y \cos(\omega_y t + \delta)$$

$$\omega_x = \frac{4\theta_x}{2\pi\sqrt{\frac{l_x}{g}}} \qquad \omega_y = \frac{4\theta_y}{2\pi\sqrt{\frac{l_y}{g}}}$$

The harmonograph is far more than an artistic novelty. It is an excellent tool for studying the behaviour of oscillating systems. Because mechanical and electromagnetic oscillations are described by the same basic mathematical equations, the behaviour exhibited by the harmonograph is related to the behaviour of radio waves, microwaves, visible light, and alternating current circuits.

Beyond its popularity in the Victorian parlour, the harmonograph has been shown to be a useful device for visualizing mathematical relationships. The intricate beauty of the patterns created by the harmonograph generates enthusiasm for comprehension of the underlying physics and mathematics.

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MUSICAL PHYSICS:
THE STUDY OF VIBRATING COLUMNS OF AIR IN MUSICAL INSTRUMENTS

Thomas Zajac
Summerland Secondary School, Grade 8

Purpose

I was trying to figure out how music is produced in a pipe organ, flute, and other brasses and woodwinds. I was also wondering if musical instrument making depends totally on the skill and experience of the draftsman, or if there is some kind of mathematical connection.

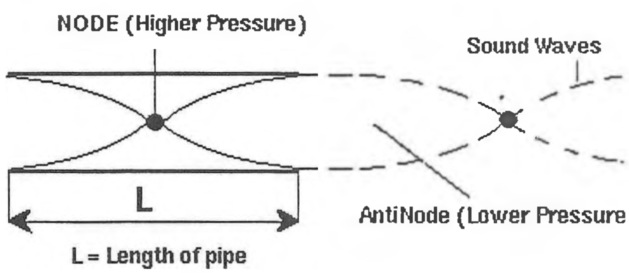
Hypothesis

I suspect that it depends on both. There must be a mathematical explanation - but how accurate is it? Well, I will study this problem and make experiments. I will try to make a 15th century pipe organ using 20th century test equipment.

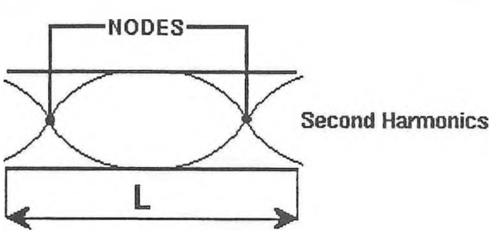
Theory

I did some studies and found out that all pipe instruments produce sound from vibration of the standing sound waves in a column of air in the pipe. Frequency of the tone played depends on the length of the pipe. I also found out that vibrations of the air column is set up by the vibrating lip of the player of brass instruments and by the airstream directed against one edge of an opening for woodwind instruments. The air within the tube vibrates with a variety of frequencies, but only certain frequencies persist. They are called resonant.

Theory of the Open Tube

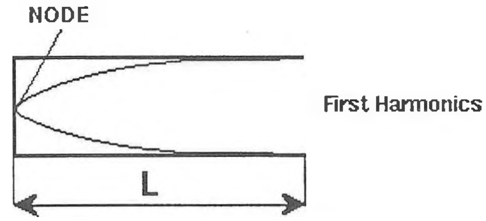


The graph within the tube represents standing waves (motion of air molecules) for air to vibrate, there must be at least one NODE within the tube. If the frequency doubles - there will be two nodes - and the tone will sound one octave higher, say C to C_1 it is called SECOND HARMONICS. I can easily demonstrate it in my experiment.

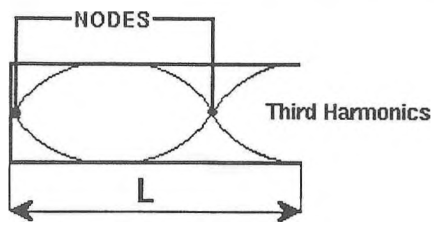


As you see it, the pipe will vibrate in resonance every time the tone is increased 1 octave - C to C_1 to C_2, etc.

Theory of the Closed Pipe



For the closed pipe, there is always a NODE at the closed end and an ANTINODE at the open end. The only difference is that there are only ODD HARMONICS presented so the pipe will be in resonance only every second octave, like C_1 to C_3 to C_5, etc.

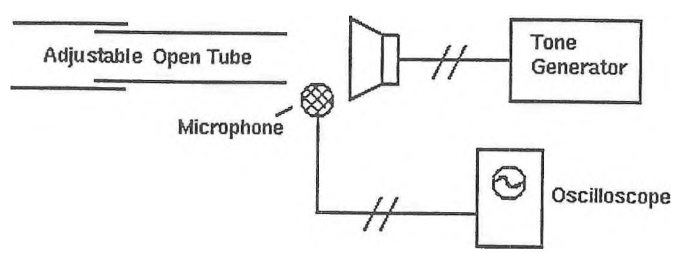


I also discovered that for the same frequency - say 440 Hz = note A, the length of the open pipe must be 2x longer than for the closed pipe (open pipe - 162 mm; closed pipe - 81 mm).

Test and Experiment Results

Basically, I made four experiments with interesting results.

Open Pipe Experiment No. 1.



1) I calculated the length of the pipes from the formula and recorded it in the table.

2) I placed an adjustable open pipe on the table with a speaker as the source of vibrations (tone) - say 440 Hz = note A, which was supplied by the tone generator.

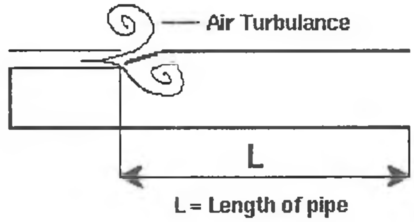
3) Then I slowly adjusted the length of the pipe and at the same time I observed the wave form on the oscilloscope. At the certain point I noticed increase in the volume and wave pattern grew taller due to the increase of volume of the sound because the pipe was in resonance with the frequency of 440 Hz.

4) I measured the length of the pipe and recorded it on the table. The difference between the calculated and tested length was 34 mm.

I them repeated the procedure 8 times for all notes of the musical scale between C to C_1. Then I cut all 8 pipes from plastic water pipes and made a small electronic pipe organ. The pipes are removable so they can be used in other demonstrations like the seashell theory. When you hold a seashell next to your ear, you are just hearing the "tube" that resonates to certain frequencies in the spectrum of background sounds and one pitch is dominant. By listening to all pipes in a certain order you can produce a tune.

Open Pipe Music Experiment No. 2

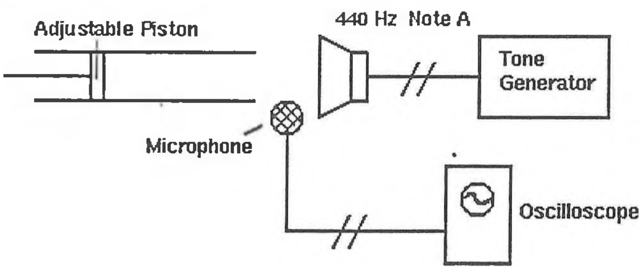
I calculated all the lengths of the pipes for the musical scale of C_1 to C_2. Then I made eight whistles according to the length I calculated.



After this was done, I played each note and tuned the whistle by trimming them (by ear) with a piano. I found this extremely difficult to do, and they are still somewhat out of tune by a few H. There is also a big difference between "calculated" and "tuned" lengths. Perhaps because of air turbulence.

Closed Pipe Experiment No. 3

This experiment is the same in principle as experiment No. 1. The only difference is that the pipe is CLOSED at one end with an adjustable piston.



I calculated the length for 440 Hz as 195 mm. The resonance length tested as 190 mm. I didn't repeat this experiment for other notes. As I see it, the same type of testing could be used to find the resonant frequency in any hollow object of any shape which would be impossible to calculate.

Closed Pipe Music Experiment No. 4

This is somewhat like experiment No. 2, except that the pipe is closed at one end. I calculated the lengths of the pipes for the notes C_1 to C_2 in the musical scale. Then I cut all the pipe 1/2 cm longer and plugged the bottom with wooden plugs. I tuned them by adjusting the plugs in or out of the pipe. This was very successful and the difference between the calculated length and the tuned length was very small as you see in the table. You can play pipes like blowing across the top of a pop bottle. The sound made is flute-like and sounds rather nice.

Conclusions

As I see it, there is more to it in making a musical instrument than just theory. Those old craftsmen of the 15th century were very good at DOING PHYSICS without actually knowing it - THEORY came later.

I had no problem with my experiments and testing, but I had some difficulty before I used the oscilloscope in experiment 1 and 3. I was trying to use different powders in the glass tube so it would form wave patterns - as the books recommended - but it would only work when the volume was very loud. I also found it difficult to work with sound as you can't see it and it varies too much.

I could have improved the testing by using an oscilloscope to greater extent by calibrating. I also could have studied different patterns of waves of different instruments, but this was the first time I used the oscilloscope.

Bibliography

Giancoli, Douglas C. Physics.

Doing Physics - Pipe Music, The Physics Teacher, March 1987, Volume 25.

Note: The actual tables of results from the four experiments as well as a diagram of the audio generator and oscilloscope patterns appeared in the complete report.

WHAT'S NEW ??

Promotions
Deaths
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Moves
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Distinctions
Other news

Do you have any news that you would like to share with *Canadian Acoustics* readers? If so, fill in and send this form to:

QUOI DE NEUF ??

Promotions
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Autres nouvelles

Avez-vous des nouvelles que vous aimeriez partager avec les lecteurs de l'*Acoustique Canadienne*? Si oui, écrivez-les et envoyer le formulaire à:

Jim Desormeaux, Ontario Hydro, 757 McKay Road, Pickering, Ontario L1W 3C8

COMPUTER VOICE RECOGNITION

Kevin Greer and Suresh Pereira
Thousand Islands, Grade 13, Brockville, Ontario

In 1950, Bell labs attempted to develop a rudimentary voice recognition, but lacked the technology for such a feat. Since them with the advent of Artificial Intelligence and more efficient information storage, voice recognition has become much more feasible. However, to date most people are unaware of its existence, and it remains quite difficult to accomplish.

Basically, this project revolves around a voice recognition system that is both user-dependent and single word; that is, one person programs in some words, and the computer will then be able to recognize the words when repeated.

When a word is spoken into the microphone, it travels to an analog-digital converter where the analog signal of the voice is turned into a digital signal understood by the computer. This digital signal is read through the printer port. The software (designed exclusively by the entrants) then produces a dot-graph plotting amplitude vs. time, and this dot-graph is then used to check the word.

Three methods were originally developed to check the word entering the system. The first method imposed a ten by ten grid on the amplitude-time graph (A-T graph) and likened the grid to a matrix; thereafter, the values were placed in the corresponding matrix locations. This matrix was then stored beside the word. The second method first imposed ten columns on the A-T graph, and the average displacement (with all values considered positive) of the points from the Time axis was stored in a 10-length array, after that ten rows were imposed on the A-T graph, and the amount of dots within each row was stored in a 10-length array. Since it was felt that the second method, by using the row aspect, had a slight advantage, a third method was developed which only used the column aspect of the second method.

In order to compare stored words with incoming words, the three methods developed their respective matrices, which were then subtracted from the stored matrices. Each location within the resultant matrix was then squared to emphasize error. And then the locations were summed, producing a number that represented deviance from the stored word.

Experiments were then performed to determine the reliability of the system for 1) Number of words in Library, 2) Number of Lessons, lesson being the amount of times each word is stored in the library, and 3) Background Noise. These tests served a dual purpose. First, they determined what factor affected the systems, and second they determined which of the three methods was best.

However, it was found that some words were had to tell apart, cases being "one" and "four" and "left" and "right". The reason for this was suspected to be the lack of the use of frequency to check the words. To this end, two methods of frequency analysis were developed. The first was a spectro-analysis, but this method hasn't yet been used to test words, though it soon will be. The second method was similar to a spectro-analysis but it only paid attention to the major frequencies by checking for dots several units above and below the T-axis rather than checking for dots on the axis. This second method was easier to implement, and thus used in lieu of the spectro-analysis because of the lime-limitation. While comprehensive tests weren't performed to check the accuracy of the frequency analysis, the system no longer mistook "one" for "four" or "left" for "right"; and it just couldn't miss with a musical note.

Further developments include more efficient amalgamation of A-T and frequency analysis. Also, applications of voice recognition are to be both simulated on the computer and demonstrated.

Our conclusions were that your system, using A-T graphs, was accurate up to ten words, at which point it became almost useless. Further, it was concluded that any real recognition system would have to have frequency analysis of some design. It was also concluded that our second method of A-T analysis (the column then the rows) was the most reliable of the three.

Bibliography

Scientific American. (1988), "Trends in Computing", Computer Software for Intelligent Systems, Special Issue. Vol. 1.

Byte Magazine. (1984). The Texas Instruments Speech Command Systems, June.

Discover Magazine. (1988). 2001 Computers: Living inside your PC, November.

Note: Accompanying appendices showing test results and sample screen output were included in the original report.

(For this project, Kevin Greer and Suresh Pereira were awarded the CAA prize in Acoustics at the 1989 Canada-Wide Science Fair. Both students have recently completed their first year with "A" standing at the University of Waterloo in Computer Science and Physics, respectively.)

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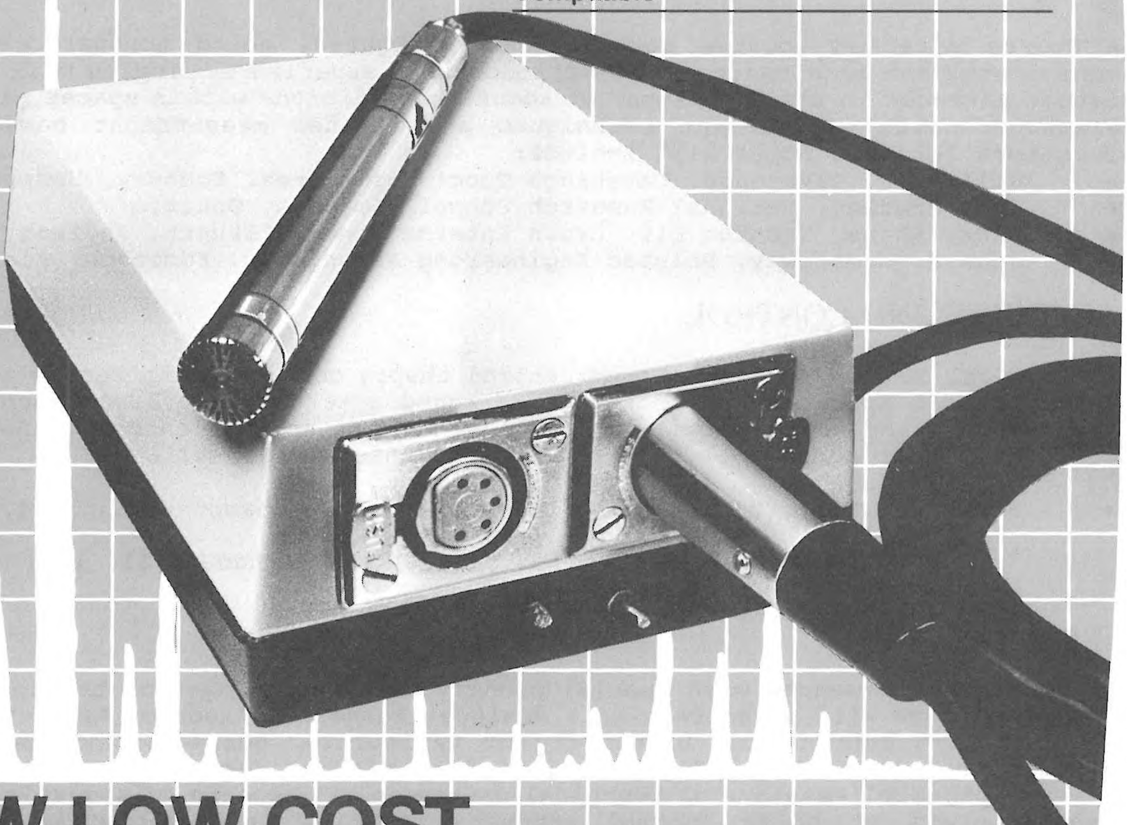

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ACOUSTICS BEGINS WITH ACO

CANADIAN ACOUSTICAL ASSOCIATION
1991 Acoustics Week In Canada
Ramada Renaissance, Edmonton, Alberta

SEMINARS (October 7 - 8)

NOISE AND VIBRATION CONTROL IN BUILDINGS

This course will present basic and advanced criteria for noise and vibration control in buildings, particularly at the design stage. All noise sources will be discussed, including low-frequency duct rumble, building vibration and ground vibration. The lecturers include:

- Charles Ebbing, Carrier Corporation, Syracuse, NY
- Doug Reynolds, University of Nevada, Las Vegas
- Don Allen, Vibron Ltd., Toronto
- Steve Wise, Digisonix Corp., Stoughton, Wis.

RECENT ADVANCES IN ELECTROACOUSTIC MEASUREMENTS AND HARDWARE

A course directed towards sound system designers, sound contractors, acoustic consultants and architects with electroacoustic experience. Topics will include the latest advances in the assessment of acoustic conditions within spaces, acoustic and electroacoustic measurement techniques and related measurement hardware. The lecturers for this topic will include:

- William J. Cavanaugh, Cavanaugh Tocci Associates, Sudbury, Massachusetts
- John Bradley, National Research Council, Ottawa, Ontario
- Larry Shank, Techron Div. Crown International, Elkhart, Indiana
- John R. Hemingway, Bolstad Engineering Associates, Edmonton, Alberta

ACTIVE SOUND CONTROL

A technical course on active sound control theory combined with recent advancements and practical applications using active sound attenuation. Discussion will be on various free and enclosed sound fields, as well as active control within headsets, ducts, aircraft and cars. The lecturer for this session will be:

- Steven J. Elliott, I.S.V.R., University of Southampton, England.

DEADLINE FOR REGISTRATION OF SEMINARS IS AUGUST 31, 1991

SYMPOSIUM (October 9 - 10)

This program commences with special plenary sessions on each of the two days. The guest speakers will be concert hall designer Russell Johnson of Artec Consultants, New York and John Ohala, University of California, Berkley, who specializes in experimental phonetics and phonology. Each plenary session will be followed by several parallel sessions of technical papers on all aspects of acoustics. As well, manufacturers of noise control products, testing instrumentation and related equipment will be exhibiting their items. A Thursday evening banquet for participants and their guests will conclude the weeks formal events and will include the presentation of awards. The structured sessions, to date, are as follows:

- AUDITORY REHABILITATION
- SPEECH PERCEPTION AND RECOGNITION
- LARGE ROOM ACOUSTICS
- ACOUSTICS IN SMALL ENCLOSURES
- ACOUSTICAL TESTING OF BUILDING COMPONENTS
- UNDERWATER ACOUSTICS
- ENVIRONMENTAL AND COMMUNITY NOISE
- ELECTROACOUSTICS
- MECHANICAL NOISE AND VIBRATION

CANADIAN ACOUSTICAL ASSOCIATION
1991 Acoustics Week In Canada
Ramada Renaissance, Edmonton, Alberta

CAA ANNUAL GENERAL MEETING

The meeting will be held on Thursday, October 10, 1991 at the hotel. All CAA members are urged to attend.

COMPANION PROGRAM (October 9 - 10)

A schedule of events and site visits to local attractions has been arranged for the spouses of participants. Cultural and historical buildings will be toured, including the largest shopping and entertainment complex in the world, the West Edmonton Mall.

ROCKY MOUNTAIN BUS TOUR (October 11 - 13)

A three day, conducted bus tour is being planned for all those interested in sightseeing before heading home. The places featured on this trip are Jasper, Yoho and Banff National Parks, the Icefield Parkway and Drumheller (Tyrrell Museum of Paleontology). The tour is expected to end in Calgary on Sunday, October 13. Participants will have the choice to take a flight home from Calgary or complete the journey back to Edmonton late in the evening.

HOTEL INFORMATION/AIR TRANSPORTATION

All meeting activities are to be held in the Ramada Renaissance Hotel, 10155 - 105 Street, Edmonton, Alberta, T5J 1E2. A block of rooms has been reserved at reduced rates as follows: Regular rooms, single or double occupancy - $73.00 per night; Renaissance Club Floor, single or double occupancy - $88.00 per night; Executive Suite, single or double occupancy - $125.00 per night. Federal and Provincial Taxes extra. The reduced rate release date is September 6, 1991. Late reservations will be made on a space available basis.

To reserve a room, complete and mail the registration card contained in the information package or call the Hotel at (403) 423-4811, or FAX (403) 423-3204.

Reduced air fares for delegates are available from Canadian Airlines International, who have been designated as the Official Conference Airline. To obtain air fare discounts, call toll-free 1-800-665-5554, Canada and USA, and quote Conference Registration Number 0621.
Discounts are also available on Canadian Air Cargo for demonstration materials.

Ground transportation from the Edmonton International Airport to the Ramada Renaissance will cost approximately $32.00 by taxi. Shuttle bus service is available at $9.00 per person, one way, $16.00 per person, round trip, plus tax.

For a complete information package on the entire Acoustics Week in Canada program, write, phone, of FAX to:

CANADIAN ACOUSTICAL ASSOCIATION
1991 CONVENTION COMMITTEE
c/o BOLSTAD ENGINEERING ASSOCIATES LTD.
9249 - 48 STREET
EDMONTON, ALBERTA T6B 2R9
Tel. (403) 465-5317 Fax (403) 465-5318

COURS (7 - 8 octobre)

Trois cours sont offers en anglais. On vous prie de voir le côté anglais pour les descriptions et de vous inscrire **avant le 31 août, 1991**.

SYMPOSIUM (9 - 10 octobre)

Chaque jour débutera avec une plénière. Les conférenciers invités sont: le dessinateur de salles de concert, Russell Johnson d'Artec Consultants - New York, et John Ohala de l'Université de la Californie à Berkley, un spécialiste de la phonologie et de la phonétique expérimentale. Ces sessions seront suivies de sessions parallèlles de communications couvrant tous les aspets de l'acoustique. Il y aura, comme toujours, une exposition de manufacturiers de produits de contrôle du bruit et d'instrumentation. Le banquet jeudi soir couronnera le congrès avec la remise des prix. À date, voici les sessions prévues:

- RÉHABILITATION AUDITIVE
- PERCEPTION ET RECONNAISSANCE DE LA PAROLE
- L'ACOUSTIQUE DE GRANDES SALLES
- L'ACOUSTIQUE DE PETITS ESPACES
- TEST DE MATÉRIAUX DU BÂTIMENT
- L'ACOUSTIQUE SOUS-MARINE
- BRIUT COMMUNAUTAIRE ET ENVIRONNEMENTAL
- ÉLECTROACOUSTIQUE
- BRUIT ET VIBRATIONS MÉCANIQUES

L'ASSEMBLÉE ANNUELLE DE L'ACA

L'assemblée annuelle aura lieu le jeudi, 9 octobre 1991 à l'hôtel Rammada Renaissance. Tous les membres de l'ACA sont priés de s'y rendre.

PROGRAMME POUR LES PERSONNES QUI ACCOMPAGNENT (9 - 10 octobre)

Le tour de ville prévu permettera aux personnes qui accompagnent les participants de visiter les sites historiques et culturels d'Edmonton. Natrullement il y aura une randonnée aux fameux centre d'achats et d'amusements: West Edmonton Mall.

TOURNÉE DES MONTAGNES ROCHEUSES (11 - 13 octobre)

Ceux qui désirent se rendre dans les Rocheuses et voir les beautés naturelles de l'Alberta pouront profiter d'un voyage organisé des parc nationaux de Jasper, Yoho, et Banff. Ce voyage en autocar incluera également une visite au musée Tyrell de paléontologie à Drumheller et se terminera à Calgary dimanche, le 13 octobre. Les voyageurs auront le choix de rester à Calgary ou de retourner à Edmonton plus tard ce soir-là.

RÉSERVATIONS À L'HÔTEL

Toutes les activitées de la semaine se dérouleront à l'hôtel Ramada Renaissance, 10155 - 105 rue, Edmonton, Alberta, T5J 1E2. Un bloc de chambres a été réservé à des taux préférentiels:

- Chambres regulières (occupation simple ou double) - 73,00$ par soir
- Renaissance Club (occupation simple ou double) - 88,00$ par soir
- Suites Exécutives (occupation simple ou double) - 125,00$ par soir

Toutes taxes fédérales et provinciales ne sont pas comprises. Ces taux réduits sont valables jusqu'au **6 septembre, 1991**. Après cette date les réservations seront faites si l'espace le permet. Afin de réserver une chambre retournez la carte d'enregistrement incluse dans le paquet d'information ou contactez l'hôtel au (403) 423-4811 ou par télécopieur au (403) 423-3204

TRANSPORTATION AÉRIENNE

Canadian Airlines International offre un rabais spécial pour le congrès de l'ACA, sur ses vols à destination d'Edmonton. Afin d'obtenir ses escomptes contctez le 1-800-665-5554 sans frais au Canada et aux E.U. et faites référence au "*Conference Registration Number*" 0612.

Les coûts de taxi de l'aeroport International d'Edmonton à l'hôtel Ramada Renaissance sont environs 32,00$. L'autobus de navette est aussi disponible et coute 9,00$ par personne, une direction, et 16,00$ par personne, aller et retour (taxes non-comprises).

Pour de plus amples renseignments et le paquet d'information complète de la Semaine d'Acoustique Canadienne 1991 écrivez, appellez ou contactez par télécopieur:

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CALL FOR PAPERS

Acoustics Week In Canada
October 7-10, 1991

Acoustics Week in Canada, 1991, will be held at the Ramada Renaissance Hotel, Edmonton, Alberta. The week will begin with two days of technical seminars on modern advances in electroacoustic techniques, active noise control as well as noise and vibration control in buildings. Specific details and registration for these courses will be published in the April issue of Canadian Acoustics. The technical program will take place on October 9 and 10, following the seminars.

There are no events scheduled for Friday, October 11. However, for those interested participants, a weekend bus tour through the scenic Rocky Mountains is planned commencing on this day. As well, out-of-town guests will have an opportunity to enjoy the local attractions before heading home.

TECHNICAL PROGRAM
October 9 and 10, 1991

The technical program will include keynote speakers in special plenary sessions which will be followed by the general sessions. Authors are invited to submit abstracts for presentation in these general sessions on all aspects of acoustics, however, papers in specific areas are especially encouraged. These include:

- architectural acoustics with emphasis on both large and small rooms including speech intelligibility
- acoustic measurements and testing including acoustic intensity, signal analysis and processing, electroacoustic systems
- environmental and community noise standards with emphasis on rural noise problems, occupational health concerns
- speech and hearing including speech production and perception, auditory rehabilitation, normal and disabled speech communication, assistive listening devices
- noise and vibration control specifically active and passive systems, low frequency problems in HVAC, building and ground vibrations

The organizers intend to develop several structured sessions around a particular theme and invite ideas from potential authors. Group submissions will be reviewed as a complete package. Papers submitted independently will be placed into appropriate categories for presentation.

Authors should submit, before 30 April 1991, an abstract prepared in accordance with the instructions on page 42. All submissions will be reviewed to ensure suitability. Authors of accepted abstracts will be expected to submit, before 31 July 1991, a written version of their paper, prepared in accordance with the intructions on page 43 and to be published in the Proceeedings (September) Issue of Canadian Acoustics without review. Abstracts, proceedings articles and requests for further information should be directed to:

Dr. M.G. Faulkner, Department of Mechanical Engineering,
University of Alberta, Edmonton, Alberta, T6G 2G8
Telephone: (403) 492-3446 FAX: (403) 492-2200

STUDENT AWARDS

Students are particularly invited to participate. In addition to the student awards for papers available from the CAA, a limited number of assistance grants for student travel and housing will be available.

APPEL AUX COMMUNICATIONS

Semaine de'Acoustique Canadienne
le 7-10 octobre, 1991

La semaine de l'Acoustique Canadienne 1991 aura lieu à l'hôtel Ramada Renaissance d'Edmonton, Alberta. La semaine débutera avec deux jours de séminaires techniques traitant d'avances en techniques électro-acoustiques, contrôle actif du bruit, ainsi que le contrôle du bruit et des vibrations dans le bâtiment. Les détails ainsi que le formulaire d'inscription seront publiées dans le numéro d'avril de l'Acoustique Canadienne. Le programme technique suivera les 9 et 10 octobre, 1991.

La journée de vendredi, le 11 octobre est libre afin que ceux qui le désirent puissent participer à une excursion scénique des Montagnes Rocheuses ou tout simplement de jouir d'Edmonton.

PROGRAMME TECHNIQUE
le 9 et 10 octobre, 1991

Le programme technique débutera avec des communications invitées en session plénière suivi de sessions générales. Vous êtes invités à soumettre des résumées de communications dans tous les domaines de l'acoustique. Cepandant, les domaines suivants sont particulièrement encouragées:

- l'acoustique architecturale de petites et grandes salles avec emphase sur l'intelligibilité de la parole
- les méthodes de mesures acoustiques tel que l'intensimétrie,l'analyse des signaux,les systèmes électro-acoustiques
- le bruit environnemental et communautaire; surtout les problèmes de bruit rural, la santé du travail
- la parole et l'audition tel que la production et perception de la parole, réhabilitation auditoire, la communication orale, technologie d'assistance auditive
- le contrôle du bruit et des vibrations, spécifiquement le contrôle actif et passif, problèmes de basse fréquences dans les systèmes de ventilation, vibrations du sol et du bâtiment.

L'organisateur développera plusieurs séssions structurées autour d'un thème particulier et invite des idées à ce sujet. Les soummisions de groupe seront arbitrées ensemble comme une unité. Les communications indépendantes seront regroupées dans les catégories appropriées.

Les auteurs devraient soumettre, avant le 30 avril 1991, un sommaire se conformant aux directives publiées à la page 42. Toutes les soumissions seront arbitrées. Chaque auteur des sommaires acceptés devrait soumettre, avant le 31 juillet 1991, une version écrite de sa communication, se conformant avec les directives publiées à la page 43 et à paraître sans arbitrage dans le 'cahier des actes' (numéro de septembre) de l'Acoustique Canadienne. Tous les sommaires, les versions écrites et les questions au sujet du programme technique doivent être addressés à:

Dr. M.G. Faulkner, Department of Mechanical Engineering
University of Alberta, Edmonton, Alberta T6G 2G8
Téléphone: (403) 492-3446 FAX: (403) 492-2200

PRIX ETUDIANT

Les étudiants sont fortement encouragés à participer. A cette fin un certain nombre de subventions de voyage sont disponibles en plus des prix de l'ACA pour les présentations.

Instructions for the Preparation of Abstracts for Papers to be Presented at the 1991 Meeting of the Canadian Acoustical Association

1. Quadruplicate copies of an abstract are required for each meeting paper; one copy should be an original. Send the four copies to the Technical Program Chairperson, Gary Faulkner, Dept. of Mech. Eng., University of Alberta, Edmonton, T6G 2G8, in time to be received by April 30, 1991. Either English or French may be used. A cover letter is not necessary.

2. Limit the Abstract to 300 words, including title and first author's name and address; names and addresses of coauthors are not counted. Display formulas set apart from the text are counted as 40 words. Do not use the forms "I" and "we"; use passive instead.

3. Title of abstract and names and addresses of authors should be set apart from the abstract. Text of abstract should be one single, indented paragraph. The entire abstract should be typed *double spaced on one side* of 8 1/2 x 11 in. or A4 paper.

4. Be sure that the mailing address of the author to receive the acceptance notice is complete on the abstract, to insure timely deliveries.

5. Do not use footnotes. Use square brackets to cite references or acknowledgements.

6. Underline nothing except what you wish to be italicized.

7. If the letter l is used as a symbol in a formula, loop the letter l by hand and write "lc ell" in the margin of the abstract. Do not intersperse the capital letter O with numbers where it might be confused with zero, but if unavoidable, write "capital oh" in the margin. Identify phonetic symbols by appropriate marginal remarks.

8. At the bottom of an abstract give the following information:

    (a) If the paper is part of a special session, indicate the session.
    (b) Name the area of acoustics most appropriate to the subject matter: Auditory Rehabilitation, Speech Perception and Recognition, Large Room Acoustics, Small Enclosures, Acoustical Testing of Building Components, Underwater Acoustics, Environmental and Community Noise, Electroacoustics, Mechanical Noise and Vibration Control or other.
    (c) Telephone number, including area code, of the author to be contacted for information. non-Canadian authors should include country.
    (d) If more than one author, name the one to receive the acceptance notice.
    (e) Overhead projectors and 35-mm slide projectors will be available at all sessions. Describe on the abstract itself any special equipment needed.

[Adapted from Acoustical Society of America Guidelines]

Instructions pour la Préparation des Articles à être Publiés dans le Cahier des Actes du Congrès

Général

Soumettre un article prêt-à-copier d'un maximum de deux pages présenté en deux colonnes, en conformité avec l'exemple présenté aux pages 31-34 de ce numéro. Ne pas inclure de sommaire. Tout le texte en caractères Times-Roman. Disposer les figures dans le haut ou le bas des pages si possible. Lister les références dans un format logique à la fin du texte. Envoyer l'article au président du Programme Technique avant le 31 juillet 1991. Le format optimal peut être obtenu de deux façons:

Méthode directe

Imprimer directement sur deux feuilles 8.5" x 11" en respectant des marge de 3/4" dans le haut et sur les côtés et un minimum de 1" dans le bas. Titre en 12pt, caractères gras, en simple interligne (12pt), centrés sur la page. Le reste du texte en 9pt en 0.75 (9pt) interligne, dans un format en deux colones, avec une larguer de colonnes de 3.4" et une séparation de 1/4". Noms des auteurs et adresses centrés sur la page avec les noms en caractères gras. Les titres de sections en caractères gras.

Méthode indirecte

Dactylographier ou imprimer comme suit, réduire au trois-quart (s.v.p., s'assurer de bonnes photocopies) et assembler l'article sur un maximum de deux pages 8.5" x 11" avec des marges de 3/4" dans le haut et sur les côtés et un minimum de 1" dans le bas. Titre en 16pt avec 1.33 (16pt) interligne, centré sur la page. Le reste du texte en 12pt avec simple (12pt) interligne. Noms et adresses des auteurs centrés sur la page avec les noms en caractères gras. Titres des sections en caractères gras. Imprimer les colonnes de texte sur quatre feuilles 8.5" x 14" avec une largeur de colonnes de 4.5", une longeur maximum de 12.25", en laissant de la place pour le titre, les noms et les adresses sur la première page.

Instructions for Preparation of Articles to be Published in the Conference Proceedings Issue

General

Submit the camera-ready article on a maximum of two pages in two-column format, as exemplified on pages 31-34 of this issue. Do not include an abstract. All text in Times-Roman font. Place figures at the top and/or bottom of the pages, if possible. List references in any consistent format at the end. Send to the Chairperson of the Technical Programme by 31 July 1991. The optimum format can be obtained in two ways:

Direct method

Print directly on two sheets of 8.5" x 11" paper with margins of 3/4" top and sides, and 1" minimum at the bottom; Title in 12pt bold with single (12pt) spacing, centred on the page; All other text in 9pt with 0.75 (9pt) line spacing, in two-column format, with column width of 3.4" and separation of 1/4"; Authors names and addresses centred on the page with the names in bold type; Section headings in bold type.

Indirect method

Type or print as follows, reduce to three-quarters size (please ensure good copies) and assemble article on a maximum of two 8.5" x 11" pages with margins of 3/4" top and sides, and 1" minimum at the bottom. Title in 16pt bold type with 1.33 (16pt) line spacing, centred on the page; All other text in 12pt with single (12pt) line spacing; Authors names and address centred on the page with the names in bold type; Section headings in bold type. Print individual text columns on four sheets of 8.5" x 14" paper with a column width of 4.5", a maximum length of 12.25", and leaving room for the title and names and addresses on the first page.

TRAVEL SUBSIDY
FOR STUDENTS
1991 Acoustics Week In Canada
Edmonton, Alberta October 7 - 10

The Canadian Acoustical Association (CAA) annually hosts a four-to-five day conference, dealing with a wide variety of topics related to acoustics. This year, the week will begin with the following two day seminars to be held concurrently.

1) Active Sound Control
2) Noise and Vibration Control in Buildings
3) Recent Advances in Electroacoustic Measurements

The seminars will be followed by a symposium where technical papers are presented. Some of the structured sessions include; speech perception and recognition, auditory rehabilitation, large room acoustics, small enclosures, acoustical testing of building components, underwater acoustics, environmental and community noise, electroacoustics, mechanical noise and vibration control.

If you are a student involved in acoustic study or research, we invite you to attend this years conference in Edmonton, Alberta. Students that present a technical paper will be eligible to receive an award for their contribution.

To encourage student participation, a travel fund has been established to partially defray transportation and housing expenses. The amount granted to each student will depend on the number of requests received. To apply for a travel subsidy, students should submit a brief informal written proposal to:

CANADIAN ACOUSTICAL ASSOCIATION
1991 CONVENTION COMMITTEE
c/o Bolstad Engineering Associates Ltd.
9249 - 48 Street, Edmonton, Alberta, T6B 2R9
Tel. (403) 465-5317 Fax (403) 465-5318

which should be mailed in time to be received by July 15, 1991.

The proposal should indicate your status as a student, whether or not you have submitted an abstract to present a paper at the conference, whether you are a member of CAA, your travel plans (i.e. whether you will be travelling alone or with other students), and any other information you may consider to be relevant. Preference will be given to full-time students at a University or post-secondary institution using the most economical mode of transportation.

Subside de voyage
pour étudiants
Congrès de l'Acoustique Canadienne 1991
Edmonton, Alberta du 7 au 10 octobre

Le congrès annuel de l'Association Canadienne d'Acoustique (ACA) couvre une variété de sujets qui se rattachent à l'acoustique. Cette année, la semaine débuttera avec trois cours de deux jours présentés simultanément (en anglais):

1) Active Sound Control
2) Noise and Vibration Contol in Buildings
3) Recent Advances in Electoacoustic Measurements.

Les deux derniers jours du congrès seront consacrés à un symposium de communications techniques. Parmi les sessions structurées, l'on propose les thèmes suivants: la perception et la reconnaissance de la parole, la réhabilitation auditive, l'acoustique de grandes salles, test de matériaux du bâtiment, l'acoustique sous-marine, le bruit environnemental et communautaire, l'électro-acoustique, le contrôle du bruit et des vibrations mécaniques.

Si vous êtes étudiant(e) en acoustique nous vous invitons à participer à notre congrès à Edmonton, Alberta. Il y a des prix pour les meilleures présentations étudiantes.

Afin d'encourager la participation étudiante, un fonds a été établi pour aider à défrayer les coûts de transport et de logement. Le montant octroyé à chaque étudiant(e) dépend du nombre de demandes reçues. Une soumission écrite doit être reçue par le comité organisateur avant le 15 juillet 1991, à l'adresse suivante:

L'ASSOCIATION CANADIENNE d'ACOUSTIQUE
1991 CONVENTION COMMITTEE
a/s Bolstad Engineering Associates Ltd.
9249 - 48 Street, Edmonton, Alberta, T6B 2R9
Tel. (403) 465-5317 Télécopieur (403) 465-5318

Votre soumission doit indiquer votre situation en tant qu'étudiant(e), si vous avez soumis un résumé afin de présenter une communication, si vous êtes membre de l'ACA, vos plans de voyage (i.e. si vous voyagez seul(e) ou avec d'autres participants) et toute autre information que vous jugez utile. La préférance sera donnée aux étudiants(e)s qui fréquentent une université ou autre institution post-secondaire à plein temps et à ceux qui choisiront le moyen de transport le plus économique.

REGISTRATION FORM
(FORMULAIRE D'INSCRIPTION)
1991 Acoustics Week In Canada
Ramada Renaissance, Edmonton, Alberta

Surname (Nom): ______________________ FirstName (Prénom): ______________________

Representing (Représentant): ____

Address (Adresse): ____

____

____

Postal Code (Code Postal): ______________ Telephone: (______) ______________

Companion Name (Nom de Personnes qui accompagnent) ______________________

SEMINARS (SÉMINAIRES en anglais)
October 7 - 8 (octobre) 1991

		Amount (Montant)
NOISE AND VIBRATION CONTROL IN BUILDINGS	$275.00	$________
RECENT ADVANCES IN ELECTROACOUSTIC MEASUREMENTS	$275.00	$________
ACTIVE SOUND CONTROL	$300.00	$________

SYMPOSIUM
October 9 - 10, 1991

REGISTRATION (INSCRIPTION)			
- before August 31 (avant le 31 aôut)		$ 75.00	$________
- after August 31 (après le 31 aôut)		$ 85.00	$________
STUDENT REGISTRATION (INSCRIPTION D'ETUDIANT)		$ 20.00	$________
BANQUET TICKETS (Billets) ________	X	$ 35.00	$________
COMPANION PROGRAM (Programme pour les Personnes qui accompagnent)		$ 15.00	$________
	TOTAL		$________

____ YES, I would like to obtain more information on the Rocky Mountain Bus Tour October 11 - 13, 1991

____ OUI, J'aimerais obtenir plus d'information au sujet de la tournée des Montagnes Rocheuses 11 - 13 octobre, 1991

PLEASE make cheques payable in Canadian funds to CAA 1991 CONVENTION and mail to
S.V.P. Faites vos chèques à l'ordre de CAA 1991 CONVENTION en fonds Canadiens et postez à

CANADIAN ACOUSTICAL ASSOCIATION
c/o BOLSTAD ENGINEERING ASSOCIATES LTD.
9249 - 48 STREET
EDMONTON, ALBERTA, CANADA, T6B 2R9

The Canadian Acoustical Association
l'Association Canadienne d'Acoustique

INVENTOIRE DES ACTES DE CONGRES ET PUBLICATIONS DE L'ACA

L'Association a reçu récemment plusieurs demandes d'achats d'actes de congrès et de publications de l'ACA. Ceux-ci sont, semble-t'il, dispersés à travers le pays, principalement entre les mains des organisateurs antérieures. Nous aimerions maintenant les localiser afin de pouvoir les vendre. Nous apprécierions que ceux et celles qui sont en possession de ces actes de congrès et publications de l'ACA communiquèrent avec Murray Hodgson. Tél: 613-993-0102 Fax: 613-954-5984.

PROGRAMMES OF EDUCATION IN ACOUSTICS AND VIBRATION

A subcommittee of the Board of Directors has been given the task of compiling a list of educational opportunities in Acoustics and/or Vibration available in Canada. We are interested in programmes given at all levels, whether high school or graduate school, degree or non-degree. If you know of or are involved in such a program, please fill out and mail the short questionnaire below.

PROGRAMMES DE FORMATION DANS LES DOMAINES DE L'ACOUSTIQUE ET DES VIBRATIONS

Un sous-comité du conseil d'administration a reçu le mandat de dresser une liste de milieux qui offrent des programmes de formation dans le domaine de l'acoustique et/ou des vibrations au Canada. Nous sommes intéressés par les programmes de tout niveaux, menant ou non à un diplôme. Si vous connaissez ou si vous êtes impliqué dans un tel programme, s'il-vous-plaît, complétez et postez le court questionnaire qui suit.

Name and title of respondent / Nom et titre du répondant:

Affiliation of respondent / Affiliation du répondant:

Telephone number of respondent / Numéro de téléphone du répondant:

Location of programme / Lieu du programme de formation:

Brief description of programme / Brève description du programme:

Contact person for programme information / Personne à contacter pour information:

Please return this form to: / S'il-vous-plaît, retournez ce questionnaire à:

Dr. Sharon M. Abel
Hearing Research Laboratory, Rm. 843, Samuel Lunenfeld Research Institute, Mount Sinai Hospital,
600 University Avenue, Toronto, Ontario, Canada M5G 1X5

Institut d'acoustique du Canada atlantique

Les communautés industrielles et de recherche de la région Atlantique ont un intérêt durable en acoustique. Bien que la manifestation la plus évidente de cet intérêt soit l'implication en acoustique sous-marine de certains laboratoires du gouvernement (e.g. Hermes, Oceanroutes Canada, Vemco, etc.), il y a plusieurs autres organisations locales intéressées par d'autres activités variées, tels l'acoustique architecturale et médicale, ou le contrôle non-destructif.

Au cours du printemps et de l'été 1990, des membres de la communauté acoustique de la Nouvelle-Écosse ont été invités à une série de rencontres pour discuter de la formation d'une organisation qui fut appelée l'Institut d'acoustique du Canada Atlantique. Un groupe de travail a été formé pour réaliser cette idée, sous la présidence de Harold Merklinger du Centre de recherches de la défense Atlantique. Vu l'intérêt exprimé par des travailleurs d'autres provinces, il a été décidé d'élargir le champ d'activités pour inclure tout le Canada Atlantique. Les membres de ce groupe représentent les divers intérêts des secteurs académiques, privés, et de la recherche gouvernementale de la région.

L'institut à but non-lucratif a deux buts principaux. Il fera la promotion de l'éducation en acoustique par des activités telles: l'amélioration de la bibliothèque des sciences déjà existante d'une université locale, l'encouragement à l'établissement d'une chaire en acoustique dans une université locale, et l'aide à la création et à l'enseignement de cours d'université apparentés, aux niveaux gradués et postgradués. Il fera la promotion de la commercialisation de l'acoustique en facilitant les interactions entre les universités, les laboratoires du gouvernement, et le secteur privé, et en améliorant l'accès des chercheurs et développeurs à l'information, au matériel spécialisé et aux installations de la région Atlantique.

L'institut n'aura pas ses propres installations, mais fera plutôt la promotion de l'utilisation complète et du partage des installations existantes. Le personnel sera d'abord recruté parmi les volontaires, bien que du personnel à temps partiel pourra être employé si les activités le permettent.

L'institut sera fondé par des souscriptions venant du secteur privé, mais l'adhésion sera ouverte à toutes les parties intéressées. Les détails de l'adhésion, de l'administration de l'institut et un budget fonctionnel sont présentement formulés. Pour plus d'information, contactez le Dr. Harold Merklinger, Chef de section/Acoustique sous-marine, CRDA, Case Postale 1012, Dartmouth, Nouvelle-Écosse, B2Y 3Z7.

Institute of Acoustics of Atlantic Canada

The research and industrial communities in the Atlantic Region area have an enduring interest in acoustics. While the most obvious manifestation of this is the involvement of government laboratories (e.g. DREA and BIO) and firms (e.g. Hermes, Oceanroutes Canada, Vemco, etc.) in underwater acoustics, there are many other local organizations concerned with activities as widely varied as architectural and medical acoustics or non-destructive testing.

During the spring and summer of 1990, members of the Nova Scotia acoustics community were invited to a series of meetings to discuss the formation of an organization which has come to be called the Institute of Acoustics of Atlantic Canada. A small working group under the chairmanship of Harold Merklinger of the Defence Research Establishment Atlantic was formed to bring this idea to fruition. In response to interest expressed by workers in other provinces it was decided to broaden the scope of activity to embrace all of Atlantic Canada. Members of the group represent a cross-section of acoustics interests in the academic, government research and private sectors within the region.

The not-for-profit Institute will have two main aims. It will promote acoustics education through activities such as enhancing an existing science collection in a local university library, encouraging establishment of a chair in acoustics at a local university, and assisting in the creation and teaching of related undergraduate and postgraduate university courses. It will promote commercialization of acoustics by facilitating the interactions between universities, government laboratories and the private sector and by improving access of researchers and developers to information, specialized equipment and facilities in the Atlantic Region.

The Institute will not have facilities of its own, but rather will promote the full utilization and sharing of existing facilities. Initially all staffing will be on a voluntary basis, though part-time staff may be employed if activity warrants.

The Institute will be funded by subscriptions from the private sector but membership will be open to all interested parties. The details of membership in and management of the Institute and a working budget for it are currently being formulated. For further information, please contact Dr. Harold Merklinger, Head/Underwater Acoustics, DREA, P.O. Box 1012, Dartmouth, Nova Scotia B2Y 3Z7.

Harold Merklinger

ARCHITECTURAL STRATEGIES TO AVOID NOISE PROBLEMS IN CHILD CARE CENTRES

by L. Melançon, C. Truchon-Gagnon, M. Hodgson

"Architectural Strategies to Avoid Noise Problems in Child Care Centres" was written by Line Melançon, an architectural trainee, with acoustical input from Murray Hodgson and Claire Truchon-Gagnon. It is the first document of its kind describing the acoustical criteria appropriate for daycare centres and giving an introduction to architectural acoustics as it applies to daycare centres. this is an important area and the authors should be commended.

One of the problems with writing a document of this kind is the difficulty in defining the audience and aiming the material to it. It is not clear who this publication is written for. It summarizes the basics of architectural acoustics in a concise but also rather technical manner. Many daycare facilities are now designed with little attention to acoustics and certainly this document may help to correct this. However, if acoustical design were required, most architects would work in conjunction with an acoustical consultant and this is not made clear except for a passing reference.

The acoustical information gives a summary of architectural acoustics. It gives an introduction to the terminology and sketches of various constructions, with their performance. The information is quite comprehensible and well written, but is of limited practical use to most architects because they would rarely delve into the calculations required on their own. However, some of the general guidelines and sketches would be useful. The acoustical information should be for the most part already well known to acoustical consultants. It appears to be far too technical for lay people such as building owners or daycare managers. They would have great difficulty in implementing the control measures described without professional assistance.

Some of the control measures would rarely be used in practice. For example, the document speaks about replacing existing floors and walls. Extensive modifications to the base structure in existing buildings would be done rarely and would be quite expensive. It also has a sketch for a custom-designed homemade silencing system for heating and ventilation systems and plumbing in a house, again unlikely to be done in practice. Avoiding certain room shapes, as suggested, is also not practical in existing structures.

The criteria introduced (with little backup) at the beginning of the document require that "shouting should be imperceptible from one area to another". These criteria are in our opinion quite restrictive and lead to the requirements of expensive wall constructions and layouts. Essentially, these criteria require that groups of 10 children be in individual rooms separated by high-performance walls. In practice, caregivers like to have good visual and aural communication between groups to allow better supervision for the staff and additional stimulation for the children. Indeed, there are examples of successful open-plan daycares which are given good reviews by the staff.

The document discusses the siting of daycare facilities to avoid noisy environments. However, they discuss this only in terms of its impact on interior sound levels, which can be controlled relatively easily with good windows and do not give criteria or requirements for outdoor play areas. In addition, they do not discuss at all the equally important issue of noise from the daycare facility impacting on neighbouring uses.

While a useful basic guideline, if used with discretion, the document discusses acoustical design in isolation and without the reference to other considerations normally encountered in a project. it would be more useful if it were integrated as a chapter in a book on the total design of daycare facilities, including examples of real facilities and input from user groups. This would allow the acoustical requirements to be more clearly balanced against the other requirements of such facilities.

Kalina Serlin, B. Arch. O.A.A.,
Bregman and Hamann Architects
481 University Avenue
Toronto, Ontario

Tim Kelsall, M.A.Sc.
Hatch Associates Ltd.
21 St. Clair Avenue East
Toronto, Ontario M4T 1L8

The Canadian Acoustical Association
l'Association Canadienne d'Acoustique

BOARD OF DIRECTORS MEETING / REUNION DES DIRECTEURS

Date:	May 26 mai 1991*
Time/Heure:	10:00 a.m./10h00
Place/Endroit:	Conference Room, Building M20 National Research Council, Ottawa*

AGENDA / ORDRE DU JOUR

1. Report of the President (B. Dunn)
2. Report of the Executive Secretary (W. Sydenborgh)
3. Report of the Treasurer (G. Bolstad)
4. Report of the Editor of Canadian Acoustics (M. Hodgson)
5. Report of the Membership Chairperson (M. Zagorski)
6. Progress Report on Acoustics Canada '91 (G. Bolstad)
7. Prizes:
   - Directors Award (C. Laroche)
   - Postdoctoral Prize (S. Abel)
   - Bell Speech Prize (L. Brewster)
   - Underwater Acoustics Prize (D. Chapman)
   - Student Presentations (A. Behar)
   - Eckel Award (M. Hodgson)
8. Report from Chairperson of Education Committee (S. Abel)
9. Report on International INCE and Internoise '92 (T. Embleton)
10. Report of the Overall Prize Review Committee (A. Behar)
11. Status Report on Science Fairs (A. Cohen)
12. Status Report on 1994 International Congress of Audiology (L. Brewster)
13. Status Report from the CAA Halifax Chapter (D. Chapman)
14. Other Business:
    - Requests for information on job availability (B. Dunn)
    - Balance of organization (B. Dunn)
    - Canadian Imperial Emblems (W. Sydenborgh)
    - Fraudulent use of CAA name (M. Hodgson)
    - New business

*Date and location are subject to change

INFORMATION DU PRESIDENT

Même si elle semble encore éloignée dans le temps, la Semaine Canadienne de l'Acoustique '91 est vraiment proche quand on considère le temps nécessaire pour produire une soumission de recherche. Les résumés doivent être déposés avant le 30 avril. Avez-vous déjà complété la recherche? Les formulaires d'inscription pour les séminaires techniques seront présentés très tôt. Il est probablement plus avantageux pour vous, les consommateurs potentiels, d'attendre à la dernière minute. Cependant, je vous incite ardemment à vous inscrire le plus tôt possible. Mettre au point ce programme est comparable à la spéculation sur le marché boursier. Le président technique doit procéder comme s'il y avait suffisamment d'inscriptions afin de ne pas perdre d'argent. Cependant, le jour arrive où une décision d'annuler ou non doit être prise. Si trop de gens ont attendu, le programme doit être annulé; ceux qui se sont déjà inscrits sont déçus; l'ACA peut perdre son dépôt. Avoir une idée minimale du nombre de personnes qui s'enrégistreront à l'hôtel et qui vont profiter de forfaits aériens aide les organisateurs du congrès à mieux respirer. Nous apprécierions donc grandement la promptitude que vous mettrez à nous faire part de vos projets.

Dans le même ordre d'idées, il y a la venue prochaine de Inter Noise '92. Ce serait merveilleux si les acousticiens canadiens pouvaient être présents et rapporter des travaux de grande classe à ce congrès. Laissez-moi vous presser encore une fois de penser à l'avance à ce congrès.

Lors de la dernière assemblée générale, il y a eu une importante discussion sur le manque d'équilibre dans l'organisation au cours des dernières années. Il y avait un sentiment que l'ACA était devenue un serviteur trop important des universitaires. Un nombre assez imposant de membres me rapportaient qu'ils écriraient et exprimeraient leurs visions afin que le conseil d'administration et les membres puissent y répondre. Je n'ai reçu aucune lettre à ce jour. Ceci est un peu décevant. Même si je suis moi-même professeur, je constate le déséquilibre. Cependant, je crois que si nous désirons redresser la situation, le plus grand nombre de suggestions devrait venir des non-universitaires. S'il-vous-plaît écrivez-moi, si possible avant le mois de juin.

Il y a peut-être d'autres sujets que vous aimeriez voir discutés lors de la prochaine réunion du conseil d'administration en juin. Si c'est le cas, veuillez m'écrire ou communiquer avec un des membres du conseil avec lequel vous vous sentez à l'aise. C'est la meilleure façon de nous permettre de formuler des programmes et politiques générales qui vous satisferont. En fait, vous pouvez influencer le rôle ou la mission de l'association de façons importantes.

NOTE FROM THE PRESIDENT

Although it seems a long time off, Acoustics Week in Canada '91 is really very close when the time necessary to produce a research submission is considered. Abstracts are due by April 30. Have you even completed the research yet? Very soon registration forms will appear for the technical seminars. It is probably convenient for you, the potential consumer, to wait until the last moment. However, let me plead with you to register early. Setting up these programs is like speculating on the stock market. The Technical Chairperson has to proceed as if there will be enough registrants to not lose big money. However, a day comes at which a decision has to be made whether to go or cancel. If too many people have waited, the program is cancelled; those who have already signed up are disappointed; the CAA may lose its deposit. Even having some idea of how many registrants will register in the hotel and how many will avail themselves of possible airline packages makes the convenors breathe more easily. Out of kindness if nothing else, please get organized early.

In the same line of thought is the imminence of Inter-Noise '92. It would be marvelous if Canadian acousticians could turn out and report some real class research at these meetings. Let me urge you to start thinking ahead towards that meeting as well.

At the last general meeting there was considerable discussion regarding the lack of balance in the organization in recent years. There was a feeling that the CAA had become too much a servant of academia. A rather large number of members said they would write to me and express their views so that the Board of Directors first, and then the membership as a whole, could respond. To date I have received no letters. This is a little disappointing. Even though I am an academic myself I do see the imbalance. However, I do believe that if it is to be redressed the larger number of suggestions should come from the non-academics. Please do write me. If possible write before June.

Actually there may be more concerns that those I've mentioned above that you wish discussed under new business at the Board of Directors meeting in June. If so, please write to me or to whomever you feel comfortable to communicate with on the Board. This is the way to have us formulate programs, and policy in general, that satisfy you. Indeed in many ways you can influence the role or mission of the whole association quite considerably.

Bruce E. Dunn

NEWS / INFORMATIONS

CONFERENCES

E-33 on Environmental Acoustics: Trump Taj Mahal, Atlantic City, NJ, April 15-17, 1991. Contact: Stephen Mawn at 215-299-5521.

Active Control of Sound and Vibration: Tokyo, Japan, April 9-11, 1991. Contact: Dr. Hideki Tachibana, Secretary of the Symposium, University of Tokyo. +81-3-3479-0257 or FAX at +81-3-3379-1456.

Acoustical Society of America Meeting: Baltimore, Maryland, April 29 to May 3, 1991. Contact: Orest Diachok, Mechanical Engineering Dept., The Catholic University of America, Washington, DC 20064. Tel. 202-319-5170.

Recent Advances in Underwater Acoustics: (Institute of Acoustics) Hotel Prince Regent, Weymouth, England, May 20-22, 1991. Contact: Dr. G.W. Neal, MIDA, Marconi Underwater Systems Ltd., Leanne House, Avon Close, Grandby Estate, Weymouth, Dorset DT4 9UX, England. Tel. 305 760716.

Noise-Con 91 Seminar: Tarrytown, New York, July 12-13, 1991. Contact: Institute of Noise Control Engineering, P.O. Box 3206, Arlington Branch, Poughkeepsie, New York, 12603.

INCE Fundamentals and Professional Examinations: Tarrytown, New York, July 14, 1991. Contact: Institute of Noise Control Engineering, P.O. Box 3206, Arlington Branch, Poughkeepsie, New York 12603.

14th International Congress on Acoustics: Beijing, China, September 3-10, 1992. Contact: ICA Secretariat, Institute of Acoustics, P.O. Box 2712, Beijing 100080, China or FAX at 2561457.

6th International Meeting on Low Frequency Noise and Vibrations: Leiden, The Netherlands, September 4-6, 1991. Contact: Dr. W. Tempest, Multi-Science Publishing Co. Ltd., 107 High Street, Brentwood, Essex CM14 4RX, United Kingdom.

Inter-Noise 91 (Costs of Noise): Sydney, Australia, December 2-4, 1991. Contact: Christine Bourke, Conference Secretariat, University of New South Wales, P.O. Box 1, Kensington, NSW 2033, Australia.

COURSES

Acoustics and Signal Processing: The Pennsylvania State Unviersity, June 1991 (four weeks). Contact: Dr. Alan D. Stuart, Summer Program Coordinator, The Penn State Graduate Program in Acoustics, P.O. Box 30, State College, PA 16804. Tel. 814-863-4128.

Sound Intensity: AVNC, June 24-28, 1991. Contact: Continuing Education Division, 250 Shagbark Drive., R.D. #1, Cheswick, PA 15024.

PEOPLE IN THE NEWS

John E.K. Foreman, Professor Emeritus, Mechanical Engineering, University of Western Ontario, is the author of the new book entitled Sound Analysis and Noise Control. This book is a self-contained resource designed specifically to provide engineers with the basic science background they need to understand the behaviour of sound. To place an order, call 416-752-9100 and quote SSSA 0001.

CONFERENCES

E-33 on Environmental Acoustics: Trump Taj Mahal, Atlantic City, New Jersey, du 15 au 17 avril 1991. Contacter: Stephen Mawn; téléphone 215-299-5521.

Active Control of Sound and Vibration: Tokyo, Japon, du 9 au 11 avril 1991. Contacter: Dr. Hideki Tachibana, Secretary of the Symposium, University of Tokyo; téléphone +81-3-3479-0257; télécopieur +81-3-3379-1456.

Réunion de l'Acoustical Society of America: Baltimore, Maryland, du 29 avril au 3 mai 1991. Contacter: Orest Diachok, Mechanical Engineering Dept., The Catholic University of America, Washington, DC 20064; téléphone 202-319-5170.

Recent Advances in Underwater Acoustics: (Institute of Acoustics), hôtel Prince Regent, Weymouth, Angleterre, du 20 au 22 mai 1991. Contacter: Dr. G.W. Neal, MIOA, Marconi Underwater Systems Ltd., Leanne House, Avon Close, Grandby Estate, Weymouth, Dorset DT4 9UX, England; téléphone 305 760716.

Conférence Noise-Con 91: Tarrytown, New York, les 12 et 13 juillet 1991. Contacter: Institute of Noise Control Engineering, P.O. Box 3206, Arlington Branch, Poughkeepsie, New York 12603.

INCE Fundamentals and Professional Examinations: Tarrytown, New York, le 14 juillet 1991. Contacter: Institute of Noise Control Engineering, P.O. Box 3206, Arlington Branch, Poughkeepsie, New York 12603.

14e congrès international sur l'acoustique: Beijing, Chine, du 3 au 10 septembre 1992. Contacter: ICA Secretariat, Institute of Acoustics, P.O. Box 2712, Beijing 100080, Chine; télécopieur 2561457.

6e rencontre internationale sur le bruit et les vibrations basse fréquence: Leiden, Pays-Bas, du 4 au 6 septembre 1991. Contacter: W. Tempest, Multi-Science Publishing Co. Ltd., 107 High Street, Brentwood, Essex CM14 4RX, Grande-Bretagne.

Conférence Inter-Noise 91 (sur les coûts du bruit) Sydney, Australie, du 2 au 4 décembre 1991. Contacter: Christine Bourke, Conference Secretariat, University of New South Wales, P.O. Box 1, Kensington, NSW 2033, Australie.

COURS

Acoustics and Signal Processing: The Pennsylvania State University, juin 1991 (4 semaines). Contacter: Dr. Alan D. Stuart, Summer Program Coordinator, The Penn State Graduate Program in Acoustics, P.O. Box 30, State College, PA 16804; téléphone 814-863-4128.

Sound Intensity: AVNC, du 24 au 28 juin 1991. Contacter: Continuing Education Division, 250 Shagbark Drive, R.D. #1, Cheswick, PA 15024.

LES GENS QUI FONT PARLER D'EUX

John E.K. Foreman, professeur émérité de génie mécanique à l'université Western Ontrario, est l'auteur d'un nouvel ouvrage intitulé *Sound Analysis and Noise Control*. Cet ouvrage décrit, à l'intention des ingénieurs, les notions scientifiques fondamentales nécessaires à la compréhension du comportement du son. Pour le commander, composez le (416) 752-9100 et indiquez la référence SSSA 0001.

NEW PRODUCTS

CSA's new package on Hearing Conservation is now available. This package of standards will help you evaluate or establish hearing conservation programs. It contains Z94.2-M1982, Hearing Protectors; Z107.0-1984, Acoustical Terms in CSA Standards; Z107.4-M86, Pure Tone Air Conduction Audiometers for Hearing Conservation and Screening; Z107.6-M89, Pure Tone Air Conduction Threshold Audiometry for Hearing Conservation and Z107.56-M86, Measurement of Occupational Noise Exposure. You may order this package numbered 1103 now. The list price is $103 for members and $112 for non-members.

INAUGURAL MEETING OF THE CAA HALIFAX CHAPTER

On Wednesday evening, February 20th 1991, the newly formed Halifax Chapter of the CAA held its first meeting at the Maritime Museum of the Atlantic with 31 persons in attendance. The inaugural speaker was Dr. Ian Fraser of the Defence Research Establishment Atlantic, who presented an informative and entertaining talk titled *Sounds of the Sea*, based on his research work in underwater acoustics. At the meeting, the by-laws of the Halifax Chapter were signed by the first Board of Directors: Annabel Cohen, Fred Cotaras, Bob Courtney, John Gillis, and David Chapman. At the time of writing the Chapter has 38 paid-up members.

NOUVEAUX PRODUITS

Le nouvel ensemble de normes de la CSA sur la protection de l'ouïe est maintenant disponible. Ces normes vous aideront à évaluer et à mettre sur pied des programmes de protection de l'ouïe. L'ensemble, disponible en anglais seulement, comprend les normes suivantes: Z94.2-M1982, Hearing Protectors; Z107.0-1984, Common Acoustical Terms in CSA Standards; Z107.4-M86, Pure Tone Air Conduction Audiometers for Hearing Conservation and Screening; Z107.6-M89, Pure Tone Air Conduction Threshold Audiometry for Hearing Conservation; Z107.56-M86, Measurement of Occupational Noise Exposure. L'ensemble porte le numéro 1103; son prix est de 103 $ pour les membres et 112 $ pour les non-membres.

RENCONTRE INAUGURALE DE LA FILIALE D'HALIFAX DE L'ACA

Mercredi soir, le 20 février 1991, 31 personnes se sont présentées au Musée maritime de l'Atlantique, pour la première rencontre de la Filiale d'Halifax de l'ACA, récemment fondée. L'orateur à l'inauguration, le Dr. Ian Fraser du Centre de recherches pour la défense Atlantique, a présenté un exposé très vivant et informatif sur les "Bruits de la mer", basé sur ses recherches en acoustique sous-marine. A la rencontre, les règlements administratifs de la Filiale d'Halifax ont été signés par les membres du premier Conseil d'administration: Annabel Cohen, Fred Cotaras, Bob Courtney, John Gillis, et David Chapman. A cette date, la Filiale a 38 membres.

The Canadian Acoustical Association	l'Association Canadienne d'Acoustique

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