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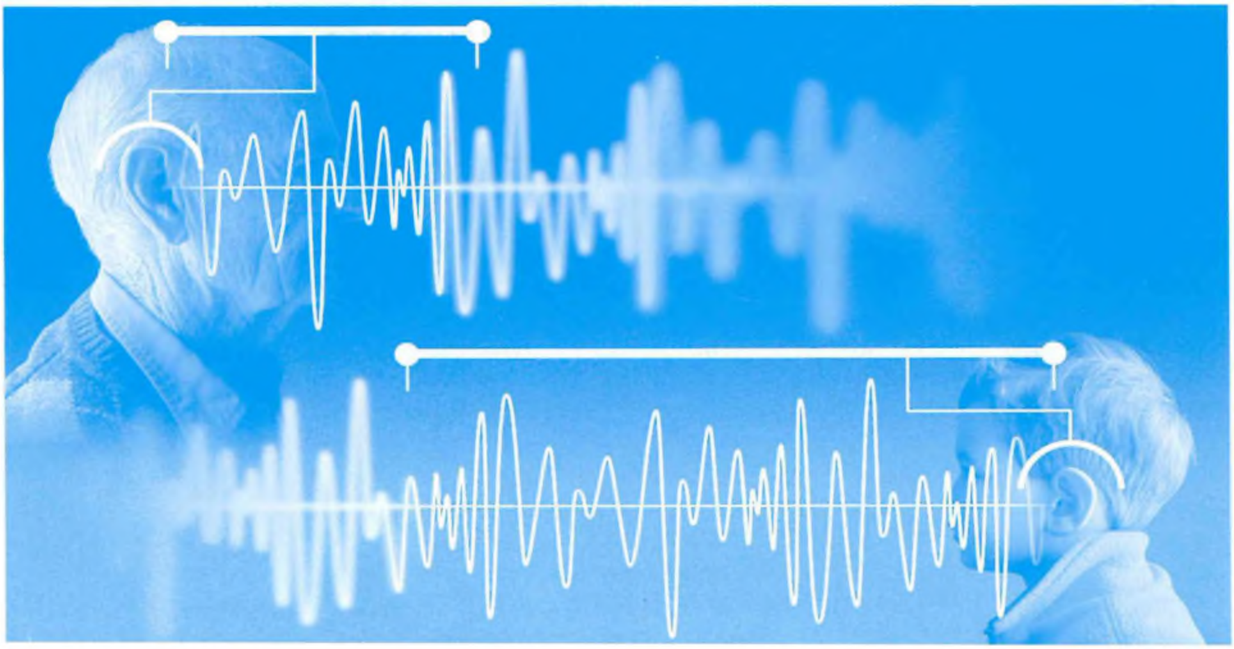

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THE CANADIAN ACOUSTICAL ASSOCIATION
P.O. BOX 1351, STATION "F"
TORONTO, ONTARIO M4Y 2V9

L'ASSOCIATION CANADIENNE D'ACOUSTIQUE
C.P. 1351, SUCCURSALE "F"
TORONTO, ONTARIO M4Y 2V9

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MESSAGE FROM THE PRESIDENT / MESSAGE DU PRÉSIDENT

www.caa-aca.ca.

CAA has a new web site. Of course we have had a web site for some years with the basic information about our association thanks to the efforts of Don Jamieson and his various helpers at the University of Western Ontario. This was a great start but was difficult to find unless you saw the address in *Canadian Acoustics*. Now as a result of Dave Stredulinsky's efforts we have a new web site that everyone should be able to find.

Our site is now in its infancy but with your input and suggestions it will grow to serve you better. However, perhaps the biggest problems are getting the information that we wish to include and keeping it updated. The site already has many useful details of our association and includes a complete index of all volumes of *Canadian Acoustics* developed from Doug Whicker's personal database. We would like our web site to be the main source of information on all of our various prizes.

I hope you will have suggestions for adding further information. I would like to add material from our operations manual, details of our history and our student awards, as well as minutes of recent meetings. What would you like to include? We have limited resources but we would like to know how you think we can improve our site. Take a look at what we have today and send your suggestions and corrections to Dave Stredulinsky.

John Bradley

www.caa-aca.ca.

L'ACA a un nouveau site web. Nous avions bien entendu un site qui présentait les informations de base sur l'association depuis un certain temps, grâce aux efforts de Don Jamieson et de ses nombreux collègues de l'Université Western en Ontario. Ce site représentait un très bon départ, mais il était difficile de le trouver à moins d'avoir vu l'adresse dans l'*Acoustique canadienne*. Grâce aux efforts de Dave Stredulinsky, nous avons maintenant un nouveau site web qui devrait être facile d'accès.

Notre site en est à ses premiers balbutiement, mais avec vos commentaires et suggestions, il répondra de mieux en mieux à vos attentes. Le problème majeur, à ce stade-ci, est d'acquérier l'information que nous désirons inclure et de la garder à jour. Le site présente actuellement plusieurs détails utiles au sujet de notre association et inclut un index complet de tous les numéros de l'*Acoustique canadienne,* développé à partir de la base de données personnelle de Doug Whicker. Nous désirons que notre site web demeure la source principale d'information sur tous les prix.

J'espère que vous soumettrez des suggestions d'ajouts d'information. J'aimerais inclure du matériel tiré de notre manuel opérationnel, des détails historiques et de l'information sur les prix étudiants, ainsi que les procès-verbaux de nos récentes réunions. Qu'aimeriez-vous ajouter? Nous disposons de ressources limitées, mais nous aimerions savoir comment nous pourrions améliorer notre site. Prenez le temps de regarder ce que nous avons à ce jour et envoyez vos suggestions et corrections à Dave Stredulinsky.

John Bradley

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DURATION DISCRIMINATION IN YOUNGER AND OLDER ADULTS

Tonya R. Bergeson, Bruce A. Schneider, and Stanley J. Hamstra
Department of Psychology, University of Toronto, Toronto (ON), L5L 1C6

ABSTRACT

Ten normal hearing young adults and ten older adults were asked to identify the longer of two sequentially presented tones. The duration of the standard tones ranged from 1.5 ms to 1000 ms across blocks. Duration discrimination was not related to audiometric thresholds. These results show that older adults are much more disadvantaged than young adults when discriminating very short durations (i.e., below 40 ms) that are characteristic of speech sounds, and that this disadvantage cannot be accounted for by hearing levels.

SOMMAIRE

Nous avon demandé à des sujets jeunes (n = 10) et âgés (n = 10), dont l'acuité auditive est normale, d'identifier la plus longue de deux tonalités. La durée de la tonalité standard variait de 1,5 ms à 1000 ms. Pour un groupe des épreuves, la durée de la tonalité standard ne changeait pas. Le calcul des fractions Weber a demontré que lorsque la durée de la tonalité standard etait moins de 40 ms, les seuils de détection de longueur etaient plus élevés chez les sujets âgés. Mais la difference dans les seuils de détection des jeunes adultes et des personnes âgés a diminuée quand la durée de la tontalité standard augmentait. Éventuellement, à la plus longue durées, les différences entre les groupes d'âge dans les seuils de détection ont disparues. Aussi, les seuils de détection de longeur etaient indépendant de l'acuite auditive. Ces resultats demontrent que les sujets âgés sont plus désavantagés que le sujets jeunes pour discriminer les sons de discours de cortes durée. Ce desavantage ne peut pas être attribué au degré de déficience auditive.

1.0 INTRODUCTION

Older adults, even those with little or no hearing loss, often find it difficult to understand speech when the listening situation is less than ideal (e.g., a noisy or reverberant background) or when the rate of speech is high (e.g., Pichora-Fuller, 1997; Pichora- Fuller, Schneider, & Daneman, 1995; Wingfield, Poon, Lombardi, & Lowe, 1985). Because the temporal modulation of the speech signal has been shown to contribute substantially to speech recognition in younger adults (e.g., Kingsbury, Morgan, & Greenberg, 1998; Shannon, Zeng, Kamath, Wygonski, & Ekelid, 1995), several researchers have posited that older adults' speech understanding difficulties might stem, in part, from diminished temporal resolution (e.g., Schneider, 1997; Stuart & Phillips, 1996), although the evidence for this has been mixed. For instance, older listeners who have poor gap duration discrimination abilities have been shown to have more trouble understanding temporally degraded speech (Gordon-Salant & Fitzgibbons, 1993). On the other hand, some studies have suggested that the contribution of age-related changes in temporal resolution to speech recognition are minimal (e.g., Humes, 1996; van Rooij & Plomp, 1990; 1992). It is possible that some of the discrepancies across studies may be due to differences in how temporal resolution was measured.

One paradigm used to investigate temporal processing capacity is duration discrimination. In duration discrimination experiments, listeners are asked to detect a change in stimulus duration. For example, Abel, Krever, & Alberti (1990) measured difference limens (DLs) for changes in stimulus duration in younger normal-hearing adults (20-35 years) and older adults with normal hearing to moderately severe hearing loss (40-60 years). The standard durations of the noise signals were 20 ms and 200 ms, plus 5 ms rise/decay time. The older adults had more difficulty discriminating the signal durations than the younger adults, but performance variability was high. There were no effects of hearing loss or degree of hearing loss. In studies by Fitzgibbons and Gordon-Salant (1994, 1995), when duration DLs were measured for 250-ms tone bursts and 6.4 ms or 250 ms silent intervals between a pair of 250 ms tone bursts, older adults (65-76 years) performed more poorly than younger adults. Moreover, when the stimulus complexity was increased by presenting the target tone bursts within tonal sequences, the performance difference between older

	Weber Fractions	
Duration of Standard	Younger Adults	Older Adults
6.4 ms (500 Hz)*	1.9	3.9
6.4 ms (4000 Hz)*	2.7	4.2
20 ms (500 Hz)	0.8	1.8
20 ms (4000 Hz)	0.6	1.3
200 ms (500 Hz)	0.3	0.4
200 ms (4000 Hz)	0.2	0.4
250 ms (500 Hz)**	0.2	0.2
250 ms (4000 Hz)**	0.2	0.3

* Fitzgibbons & Gordon-Salant. 1994
Abel et al., 1990
** Fitzgibbons & Gordon-Salant, 1994; 1995

Table 1.Approximate duration discrimination Weber fractions (t/t) for younger and older adults across various standard stimulus durations.

and younger adults also increased (Fitzgibbons & Gordon-Salant, 1995). Once again, hearing loss had no effect on these results.

Although the differences between younger and older adults' duration discrimination skills were significant at the various durations, it is still unclear whether the duration of the stimuli has any effects on younger and older adults' duration discrimination abilities. Table 1 shows a summary of the results of the duration discrimination studies described above, in which duration DL measures have been converted into a Weber fraction so they can be compared across studies. It appears from these rough comparisons that duration discrimination is more difficult at the shorter standard durations (i.e., 6.4 ms and 20 ms) and that this effect is greater for older listeners than younger listeners.

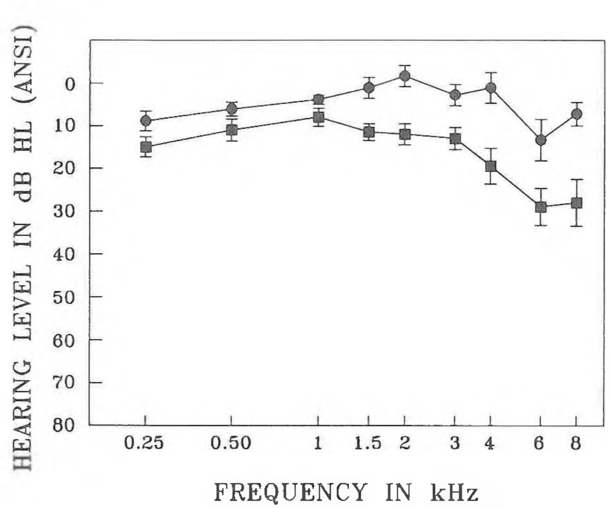

Figure 1. Average audiograms (left ear) for the younger (circles) and older (squares) adults. Standard error bars are shown.

In the present experiment, we examined the temporal resolution abilities of younger and older adults in a duration discrimination paradigm in which we systematically varied the standard tone duration from 1.5 ms to 1000 ms. Based on the duration discrimination literature presented previously, we predicted that older adults would perform more poorly than younger adults, and that this age effect would be much more pronounced at short standard tone durations, independent of audiometric thresholds.

2.0 METHOD

2.1. Participants

Ten younger adults (mean age = 22.3 years; S.D. = 1.6 years) and ten older adults (mean age = 70.9 years; S.D. = 5.7 years) were paid participants in this experiment. Four additional participants (two from each age group) failed to complete all sessions and were excluded from all analyses. The younger adults were students at University of Toronto at Mississauga; the older adults were recruited from a pool of seniors from the local community. All participants had pure-tone, air- conduction thresholds 25 dB HL between 0.25 and 2 kHz. Figure 1 plots the average audiograms for younger and older adults. The threshold levels of older adults are no more than 12 dB higher than those of younger adults for frequencies 2 kHz. Beyond 3 kHz, hearing loss in older adults increased with frequency, indicating that they were in the early stages of presbycusis.

2.2 Stimuli and Apparatus

Stimuli were generated digitally with a sampling rate of 20 kHz and converted to analog form using a 16-bit Tucker Davis Technology (TDT) digital-to-analog converter.

The 2 kHz tone was gated on and off by multiplying it by an envelope constructed by summing a series of Gaussian functions (standard deviation ½ ms), spaced ½ ms apart (see Figures 2A, 2B, and 2C). As Figure 2 shows, the sum of a series of Gaussians forms a flat top envelop with ogival rise and decay times. The duration of the stimulus was defined as the time between the centers of the first and last Gaussian envelopes comprising the sum. For durations greater than 1.5 ms, the centers of the first and last Gaussians in the series correspond to the ½ power points of the envelope. Hence stimulus duration is the interval between the ½ power points.

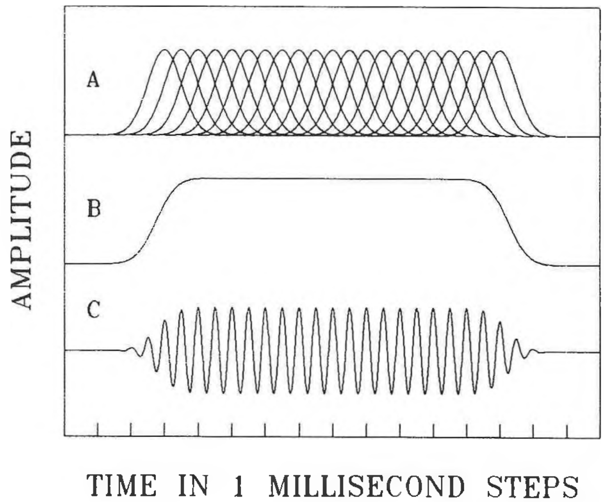

Figure 2. The 21 Gaussian envelopes (s.d. = ½ ms) in panel A are added together to define the envelope in panel B. This envelope is multiplied by 2-kHz tone to produce the tone shown in panel C. The ½ power points on the envelope correspond to the peaks of the first and last Gaussian envelopes in panel A. Therefore the duration of the stimulus (time between ½ power points) is specified by the time between the peaks (10 ms) of the first and last Gaussians in the envelope.

For stimuli 400 ms and longer, the sound pressure level of the stimulus during its steady-state portion was 66.5 dB SPL. For stimuli shorter than 400 ms, the total energy in the stimulus was set equal to the total energy in the 66.5 dB SPL, 400-ms tone. Thus, stimuli less that 400 ms in duration were equated for energy, stimuli longer than 400 ms were equated for sound pressure level. Short duration stimuli were equated for total energy because of the intensity-time tradeoff, and to minimize spectral differences between tones of different durations. The standard tone durations, the starting comparison tone duration for each standard tone, and the length of the unit steps separating successive comparison tones are all listed in Table 2. The starting comparison tone durations were selected after pilot testing several young and old adults on the procedure. Stimuli were presented to the left ear over TDH-49 earphones in a single-wall sound-attenuating booth.

2.3 Procedure

Duration discrimination thresholds were determined by presenting stimuli at each standard tone duration in a 2IFC paradigm. A staircase procedure was used to determine the 79.7% point on the psychometric function (Levitt, 1971). At the beginning of a block, a standard tone duration was chosen and the comparison tone duration was set to the value listed in Table 2. The standard and comparison tones were randomly assigned to the two intervals. After each trial was initiated by pressing a button, the two tones would occur, separated by a 100 ms silent period. Participants were asked

Standard tone duration (ms)	Starting comparison tone duration (ms)	Unit step length (ms)
1.5	72.0	0.5
5.0	99.5	0.5
10.0	72.0	0.5
20.0	89.0	1.0
40.0	182.0	2.0
80.0	204.0	4.0
200.0	500.0	5.0
400.0	1000.0	10.0
1000.0	2000.0	10.0

Table 2. Durations of standard and comparison tone stimuli and unit steps in the staircase procedure.

to choose which interval they thought contained the longer tone by pressing one of two buttons that corresponded to the two intervals. Lights on the response box indicated the beginning of the trial and whether the participants' response had been correct. The duration of the comparison tone was adjusted trial-by-trial according to a 3 down, 1 up rule. That is, if participants successfully discriminated between the two tone durations 3 times in succession, the next comparison tone duration would be decreased (closer in duration to the standard tone). However, if the participant responded incorrectly the comparison tone duration would be increased. Each block was terminated after 12 reversals; duration discrimination thresholds were defined as the mean of the last 8 reversals.

The order of standard tone durations was randomly assigned to each participant. Although all participants completed this procedure four times (four 1- to 1.5-hour sessions were required per participant), the first runs at all standard tone durations were treated as practice sessions and were not included in subsequent analyses; only the last three runs were used for the final threshold estimate.

3.0 RESULTS

Figure 3 plots the mean threshold duration increment (t) as a function of the duration of the 2-kHz standard tone in log-log coordinates for younger (circles) and older (squares) adults. Also shown are mean threshold values as a function of the duration of a 1 kHz tone for the two observers from Abel's (1972) experiment (triangles). The straight lines fit to the data from both of these experiments have identical slopes

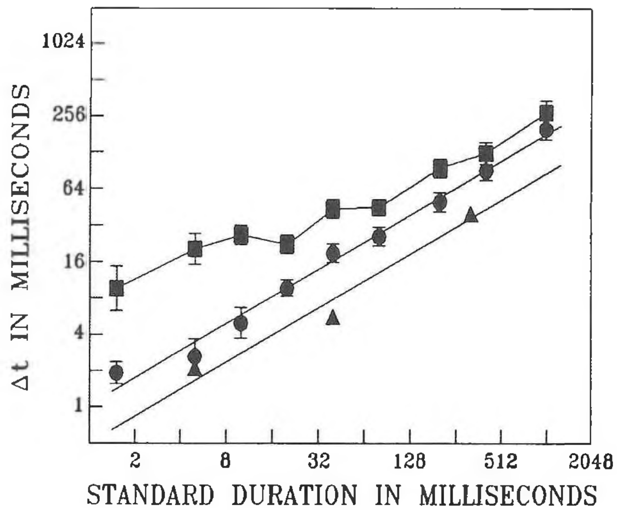

Figure 3. Average threshold duration increment (Δt) (geometric mean) and standard errors as a function of the duration of the standard stimulus for younger (circles) and older (squares) adults. Also shown are the average data from Abel (1972).

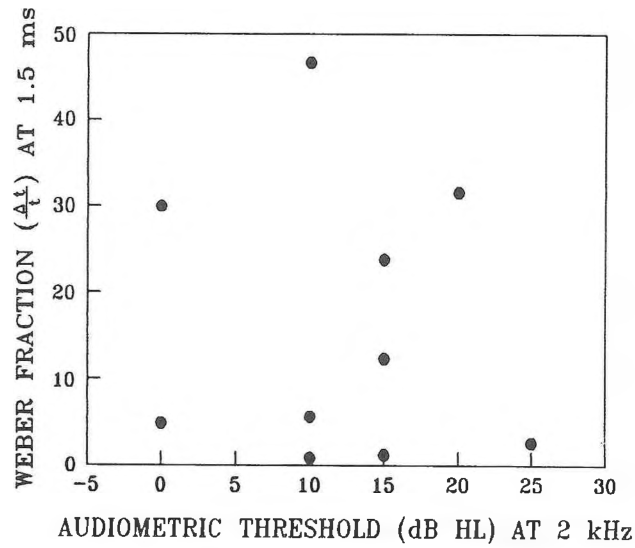

Figure 5. Scatterplot of older adults' duration discrimination Weber fractions at the 1.5 ms standard tone duration and older adults' audiometric thresholds at 2 kHz.

(0.74) but different intercepts. This means that for both sets of younger adults, t is a power function of duration with an exponent equal to 0.74; however, Abel's participants were more sensitive to changes in duration than the younger adults in the current experiment.[1]

At short durations, older adults have t values that are considerably higher than those of younger adults. However, at the longer durations, the two functions tend to converge. Figure 4 shows how relative sensitivity (the Weber fraction, t/t) varies as a function of standard duration. Relative sensitivity for older adults at the shortest duration (1.5 ms) was, on average, almost 7 times greater than for younger adults, compared to just 2 times greater at the 20 ms standard tone duration. This larger difference between younger and older adults' duration discrimination abilities at the 1.5 ms standard tone duration is also much larger than those performance differences found in previous duration discrimination studies (e.g., Abel et al., 1990; Fitzgibbons & Gordon-Salant, 1994; 1995).

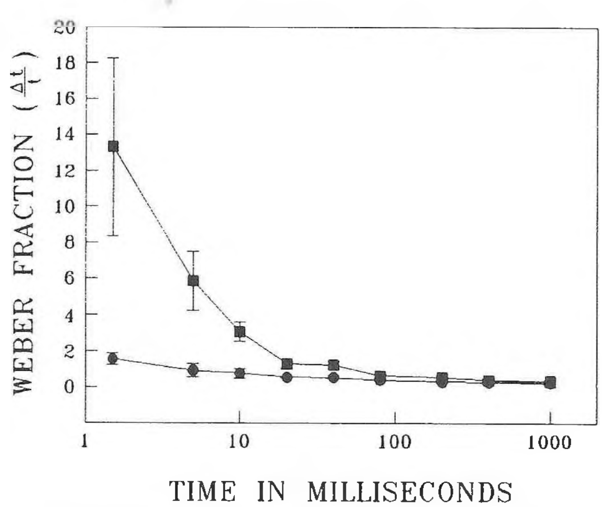

Figure 4. Average (arithmetic mean) younger (circles) and older (squares) adults' duration discrimination Weber fractions and standard errors as a function of standard tone duration.

To ensure that the variability in the older adults' performance at the shortest duration could not be explained by their audiometric thresholds, we compared the older listeners' Weber fractions at the 1.5 ms standard tone duration to their audiometric thresholds at 2 kHz. The scatterplot in Figure 5 reveals that the duration discrimination difficulties of older adults with relatively good hearing are not related to their audiometric thresholds.. In fact, younger and older adults' Weber fractions were not significantly correlated with audiometric threshold at 2 kHz at any of the standard tone durations (see Table 3). It is also important to note that not all older adults differed from younger adults, as can be seen by the data points near the abscissa in Figure 5.

4.0 DISCUSSION

Duration discrimination is much more difficult for older

[1] **Foot note:** The two participants in Abel's study were experienced observers, and had mean duration- discrimination thresholds that were lower than our mean thresholds. However, duration- discrimination thresholds for some of our young adults were as low or lower than those of Abel's observers.

Standard Tone Duration	Younger Adults	Older Adults
1.5 ms	0.217	0.178
5 ms	-0.248	0.039
10 ms	-0.182	-0.101
20 ms	0.068	-0.129
40 ms	-0.017	-0.032
80 ms	-0.428	0.344
200 ms	-0.189	0.223
400 ms	0.079	-0.045
1000 ms	0.304	-0.396

Note: None of the correlations are significant at $\underline{p} < .05$.

Table 3. Correlation between standard tone duration and audiometric threshold at 2 kHz.

listeners than for younger listeners at very short standard tone durations, but becomes easier at longer standard tone durations, where the performance of older and younger listeners is nearly identical. Younger listeners' duration discrimination performance also improves with increasing standard tone duration, but the slope is not nearly as steep as that of older listeners. The differential results for older and younger listeners are independent of audiometric thresholds, as expected from similar results reported in most duration discrimination experiments. That is, age-related changes in hearing threshold level most likely have no systematic effect on duration discrimination for older adults with relatively good hearing. Although the independence of duration discrimination and hearing thresholds is consistent with the suggestion of other researchers (e.g., Fitzgibbons & Gordon-Salant, 1996) that older adults' duration discrimination deficits reflect central rather than peripheral auditory dysfunction, the contribution of peripheral factors to these deficits cannot be ruled out. For example, age-related losses in the precision of temporal coding in the auditory nerve could lead to poorer duration discrimination. Thus, the results reported here cannot discriminate between losses in precision of temporal coding in the auditory periphery, and losses occurring more centrally.

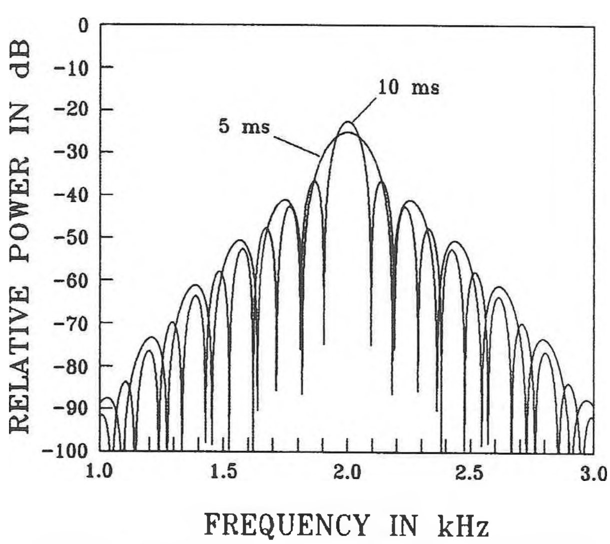

Figure 6. Relative power spectral density functions for tones of 5 and 10 ms duration. Each tone was first normalized to have unit energy.

It is important to note that performance variability decreased with increasing standard tone duration, especially for the older adults. That is, performance variability was quite large at the shortest standard tone durations. In fact, some of the older adults' duration discrimination abilities did not differ from those of the younger adults for brief stimuli, similar to the results of Fitzgibbons and Gordon-Salant (1994).

Another important issue is whether the listeners were responding to temporal differences rather than to spectral differences between stimuli at the shorter stimulus durations. However, an examination of the spectral differences between different short-duration stimuli indicate that it is unlikely that younger adults were discriminating on the basis of spectral differences. Figure 6 shows that the spectral density functions for a 5 ms and a 10 ms tone are quite comparable. In general, the envelopes of the spectral density functions for short- duration stimuli are quite similar. However, with

	Weber Fraction	
Duration of Standard	Younger Adults	Older Adults
20 ms (500 Hz)	0.8	1.8
20 ms (4000 Hz)	0.6	1.3
20 ms (2000 Hz)*	0.6	1.3
200 ms (500 Hz)	0.3	0.4
200 ms (4000 Hz)	0.2	0.4
200 ms (2000 Hz)*	0.3	0.6

* Present experiment
Abel et al. (1990)

Table 4. Comparison of duration discrimination Weber fractions for younger and older adults at standard stimulus durations of 20 ms and 200 ms.

increasing duration, the width of the center and side bands decreases while the number of sidebands increases. Because of the overlap in these distributions it is more likely that the discriminability of these two stimuli is based on their duration difference (5 vs 10 ms) than on their spectral differences.

The pattern of results from the present experiment is consistent with several previous studies. First of all, Small and Campbell (1962) found that young adults' temporal discrimination ability diminished as standard duration decreased from 400 ms to 0.4 ms. Furthermore, Getty (1975) investigated two highly practiced listeners' duration discrimination for empty auditory intervals ranging from 50 ms to 3200 ms and also found that the Weber fraction function dropped over the shorter standard durations and then flattened out up to 2000 ms. Finally, the results of younger and older listeners at standard tone durations of 20 ms and 200 ms in the present experiment are quite similar to the duration discrimination Weber fractions of Abel et al. (1990) at the same durations, as shown in Table 4.

These results have implications for older listeners' understanding of speech, especially speeded speech or speech in noise. Considering that critical phonemic information in speech often occurs at durations much shorter than 20 ms, older adults would have a very difficult time utilizing such cues to decipher particular words in the speech stream, especially in noisy situations. In addition, Peterson and Lehiste (1960) have shown that, in English, the duration of a vowel is influenced by the preceding or following consonant. For example, the vowel duration in the word "rice" is much shorter than vowel duration in the word "rise." Hence, vowel duration can serve as an additional cue to word identification in noisy situations where the consonants may be partially or completely masked. Older adults would be disadvantaged in such situations if they could not easily discriminate differences in vowel duration.

Some studies of older adults' temporal processing have supported this idea. For example, Lutman (1991) found that older adults with extremely poor gap detection thresholds also tended to have diminished speech identification scores. Furthermore, Gordon-Salant and Fitzgibbons (1993) found that gap duration discrimination is related to older adults' ability to recognize reverberant speech, as mentioned earlier. However, they did not find strong correlations between duration discrimination and understanding of temporally distorted speech. Similarly, Abel et al. (1990) did not find that duration discrimination was a factor in the intelligibility of speech.

In conclusion, the present study demonstrates that older adults perform more poorly than younger adults at duration discrimination for short duration stimuli, but older and younger adults perform similarly at longer duration stimuli. This diminished temporal processing capability in older adults could make it more difficult for them to process speech in difficult listening situations where there is noise, reverberation, or when speech is speeded.

5.0 AUTHOR'S NOTE

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6.0 REFERENCES

Abel, S. M. (1972). Duration discrimination of noise and tone bursts. Journal of the Acoustical Society of America, 51, 1219-1223.

Abel, S. M., Krever, E. M., & Alberti, P. W. (1990). Auditory detection, discrimination and speech processing in ageing, noise-sensitive and hearing-impaired listeners. Scandinavian Audiology, 19, 43-54.

Fitzgibbons, P. J., & Gordon-Salant, S. (1994). Age effects on measures of auditory duration discrimination. Journal of Speech and Hearing Research, 37, 662-670.

Fitzgibbons, P. J., & Gordon-Salant, S. (1995). Age effects on duration discrimination with simple and complex stimuli. Journal of the Acoustical Society of America, 98, 3140-3145.

Fitzgibbons, P. J., & Gordon-Salant, S. (1996). Auditory temporal processing in elderly listeners. Journal of the American Academy of Audiology, 7, 183-189.

Getty, D. J. (1975). Discrimination of short temporal intervals: A comparison of two models. Perception and Psychophysics, 18, 1-8.

Gordon-Salant, S., & Fitzgibbons, P. J. (1993). Temporal factors and speech recognition performance in young and elderly listeners. Journal of Speech and Hearing Research, 36, 1276-1285.

Humes, L. E. (1996). Speech understanding in the elderly. Journal of the American Academy of Audiology, 7, 161-167.

Kingsbury, B. E. D., Morgan, N., & Greenberg, S. (1998). Robust speech recognition using the modulation spectrogram. Speech Communication, 25, 117-132.

Levitt, H. (1971). Transformed up-down methods in psychoacoustics. Journal of the Acoustical Society of America, 49, 467-477.

Lutman, M. E. (1991). Degradations in frequency and temporal resolution with age and their impact on speech identification. Acta Otolaryngol. Supp. 476, 120-126.

Peterson, G. E., & Lehiste, I. (1960). Duration of syllable nuclei in English. Journal of the Acoustical Society of America, 32, 693-703.

Pichora-Fuller, M. K. (1997). Language comprehension in older listeners. Journal of Speech-Language Pathology and Audiology, 21, 125-142.

Pichora-Fuller, M. K., Schneider, B. A., & Daneman, M. (1995). How young and old adults listen to and remember speech in noise. Journal of the Acoustical Society of America, 97, 593-608.

Schneider, B. A. (1997). Psychoacoustics and aging: Implications for everyday listening. Journal of Speech-Language Pathology and Audiology, 21, 111-124.

Shannon, R. V., Zeng, F-G., Kamath, V., Wygonski, J., & Ekelid, M. (1995). Speech recognition with primarily temporal cues. Science, 270, 303-304.

Small, A. M., & Campbell, R. A. (1962). Temporal differential sensitivity for auditory stimuli. American Journal of Psychology, 75, 401-410.

Stuart, A., & Phillips, D. P. (1996). Word recognition in continuous and interrupted broadband noise by young normal hearing, older normal hearing, and presbyacusic listeners. Ear and Hearing, 17, 478-489.

van Rooij, J. C. G. M., & Plomp, R. (1990). Auditive and cognitive factors in speech perception by elderly listeners. II: Multivariate analyses. Journal of the Acoustical Society of America, 88, 2611-2644.

van Rooij, J. C. G. M., & Plomp, R. (1992). Auditive and cognitive factors in speech perception by elderly listeners. III: Additional data and final discussion. Journal of the Acoustical Society of America, 91, 1028-1033.

Wingfield, A., Poon, L. W., Lombardi, L., & Lowe, D. (1985). Speed of processing in normal aging: Effects of speech rate, linguistic structure, and processing time. Journal of Gerontology, 40, 579-585.

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CANADIAN STANDARDS ASSOCIATION ACTIVITY IN ACOUSTICS

2001 UPDATE

Tim Kelsall
Hatch Associates, 2800 Speakman Drive, Mississauga, Ontario L5K 2R7
tkelsall@hatch.ca

ABSTRACT

This article gives an update of Canadian Standards activities in Canada, especially those of the Canadian Standards Association. CSA currently have 10 Acoustics Standards and two more with significant acoustics content. Two committees and a variety of subcommittees involving many Canadian acousticians and industry representatives write and review these standards for the Acoustics commmunity. An update is given of the main activities and future directions of these groups

SOMMAIRE

Cet article présente une mise a jour des activités de normalisation au Canada, tout particulièrement celles de l'Association canadienne de normalisation. L'association a présentement 10 normes acoustiques et deux autres comportant des normes acoustiques détaillées. Deux comités et divers sous-comités comprenant plusieurs acousticiens canadiens et représentants de l'industrie rédigent et passent en revue ces normes pour la communauté acoustique. Une vue d'ensemble de leurs activités premières ainsi que la direction future de ces groupes y est présenté.

INTRODUCTION

This article is intended to give an update for 2001 of acoustics standards activity in Canada, concentrating on CSA acoustical standards. The Canadian Standards Association is the largest standards writing body in Canada and one of the largest in the world. There have been CSA standards in Acoustics for over 25 years and the Z107 Committee on Acoustics and Noise Control is still active in many areas.

COMMITTEE ACTIVITIES

There are two CSA Technical Committees in Acoustics :

Z94 is responsible for the Hearing Protection Standard Z94.2 which defines Type A, B, and C type hearing protectors and is widely referred to in occupational noise regulations. They have recently approved a major new version of this standard in light of changes to the US hearing protector standards and procedures. This will mean the introduction of the user fit hearing protector measurements, similar to those used by ANSI and now recognized as being more representative of how hearing protectors are used in industry than the old technician fitted testing methods.

Z107, the Acoustics and Noise Control Technical Committee, is responsible for all other Acoustics standards. Several members belong to both committees and provide liaison between them.

Z107 is divided into 9 subcommittees. These include:

Hearing Measurement,

Vibration,

Powered Machines

Industrial Noise,

Transportation Noise,

Editorial (which reviews all proposed standards), Building Acoustics,

Instrumentation Calibration and

Liaison with the Canadian Steering Committee for ISO TC43 and TC43(1). Each subcommittee is responsible for the standard or standards within its area.

As global harmonisation becomes more important, CSA has started to adopt and endorse international standards where possible rather than writing their own. In areas where standards apply to goods coming from or going to other countries, use of international standards makes considerable sense.

Adopting a standard, which means republishing it, with changes or additions if necessary, costs less than half the cost of writing a new standard. Endorsing, which means that the standard has been reviewed and found suitable for Canadian use is the least expensive option, but less useful because the standard is not so readily available. Given our location, adopting or endorsing international or US acoustical standards has been common practice for years.

Currently there are 22 standards from ANSI, ISO and ASTM out for ballot to be endorsed.

.Table 1 shows all the Canadian Standards currently in force and also lists two standards whose Acoustics sections were written with the assistance of the Z107 committee. This table will also soon be found at the CAA website and will be kept up to date there. Meanwhile the list can be found at http://www.csa-intl.org/onlinestore/GetCatalogDrillDown.asp?Parent=6

CURRENT ACTIVITIES

Some current highlights include:

Transportation

The newest standard to be published is Z107.9, Highway Noise Barriers. It came out in early 2000 and sold out its first printing of 100 within months. This standard is an adaptation of the Ontario MTO Highway Noise Barrier specification. It is intended to provide municipalities, developers, road and highway departments, railways and industry with a standard specification which can be used to define the construction of barriers intended for long term use in Canadian conditions.

This is much more than simply an acoustics standard. It fills an important need in the industry and drafts have been used by several municipalities in recent years. Essentially it allows regulators, consultants or engineers to specify a barrier's construction and durability simply by referring to one standard.

Specific manufacturers' barrier designs are certified as complying with the standard in such areas as: materials used, weathering and corrosion resistance testing, STC, NRC, etc. Each barrier installation is reviewed and certified for compliance with such items as footings design, material sample testing, welding, caulking, backfilling, etc. The US Highway Barrier Design Manual is already harmonised with the CSA standard, as is the Ontario OPS.

At present this standard is caught in a chicken and egg scenario. CSA have not committed to certifying barriers until they are sure there is sufficient demand and governments are unable to ask for certified barriers until the certification is in place. Efforts are underway at the technical level to resolve this deadlock.

Industry

The Industrial Noise Subcommittee is the most varied and active subcommittee.

Ongoing activities include:

A working group looking at adopting the ISO 1996 rating systems for community noise (for tonality and impulse corrections among others)

A writing group preparing Guidelines For The Declaration Of Machinery Noise Emission Levels,

Guidelines For The Declaration Of Machinery Noise Emission Levels

Guidelines For The Declaration Of Machinery Noise Emission Levels will be a voluntary guide for noise labelling of machinery for use in Canada and compatible with the European regulations to allow machinery to be sold into that market.

Labels in this context refer to a statement of sound levels produced by the equipment which would be included with the instruction or maintenance manual. Measurements are made according to ISO standards and include estimates of the likely variability of the measurements.

Currently the standard is about to go out for ballot.

Adoption of ISO1996

A working group chaired by Chris Krajewski and including several Ontario consultants is examining using ISO 1996 as a way of updating the way tonal and impulse sounds are handled in community noise. They are currently running round robin tests of the procedures with various sample sounds. Stephen Keith of Health Canada is acting as liaison with the ISO committee.

The first round of tests was reported at the recent Canadian Acoustics conference and a second round is ongoing. The standard is written to be compatible with a number of different regulations in Europe. A first draft of an informative annex relating the standard to the Canadian context is underway.

Building Acoustics

The Building Acoustics subcommittee has recommended a large series of ASTM standards for endorsement.

These include ASTM C384, E795, C423 on measuring absorption, ASTM E90, E336, E497, E557 on transmission loss of partitions, E596 on enclosures, E966 on building facades and E989, 492 and 1007 on impact sound transmission through floors.

Instrumentation and Calibration

The Instrumentation and Calibration subcommittee have no standards of their own; instead they have endorsed or adopted IEC instrumentation standards and ANSI standards which can then be referred to in Canadian regulations and other standards. Every five years or more frequently the standards are reviewed automatically to ensure that the latest standards are being endorsed and that they are still suitable for use in Canada. In addition, the chairman, George Wong, is actively involved with the ISO and IEC working groups.

They recently recommended the following standards for endorsation :

ANSI S1.11 on filters, S1.13 on sound measurement and S1.4 and IEC 60651 on sound level meters.

Editorial

The Editorial subcommittee have endorsed the ANSI Standard for Acoustics Terminology and have had input into it. This standard is updated regularly by ANSI and is reviewed by this subcommittee each time it is revised. The Editorial subcommittee main job is to review every standard written by a Z107. subcommittee, both as a final technical review and to ensure it meets the CSA editorial requirements. They recently finished a major review of the labeling standard.

Main Z107.9 Committee

The committee meets twice a year, once during the Canadian Acoustics Week and once in the spring. The latest meeting at the Alliston conference was well attended and lively. They review progress by each subcommittee and vote on any new work proposals. The main committee is the last technical hurdle for a standard. The CSA will then have their editors put it into final form. The steering committee, to which the main committee reports, approves work and reviews completed standards, however they cannot make technical changes.

The main committee also hears reports from members who provide liaison with the ISO, IEC ANSI and ASTM acoustics activities.

One other initiative that the main committee has been trying to propose for some years is a Guideline to provide a standard which summarises the major Canadian and International Standards for Canadian industry users. This is intended to make Acoustical Standard more accessible to Canadian users. Recently they were given authorization to proceed with this project.

New members are encouraged and anyone interested may contact Cameron Sherry, the Chairman, or the author, the vice chair. This article is the third in a series which will provide more information on the activities underway in all areas of Acoustics Standards in Canada.

Table 1- CSA Acoustics Standards

CAN3-Z107.4-M86 Pure Tone Air Conduction Audiometers for Hearing Conservation and for Screening

Audiomètres tonals à conduction aérienne pour la préservation de l'ouïe et pour le dépistage

CAN/CSA-Z107.6-M90 Pure Tone Air Conduction Threshold Audiometry for Hearing Conservation

CAN/CSA-Z107.9-00: Standard for Certification of Noise Barriers

Z107.51-M1980 (R1994) Procedure for In-Situ Measurement of Noise from Industrial Equipment

Z107.52-M1983 (R1994) Recommended Practice for the Prediction of Sound Pressure Levels in Large Rooms Containing Sound Sources

Z107.53-M1982 (R1994) Procedure for Performing a Survey of Sound Due to Industrial,Institutional, or Commercial Activities

CAN3-Z107.54-M85 (R1993) Procedure for Measurement of Sound and Vibration Due to Blasting Operations

Méthode de mesure du niveau sonore et des vibrations émanant des opérations de dynamitage

CAN/CSA-Z107.55-M86 Recommended Practice for the Prediction of Sound Levels Received at a Distance from an Industrial Plant

Pratique recommandée pour la prévision des niveaux sonores reçus à une distance donnée d'une usine

Z107.56-94 Procedures for the Measurement of Occupational Noise Exposure

Méthode de mesure de l'exposition au bruit en milieux de travail

Z94.2-94 · CAN/CSA-Z94.3-92

Hearing Protectors

Protecteurs auditifs

Standards with Acoustics Component:

Z62.1-95 Chain Saws

CAN/CSA-Z412-M00 Office Ergonomics

L'ergonomie au bureau

ENDORSED STANDARDS

ANSI S1.1-1994 Acoustical Terminology

ANSI S1.4-1983 Specification for Sound Level Meters

ANSI S1.11-1966 Octave, Half-octave, and Third Octave Band Filter Sets

ANSI S1.13-1971 Methods for the Measurement of Sound Pressure Levels

ANSI S1.31-1980 Precision Methods for the Determination of Sound Power Levels of Broad-band Noise Sources in Reverberation Rooms

ANSI S1.32-1980 Precision Methods for the Determination of Sound Power Levels of Discrete-frequency and Narrow-band Noise Sources in Reverberation Rooms

ANSI/ASTM E492- Laboratory Measurement of Impact Sound1977 Transmission Through Floor-ceiling Assemblies Using the Tapping Machine

ASTM C384-85 Impedance and Absorption of Acoustical Materials by the Impedance Tube Method

ASTM E1007-84 Field Measurement of Tapping Machine Impact Sound Transmission Through Floor-ceiling

IEC 651 (1979) Sound Level Meters

ISO 4872-1978 Acoustics—Measurement of Airborne Noise Emitted by Construction Equipment Intended for Outdoor Use—Method for Determining Compliance -with Noise Limits

ISO 6393-1985 Acoustics—Measurement of Airborne Noise Emitted by Earth-Moving Machinery—Method for Determining Compliance with Limits for Exterior Noise—Stationary Test Conditions

ISO 6394-1985 Acoustics—Measurement of Airborne Noise Emitted by Earth-moving Machinery—Operator's Position—Stationary Test Conditions

ISO 6395-1988 Acoustics—Measurement of Exterior Noise Emitted by Earth-moving Machinery—Dynamic Test Conditions

SAE J919-1986 Sound Measurement - Earthmoving Machinery -Operator Singular Type

SAE J1096-1985 Measurement of Exterior Sound Levels for Heavy Trucks under Stationary Conditions

ASTM C423-84a Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method

ASTM E90-1985 Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions

ASTM E336-84 Measurement of Airborne Sound Insulation in Buildings

ASTM E497-1981 Installation of Fixed Partitions of Light Frame Type for the Purpose of Conserving Their Sound Insulation Efficiency

ASTM E557-1981 Architectural Application and Installation of Operable Partitions

ASTM E596-1986 Laboratory Measurement of the Noise Reduction of Sound-Isolating Enclosures

ASTM E597-1981 Determining a Single-number Rating of Airborne Sound Isolation for Use in Multiunit Building Specifications

ASTM E795-1983 Mounting Test Specimens During Sound Absorption Tests

ASTM E966-1984 Field Measurement of Airborne Sound Insulation of Building Facades and Facade Elements

ASTM E989-1984 Determination of Impact Insulation Class (11c)

REFERENCES:

1. C. Krajewski, Rating Sound Level- A New Method for Description and Measurement of Environmental Noise-An Overview of Amendment 1 to ISO 1996-2, Canadian Acoustics, Volume 29, No. 3, September, 2001

2. William J. Gastmeier and James L. Feilders, ISO 1996 Acoustics – Description and Measurement of Environmental Noise Round Robin Testing, Canadian Acoustics, Volume 29, No. 3, September, 2001

3. Stephen Keith, Stephen Bly, Tim Kelsall, A preview of the Draft CSA Guideline – Noise Emission Declarations for Machinery, Canadian Acoustics, Volume 29, No. 3, September, 2001

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LOUDNESS ENCODING AT THE AUDITORY NERVE

Elad Sagi[a], Kenneth H. Norwich[ab] and Hans Kunov[c]
Sensory Communication Group, Institute of Biomaterials and Biomedical Engineering
a) Department of Physiology, b) Department of Physics; c) Department of Computer and Electrical Engineering
University of Toronto, Toronto, Ontario, Canada

The 'sone' scale developed by Stevens (1956) describes the rate at which loudness grows with sound level. Using a method of magnitude estimation, human participants were required to quantify the loudness of a stimulus tone relative to a reference tone of some fixed level and frequency (or frequencies). For example, a 1 kHz reference tone at 40 dB SPL was assigned an arbitrarily scaled value of, say, 100. A 1 kHz stimulus tone deemed twice as loud would then be assigned a value of 200. After all stimulus tones were presented, the assigned values were then normalized such that the reference tone was given a value of 1 'sone'.

A full logarithmic plot of loudness (in sones) against sound level (in dB) yields a curve that is linear over much of its extent. The slope of the linear portion of this curve gives the loudness exponent, *n*, which describes the rate at which loudness grows with sound level. That is, the relationship between loudness, *L*, and sound level, *I*, is approximately

$$L \propto I^n \qquad (1)$$

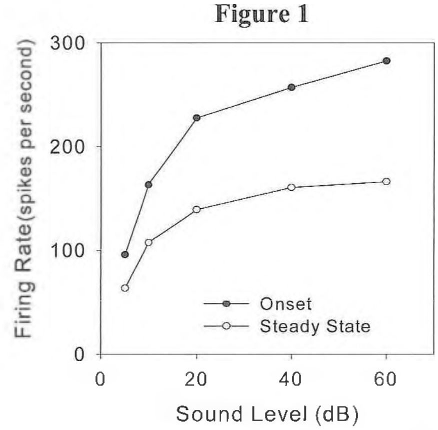
where sound level is represented here as a linear measure.

The loudness exponent, *n*, is characteristic of the stimulus frequency (or frequencies) used for experimentation and varies from about 0.3 for 1 kHz tones to greater than 0.4 for pure tones of higher and lower frequencies. Whereas the 'Loudness function' in Equation (1) holds true for the human perceiver, we are interested in the extent to which this relationship is reflected at the auditory nerve.

In response to a tone stimulus of constant sound level, the stereocilia of a given inner hair cell within the cochlea become deflected resulting in a depolarization of the cell's receptor potential followed by the release of neurotransmitter. Approximately 20 auditory nerve fibers synapse onto this hair cell, each of which produce action potentials at a rate proportional to the amount of neurotransmitter release (Slepecky, 2000). The initial rate of neural firing, however, does not persist. For the duration of the stimulus, the neural response peaks immediately after onset of the tone and is followed by a component that adapts rapidly to a steady state.

As the sound level of the stimulus tone is increased, both the onset and steady state firing rates will become larger, but tend to saturate at higher intensities depending on the spontaneous rate of the nerve fiber. This feature is demonstrated in Figure 1, adapted from Smith (1979). Firing rate was measured from a single fiber of the auditory nerve in the Mongolian gerbil in response to a 50 Hz narrow-band stimulus of constant sound level centered around the characteristic frequency of the fiber at 1.86 kHz.

Figure 1



Neither the onset nor the steady state firing rate displays the necessary growth with sound level that would be characteristic of the loudness function. Similarly, Relkin and Doucet (1997) found that a gross measure of neural firing in the form of a perstimulus compound action potential taken from the chinchilla auditory nerve also does not demonstrate the required growth. That is, loudness is not simply proportional to the auditory nerve spike count.

Individual units of the mammalian auditory nerve fall into three categories, depending on their spontaneous firing rate. Units of high, medium and low spontaneous rates respond to low, medium and high sound levels respectively (Liberman, 1978). Hence, one might suggest that sound level is coded by the recruitment of subgroups of fibers in response to increasing sound levels. Nevertheless, if loudness were to be preserved amongst these fibers, each fiber would be required to encode the psychophysical growth of loudness, regardless of the limited dynamic range per fiber.

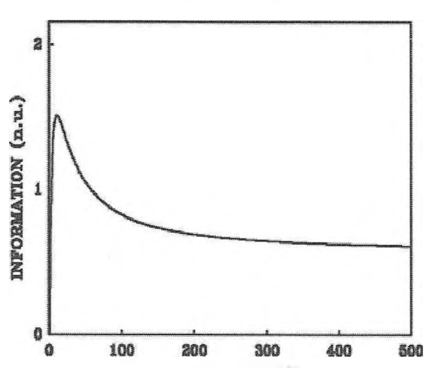
We propose that in each fiber of the auditory nerve, the loudness of a tone can be represented as an information such that the greater the loudness, the greater the information. Within information theory, information is defined as the difference between the stimulus uncertainty and the stimulus equivocation.

Consider a pure tone stimulus of 'constant' sound level acting on the inner hair cell. On a moment-by-moment basis, the square of the peak amplitude will fluctuate by an amount ΔI about the mean sound level I. That is, the hair cell is presented with a normal distribution of sound level values with a mean of I dB and standard deviation of ΔI dB. Similarly, the inner hair cell is by no means exact in its ability to detect the instantaneous sound level and will make errors, say by an amount σ dB.

Taken together, ΔI and σ determine the stimulus uncertainty and the stimulus equivocation respectively. Hence, one can calculate the information on a moment-by-moment basis simulating the process through which the inner hair cell samples the stimulus level. Figure 2 is a representative example of the information (in natural units [n.u.]) calculated as a function of the number of trials (or samples) for this process. Characteristically, the information rises to a peak and subsequently falls to an asymptotic value. For a given value of ΔI, the peak and asymptotic values are completely determined by σ.

We propose that the calculated information is proportional to the firing rate one would observe in a single auditory nerve fiber in response to a constant sound level. Hence, the ratio of onset to steady state firing should equal the ratio of peak to asymptotic information.

Figure 2



By way of example, let us use the data from Figure 1. At each stimulus level, one can calculate the ratio of onset to steady state firing rate. Using these ratios, one can generate the corresponding information curves.

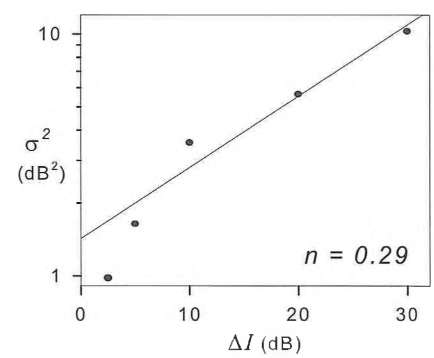
First, however, we must define the value of ΔI. We suggested above that the hair cell is presented with a stimulus uncertainty measurable in decibels. We simply assume here that $\Delta I = I/2$ dB corresponding to a square root law in linear space.

Using this relationship, one can now determine the values of σ required to generate information curves such that the ratio of peak to asymptotic information corresponds to the ratio of onset to steady state firing rate at a given stimulus level.

Figure 3 represents a full logarithmic plot of variance, i.e. σ^2, against ΔI (already a logarithmic measure). Notably, the slope of the straight line is measured at 0.29 corresponding to the loudness exponent of Equation 1.

Hence, in every auditory nerve fiber, the loudness becomes encoded in the error intrinsic to the fiber as it samples the sound level of the stimulus tone.

Figure 3



Liberman, M. C., (1978). Auditory-nerve response from cats raised in a low-noise chamber. *Journal of the Acoustical Society of America*, **63**, 442-455.

Relkin, E. M. & Doucet, J. R. (1997). Is loudness simply proportional to the auditory nerve spike count? *Journal of the Acoustical Society of America*, **101**, 2735-2740.

Slepecky, N. B., Galsky, M. D., Swartzentruber-Martin, H., Savage, J. (2000). Study of afferent nerve terminals and fibers in the gerbil cochlea: distribution by size. *Hearing Research*, **144**, 124-134.

Smith, R. L. (1979). Adaptation, saturation, and physiological masking in single auditory-nerve fibers. *Journal of the Acoustical Society of America*, **65**, 166-178.

Stevens, S. S. (1956). The direct estimation of sensory magnitudes-loudness. *American Journal of Psychology*, **69**, 1-25.

Signal Processing for a Visual Hearing Aid

E. McDonald, H. Kunov and W. Wong
Sensory Communication Laboratory, Institute of Biomaterials and Biomedical Engineering
University of Toronto, Toronto, Ontario, Canada

Introduction

Speech is one of the most important forms of human communication. Unfortunately, many people who suffer from hearing loss have trouble perceiving and understanding speech - particularly in noisy environments. The long-term goal of this research is to develop a visual aid for people with high frequency hearing loss, the most prevalent form of auditory impairment. This aid would present important speech information through peripheral vision using an LED bar graph mounted in the frame of a pair of glasses.

Previous research suggests that acoustical enhancement of plosives and fricatives can improve the intelligibility of fluent speech[1,2]. Due to the manner in which plosives, fricatives, and affricates are produced, these phonemes should contain significant high frequency energy content. Two strategies were devised to try and detect plosives and fricatives based on the high frequency energy content.

Methods

For an application of a visual hearing aid, it is important that the visual output is perceived as being synchronous with the audio stimulus the user receives. The total delay through the system was required to be less than 15 ms. As each strategy was being simulated in LabVIEW, it was easier to design algorithms which operated on short non-overlapping sequences of data, rather than those which updated the output with every input sample. For the simulation of each strategy, the input signal was broken up into non-overlapping segments of 220 samples (approximately 5 ms at a sampling rate of 44.1 kHz).

The first strategy, High Frequency Energy (HFE), filtered each segment with a fourth order butterworth high-pass filter (f_0 = 3.5kHz) and then calculated the total energy in each segment. This energy was then converted into arbitrary decibel units. The LED value for each segment was then calculated by quantizing the energy output (in dB) into 1 of 9 levels. An 8 (the highest level) corresponded to the global peak value. A 0 (the lowest level) corresponded to an energy level 25 dB or more below the global peak value. In a real time system, the thresholds used for quantization would be based on a long-term average energy.

The second strategy was the High Frequency Energy Ratio (HFER). The first step in this strategy was to estimate the power spectrum using an FFT. The energy in the 3.6-6 kHz band was estimated by summing the energy in the bins corresponding to this region. The energy in the 600-1000 Hz band was estimated in the same way. Finally, the LED value was calculated by quantizing the ratio of the energies in the higher region versus the lower region into 1 of 9 levels. A ratio of 20 or more would correspond to an LED value of 8 (the highest level). A ratio of 1 or less would correspond to an LED value of 0 (the lowest level).

Testing of each detection strategy was carried out using the sentence "Jeff's toy go cart never worked" as spoken by four male and two female speakers. The speech waveforms were downloaded from the TIMIT speech database[3]. Each waveform was inspected by hand to determine the regions where plosives and fricatives were present and those where they were not. Pink noise was then added to each waveform to create four test conditions: clean speech, 12 dB SNR, 6 dB SNR, and 0 dB SNR. A LabVIEW program was used to compare the output of the detector with the hand marked regions for each waveform and calculate the true positive and false positive rates based on a threshold.

By varying the threshold used, Receiver Operator Characteristic (ROC) curves were generated from the resultant pairs of false positive and true positive rates.

Results and Discussion

The areas under the ROC curve for each condition is given in Table 1.

Test Condition	HFE	HFER
Clean Speech	0.670	0.678
12 dB SNR	0.644	0.710
6 dB SNR	0.633	0.720
0 dB SNR	0.591	0.650

Table 1. Areas under ROC curves for Plosive/Fricative/Affricate detector

It is clear that both methods performed poorly at detecting plosives, fricatives and affricates. The area under each curve is not significantly greater than 0.5

(which corresponds to random guessing). A closer examination of the errors suggested that both methods were not detecting the plosive phonemes or voiced fricatives. However, each detector appeared to be reasonably good at detecting unvoiced fricative and affricate phonemes.

A second run was conducted using each method as an unvoiced fricative and affricate detector (detection of a plosive or voiced fricative was be considered a false detection). The areas under the ROC curve for each condition is given in Table 2. In comparison of these results with the previous results, it is clear that both methods performed significantly better as a fricative detector alone than as a plosive and fricative detector (areas of 0.98 vs. 0.67 for HFE, 0.91 vs. 0.68 for HFER).

Test Condition	HFE	HFER
Clean Speech	0.984	0.908
12 dB SNR	0.971	0.975
6 dB SNR	0.951	0.947
0 dB SNR	0.850	0.876

Table 2. Areas under ROC curves for Unvoiced Fricative/Affricate detector on "Jeff's toy go-cart never worked"

Unfortunately, the sentence "Jeff's toy go-cart never worked" does not contain many unvoiced fricatives or affricates. Thus, a second sentence was found which had more unvoiced fricatives and affricates. The sentence chosen was "She always jokes about too much garlic in his food". The TIMIT database contained recordings from seven male speakers. This sentence was processed in the same manner as the first sentence. The areas under the ROC curve for each condition is given in Table 3.

Test Condition	HFE	HFER
Clean Speech	0.936	0.859
12 dB SNR	0.909	0.925
6 dB SNR	0.857	0.880
0 dB SNR	0.727	0.789

Table 3. Areas under ROC curves for Unvoiced Fricative/Affricate detector on both test sentences

The two detection strategies did not perform as well on the second sentence as they did on the first sentence. The cause of this may be due to effects of coarticulation. It was noted when hand marking the wav files for the second sentence that several phonemes appeared to have been significantly affected by coarticulation.

It is also interesting to note that the HFE method performed better than the HFER method in the condition of clean speech (ie. no noise). However, in pink noise, the HFER method performed better than the HFE. As both methods do not require significant computation to perform, perhaps both could be offered in an aid with an option to switch between each strategy depending on the noise condition.

References

[1] D. Ebrahimi, Preliminary research on a peripheral vision lipreading aid, M.A.Sc. Thesis, University of Toronto, 1987.

[2] V. Hazan, S. Simpson, The effect of cue-enhancement on the intelligibility of nonsense word and sentence materials presented in noise, Speech Communication, 24: 1998, 211-22

[3] TIMIT Speech database, Linguistic Data Consortium, Univeristy of Pennsylvania, http://morph.ldc.upenn.edu/lol/timit.html

The Elastic Structure of the Cochlear Partition

Taha S. A.Jaffer[1,2], Hans Kunov[1,2] and Willy Wong[2]

1) Institute of Biomaterials and Biomedical Engineering,University of Toronto, Toronto, Ontario, Canada M5S 3G9

2) Department of Computer and Electrical Engineering, University of Toronto, Toronto, Ontario, Canada M5S 3G4

1. Introduction

In most theoretical models, each resonant section of the cochlear partition (CP) is considered unconnected to its nearest neighbours. The motivation to describe various otoacoustic, perceptual, and pathological auditory phenomena has spurred the modification of this simple model to include a variety of non-linear dynamics. In this paper, we examine one further modification; the inclusion of elastic tissue that longitudinally couple one resonant region on the CP to another. One immediate implication is the production of the realistic $2f_1 - f_2$ distortion product otoacoustic emission (DPOAE). Thus, such structural mechanics may provide an answer to the seeming paradox of DPOAE production in dead ears.

2. Background and Motivation

The human ear is capable of transducing sound vibrations of the eardrum with amplitudes smaller than the diameter of a water molecule over a frequency range spanning 3 orders of magnitude. To account for this remarkable acuity, Thomas Gold suggested that the ear filters sound vibrations actively, and as a consequence, should produce sounds of its own [1]. Known as Otoacoustic Emissions (OAE's), these actively produced sounds were first recorded by David Kemp in 1978 [2].

Today, it is well established that motile hair cells in the cochlear sensory epithelium are the source of this activity. Their damage or necrosis have been linked to hearing pathology. Consequently, clinically monitoring the loss of OAE's is thought to provide an objective diagnosis of hearing dysfunction. In the clinic today, DPOAE's are used to screen newborn infants for hearing loss. Probing the ear with two simultaneous tones at frequencies f_1 and f_2 produces DPOAE's, which are the non-linear harmonic and intermodulation distortions produced by the active motion of the sensory hair cells. Oddly, the most prominent distortion occurs at a frequency $2f_1 - f_2$ for all mammals, reptiles, and birds. For this reason, the $2f_1 - f_2$ DPOAE is used extensively in clinical applications.

3. Hypothesis

There does exist some controversy over the clinical suitability of DPOAE based hearing assessment. Active mechanisms are not the only source of cubic distortions in the cochlea [3]. Skeptical clinicians have always been quick to point out that DPOAE's are recorded in dead ears where active cochlear mechanisms are no longer physiologically viable [4]. Dead hair cells, by definition, are no longer motile. How is it possible to record DPOAE's many hours after death? So there exists an air of paradox surrounding DPOAE utility; on one hand they are related to the healthy function of living cochleae, on the other, they are present in dead cochleae. How is it possible to elicit a response associated with a healthy ear from a dead ear?

We feel that the answer to this paradox lies in the structure of the sensory epithelium that houses the sensory hair cells. One common feature of living and dead cochlea is their structure. Exclude the activity of the outer hair cells and what remains is the sensory epithelium within which all the sensory cells reside. This sensory epithelium is known as the cochlear partition and can be likened to a piano keyboard - every section along its length is tuned for a particular frequency [5]. Popular cochlear models treat each piano key as a driven damped oscillator uncoupled to its nearest neighbours. The simplicity of this model is appealing and qualitatively describes a number of linear auditory phenomena.

In reality, the cochlear partition is a contiguous cellular scaffold spanning the length of the cochlea. Every resonant section is coupled structurally to its nearest neighbours through tight cellular junctions, adherens junctions, gap junctions, and desmosomes [6]. These points of attachment function to provide structural integrity, to separate ions within the cochlear fluids, and to maintain channels of chemical communication between cells. Mechanically, we suggest that such coupling is inherently elastic and can account for a number of observed non-linear cochlear phenomena including DPOAE's. Such elasticity is present in both live and dead cochleae, although its effects appear to be more pronounced in a dead ear [7,8]. Since this elasticity is heightened in dead cochleae, we hypothesize that the longitudinal cellular elasticity should be responsible for DPOAE production in dead ears.

4. Results and Discussion

In our model, we take structural elastic coupling to be a critical feature of the cochlear system and responsible for cubic DPOAE production in dead cochleae. Since the cellular coupling is similar to that of Reisner's membrane or that of healthy vascular tissue, we assume that the longitudinal elasticity in our model is also similar. Using experimental data from dead cochleae [9], our numerical solutions of the non-linear partial differential equations that describe the cochlear system demonstrate the production of cubic DPOAE's (see Figure 1). The technique to solve the non-linear cochlear system of equations is that suggested by Diependaal [10].

The non-linear effects are many and mimic aspects of DPOAE production in humans. For instance, the largest DPOAE produced in our numerical solutions was 7 dB (SPL) which is well within clinical limits. The level of the distortion rises in proportion to the stimulus with a slope of 3. Also, the $2f_1 - f_2$ distortion product is prominent over a wide range of longitudinal elasticity. The distortion level also increases as the tissue elasticity is increased, however, significant chaotic behaviour results for elasticity approaching that of pathologically stiff vascular tissue until they disappear altogether. Furthermore, the DPOAE's are not produced at the f_1, f_2, or $2f_1 - f_2$ locations, but in between these locations.

5. Summary

In this paper we have examined the inclusion of structural elasticity amongst the resonant sections of the standard cochlear model. In most theoretical models, each resonant section is considered unconnected to its nearest neighbours. Histologically, this is not true, as there are many cellular junctions between the cells in the sensory epithelium of the cochlea. An immediate implication of adding such mechanics is the production of realistic 2f1-f2 distortion product otoacoustic emissions with properties similar to those found in clinical recordings. Since the structural coupling is not dependent on any active mechanism (which presumably is present only in living ears), our simulation provides an answer as to how dead ears produce cubic DPOAE's.

6. References

[1] Gold, T. Proc.R.Soc.Lond.B.Biol.Sci. 135:492-498, 1948.
[2] Kemp, D.T. J.Acoust.Soc.Amer. 64:1386-1391, 1978.
[3] Yates, G.K. in Hearing (ed. Moore, B.C.J.) Academic Press, 1995.
[4] Lonsbury-Martin, B.L., Martin, G.K., Probst, R., and Coats, A.C. Hear.Res. 28:173-189, 1987.
[5] Patuzzi, R. in The Cochlea (eds. Dallos, P., Popper, A.N., and R.R.Fay) Springer, 1996.
[6] Slepecky, N.B. in The Cochlea (eds. Dallos, P., Popper, A.N., and R.R.Fay) Springer, 1996.
[7] Voldrich, L. Acta Otolaryng. 86:331-335, 1978.
[8] Von Békésy, G. J.Acoust.Soc.Amer. 20:227, 1948.
[9] Viergever, M.A. Mechanics of the Inner Ear. Delft University Press, 1980.
[10] Diependaal, R. Nonlinear and Active Cochlear Models. Delft University Press, 1988.

Acknowledgements

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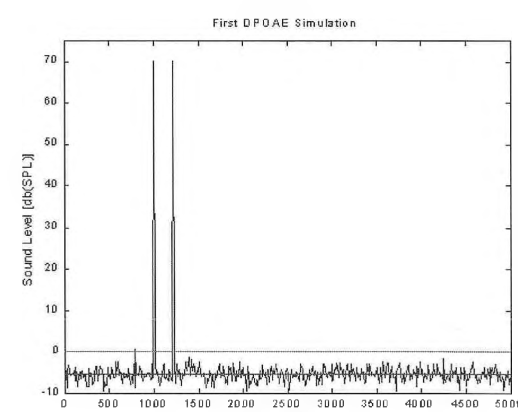

Figure 1. Distortion Product Otoacoustic Emission from Numerical Model. This figure depicts the cubic DP produced when the model was presented two tones at 1000 Hz and 1210 kHz at 70 dB (SPL). The bottom level represents the noise floor whereas the upper line show the five standard deviation from the noise floor. Clearly, a $2f_1 - f_2$ distortion is seen at 790 Hz.

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COMPARATIVE INVESTIGATION OF MUFFLER MODELS

Colin Novak, Helen Ule, and Robert Gaspar
University of Windsor, Mechanical, Automotive and Materials Engineering, 401 Sunset Ave.; Windsor, ON

1. INTRODUCTION

The reduction of automotive noise, both internal and external, has become a paramount issue in the area of car development. Engine developers have answered the demand from the public for improved engine performance by increasing engine efficiency through lowering inlet and outlet valve resistance. As a result, greater amplitudes of noise can propagate through the exhaust system downstream of the exhaust valves. Given the greater legislative emphasis on lowering automotive noise emissions, there are many restrictions imposed on exhaust system manufacturers who must not only attain higher attenuation levels with their products, but they must do so in conjunction with lower flow resistance in order to maintain performance. [2]

In the past, the acoustical design of the exhaust system has been a trial and error process resulting in a design time cycle which is too long to meet the needs of the automotive manufacturers, as well as being cost prohibitive. In an effort to reduce these development costs and overall design time, the development of computer based systems for acoustical modeling have been implemented. [6] Given the powerful software packages that are now available, very reliable prediction of engine noise, including exhaust, can be obtained. Unfortunately, many of these software packages have become so sophisticated that the input criteria has become extremely involved, thus again, increasing both development time as well as amount of skills required to use these design packages.

The purpose of this paper is to investigate the feasability of using simplified theoretical modeling equations as a preliminary step in the design process for exhaust muffler systems. Specifically, the results of a theoretical equation for a simple expansion chamber muffler are compared to the results of a computer model. Further, the results of a relatively simple computer model are then compared to the results of a very complex computer simulation model of a muffler system complete with a modeled internal combustion engine as the source. The muffler dimensions used in this investigation are illustrated in Figure 1.

2. MUFFLER THEORY

The muffler design used in this investigation is a simple single expansion chamber muffler chosen for its simplicity in

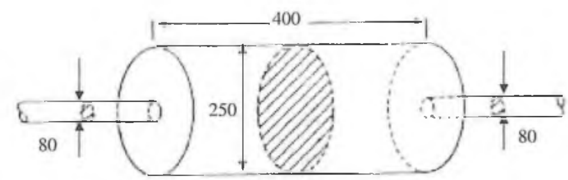

Figure 1: Modeled Muffle Dimensions

establishing theoretical behavior. This type of muffler is classified as a reactive muffler in which its performance is mainly determined from its geometrical shape which initiates an impedance mismatch for the acoustical energy traveling along the duct. "This impedance mismatch results in a reflection of part of the acoustic energy back toward the source of sound", thus preventing some of the energy from being transmitted past the muffler.

The criteria used for measuring the effectiveness of the theoretical model compared to the simple computer model is the realized Transmission Loss (L_{TL}). The calculated transmission loss illustrates the relationship between the sound power of the incident wave at the muffler inlet and the sound power in the transmitted wave at the muffler outlet and is given in the units of decibels (dB). While it is a useful analytical tool, transmission loss measurements can be difficult, but not impossible, to determine experimentally. For a single expansion chamber muffler the transmission loss is given by the periodic equation below. [1]

$$L_{TL} = 10 \log \left[1 + \frac{1}{4} \left(m - \frac{1}{m} \right)^2 \sin^2 kl \right]$$

Here the behavior of the muffler is influenced by the ratio of the cross sectional areas of the chamber and duct (m), the length of the chamber (l) and the wavelength of sound ( ) at the temperature of the gas in the muffler. The general transmission loss of an expansion chamber of dimensions l and m is given in Figure 2. [3] It should be noted that this theoretical representation is in the absence of steady airflow.

Insertion Loss (L_{IL})was used to compare the simple computer model to the results of the complex simulation model complete with a modeled internal combustion engine as the dynamic noise source. Insertion loss is simply the difference, in decibels, between two sound pressure levels meas-

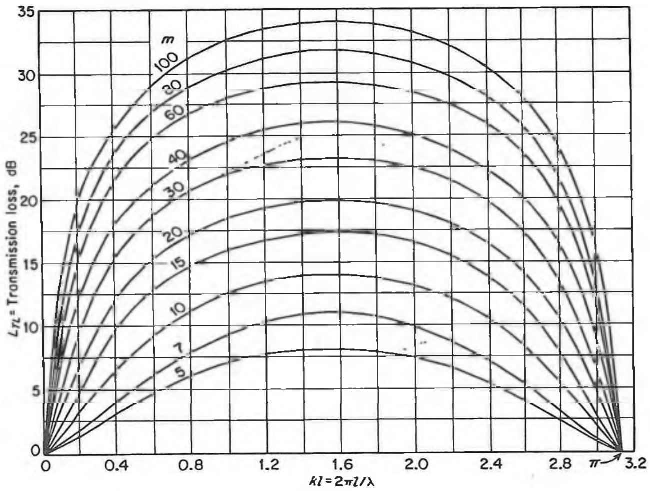

Figure 2: Transmission Loss of Expansion Chamber

ured at the same location before and after the muffler is inserted between the measurement location and the source.

3. COMPUTER MODEL

To model the transmission loss, a computer software package call Ricardo WAVE was used. "WAVE is a computer-aided engineering code developed by Ricardo to analyze the dynamics of pressure waves, mass flows and energy losses in ducts. WAVE provides a fully integrated treatment of time-dependent fluid dynamics and thermodynamics by means of a one-dimensional formulation incorporating a general thermodynamic treatment of various working fluids." [5] The transmission loss is calculated using a computer analog of the Chung-Blaser experimental technique where a two-probe microphone is placed both upstream and downstream of the muffler. A pseudo-white noise generator acts as the dynamic source at the upstream end of the muffler and an anechoic termination is placed at the far downstream location. The transmission loss is then calculated and plotted versus frequency. [4]

To model the insertion loss of the muffler, two computer models were created with WAVE and the results were compared to each other. The simpler model was the same as that used in the transmission loss simulation. Here measurements downstream of the muffler location were made with both the muffler in place and again with the muffler replaced with a straight pipe. These results were then compared to results from a much more complex simulation. Here, the muffler was placed within an entire exhaust system which was attached to a modeled 16 valve 4 cylinder engine complete with combustion. This representation includes realistic temperatures and mass flows.

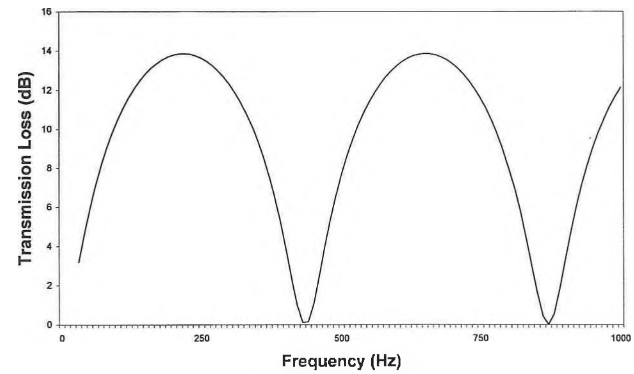

Figure 3: Theoretical Transmission Loss Results

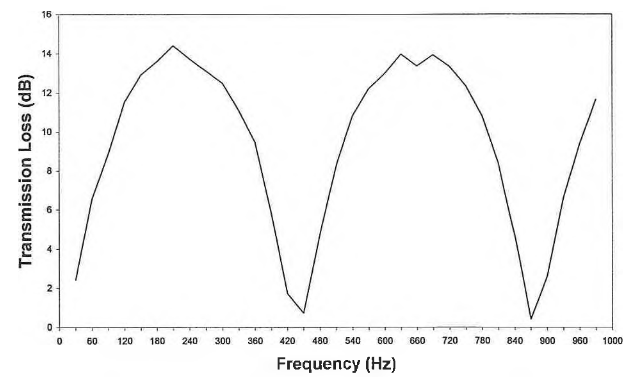

Figure 4: Computational Transmission Loss Results

4. RESULTS OF TRANSMISSION LOSS CALCULATIONS

The theoretical transmission loss results obtained from equation1 discussed earlier are illustrated in Figure 3. For the wavelength at the gas temperature of 300 kelvin and for the specific muffler dimensions chosen, the theoretical equation predicts that the maximum transmission loss of almost 14 dB will first occur at 220 Hz and, thereafter, cyclically repeat with a wavelength of 440 Hz. There is also a significant reduction of transmission loss at 440 Hz which again repeats with the same wavelength of 440 Hz. It should be noted that the literature suggests that these transmission loss results for a single expansion chamber should not be affected by the presence of a superimposed steady flow as long as it does not have a velocity greater than 35 m/s. It has been found that the flow noise can become significant at very high velocities, thus rendering the muffler ineffective.

Examination of the computational results obtained from WAVE and given in Figure 4 show very similar results. The maximum transmission loss again appears at 440 Hz with a periodic curve of wavelength equal to 440 Hz. The computational results give a maximum transmission loss of just over 14 dB. This is only a slight increase over the theoretical results presented above. Smoother representations of the

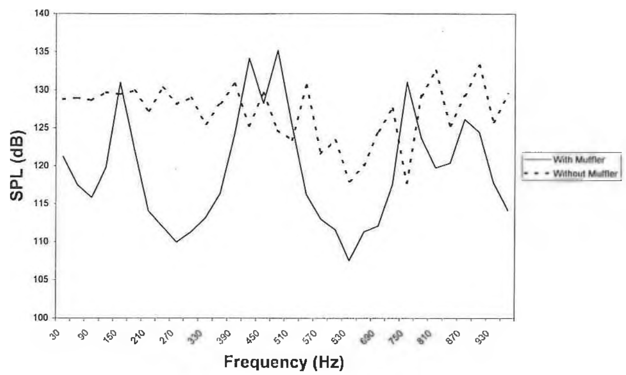

Figure 5: Insertion Loss For Simple Computational Model

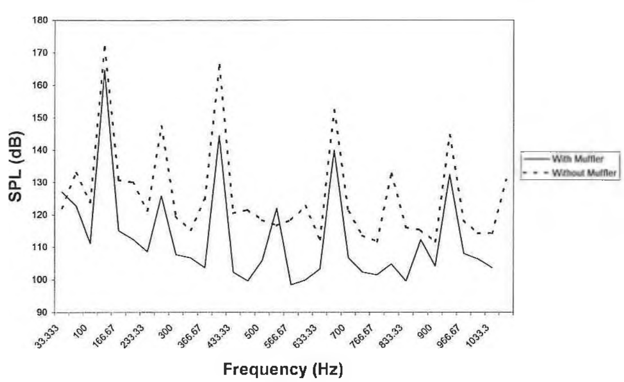

Figure 6: Insertion Loss for Complex Computational Model

computational curve may be possible if the model were subdivided with a greater discretization number. The trade off would be an increase in computational time. The overall character of the curve, however, remains the same with respect to amplitude and frequency.

5. RESULTS OF INSERTION LOSS CALCULATIONS

Figures 5 and 6 illustrate the insertion loss predictions for the simple computational model and the complex simulation respectively. The dotted and solid lines represent the sound pressure levels downstream of the muffler location without and with the muffler inserted.

For the simple model, the sound pressure levels determined at the downstream position from the muffler location are, for the most part, between 10 dB and 20 10 dB lower than the measurements without the muffler in place. The exception to this is at about 170 Hz, 500 Hz and 760 Hz where any insertion loss becomes negligible. For the complex simulation, the effects of the muffler are obvious.

Across the entire frequency spectrum, the noise level is approximately 20 dB less with the inclusion of the muffler over the noise level without the muffler. This represents a significant contribution to the attenuation of the produced sound level by the modeled engine. These results also follow those predicted by the simple simulation.

6. CONCLUSIONS

While not an exhaustive study, this investigation has demonstrated the merits of using the fundamental equations for preliminary design considerations for muffler systems. It has been demonstrated that the transmission loss results from the computational simulation closely resembles those predicted using the theory with a realized maximum transmission loss of 14 dB. It has also been shown that a significant insertion loss can be achieved with the addition of the muffler in both a simple and a complex computational model. The purpose of this investigation was to establish whether there is value in using fundamental approaches for preliminary design considerations in the design of muffler systems. It has been shown that such simple approaches do have merit.

7. REFERENCES

1. Beranek, L., "Noise and Vibration Control", McGraw- Hill, Cambridge, MA, 1988.

2. Boonen, R., Sas, P., "Development of an Active Exhaust Silencer for Internal Combustion Engines using Feedback Control", Society of Automotive Engineers, 1999-01-1844.

3. Harris, C., "Handbook of Noise Control", McGraw-Hill, New York, NY, 1957.

4. Nishio, Y, Kohama, T., Kuroda, O., "New Approach to Low-Noise Air Intake System Development", Society of Automotive Engineers, 911042.

5. "Ricardo Wave Acoustic Manual", Burr Ridge, IL, 2001.

6. "Ricardo Wave Basic Manual", Burr Ridge, IL, 2001.

7. Sacks, M., Hackney, S., "Performance of Acoustic Components for Engine Induction Systems", Society of Automotive Engineers, 880081.

8. Selamet, A., Dickey, N. S., Radavich, P. M., "Theoretical, Computational and Experimental Investigation of Helmholtz Resonators: One-Dimensional versus Multi- Dimensional Approach", Society of Automotive Engineers, 940612.

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Prediction, Visualization and Auralization of Noise in Industrial Workrooms During Computer 'Walk-Through' – the *PlantNoise* System

Murray Hodgson and Nelson Heerema
School of Occupational and Environmental Hygiene and Department of Mechanical Engineering,
University of British Columbia, 3rd Floor, 2206 East Mall, Vancouver, Canada V6T 1Z3

1. INTRODUCTION

In industrial workrooms, in order to limit the risk of hearing loss, as well as to promote the adequate recognition of speech and warning signals, it is necessary to limit noise levels and reverberation times to acceptable levels at work positions. The distribution and levels of noise generated by sources in industrial workrooms are affected by room geometry, construction materials and equipment layout. Acousticians can implement noise-control measures at the design stage of new workrooms by appropriately controlling these factors, as well as by specifying quiet machinery. Noise reduction is also achieved by the use of noise-control measures such as barriers, acoustical enclosures and sound-absorbing surface treatments. In order to achieve sufficient noise control in the most cost-effective way, the acoustical designer needs to be able to evaluate and compare design options. Prediction of the workroom noise can provide useful objective information to a designer who is responsible for ensuring that the acoustical conditions are satisfactory. However, subjective information about the sound field, obtained by listening to the noise, can also be very useful in demonstrating the need for adequate noise control. Subjective experiences can be realized using acoustical-virtual-reality (auralization) techniques.

This paper presents a new approach to industrial-noise modeling, which takes the form of a combined industrial-noise prediction, visualization and auralization system, called *PlantNoise*. The system is designed to predict and present noise to a listener in a way that accurately simulates the noise levels that a worker in a workroom would be exposed to. A graphical user interface allows the user to visualize virtual location within the workroom and to 'walk-through' it, experiencing the noise updated in real time. Total and octave-band noise levels and octave-band reverberation times are displayed to the user. New empirical models are used to predict the noise levels and reverberation times. A major objective of this work was to develop a system that is readily accessible to acoustical consultants, industrial hygienists, suppliers of noise-control products and other professionals.

2. SOUND-FIELD PREDICTION

Noise levels and reverberation times, in octave bands from 125 to 4000 Hz, were predicted using novel empirical models. These were developed using multivariable linear-regression analysis of experimental data from 30 'typical' industrial workrooms. The workrooms were either empty or fitted. Some contained sound-absorptive treatments. Details of the models and their derivations and evaluation are presented elsewhere [1].

3. INPUT DATA AND SYSTEM OPERATION

The operation of *PlantNoise* is straightforward. A data-file contains all workroom-specific information, including dimensions, surface types, source sound-power levels and information on the workroom fittings. All other information required by the *PlantNoise* system, including headphone and soundcard calibration constants (see below), surface-absorption coefficients and A-weighting constants, is contained within the main executable. Input data describing the workroom are grouped into three categories, as detailed below, along with the adjustable input parameters for each case:

Fittings - proportion of floor area covered, average fitting height, number of fittings; Sound sources - description, coordinates, octave-band sound-power levels;

Surfaces and absorption - area of hard (concrete, etc.) surfaces, area of paneled (steel-deck roof, metal cladding, doors, etc.) surfaces, area of acoustically treated surfaces, octave-band absorption coefficients of the acoustically treated surfaces, octave-band air-absorption exponents. Presumed absorption coefficients for the hard and paneled surfaces are built into the prediction models; those for the treated surfaces are user-defined.

After first reading in the workroom data, the program visualizes the workroom floor plan, with sound sources and a 1-m receiver grid superimposed, and the sound-level / reverberation-time displays. Noise levels at the default receiver position, as well as reverberation times, are calculated and displayed. The program initializes the soundcard, loads octave-band noise files, and commences noise generation based on the predicted noise levels at the receiver position. The user can then 'walk-through' the workroom by moving the receiver icon to any grid position bounded by the four walls. The user is able to interact with the simulation, and experience the visualized and auralized noise levels, while 'walking-through' the virtual workroom on the screen. Noise contour maps can be plotted at any time. Furthermore, at any time the workroom can be modified - for example, to simulate and test noise-control measures - by adjusting the workroom parameters; the new noise is visualized and auralized and new maps are plotted.

Figure la is a simulated *PlantNoise* visual display, showing the floor plan of a moderately-densely-fitted workroom with dimensions of 61 m by 34 m by 5 m high, containing four noise sources (total sound-power levels of 95, 95, 100 and 105 dB, respectively). The workroom has 3024 m^2 of hard surfaces (the floor and walls), 2074 m^2 of paneled surfaces (the steel-deck ceiling) and no acoustical treatment. The smiley-face icon represents the receiver position. The lower central portion of the screen displays graphically the octave-band sound-pressure levels at the receiver position. The levels are updated in real time during 'walk-through', and after parameter adjustments. Also displayed are the predicted octave-band reverberation times, which do not change with receiver position. They are updated only when workroom parameters are adjusted - for example, to reflect the effect of the addition of acoustical treatment to the workroom.

4. AURALIZATION

Noise generation involves a sound-card replaying anechoic, octave-band noise corresponding to the predicted octave-band sound-pressure levels at the current receiver position, using octave-band noise files resident in the card's DRAM memory. The objective of the auralization component of the system was to replicate octave-band noise levels as accurately as possible. To this end, calibration is required for the sound-output devices used in system - the Sennheiser HD480 headphones and the SoundBlaster sound-card. Both devices exhibit non-linear responses in both frequency and magnitude, requiring compensation to achieve a linear input/output transfer function for the system as a whole. A more significant problem is that of the filtering of sound by the external ears. The assumption of a diffuse sound field was made. The objective was effectively, therefore, to simulate levels corresponding to a diffuse sound field at a listener position, using diffuse-field head-related transfer functions. In order to achieve the desired diffuse-field simulation, the headphone/ear transfer function and hardware non-linearities must be removed from the overall system transfer function, and the diffuse-field head-related transfer functions applied.

5. SIMULATING NOISE-CONTROL MEASURES

There are two common workroom noise-control measures that can be simulated and tested using *PlantNoise*. The first is the application of sound-absorbing acoustical treatments to the room surfaces to increase the average surface-absorption coefficient. The second consists of installing acoustical enclosures around noisy equipment to reduce the radiated output power. To illustrate how such treatments can be simulated with the *PlantNoise* system, consider the noisy workroom shown in Figure 1a, and discussed above.

As indicated by the noise contours, levels in the untreated workroom varied from 77 to 93 dBA, being highest in the vicinity of dominant source 4. The reverberation time was about 1.8 s. Subjectively, the noise was very loud, and was annoying due to its dominant high-frequency content. Acoustical treatments were applied as follows:

1. Absorptive surface treatment - covering the ceiling with an absorptive treatment was accomplished by modifying the relative areas of the paneled and treated surfaces. 2074 m^2 were subtracted from the panel-surface area and added to the treated-surface area. The absorption coefficients of the treatment were also entered - in this case values increasing with frequency from 0.4 to 0.8 were used to represent suspended baffles;

2. Enclosing a sound source - enclosing a sound source was accomplished by reducing the source sound-power levels by an amount equal to the attenuation expected from the enclosure. In the present example, the total sound-power output of source 4 was reduced by 15 dB.

The simulated *PlantNoise* display in Figure 1b shows the noise levels and reverberation times after the addition of the surface treatment and the enclosure of source 4. Noise levels have been reduced by 10-15 dBA. The reverberation time has been reduced to about 0.6 s.

Subjectively, the loudness was more than halved and the noise was less annoying, since the acoustical treatments resulted in the high-frequency noise being less dominant.

6. CONCLUSION

Numerous improvements in *PlantNoise* are planned or currently being implemented. It could be extended to predict noise exposure from worker time/motion information [2]. There is considerable potential for improving the realism of the subjective experience provided by the auralization component of the system. For example, the system could be extended to allow simulation of the radiation by noise sources of pure-tone and impulsive sounds. Equipment-noise signatures could be recorded, digitized and stored in the system for replay at predicted levels. Reverberation could be superimposed on the predicted noise.

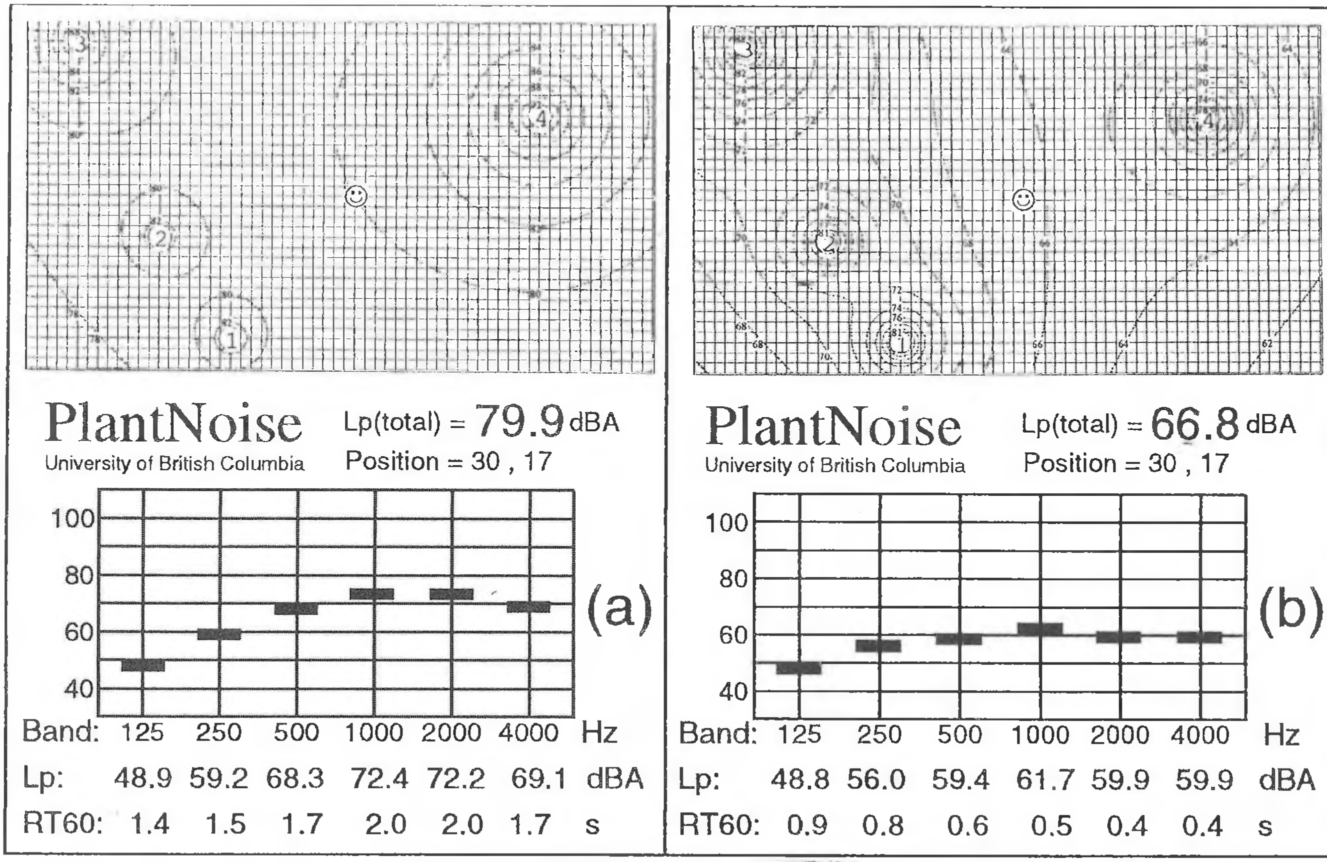

FIGURE 1. Simulated PlantNoise visual displays, showing A-weighted noise levels, and reverberation times, in a large, fitted workroom (a) before treatment; (b) after treatment.

7. REFERENCES

1. N. Heerema and M. R. Hodgson, "Empirical models for predicting noise levels and reverberation times in industrial workrooms", *Appl. Acoust.* 57(1) 51-60 (1999).

2. A. M. Ondet, "Prediction of occupational noise exposure", *Proc. Internoise* '96, 3035-3038 (1996).

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Prediction of Sound Levels in Rooms with Local- and Extended-Reaction Surfaces

Murray Hodgson and Andrew Wareing

School of Occupational and Environmental Hygiene and Department of Mechanical Engineering,
University of British Columbia, 3rd Floor, 2206 East Mall, Vancouver, Canada V6T 1Z3.

A new wave-based model which predicts steady-state sound-pressure levels in rooms bounded by extended-reaction surfaces has been developed and used to study the effect of modeling room surfaces as of extended or of local reaction.

1. MODEL DEVELOPMENT

The new model combined two approaches – a triangular beam-tracing model with phase for the room, and a transfer-matrix model for the surfaces. The model works in the frequency domain.

Room model - A spherical wave was approximated by a point source surrounded by an icosahedron with subdivided faces. Each beam was propagated through the room by tracing its central ray up to a specified reflection order in an attempt to find a valid source-receiver path. The beam face represents a portion of the spherical sound wave-front as a complex pressure (with magnitude and phase). With each surface reflection, the associated complex pressure reflection coefficient was multiplied by the incident beam's complex pressure to find the pressure at the reflected beam front. The sum of the complex pressures at the beam face for each occurrence of a valid source-receiver path is that beam's contribution to the sound pressure at the receiver. The sum of the pressure contributions from all beams yields the steady-state sound-pressure level at the receiver point.

Surface model - A transfer-matrix approach was adopted to predict the acoustical properties of extended- or local-reaction surfaces. This model calculates the surface impedance and pressure reflection coefficient of multi-layered surfaces. These surfaces consist of a series of isotropic layers with finite thickness and infinite lateral extent, and materials classified as either fluid, elastic-solid or elastic-porous. Biot theory is used in the transfer-matrix formulation of the porous layer. The complete model comprised the assembly of the boundary conditions at each layer interface; this involved interface matrices and the transfer matrix of each layer. The surface impedance and pressure reflection coefficient of the multi-layered surface, modeled as of extended- or local-reaction, were obtained from the assembled transfer matrix.

The two models were integrated to form the new room-prediction model. The transfer-matrix model output the complex reflection coefficient and surface impedance. The inputs were frequency, incident angle and the material properties of the layers. It was called in the beam-tracing program at each occurrence of a surface reflection from a multi-layered surface, to calculate the reflection coefficient.

2. VALIDATION

The beam-tracing and transfer-matrix models were validated separately. Predictions by the beam-tracing model were compared with those by a method-of-images model which included phase, for several room/surface configurations (described below). This involved studying the number of beams, and of reflections, required to obtain reliable predictions. Good agreement was obtained using 2500 beams and 25 reflections. Predictions by the transfer-matrix model were compared with theory or published experimental results in the case of surfaces commonly found in rooms, with excellent agreement.

3. PREDICTIONS AND RESULTS

The new model was used to study three rooms: a small office (3 ´ 3 ´ 3 m3); a corridor (10 ´ 3 ´ 3 m3); a small industrial workroom (10 ´ 10 ´ 3 m3). In each case, one wall comprised one of five test surfaces - a single glass plate, double drywall panels, double steel panels, carpet on concrete, or a suspended acoustical ceiling - which were modeled as of either local or extended reaction. Other room surfaces had frequency and angle invariant absorption coefficients of 0.1.

Figure 1 shows the case with the greatest difference between the two results – the corridor with a suspended acoustical ceiling. The study results can be summarized as follows, in terms of the difference between the extended- and local-reaction levels:

- All rooms with a single glass plate showed no difference;
- With double drywall panels on the walls of the office and corridor, there were differences at low frequency, with extended reaction giving 1-9 dB higher levels;
- With double steel plates on the walls of the workshop, the extended-reaction level was higher by 2 dB in the 63 Hz octave band. The local-reaction level was higher by 3 dB and 2 dB in the 125 Hz and 250 Hz octave bands, respectively.

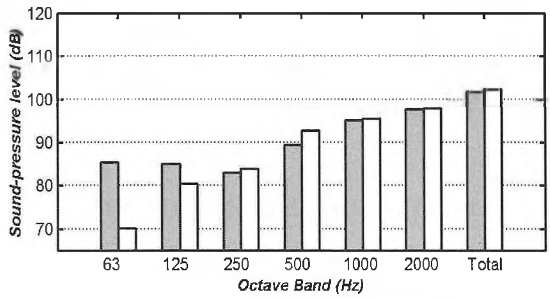


Fig. 1. Octave-band sound-pressure levels predicted in the corridor with a suspended acoustical-tile ceiling. Extended reaction - grey bar; local reaction - white bar.

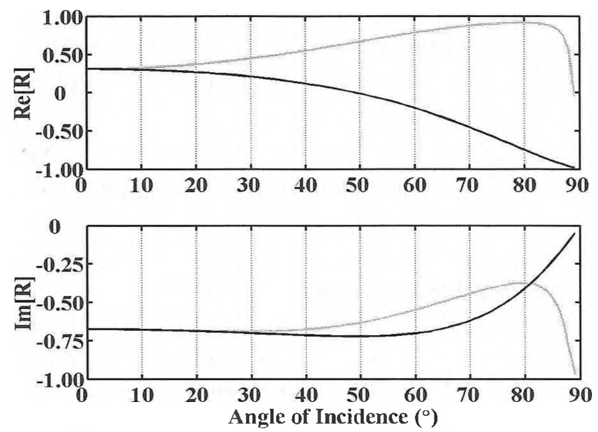


Fig. 2. Angle dependence of the real and imaginary parts of the reflection coefficient R of a suspended acoustical ceiling, at 63 Hz: Extended reaction - grey line; Local reaction – black line.

In the above cases, levels were similar at high frequency.

- With a carpeted floor in the office and corridor, local-reaction levels were 1–3 dB higher in the 500–2000 Hz octave bands;

- In the office and corridor with a suspended acoustical ceiling, the extended-reaction levels were up to 15 dB higher at low frequency, and the local-reaction levels were slightly higher at high frequency;

- In the workshop with a double steel-panel ceiling, the local-reaction level was higher by 2–3 dB in the 63 Hz, 125 Hz and 500–2000 Hz octave bands. The extended-reaction level was slightly higher in the 250 Hz octave band;

- In the workshop with a fibre-glass-lined concrete ceiling, the two levels were similar in all bands.

The results can be partially explained by an analysis of the reflection coefficients of the test surfaces in the two cases, and of the dominant wave-incidence angles on the test surface. For example, Figure 2 shows the real and imaginary parts of the two reflection coefficients relevant to Figure 1 at 63 Hz; values are generally higher with extended reaction, explaining the higher levels. The first-order reflection on the ceiling was incident at 76°. Generally, these results correlated well with the differences between the angular variations of the extended- and local-reaction surface reflection coefficients.

4. CONCLUSION

Following are the main conclusions of the study regarding the difference in modeling a surface as of extended or local reaction on steady-state levels:

- It is not significant when the surface is a single plate or a single layer of material (solid or porous) with a rigid backing;

- It is significant when the surface consists of multi-layers of solid or porous material and includes a layer of fluid with a large thickness relative to the other layers;

- For surfaces for which the reflection coefficient is different when obtained with an extended- or local-reaction surface impedance, the extended- and local-reaction assumption may be significant, depending on the source and receiver positions. This may be significant when the positions are such that near-grazing incidence occurs in a source-receiver path that includes a strong reflection.

From Acoustics Week in Canada 2001/De l'acte semaine candienne d'acoustique 2001

Infill Development Noise Control Challenges (And Noise Modeling Limitations) - A Case Study Of A Development Adjacent Highway 401

C. Alan Mihalj, P. Eng.
Marshall Macklin Monaghan Limited, 80 Commerce Valley Drive East, Thornhill ON, L3T 7N4

1. INTRODUCTION

This paper deals with the development of a residential subdivision within lands that were formerly used as a hydro transmission corridor. A portion of these lands abuts Highway 401, a provincial freeway that ranks as one of the busiest highways in North America.

The former hydro corridor is located in an existing single family residential subdivision that was developed in the 1960's. Sound barriers were retrofitted along Highway 401 by the Ministry of Transportation in the late 1970's. These barriers are 3.0 metres in height east and west of the former hydro corridor, and provide outdoor noise abatement for the existing subdivision located adjacent Highway 401. The existing Highway 401 sound barrier steps down to 2.4 metres in height where it crosses the former hydro corridor.

The lands located between Highway 401 and Lowcrest Boulevard will consist of twelve two-storey dwelling units fronting on Lowcrest Boulevard, and a stormwater management pond, located between the rear yards and the Highway 401 right-of-way. A noise control study was required as a condition of approval. The objective of the noise control study was to recommend appropriate outdoor and indoor noise control measures for these lands.

2. INITIAL ANALYSIS

The Ministry of Transportation provided traffic information for this section of Highway 401. Existing SADT (Summer Average Daily Traffic) volumes are approximately 370,000 vehicles per day, while the 20 year projected volumes are estimated to be 570,000 vehicles per day (SADT). This reflects constant two percent growth in traffic over the next twenty years. Sound levels on the site were predicted using the Ministry of the Environment (MOE) "STAMSON" Computer Program for Road Traffic Noise Assessment.

The sound level analysis results indicated that the first row of single family lots located north of Highway 401, would require an 11 metre high sound barrier wall in order to achieve a daytime outdoor sound level (L_{eq}16h) of 60 dBA. This sound level is within a five decibel tolerance of the MOE objective of 55 dBA, and is considered acceptable by the City of Toronto. The sound barrier would be located adjacent the Highway 401 right-of-way and would include barrier returns along the east and west side of the site.

Although this height of sound barrier is feasible from a design perspective (but just barely), it would be very costly and would have extreme visual and aesthetic impacts on both the proposed dwellings and the existing adjacent dwellings. Furthermore, it cannot be considered a practical noise control solution, especially in light of 3.0 metre high sound barrier wall that protects the existing subdivision on either side of the site.

3. SOUND LEVEL MEASUREMENTS

Discussions were then held with staff from the City of Toronto Noise Unit regarding this issue. It was suggested that existing Highway 401 sound levels be monitored to determine the existing outdoor sound levels on the site, and to compare this with the existing sound levels predicted by the STAMSON computer noise modeling program. The sound level measurements were performed at a location that would correspond to the rear yard amenity area of one of the dwelling units.

The results of the sound level monitoring indicated that the 24 hour sound level in the future rear yard amenity area was 65.8 dBA. However, the STAMSON model predicted that the 24 hour sound level should be 70.8 dBA, which is 5.0 dB greater than measured. The modeled sound levels were based on existing Highway 401 traffic volumes and included the attenuation provided by the existing 2.4 metre high Highway 401 sound barrier. During the time of the sound level measurements, Highway 401 exhibited normal traffic conditions (ie. no major traffic incidents) and weather conditions were within acceptable parameters (eg. low winds and clear conditions).

At first glance, these findings seem surprising. Generally, sound levels predicted by the STAMSON model are within ± 2 dB of measured values. The author's experience is that in many cases the discrepancy is less than 1 dB, when comparing modeled to measured sound levels. However, observations of Highway 401 provide a likely reason for the discrepancy in measured and modeled sound levels. The STAMSON noise model is derived from the U.S. FHWA (Federal Highway Administration) STAMINA noise predic-

tion model. The STAMINA noise model was developed from numerous sound level measurements of vehicles travelling on highways. Reference emission sound levels were established based on traffic travelling at constant speed in cruise mode under free-flow conditions. The emission levels were referenced to posted speed limits.
Under free-flow traffic conditions on freeways, the average speed of traffic is generally 15 to 20 km/h faster than the posted speed limit. However, the section of Highway 401 that is located adjacent the development site, suffers from significant traffic congestion for extended periods of time. During morning and evening roadway peak periods, this section of highway exhibits stop and go conditions. Consequently, the average vehicle speeds are not as high as they would be under 24 hour free-flow conditions. The STAMSON model does not account for this, thus it will over-predict the sound levels.

Another possible contributing factor to the discrepancy might be the attenuation contribution of the roadside "Jersey" concrete safety barriers that separate the east and westbound core-collector lanes. These safety barriers are approximately one metre in height. Since the STAMSON model uses a blended source height, derived from the average of the passenger car, medium truck and heavy truck source heights, the blended Highway 401 traffic source height of 1.6 metres would be higher than the "Jersey" barrier. Therefore, the "Jersey" barrier would not provide any noise attenuation. In reality, the "Jersey" barriers could be expected to provide some attenuation of both passenger car and medium truck noise, since the source heights of these vehicle types are in the order of 0.5 metres.

4. FURTHER ANALYSIS

Further discussions were held with the City of Toronto Noise Unit staff. It was agreed that a sound barrier height of 4.0 metres would be considered a practical height limit, in light of the existing 3.0 metre high Highway 401 sound barriers on either side of this development.

The STAMSON noise analysis for the development was revised using the revised barrier height of 4.0 metres and applying the sound level measurement adjustment factor of -5.0 dB. The revised analysis indicated that the 4.0 metre high sound barrier would result in attenuated rear yard daytime sound levels (L_{eq}16h) of 63 to 64 dBA under Year 2021 SADT conditions. However, these sound levels are based on a continuing two percent per annum growth rate in Highway 401 traffic volumes over the next twenty years. Yet Highway 401 is today built to its ultimate configuration and operates at capacity for many hours of the day. Therefore, it is unlikely that such traffic growth can be realized over the next twenty years but if it did occur, traffic conditions would be extremely congested. This would result in vehicles travelling at speeds much lower than the posted 100 km/h speed limit. Consequently, the rear yard sound levels would be significantly lower than predicted by the STAMSON model.

Because of this, a second analysis was performed based on current traffic volumes, but with the inclusion of the 4.0 metre high Highway 401 sound barrier. The results of this analysis indicated that the attenuated rear yard daytime sound levels (L_{eq}16h) would be 61 to 62 dBA. These sound levels are still slightly in excess of the generally accepted tolerance value of 60 dBA for outdoor amenity areas, but this difference would not typically be discernible. Given the unique situation of this infill development in an existing mature residential neighbourhood and the practical considerations of barrier height, the 4.0 metre high sound barrier was recommended for this development to control Highway 401 noise. The recommended noise control measures were reviewed and approved by the City of Toronto.

5. CONCLUSIONS

Based upon the results of the sound level measurements and analysis, the recommended 4.0 metre high Highway 401 sound barrier can be considered an appropriate outdoor noise control measure for this development. It is similar in magnitude to the existing sound barriers on either side of the site yet will provide a better sound environment than exists for the adjacent existing dwellings. Furthermore, it will not be large enough to create unacceptable aesthetic and visual impact to the development residents, nor will it be impractical to implement. In light of all of the constraints to redeveloping this property, the recommended noise control measures represent the best compromise. Finally, this study shows that care must be taken when using STAMSON to model traffic noise when the road operates under congested traffic conditions for an extended period of the day.

6. REFERENCES

- "FHWA Highway Traffic Noise Prediction Model". U.S. Federal Highway Administration, Washington D.C., December 1978.

- "ORNAMENT – Ontario Road Noise Analysis Method for Environment and Transportation, Technical Document", Noise Assessment and Systems Support, Approvals Branch, Ministry of the Environment, October 1989.

ISO 1996 "Acoustics – Description And Measurement Of Environmental Noise" Round Robin Testing

William J. Gastmeier[1] and James L. Feilders[2]
1) Howe Gastmeier Chapnik Limited, 2000 Argentia Road, Plaza One, Suite 203, Mississauga, Ontario L5N 1P7
2) Jade Acoustics Inc., 545 North Rivermede Road, Suite 203, Concord, Ontario, L4K 4H1

1. INTRODUCTION

Interest in environmental noise has been steadily increasing over the last several decades in Canada. The availability of accurate and consistent assessment methods are valuable to society in many ways, from the design of residential developments with regard to noise from road, rail and air traffic to the need of industry to obtain approvals for the operation of quiet facilities. As economic growth continues, the trends in urbanization indicate a slowing of urban sprawl with a corresponding increase in intensification and mixed land uses with higher and higher densities. Issues of noise and vibration will thereby continue to grow and develop.

Over the past several years, the the CSA 107.53 Working Group of the Industrial Noise Subcommittee of the Canadian Standards Association has been actively involved in the endorsement of ISO 1996 Standard "Acoustics – Description and Measurement of Environmental Noise" in Canada. As stated in the standard, there is a very large range of different methods currently in use around the world for different types of noise, and this creates considerable difficulties for international comparison and understanding. The broad aim of the ISO 1996 series is to contribute to the international harmonization of methods of description, measurement and assessment of environmental noise from all sources.

The standard specifies methods to assess environmental noise and predict the potential annoyance response of a community to outdoor long term noise exposure. For this purpose it defines a rating level which is the result of applying some adjustment for sound quality to a measured or predicted sound level determined over a reference time interval. Prior to endorsing these methods for use in Canada, the working group decided to conduct round robin testing to determine if it could be applied consistently in the Canadian context.

2. METHODOLOGY

A series of high quality stereo digitized sound effects were audited by the committee and two were chosen for further study. Both the chosen samples, rifle shots and hammering, exhibited highly impulsive characteristics. Both samples were recorded along with a calibration tone onto audio CD's and were distributed to the group for assessment.

Each of the seven round robin participants was instructed to use the measurement equipment and techniques they would normally use in assessing environmental sound. These ranged from fairly simple sound level meters to sophisticated real time analysers. Typically, the line level output of the participant's CD player was fed directly into the analysis equipment via an electrical input, although in at least one instance the sound was reproduced acoustically through a high quality loudspeaker system and fed into the analyser via a microphone.

3. RESULTS

Results were measured and reported in two ways. Firstly in terms of the L_{LM} (Logarithmic Mean Impulse Sound Level) which is presently the accepted means of measuring frequent impulses in Canada. It requires the use of measurement devices equipped with the impulse time weighting feature.

Secondly, the measurements were reported in terms of the Case 1 Rating Level, determined over an hourly time interval from short samples. The rating level is the sum of the measured sound level of each event (SEL) adjusted upwards by 12 decibels (highly impulsive adjustment), adjusted to account for the reference time interval and adjusted for the level of background sound. The results are reported in the following table.

ISO 1996 Round Robin Test Results

#	Gunshots		Hammering	
	RL	L_{LM}	RL	L_{LM}
1	66.9	84.2	67.6	86.0
2	66.3	84.3	67.8	82.0
3	66.4	84.4	65.7	81.1
4	66.4	85	--	84 - 86*
5	67	84.6	67	84.6
6	66.3	84.4	66.2	82.9
7	63.7	82.2	67.1	84.5

* dBAI Max

4. CONCLUSIONS

The gunshot results show excellent consistency, with the possible exception of #7, which used an acoustical signal introducing an expected but unknown degree of uncertainty. The rating level results for hammering showed better consistency than the L_{LM} method which is presently in use. The slightly higher range may be due to the frequency of the impulses. They were so frequent that those participants using simple meters were unable to capture all events. The resolution of this issue may involve the use of a Case 2 rating level for frequent impulses.

The results were seen by the committee to suggest that sufficient consistency was possible among all parties, with suitable controls. A decision was made to extend the testing to use real industrial sounds recorded in an Ontario rail facility. A CD player calibrated at the NRC will be circulated with the test sound for use by all participants for both Case 1 and Case 2 rating levels. The results will be reviewed late this year and may be reported in a future issue of the journal.

5. REFERENCES

[1] ISO 1996-1 Acoustics – Description, assessment and measurement of environmental noise – Part 1: Basic quantities and assessment procedures.

[2] ISO 1996-2 Acoustics – Description, assessment and measurement of environmental noise – Part 2: Determination of environmental noise levels.

[3] ISO 1996-2 Acoustics – Description, assessment and measurement of environmental noise – Part 2: Determination of environmental noise levels. Amendment 1.

[4] ISO 1996-3 Acoustics – Description, assessment and measurement of environmental noise – Part 3: Application to Noise Limits.

From Acoustics Week in Canada 2001/De l'acte semaine candienne d'acoustique 2001

Noise Control For Dust Collectors On An Existing Industrial Plant Located Adjacent To A New Residential Development

Tom Paige[1] **and James L. Feilders**[2]
1) Kinetics Noise Control, Inc., Vibron Products Group, 1720 Meyerside Drive, Mississauga, Ontario L5T1A3
2) Jade Acoustics Inc., 545 North Rivermede Road, Suite 203, Concord, Ontario, L4K 4H1

INTRODUCTION

As part of an application for a $35 million residential development in Ontario, noise control for an adjacent existing manufacturer of hardwood flooring material is discussed. The industry produces sawdust created by planing, sawing and sanding. Sources of noise, located on the roof, include dust collection systems and exhaust fans for drying kilns. Noise control costs totalled $500,000 including consultants. The location plan is given in Figure 1.

RESPONSIBILITY ISSUES

The local municipality has the responsibility of implementing the noise control guidelines of the Ministry of the Environment (MOE) which require the developer to address noise from all external sources. He hires an acoustical consultant, specialty consultants as needed and a noise control contractor. The acoustical consultant conducts an environmental noise assessment and makes recommendations for noise control. If a stationary source is involved such as an industry, the consultant also prepares an application for a Certificate of Approval (C of A). The C of A is issued by the MOE. The acoustical consultant also reviews the contractor's shop drawings and conducts inspections and preliminary testing.

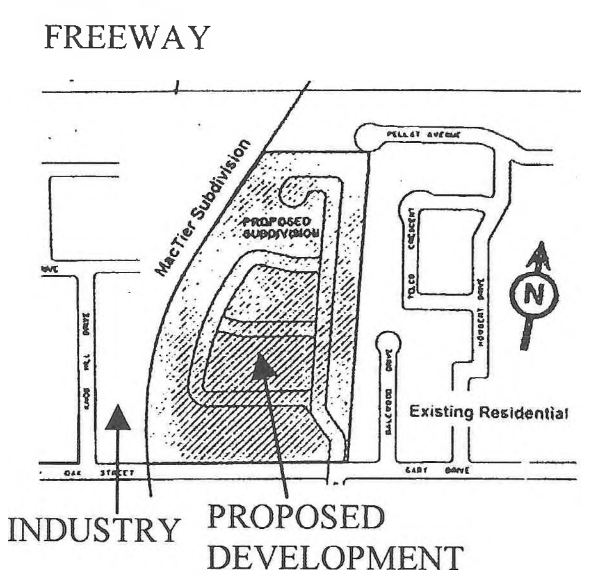


Figure 1 Location Plan

In this case, the specialty consultants include a structural engineer for upgrading of the building to take the weight of noise control measures and an air quality consultant to conduct air-flow measurements needed for the design of the noise control measures such as silencers. In addition, an acoustic specialist is used for lagging design and an independent acoustical engineer is hired to conduct the final acoustical audit required under the C of A.

The factory owner also hires an acoustical consultant to protect the industry's concerns.

The noise control contractor designs, fabricates and installs equipment based on the acoustical consultant's recommendations, calculates anticipated performance of equipment to ensure specifications are met and prepares shop drawing submittals for review prior to fabrication.

LEGAL PROCESS

The developer enters into a legal contract with industry in which the developer agrees to pay the cost of all noise control equipment. The developer posts a line-of-credit (LOC) to ensure completion and payment of costs. The noise control contractor signs a contract with the developer to provide noise control equipment. The scope of work is confirmed. The contractor receives payment as work progresses. Inspections and an acoustic audit are conducted after completion. Holdbacks are paid and the LOC is released.

ENVIRONMENTAL NOISE ASSESSMENT

The noise study identified all noise sources which included a railway line, a freeway, a local road and the industry

Acoustical analyses were then conducted including the prediction of freeway, road and rail noise, field measurements of rail vibration and field measurements of sources at the industry.

The results showed that the railway and freeway were in excess of the guidelines, the local road met the limit due to a large setback and that the industry was in excess of MOE stationary source limits.

The sound level limit for a stationary source such as the industry is the ambient or exclusion level. The measured ambient was 55 dBA daytime (no evening or night shift) while the measured industry level was 65 dBA. The excess

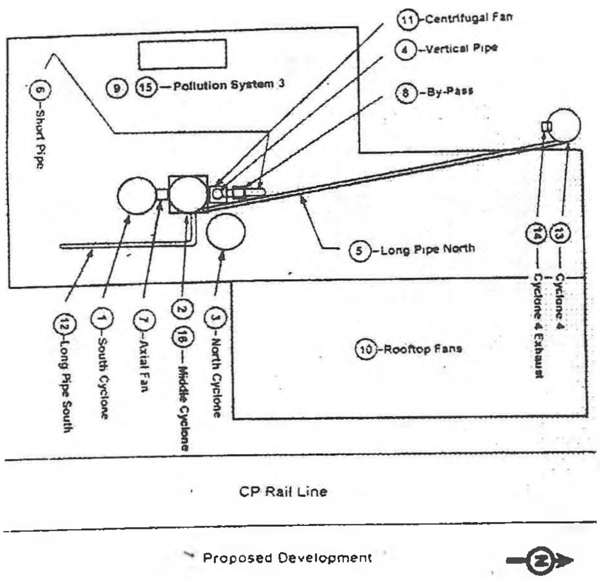


Figure 2 Source Locations

was 10 dBA. However, in case the industry decided to operate at night, measurements were taken and the nighttime level found to be 44 dBA under infrequent conditions (south wind). The MOE guidelines state that typical weather conditions are to be used, in this case, approximately 50 dBA. Consequently a design goal of 45 dBA was set which included an allowance for design and construction inaccuracies.

NOISE CONTROL MEASURES

The noise control measures for the railway and freeway were an acoustic barrier along the railway line, air-conditioning, warning clauses and appropriate house construction. Noise control measures for the industry included:

1. acoustic lagging for 4 dust-collector cyclones:
2. acoustic lagging for all related pipes and ducts
3. silencers on discharges of 3 dust collector fans
4. noise enclosures on 2 fans
5. "doghouse" noise enclosures on 13 roof-mounted exhaust fans for the kilns

Source	Distance (m)	Treatment	Leq With No Mitigation (dBA)	Leq With Mitigation (dBA)	Noise Reduction (dBA)
1 Cyclone 1	97	4" Ins. + 18 ga. Steel	49.8	28.1	22
2 Cyclone 2	97	4" Ins. + 18 ga. Steel	47.7	26.0	22
3 Cyclone 3	97	0.5" ins. + BMIC	50.2	27.7	22
4 Vertical pipe	97	1" Ins. + 18 ga. Steel	49.3	27.2	22
5 Long pipe North	97	1" Ins. + 18 ga. Steel	57.4	34.9	22
6 Short pipe	97	4" Ins. + 18 ga. Steel	48.5	28.6	20
7 Axial Fan	97	Silencer + enclosure	52.7	28.2	25
8 By-pass	97	Silencer	58.0	37.3	21
9 P.S. 3 Discharge	112	Silencer	50.5	27.0	24
10 Roof Exh. Fans	77	Enclosure	55.5	29.6	26
11 Centrifugal Fan	97	Enclosure	53.9	38.6	15
12 Long pipe South	97	1" Ins. + 18 ga. Steel	39.6	20.7	19
13 Cyclone 4 Body	97	4" Ins. + 18 ga. Steel	46.1	22.0	24
14 Cyclone 4 Ex.	97	No	15.7	15.7	0
15 P.S. 3 Casing	112	4" Ins. + 18 ga. Steel	46.2	32.3	14
16 Cyclone 2 Bot	97	4" Ins. + 18 ga. Steel	38.2	17.9	20
17 Cyclone 1 Bot	97	No	38.8	38.8	0
18 Cyclone 2 Top	97	No	31.8	31.8	0
19Cyclone 1 Top	97	No	24.1	24.1	0
Combined			64.2	45.1	19.1

Table 1 Summary of Predicted Sound Exposures

Source No.	63 HZ	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz
BARRIER SYSTEM/LAGGING/ENCLOSURE INSERTION LOSS (dB)								
1, 2, 6, 13, 15, 16	6	6	18	24	30	36	40	39
3, 4, 5, 12	3	3	8	19	24	35	30	25
10	8	11	22	38	50	40	16	16
11	6	12	18	24	30	36	40	39
SILENCER DYNAMIC INSERTION LOSS (dB)								
7, 9	8	11	22	38	50	40	16	16
8	8	16	22	38	50	40	16	16

Table 2 Minimum Acoustical Performance Requirements In dB.

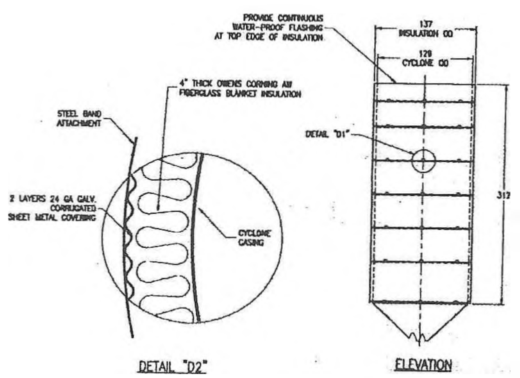
The source locations are shown on Figure 2.

NOISE CONTROL PERFORMANCE REQUIREMENTS

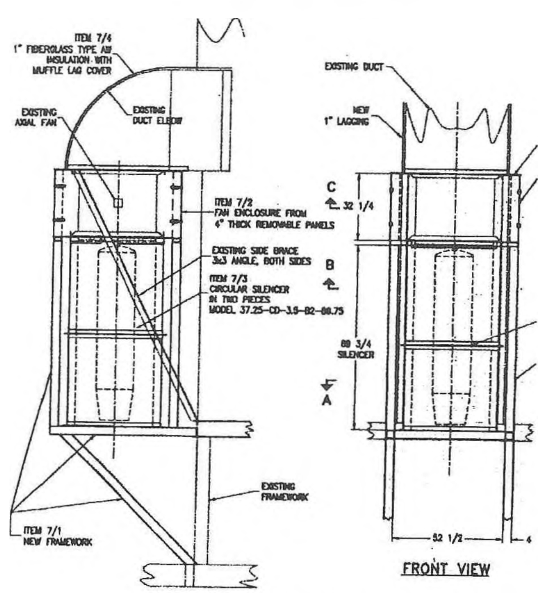
The sound levels at the receptor with and without noise control measures are given in Table 1. Table 2 presents the performance requirements for the control measures.

NOISE CONTROL DESIGN

Selected shop drawings are given below.



Cyclone Lagging Design

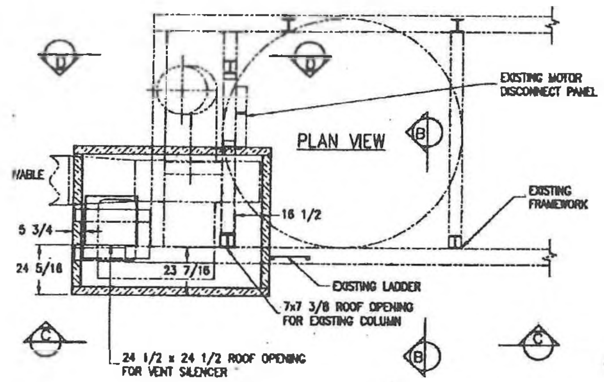


Silencer Design

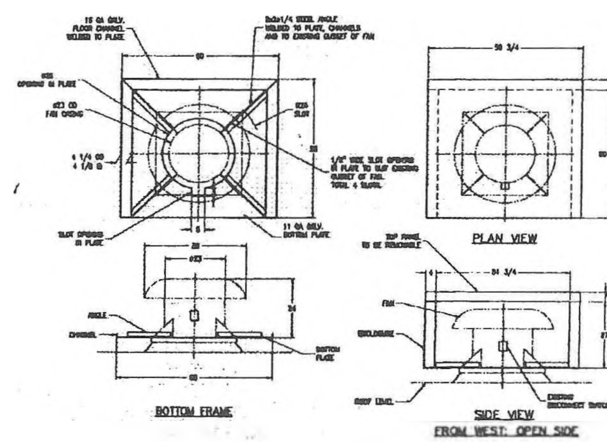
TESTING AND APPROVALS

In order to obtain approval of the subdivision, the noise report was submitted to the municipality and the noise control measures became part of subdivision agreement. The developer was required to pay for the industrial noise control.

To protect the industry, the C of A application was prepared



Fan Enclosure Design



Exhaust Fan Enclosure Design

by the developer's consultant and reviewed by the industry's consultant. The application was approved by MOE and the C of A issued, requiring an acoustic audit by an independent acoustical consultant.

The C of A audit was accepted with a measured nighttime ambient of 56 dBA and a source level of 55 dBA. The homes were occupied after completion of all noise control measures.

CONCLUSIONS

The development of residential lands adjacent to an existing industry is a complicated process requiring the cooperation of the industry. Several contractual agreements between the various parties are necessary in order to protect all involved. Having the developer pay for the industrial noise control potentially confuses the roles played by the consultants. The objective is to ensure that the industrial neighbour does not bother homeowners and that the industry can continue to operate with minimal constraints on the operation of their equipment.

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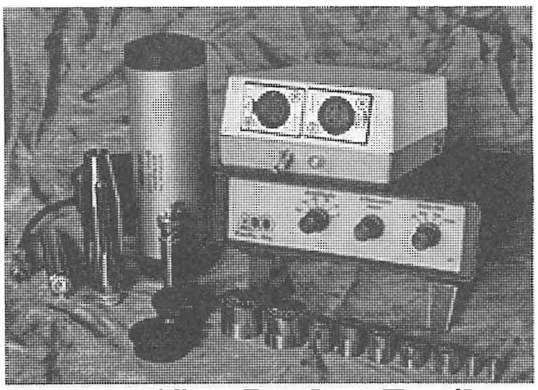

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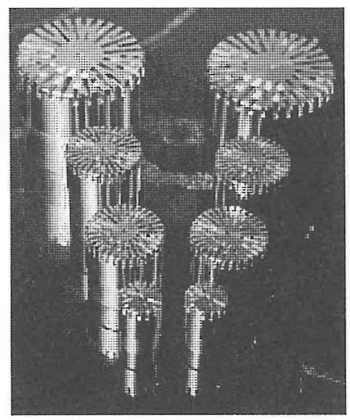

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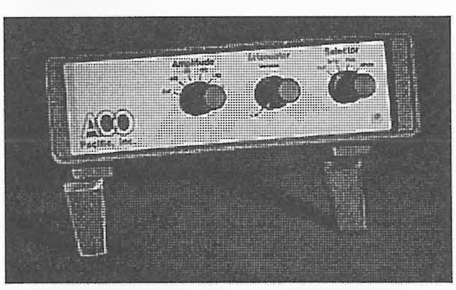

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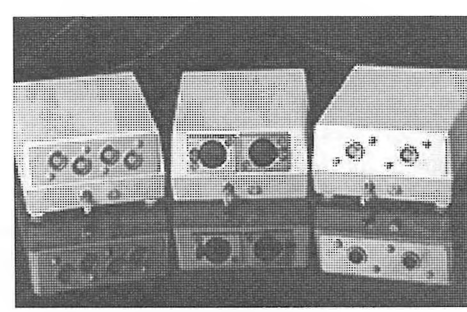

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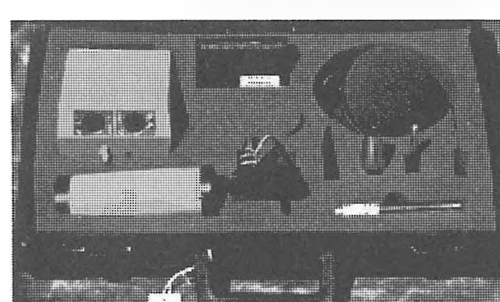

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A Comparison of Acoustic Effects of Two Stopper and Crown Systems in the Modern Flute

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Winner of the CAA Youth Science Foundation Award, 2001

ABSTRACT

A new stopper and crown system developed by flute maker Robert Bigio is reported to produce a louder, harmonically richer and faster response in the orchestra flute. Using spectral analysis software, the author compared the two systems (Standard and Bigio) in a test flute to find any significant differences in relative loudness and amplitude of recorded test note harmonics. A homemade impedance head mounted on the flute's embouchure plate was used to measure the pressure response of the flute sound wave produced in response to signal excitation (Schroeder chirp, 500 to 5000 Hz). Results showed that the Bigio unit was associated with stronger levels of amplitude and total power, higher amplitude in harmonics, and a slightly higher pressure response. The Bigio unit may be important for improving the timbre of the flute, but more work must be done to ensure that harmonic changes are more consistent, and to decide whether pressure differences make for an easier or harder blowing flute.

RÉSUMÉ

Plusieurs annoncent qu'un nouveau système de taquet et couronne dévéloppé par le fabricateur de flûtes, Robert Bigio produit un réponse plus fort, plus vite et des harmoniques plus prononcées dans la flûte d'orchestre. En utilisant des logiciels d'analyse spectrale, l'auteur avait comparé deux systèmes (Standard et Bigio) dans une flûte d'épreuve pour découvrir de différences en force relatif et l'amplitude harmonique de notes enregistrées. Un appareil de mesure d'impédance fait à la maison, installé sur la plaque d'embouchûre était utilisé pour mesuré la pression de

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CANADA WIDE SCIENCE FAIR

Report by Annabel Cohen

Jasmine Tait, a Grade 9 student from Ottawa won this year's acoustics prize at the Canada Wide Science Fair.

This project was conducted last year as an individual class assignment for the grade 8 science teacher, Mr. B. Hartnett of Greenbank Middle School, Ottawa. The research work was conducted at her home using funds awarded at the previous Ottawa regional Science Fair, 2000. At that event she won a first place in Junior Engineering for her work on optimum aperture size in pinhole photography. Jasmine Tait now attends the Grade 9 program at Sir Robert Borden High School in Ottawa.

Editor's Note: We are very happy to note that Ms. Tait submitted a brief summary of her project work that won the prize at the fair. Her full article is reproduced above.

Jasmine Tait- CWSF 2001
Recipient of the CAA Special Prize in Acoustics

la vague de son produit en réponse à le signal d'excitation (Schroeder chirp, 500 a 5000 Hz). Les résultats montrent que l'unité de Bigio était associé avec des niveaux plus forts d'amplitude et de puissance totale, et des niveaux plus haut d'amplitude harmonique et de réponse de pression. L'unité de Bigio peut être importante pour l'amélioration du timbre de la flûte, mais plus de travail doit être completé pour assurer que les changements en harmoniques sont logiques et pour décider si les différences en pression crée un flute qui est facile ou difficile à souffler.

BACKGROUND

British flute maker Robert Bigio has developed a stopper and crown (S/C) system to replace the traditional "cork" stopper-and-screw used in most flutes today (Fig.1). The stopper is cylindrical plastic (Delrin), 8 mm. long. The crown of Grenadilla wood has a hole drilled through its center. Both parts are held in place inside the flute headjoint with the pressure of O-rings. Bigio has eliminated the screw connecting stopper to crown, resulting in a longer cavity between the stopper and crown.

His innovation has been well-received internationally by flute players, some reporting a louder, richer, and faster response from their instruments. Much has been written about the importance of the stopper and crown as a tuning device, but there appears to be no published scientific studies which evaluate Bigio's invention, just discussion and speculation. Joseph S. Wisniewski, scientist and flute experimenter, has offered several interesting observations regarding the operation of the Bigio S/C: 1) The O-rings on the stopper act like a spring, sealing the tube but also allowing the stopper to vibrate under air pressure. Air in the tube between the stopper and crown also acts like a spring. The small hole drilled through the crown acts like an energy absorbing device or damper on the spring action of the stopper. 2) Changing the stopper and crown (to the Bigio S/C) would affect the partials more than the fundamental frequency of notes played. 3) The light mass of the Delrin stopper is comparable to the mass of the air column in the tube. Thus, if the mass of the stopper and the force of the springs are correctly adjusted, they could act like an extension of the flute.

PURPOSE

The purpose of the experiment was to find out whether there are observable acoustic differences in a standard test flute between the Bigio stopper and crown (Bigio S/C) and the Standard stopper and crown (Standard S/C) with respect to the following: 1) the relative loudness of the instrument over a wide range of test notes, 2) the relative amplitude of harmonics above the fundamental (affecting the timbre or "colour") for test notes, and 3) the pressure amplitude response of the flute headjoint when measured by a homemade impedance head with a piezodisk transducer.

HYPOTHESIS

1. The flute with the Bigio S/C will produce some notes with higher peak amplitudes and total power measures (dB) in frequency spectra than the Standard S/C. The greatest amplitude difference will occur in spectra of middle and higher frequency notes produced by the flute with the Bigio S/C.
2. The flute with the Bigio S/C will show some difference in the amplitude of harmonics in test notes.
3. There will be some observable difference between the two S/C units in the pressure amplitude response of the headjoint measured at the embouchure hole by my homemade impedance head .

PROCEDURE - MATERIALS

Sound Recording

A semi-professional flute (Gemeinhardt) with solid silver headjoint and B foot.

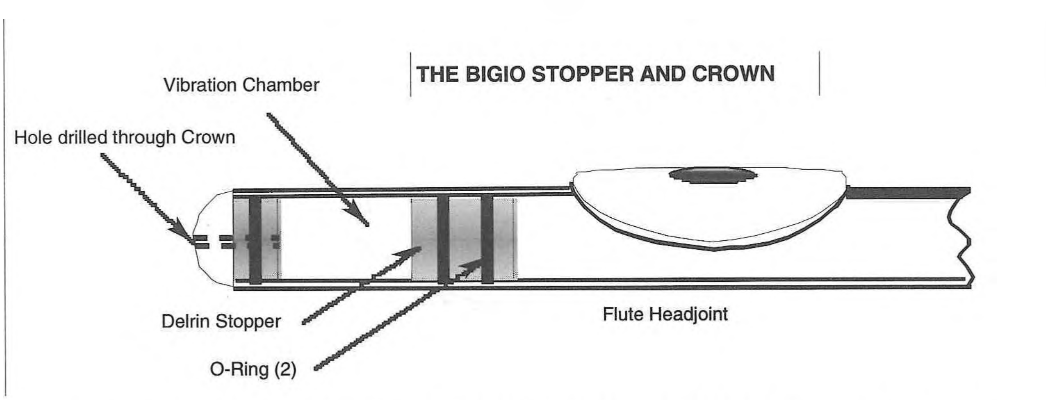

Figure 1. Diagram of a Flute Headjoint fitted with a Bigio Stopper and Crown.

An electret condenser microphone with flat response and wide frequency response 100-15000 Hz (Sony ECM - MS907) for computer recording of flute test notes.

A Pentium II computer fitted with SoundBlaster Awe 64 sound card for analogue-to-digital processing

A crown and stopper set made by Mr. Robert Bigio, flute maker, of London, England.

Impedance Measurement Head

Piezoelectric buzzer disk (Radio Shack buzzer 273-073).

A small electret, omnidirectional microphone with flat response, low impedance and wide frequency response (70 - 16000 Hz), (Optimus Tie Clip Microphone, # 33-3013).

13 mm. length of 3/4" cpvc plumbing pipe.

1/8" stereo mini plug for connecting the piezodisk to the computer sound card.

HANDI-TAK reusable adhesive used for sealing the impedance head to the lip plate.

Specifications for this impedance head came from a paper by physics professor P.L. Hoekje.

Fig. 2 shows my use of the head to measure pressure amplitude response of the flute to a test signal.

SOUND ANALYSIS SOFTWARE

1. **SpectraPlus,** version 2.32, FFT Spectral Analysis System, Sound Technology Inc., California, USA.
2. **G-Tune**, version 1.22. JHC Software, by James H. Clarke. www.jhc-software.com

PROCEDURE - METHOD

Sound Recording and Spectral Analysis of Test Notes

1. The position of each stopper in the headjoint was set at 17.3 mm from the center of the embouchure hole, and the tuning slide at 3 mm. These values are typical for many commercial flutes.
2. The assistant recorded a wide range of test notes (played by me) using SpectraPro software and saved individual samples as .WAV files on the hard drive.
3. The microphone was isolated from computer noise by a wall and pink foam insulation covering the doorway. The microphone distance from the flute player was kept at 1 m.
4. During recordings the assistant carefully tested the tuning accuracy of each note by referring to G-Tune software while I played. Test samples were accurate to within 3 cents of the note's fundamental frequency based on a scale of 440 Hz. I was told to replay notes out of tune. Microphone levels were maintained at a constant level using the Windows volume control. As the flute player, my eyes were blindfolded to prevent knowing which one of the stopper units was in use.
5. Measurements were made at a fairly consistent room temperature of 70-72 degrees F.
6. I. conducted a spectral analysis of each of the test notes using SpectraPlus software for both the Standard and Bigio S/C setups. Spectral analysis graphs were printed.
7. I entered measures of Peak Amplitude and Total Power for all test notes in a spreadsheet and represented these data in graphs.

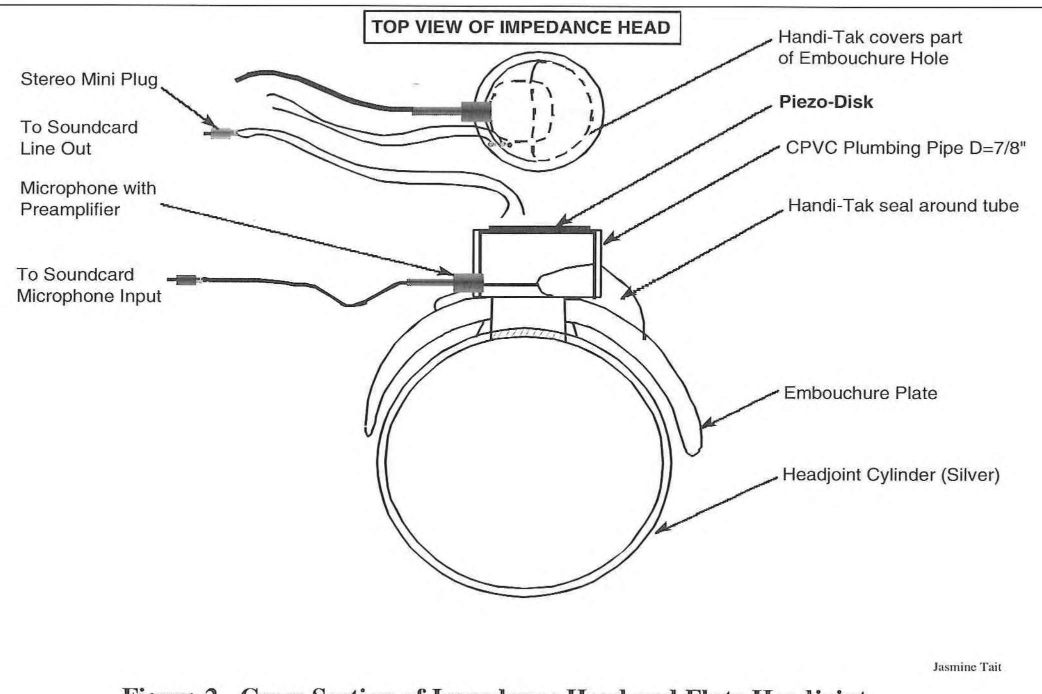

Figure 2. Cross Section of Impedance Head and Flute Headjoint.

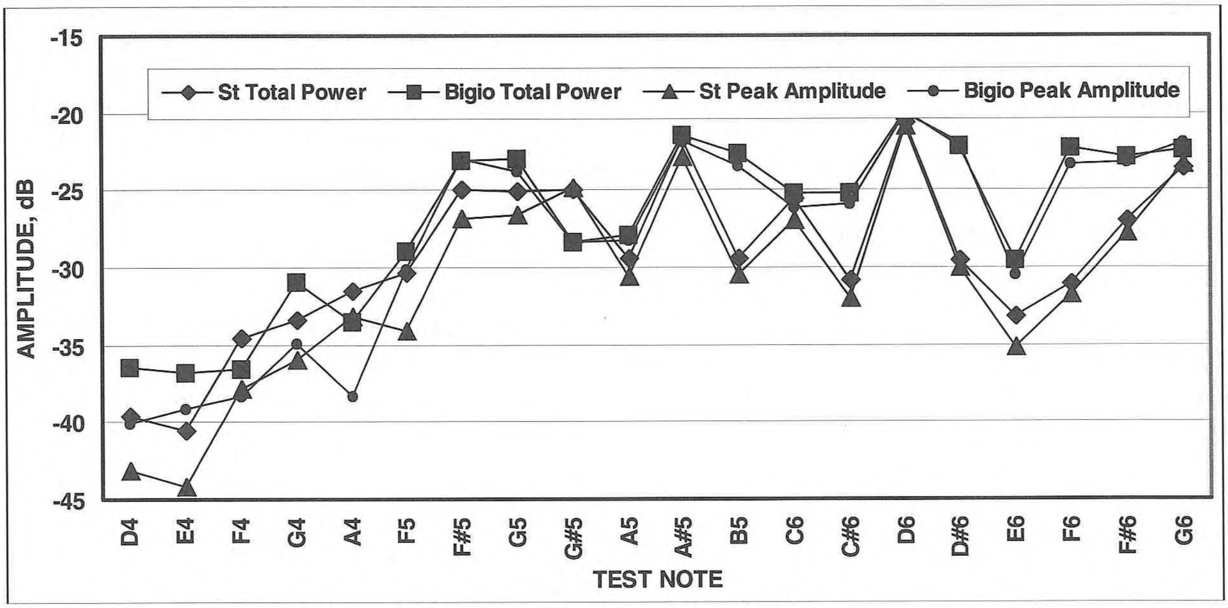

Figure 3. Total Power and Peak Amplitude by Test Note.

8. I made spectrograms of selected test note pairs to illustrate differences in the strength of frequencies over time as a colour spectrum.

Measuring Pressure Amplitude Response of the Headjoint

1. I made an impedance head to measure the pressure response of the flute sound wave coming from the embouchure opening in response to signal excitation.
2. I attached my impedance head to the lip plate using Hand-Tak re-useable adhesive and connected stereo mini plugs of piezodisk and microphone to the sound card "line out" and "mic. input", resp.
3. I attached the test headjoint to two adjustable PanaVises using Hand-Tak. The vises were isolated from vibration with sound-absorbing plastic feet.
4. I followed a simple software calibration procedure to compensate for the effects of sound card, piezodisk and microphone.
5. I loaded a Schroeder chirp test signal (500 to 5000 Hz) in SpectraPlus's signal generation utility and played it through the piezodisk for the two S/C setups.
6. I printed a spectral analysis graphs showing the headjoint pressure responses (dB) for both S/C setups. I looked for

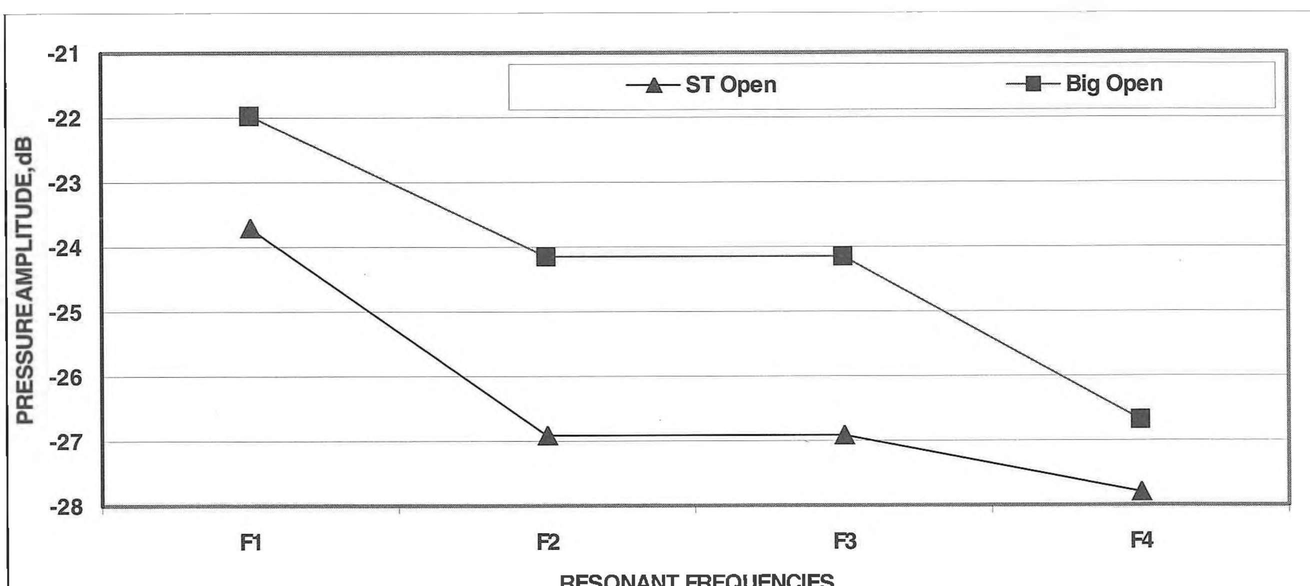

Figure 4. Impedance Measures of the Open Headjoint (Standard and Bigio S/C) for Minima Corresponding to the Headjoint's Resonant Frequencies.

any differences in the amplitude of frequency minima (4) in impedance spectra corresponding to resonant frequencies of the headjoint and I recorded their amplitudes in decibels.

RESULTS

FFT* Spectral Analysis of Recorded Notes

Total Power and Peak Amplitude

The Bigio S/C showed stronger levels of total power and peak amplitude (dB) in 17 of 20 test notes. Greatest differences occurred in frequencies for test notes above A#5 (Figure 3).

Harmonics Comparison

The Bigio S/C notes showed higher and stronger harmonics within middle and low octave notes.
Bigio notes showed highest harmonic amplitudes within low octave notes (D4, E4, F4, G4, A4 & F5).
Above F5, test note pairs showed fewer differences in harmonic amplitude (F#5, G5, G#5, A5. A#5, C6, C#6, & D6). Little significant difference was seen in the harmonic amplitude of upper octave notes above D6 (D#6, E6, F6, F#6, & G6).

FFT* Spectral Analysis of Pressure Response of Headjoint via Impedance Head

The headjoint with Bigio S/C setup showed slightly higher amplitudes at frequency minima in its pressure response to the test signal (Fig. 4). This difference was seen in tests of open and closed headjoints.

CONCLUSION

1. The Bigio S/C contributed to making a louder sound for most test notes. It was linked to stronger levels of amplitude and total power (dB).
2. In general, the Bigio unit was associated with higher harmonics within middle and lower octave notes. This may indicate that the Bigio S/C contributed to a richer flute sound than the Standard S/C in this frequency range.
3. As expected, there was a slight difference in pressure response between S/C setups as measured by the impedance head at the embouchure hole of the headjoint.

Importance: With further development and testing, the Bigio S/C could improve the performance of the flute by enhancing the colour of middle to lower octave notes, while boosting the volume of the instrument. However, work must be done to ensure that harmonic changes are more consistent throughout the flute's range of notes. I would like to see this type of stopper modified to become a digital sensor that could automatically vibrate in sympathy with the frequencies of each note. This could be applied to new digital flute technology. My research could be applicable to many other acoustical situations where damping systems help to minimize vibration caused by air flow past an opening, e.g. cargo doors and wheel wells of aircraft.

ACKNOWLEDGEMENTS

My father assisted me in sound recording of flute test notes while I played them.
Prof. Peter Hoekje, Dept. of Physics and Astronomy, Baldwin-Wallace College, Berea, Ohio gave information by telephone confirming the direction of my sound recording experiment and explaining what I would be measuring by mounting an impedance head on the flute's lip plate.

BIBLIOGRAPHY

Hansen, Uwe and Hoekje, P.L., "Air Column Resonance Demonstrations", Presented at Session 3aED, Education in Acoustics: *Demos 2000 of the 136th Meeting of the Acoustical Society of America.*

"Harmonic Advantage" (outline of J. Landell's research on his titanium flute design), http://www.chemsoc.org/chembytes/ezine/2000/kingston_feb00.htm

Ibisi, M.I. and Benade, A.H., "Impedance and impulse response measurements using low cost components," *J. Acoust. Soc. Am. Suppl.* 163, S63 (1982).

Ross, Glen, "Setting up the cork position," http://www.gwr.org/flutes/articles/cork.htm

Smith, J.R., Henrich, N., & Wolfe, J., School of Physics, University of New South Wales, Sydney Australia, "The Acoustic Impedance of the Boehm Flute: Standard and Some Non-Standard Fingerings," *Proc. Inst. Acoustics*, 19, 315-330 (1997).

Wolfe, J., Smith, J., Tann, J. and Fletcher, "Acoustic impedance of classical and modern flutes," *Journal of Sound and Vibration*, NH 2000.

Wisniewski, J.S., "The effect of the crown on flute tone," http://www.users,zetnet.co.uk/ross/flutes/articles/crown.htm

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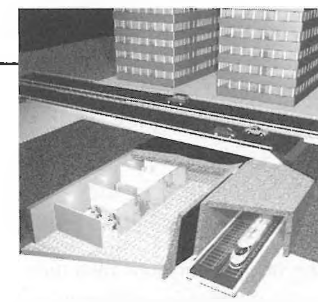

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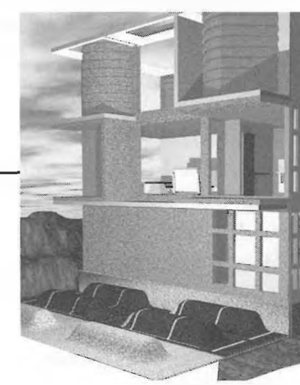

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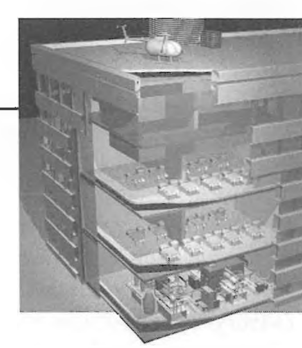

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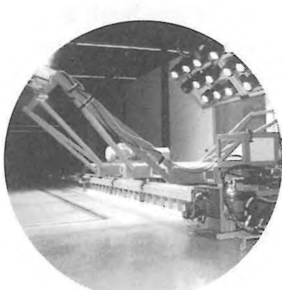

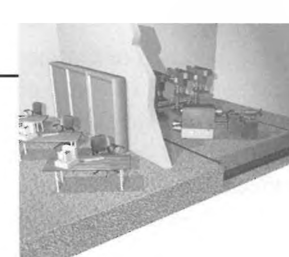

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Boundary Elements in Acoustics – Fundamentals and Computer Codes (Editor – T. W. Yu)
Published by WIT Press; 238 Pages; US$149.00
ISBN #1-85312-570-9, September 2000

The above book is a companion to the advanced Boundary Element Acoustics book reviewed by Dr. Layton Gilroy and included in this issue. My background is more rooted in FEM methods applied in sound propagation in lined ducts including baffles within the airway. However, I decided to review this book, since the book aims to describe the fundamentals of BEM for acoustics with a few elementary computer codes. Prof. T. W. Wu of the University of Kentucky has edited this book. Both Prof. Wu and Prof. Seybert have been acknowledged as the foremost experts in BEM and its application in acoustics. And hence, it is fitting that Prof. Wu was approached to edit the above book.

The book is broken into nine chapters and each of the chapters is written by different practitioners in the computational acoustics field from USA and Brazil.

Chapter 1, written by Prof. Seybert, is an introduction to linear acoustics. The material covered in this chapter is superfluous and is written as if it was an afterthought. Most of the readers would have a strong knowledge of this material. It has no flow and perhaps it would be better placed in an appendix with a complete glossary. In Section 2.6 of Chapter 1, transmission loss is defined as the main parameter used in the field to describe the performance of a silencer or a muffler. In reality, the most important parameter is insertion loss. Textbooks use transmission loss since it can be easily evaluated.

Chapter 2 introduces the fundamental Helmholtz equation that is usually solved. It also, in brief sub-sections, derives the integral equation for four areas where BEM acoustics are usually applied. The main drawback of this chapter is its brevity. For instance, it describes the CHIEF method without any details. The reader is expected to know all the relevant information about CHIEF (the acronym is not even spelled out). A lay reader would want more details presented in a book supposed to deal with fundamentals. Similarly, "Collocation" is merely mentioned without any explanation. A cursory reading of this chapter would imply that the readers have enough background understanding of fundamental acoustics and computational procedures for solving the basic wave equations posed for typical problems.

Chapters 3 and 4 present the discretization methods applied in BEM techniques for one-dimensional and two-dimensional problems and quickly lead the reader to the use of BEM for very simple text-book type problems. Perhaps, more complicated field problems should have been tackled to show the power of BEM in conjunction with the use of CHIEF.

Chapter 5 deals with the extension of BEM procedures to mixed boundary applications where the effect of thin boundaries and complex geometries like a muffler performance could be evaluated. This is one of the most interesting chapters, but the treatment is once again sketchy. Even the results of the BEM techniques are not discussed. For example, comparisons between experiment and BEM results for a muffler were presented in Figure 4. The frequency peaks between the two results are shifted and the book dismisses these shifts as minor. However, the shifts are not minor and the book does not provide any reasons for these shifts.

Chapter 6 presents the basic formulation of the indirect BEM (IBEM) which uses the jump condition across the given boundary for evaluating the acoustics of both the interior and exterior problems. After a cursory introduction to IBEM, highlighting the differences between IBEM and DBEM, detailed derivation of the basic equations are presented. The examples cited compare the results of IBEM with that of DBEM techniques. This chapter fails to point out the advantages of IBEM. Comparison of the example results with actual experimental data would have been more useful.

Chapters 7, 8 and 9 present the basic formulations to evaluate eigenfrequencies of cavities, time domain effects and the Kirchoff extension for the effects of motion on boundary sources respectively. Enormous efforts are expounded in presenting the mathematical formulations. However, only cursory treatment of the examples is provided.

Finally, I share the same reservations expressed by Dr. Gilroy in his review of the companion book. The book lacks basic flow between chapters, as it is a compilation of articles by varied researchers in BEM techniques. This book is supposed to be a set of introductory tutorial notes. One would have expected the book to provide a solid background to BEM, and its usefullness in solving actual field problems. There is a dearth of such information. The book does not highlight any comparative analysis with FEM, so as to be helpful to noise control engineers to make the correct choice between FEM and BEM methods. There is no consistency in the formatting of the book. The graphics – plots, figures, tables and sketches – could well use an editor's eye and red pen. One can only reach the conclusion that it takes more than a set of journal articles, tutorial notes, and seminar notes to create a book and hence the usefulness of this book is in doubt. The major (and perhaps the only) advantage of this book is the enclosed set of Fortran computer codes.

Ramani Ramakrishnan
Ryerson University, Department of Architectural Science
Tel: 416-979-5000, #6508
e-mail: rramakri@ryerson.ca

Boundary Elements in Acoustics – Advances and Applications (Editor – O. von Estorff)
WIT Press, 476 Pages, US$246.00, Sept. 2000
ISBN #1-85312-556-3

The text "Boundary Elements in Acoustics – Advances and Applications" is intended to present recent formulations and numerical methods for solving acoustic problems using the boundary element method (BEM). The text is an edited compilation of 14 chapters, each with different authors from industry and universities from all over the world. In general, the material covered is wide ranging with a fairly academic outlook. While it is obviously not intended strictly as a teaching text (there are no sample problem sections), many of the chapters contain quite extensive mathematics, which make it less suited to practising engineers. The text might well fit a niche as a graduate level text or a text for research scientists to explore new areas in acoustics with the BEM. Several of the chapters contain good guidelines on numerical formulations and possible areas of investigation for code development. Some of the chapters are quite informative, but as might be expected with a different author for each chapter, there is little flow from one to the next and a fair amount of repetition of the background material (how many times do we have to see the Helmholtz equation?). There is little disguising that these are individual contributions with only some care given to deleting repeated material. One might be better off searching out the individual chapters of interest as papers in the scientific literature rather than purchasing the book.

Overall, the general quality of the text is not as high as it could be, given modern typesetting capabilities. The fonts are only consistent over the majority of the chapters, not all, and the notation used is inconsistent from chapter to chapter. Of particular notice is the variation in quality and style of the figures throughout the text, which may be unavoidable given the disparate authors. Most striking is the use of greyscale versions of colour figures (usually fringe plots), which, along with the text descriptions, are rendered of little value by the conversion. Another source of annoyance was that, where numerical examples were used, there was often little discussion of the modelling of the problem and the methods used, only a presentation of the results, leaving one to wonder as to how difficult the results were to generate and how accurate they may be. One bright spot was that almost all chapters have quite extensive lists of references.

The book got off to a bad start in my view (as someone who has used both the FEM and BEM) by stating in the preface that reasons for the use of the BEM as an alternative to the FEM include its use in problems where "better accuracy was required" and that the discretisation effort is considerably reduced. I am not aware that one method is more accurate than the other and while the discretisation involved in the BEM is often easier, problem solutions are not necessarily any faster. It all depends on the problem to be solved.

The preface indicates the book is divided into 3 sections. The first outlines the governing equations and does essentially do this. The preface states the second and third sections deal with, respectively, special topics/advanced formulations and formulations for special problems. Given the subject matter of each chapter, this is a somewhat subtle distinction and there is no feel of transition from one section to another. Perhaps some sort of section title page would work.

The intent of chapter 1 was to describe the governing formulations of the BEM in acoustics. The chapter essentially starts immediately listing the required equations without explicitly stating the problem of interest. There are quite a few assumptions made in transiting between equations, which assume a fair amount of knowledge on the part of the reader. If the reader has this knowledge, what is the purpose of the chapter? As an example, in the development of the equation of state, the final equation shows up with an undefined c^2 term (of course, this is the sound speed), which may be deduced from the previous equation to be equal to dp/d? (evaluated at ? = $?_o$), but with no explanation of why this is so. In general, this was not the most useful introductory chapter. Chapter 2 was intended to discuss the numerical implementations and associated issues for the BEM in acoustics. Based on the extensive math involved in describing the various implementation issues (numerical integration and solution methodologies), this chapter was obviously not at the introductory level. That said, the chapter did do a fairly good job of describing how to implement BE methods, solution methodologies, and how to establish CPU costs for the analyses.

The second section of the text starts with the relatively brief third chapter that simply discusses methods for determining eigenvalues of acoustic spaces and removing some of the frequency dependence of the acoustic matrices. Chapter 4 discusses time dependent BE formulations and focuses quite heavily on the mathematics of the methods. Chapter 5, which deals with a hybrid BE method (in both the frequency and time domain), is also focussed quite heavily on the mathematics. This hybrid method yields symmetric matrices, which allows for faster solution techniques, and the proposed methodology seems to show some promise for large numbers of field points when combined with the usual BEM. The authors also extensively outline their Object Oriented Programming (OOP) approach to the numerical solution of the method and the level of detail in describing the basics of OOP seems somewhat out of place in a text devoted to the BEM. Chapter 6 involves descriptions of iterative solvers and multigrid methods for problems in the frequency domain. While the notation used is inconsistent with that used in earlier parts of the book, in general, the chapter gives a good discussion of the difficulties with the various techniques and possible solutions. Source simulation techniques are quite well described in chapter 7 with some very informative examples illustrating situations where these techniques seem to be advantageous. Chapter 8, which discusses inverting the BEM to reconstruct source strength distribution, was well written and informative and also gave good indications of the applicability and the limitations of these methods. Both examples (the speaker enclosure and the tire) were clearly described including the relationship between the numerical and experimental results.

In the last section, the text focussed on formulations for particular applications of the BE method, although with the numerous examples in the previous two chapters, the transition was not as obvious as was perhaps intended, particularly since most of these chapters involved the development of new formulations as well. Chapter 9 focuses on thin barriers and develops slender body theory. The authors also discuss optimization of this particular type of problem by reducing the matrix assembly time by using similar elements to generate the data for a particular element rather than recalculating the required integrals. Chapter 10 is titled "Numerical modelling of acoustic transparency" and is apparently intended to examine sound transmission through a panel; however, the intended application is not clearly presented at the start of the chapter. The chapter deals with thin structures in contact with a two-sided infinite baffle, which to my eye is of limited applicability, but the chapter does contain a fairly good discussion on incorporating damping layers in a structural-acoustic system. The focus of chapter 11 is on electro-acoustic transducers and the authors spend considerable effort in discussing FE methodologies and various FE element types for dealing with electrostrictive and magnetostrictive materials in fluid-structure interaction applications. Typically the authors then say that BE methods are available for such systems. One questions why so much effort was devoted to these questions in a BE text and so little to the development of the BE methodology. It is not apparent that BE methods were used in any of the examples cited and, in the examples used, the original colour figures have been reproduced in black and white making them of little value.

Chapter 12 deals with the application of the BEM and FEM to musical instruments. The chapter contains two well-worked examples (a guitar and a timpani) and the related discussion results in a good outline of the BE methodology and the comparisons to experimental data. Unfortunately, there is yet another review of the basic background to the BE method which should be replaced by a simple reference to an earlier chapter. The application of BE and coupled BE/FE methods to underwater acoustics are discussed in chapter 13. The chapter lacks continuity, but contains some good examples concerning scattering and underwater radiated noise. The quality of these examples is somewhat marred by the lack of colour in several of the figures which were obviously originally in colour. In particular, the numerous fringe plots are of limited use in greyscale. Finally chapter 14 was intended to focus on industrial applications and to examine the way ahead for the BE method. While the applications were clearly discussed, it is not clear that the material was not already covered in some of the other chapters, although this does result in the chapter functioning as something of a conclusion chapter. Again the quality of the images was very poor (and Figures 13 and 14 are reversed) and the section dealing with future developments and the way ahead was far too brief to be of much interest.

In my opinion, this text would most likely be useful as a graduate level text or as a guide for researchers in acoustics interested in using the BEM to explore their field, but who are unsure of the appropriate way ahead or searching for the best implementation of the BEM. For the latter group, they may be better off attempting to locate this information in the literature, as the text, while certainly containing a wealth of information, may be too broad in its coverage to justify the purchase price.

Layton Gilroy
DREA, Dartmouth, NS
e-mail: layton.gilroy@drea.dnd.ca

Room Acoustics (fourth edition)
by Heinrich Kuttruff
Published by Spon Press, 2000.
346 Pages; 95.00 Britsh Pounds
ISBN # 0-419-24580-4

For those not familiar with earlier editions of this book dating back to 1973, I should first point out that it is generally accepted as the standard reference text on the fundamentals of room acoustics and a new edition is therefore most welcome. It is certainly very impressive that one person can put together such a comprehensive text. I am not aware of an equivalent book and certainly not with a brand new edition. If you want a comprehensive introduction to the fundamentals of room acoustics, this is the book to read.

The book is intended to explain fundamental issues, and does not take a practical design guide approach. Many of the chapters are quite mathematical but never more than necessary and there is almost always a good explanation of the physical significance of each mathematical result. The reader will usually be able to grasp the various concepts without following related equations in detail.

There are a total of ten chapters. After the introduction the initial chapters cover: reflection and scattering, wave theory, and geometrical acoustics. Chapter 5 discusses reverberation and steady state energy density, followed by a chapter on sound absorption and sound absorbers. The chapters on subjective effects and measurement techniques include new material reflecting how these subjects have developed in recent years. Chapter 9 on design procedures again looks at the fundamental issues rather than to attempt to tell the reader how to design particular types of rooms. Finally, chapter 10 discusses sound reinforcement systems in rooms as well as electroacoustic reverberation enhancement.

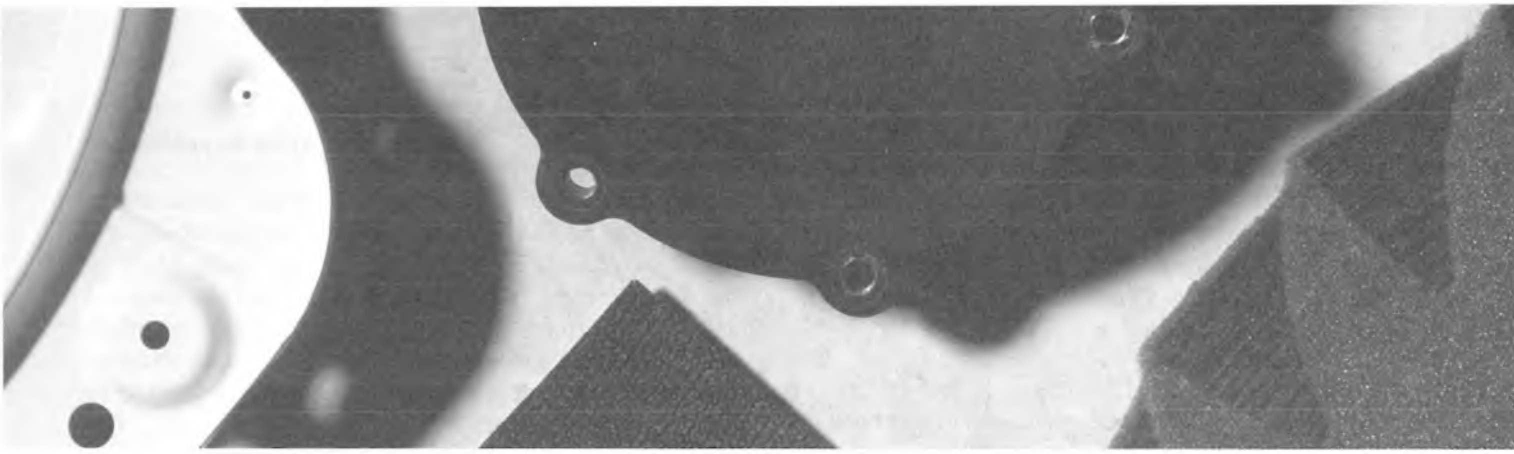
Although Professor Kuttruff is now retired, he has been for many years a key figure in German room acoustics research at the Technische Hochschule in Aachen. As a result, there is a certain German bias to this text, which is mostly a considerable advantage to English speaking readers. "Room Acoustics" includes an excellent and concise overview of much German room acoustics research that has often only been available in German. However, this bias sometimes seems to exclude work from other countries. The most obvious example is the lack of reference to Barron's Revised Theory that is now established as a more accurate means of estimating sound levels in rooms such as concert halls and auditoria.

It is, of course, difficult to include all of the latest developments in a 349-page book intended to present the basic principles. For example, although the use of Maximum Length Sequence signals to obtain impulse response measurements is now included, the alternative of using sine sweep signals, which has recently come back into favour, is not. Much of the uncertainty in current techniques to estimate audience and seat absorption and the complexity of this important topic tend to be glossed over. The discussion of electroacoustic enhancement systems is a difficult one to keep up to date because it is in a state of ongoing development. The book now includes mention of the more recent ACS system but for some reason presents this before mention of the older feedback based systems of Franssen and Parkin.

The style is certainly formal, but the translation is very good and there are very few phrases that might indicate the book is a translation. I did notice a few typographical errors but never serious enough to cause any real confusion. This fourth edition has, as might be expected, produced a polished work in a high quality printing.

You will not learn of all of the latest developments, but if you want a good grounding in the basic fundamentals of the subject of room acoustics, you would certainly benefit from this book.

John Bradley
Institute for Research in Construction
NRC, Ottawa
Tel: 613-993-9467
e-mail: john.bradley@nrc.ca



LOW FREQUENCY ACTIVE SONAR IN CANADA

James A. Theriault and David M. F. Chapman
Defence Research and Development Canada
Defence Research Establishment Atlantic, P.O. Box 1012, Dartmouth, N.S., B2Y 3Z7
theriault@drea.dnd.ca

Introduction

Recent news reports on the testing and proposed operation of low frequency active (LFA) sonar and the potential harm to marine life have focused on the activities of the US Navy and NATO. What is Canada's role in the research and development of LFA sonar systems, and what is being done in Canada to ensure that our activities are environmentally responsible? In this article, the authors will answer these and other questions. We will review the requirement for LFA sonar, introduce the TIAPS project, describe related aspects of the Canadian LFA R&D effort, and outline our man-agement of the associated environmental risk.

Does the Canadian Navy use low frequency active sonar?

At this time, the Canadian Navy does not have an operational LFA sonar, nor is it testing one; however, Defence Research and Development Canada (DRDC), which is the R&D Agency within the Department of National Defence, is running a project to investigate and demonstrate this technology. This project is called TIAPS: Towed Integrated Active-Passive Sonar. The TIAPS information will be available to the Canadian Navy to guide them in future sonar acquisitions.

Why are submarines considered a threat?

For all navies, it is important to be able to operate covertly, whether the vessels are on the surface or below the surface. Submarines are considered to be especially valuable, owing to the difficulty of detecting their presence. (Spy satellites and radar have difficulty seeing into the ocean!) During the Cold War, navies were most interested in stalking the missile-carrying submarines, often nuclear-powered, belong-ing to the other navies. With the thawing of the Cold War, the nuclear-powered submarine threat appears to have decreased, and there is now reduced emphasis on tracking submarines throughout the world's oceans. However, according to *Jane's Fighting Ships* [103rd Edition, Jane's Information Group, Alexandria, Virginia], the navies of 46 countries—large and small—still operate more than 600 diesel-electric attack submarines, each of which poses a potential threat to both commercial and naval ships. There is a risk that hostilities might break out threatening regional peace almost anywhere in the world at almost any time. The requirement to find submarines, although decreased, has not been eliminated.

TIAPS will be demonstrated from the research vessel CFAV QUEST.

Why do navies need to continually improve their sonars?

Anti-submarine warfare is a cat-and-mouse game. As the cats get better at finding and catching mice, the mice develop new ways to elude the cats. Although quiet, a nuclear-powered submarine—with its power plant running constantly—is noisier than a modern diesel-electric submarine, which can run quietly on batteries or even sit virtually silent on a shallow seabed for a time. It is possible to gain information about submarines by listening underwater without making noise oneself. This is "passive" sonar. However, to localize a submarine well enough to attack usually calls for an "active" sonar that pings and listens for echos. As sonar engineers improve passive and active sonar to find submarines, the submarine builders find ways to make their boats more quiet and to equip them with improved echo-reducing measures.

Why do navies need low frequency active sonar?

As the submarine interest shifts from the nuclear boats to the inherently quieter diesel-electric boats, the cat-and-mouse game of undersea warfare changes, to the advantage of the mice. The smaller diesel-electric boats are quieter, and they harder to find with passive sonars and conventional active sonars. The cats are countering through the development of Low Frequency Active (LFA) Sonar. LFA sonar works the same as other active sonars, but at much lower frequencies. Low frequencies are absorbed less rapidly, and it is much more difficult for a submarine to reduce its echo strength at low frequencies. These improvements extend the range of active sonar, overcoming some of the limitations of passive sonar in trying to detect the quieter submarines. Improved submarine-launched weapons (torpedoes and missiles) also increase the desire to deal with submarines at greater distance.

How "low" in frequency is LFA sonar?

The term "low" as applied to active sonars applies to a wide range of frequencies, as there are several LFA sonar concepts, depending on the application. Conventional active sonars operate in the range 3,000–30,000 Hertz (that is, cycles per second). Compared with the piano keyboard, these notes are at the top right hand end, and beyond. Though there is no universal definition, "low" frequency active sonars, depending on the maker, operate anywhere below 3,000 Hertz. The LFA "notes" are around the middle of the piano keyboard and to the left. The lower the frequency, the larger the sound sources and electronics racks need to be. The lowest-frequency, largest, and most powerful LFA sonars are those proposed for ocean basin surveillance; these generally require purpose-built ships, probably only affordable by the world's major sea powers.

What is unique about the Canadian LFA sonar?

In the near term, an LFA sonar must fit on existing ships. Moreover, the "stealth" of a warship is viewed as one of its best defences. "Pinging" an active sonar immediately broadcasts its presence, so LFA sonars will probably be used only when absolutely necessary. In this sense, DRDC's LFA concept is a *tactical* sonar with a detection range better than the current active sonars, but much less than the very long detection ranges of the LFA systems being considered for ocean *surveillance*.

What is TIAPS?

A combined active-passive sonar retains the advantages of passive sonar while also offering an option to "go active" when needed. DRDC is investigating this technology under the TIAPS (Towed Integrated Active-Passive Sonar) Project. Components of TIAPS are undergoing sea trials lasting 4–5 weeks at roughly six-month intervals. The complete system will undergo trials in about 2003 and the project will probably conclude in about 2004. All sea trials will be performed from DREA's research vessel CFAV QUEST (see photo).

What are the characteristics of the LFA sound source used in TIAPS?

The output level of the TIAPS LFA source does not exceed that of the hull-mounted active sonars already in use. The centre frequency is variable–usually about two octaves above middle C. Typical sonar pulses include a "pure" tone of constant pitch, and a "swept" tone that rises or falls over a narrow range of frequencies. The source is towed behind the ship, at variable depth depending upon water conditions and water depth

Is the TIAPS LFA source a hazard to marine life?

There has been much media attention on the potential harm of sonars on marine life, such as whales. Much of the recent concern focussed on US Navy's Low Frequency Active research sonar and the sound sources used for the Acoustic Tomography of the OCeans (ATOC) project. The precise manner in which sounds (loud or soft) can lead to harm in marine mammals is not fully known, although it stands to reason that placing a very loud sound source too close to the ear of any animal could be injurious. The zone for potential physical damage to the ears and other tissues lies close to the source; the louder the source, the greater the danger zone. At lower sound levels, sound may not physically damage a creature, but could yet startle the animal or mask its sonic communications. Mindful of the potential harm to marine mammals, DRDC is conducting the TIAPS project with due diligence to the requirements of the Canadian Environmental Assessment Act.

How do the TIAPS investigators manage the environmental risk?

Our approach to managing environmental risk of LFA sonar involves learning about the issues, preparing experimental procedures to minimize effects, and ensuring that the procedures are followed during trials.

In the planning stage, trial sites are chosen to minimize probable contact with marine mammals. In cases where our research ship must transit through an area with known environmental sensitivity, acoustic transmis-sions are forbidden.

We maintain visual watches and keep a log of marine mammal sightings.

Where possible, we maintain an acoustic "watch" using our own underwater listening devices. This acoustic "watch" also allows us to detect other sudden loud natural noise sources such as underwater volcanoes, earthquakes and even icebergs.

We do not commence experiments if marine mammals are detected.

When we begin experiments, we gradually increase the sonar output level over 30 minutes providing the opportunity for all mammals to leave the locality before full-strength tests commence.
By consulting with the principal investigators involved in all tests, the required sonar output level is independently determined for each requirement: if a test cam be performed at less than full output level, we reduce the level to the minimum required.

If we detect marine mammals entering the area, we cease transmission.

In trying to better understand marine mammal sensitivities, DRDC scientists collaborate with university, government, and private research units in the United States, England, Italy, and Australia. DRDC scientists are assisting with some aspects of research on better acoustic detection and tracking of marine mammals.

Conclusion

Submarines remain a potential threat to the navies of the world, and so far, sonar is the best available countermeasure. Defence R&D Canada is conducting an R&D project to investigate a promising new concept in active-passive sonar, including a tactical low frequency active capability. DRDC is mindful that the use of sonar could potentially harm underwater life, and is aware of the public concern over this. In fulfilling its responsibility to the Navy, DRDC recognizes its dual duty to minimize environmental impact, and to practice due diligence.

Acknowledgement

The authors thank Harold M. Merklinger for his helpful comments on the manuscript.

The Authors

James Theriault and David Chapman are both Defence Scientists at the Defence Research Establishment Atlantic, in Dartmouth, Nova Scotia. James studied Applied Mathematics at Dalhousie University (M.Sc. 1985), David studied Physics at the University of British Columbia (M.Sc. 1977), and they both have published extensively on the theory, experimentation, and modelling of underwater acoustic phenomena. Currently, They are Project Analyst and Project Manager, respectively, of the TIAPS Project.

SONAR ACTIF À BASSE FRÉQUENCE AU CANADA

James A. Theriault et David M.F. Chapman
Centre de recherches pour la défense Atlantique
Recherche et développement pour la défense Canada
theriault@drea.dnd.ca, chapman@drea.dnd.ca

Les nouvelles récentes sur d'une part les essais et la proposition d'utilisation du sonar actif à basse fréquence (LFA) et d'autre part les dommages que peut subir la vie marine se sont focalisées sur les activités de la Marine des É.U. et de l'OTAN. Quel rôle le Canada joue-t-il dans la recherche et le développement de systèmes sonars LFA et qu'est-ce qu'on fait au Canada pour veiller à ce que nos activités soient respectueuses de l'environnement? Le présent article répond à ces questions et à d'autres encore. Nous examinerons la nécessité du sonar LFA, décrirons les aspects correspondants des travaux de R & D effectués par le Canada concernant le LFA et exposerons la façon dont nous gérons les risques que le système présente pour l'environnement.

La marine canadienne utilise-t-elle le sonar actif à basse fréquence?

Pour le moment, la Marine canadienne n'a pas à sa disposition un sonar LFA qui soit opérationnel, ou sous essai. Toutefois, Recherche et développement pour la défense Canada (RDDC), l'agence de recherche et de développement (R & D) au sein du ministère de la Défense nationale, poursuit un projet visant à examiner et à démontrer cette technologie. Des composants de ce système font l'objet d'essais en mer qui durent de quatre à cinq semaines et se répètent à des intervalles de plus ou moins six mois. Le système complet sera essayé aux environs de 2003 et le projet prendra probablement fin en 2004. La Marine canadienne a besoin des renseignements obtenus de ces essais pour orienter leur acquisition de sonars.

Pourquoi les sous-marins sont-ils considérés comme une menace?

Il est important pour toutes les marines d'être capables de manœuvrer secrètement, que les vaisseaux soient en surface ou en plongée. On considère les sous-marins comme étant particulièrement précieux parce qu'il est difficile de détecter leur présence. (Les satellites espions et les radars ont de la difficulté à regarder dans l'océan!). Pendant la guerre froide, l'objectif principal des marines était de traquer les sous-marins porte-missile, souvent à propulsion nucléaire et appartenant aux autres marines. La guerre froide s'étant dégelée, la menace des sous-marins à propulsion nucléaire semble avoir diminué, et on s'intéresse moins maintenant à traquer des sous-marins dans les océans du monde. Toutefois, d'après *Jane's Fighting Ships*, [Janes's Information Group, Alexandria, Virginia, 103e édition], les marines de 46 pays – petits et grands – exploitent encore plus 600 sous-marins d'attaque à propulsion diesel-électrique, dont chacun représente une menace potentielle pour les navires commerciaux et les navires de guerre. On risque que des hostilités s'engagent, menaçant la paix régionale presque partout dans le monde et à presque n'importe quel moment. Il est donc toujours nécessaire de repérer des sous-marins bien qu'à un degré amoindri.

Pourquoi les marines ont-elles besoin d'améliorer continuellement leurs sonars?

La guerre anti-sous-marine, c'est un jeu du chat et de la souris. À mesure que le chat devient plus capable de repérer et d'attraper la souris, celle-ci trouve de nouveaux moyens d'échapper à son ennemi. Un sous-marin à propulsion nucléaire est silencieux, mais avec son moteur fonctionnant sans arrêt, il est plus bruyant qu'un sous-marin diesel-électrique moderne. Ce dernier, alimenté par des piles, peut fonctionner silencieusement ou même se poser pratiquement sur un fond océanique peu profond pendant un moment sans faire de bruit. Il est possible de recueillir des informations sur les sous-marins en écoutant sous l'eau en silence. C'est ce qu'on appelle sonar « passif ». Toutefois, repérer un sous-marin suffisamment bien pour l'attaquer, nécessite un sonar « actif » qui émet des signaux et écoute des échos. Mais, à mesure que les ingénieurs perfectionnent les sonars passifs et actifs pour détecter les sous-marins, les constructeurs de sous-marins trouvent des moyens de rendre leurs navires plus silencieux et de les équiper de systèmes qui réduisent les échos.

Pourquoi les marines ont-elles besoin de sonars actifs à basse fréquence?

Comme on s'intéresse davantage aux sous-marins diesel-électrique naturellement silencieux au détriment de ceux à propulsion nucléaire, le jeu du chat et de la souris de la guerre sous-marine change, au profit de la souris. Les sous-marins diesel-électrique, plus petits, sont moins bruyants et ils sont plus difficiles à détecter avec les sonars passifs et les sonars actifs conventionnels. Les chats répliquent en mettant au point des sonars actifs à basse fréquence (LFA). Ces derniers fonctionnent de la même manière que les autres sonars actifs, mais à des fréquences plus basses. Les basses fréquences sont absorbées moins rapidement, et il est beaucoup plus difficile à un sous-marin de réduire l'intensité de son écho à des fréquences basses. Ces améliorations étendent la portée des sonars actifs, qui dépassant les limites des sonars passifs essayant de détecter les sous-marins très silencieux. D'autre part, l'amélioration des armes lancées par sous-marin (torpilles et missiles) stimule le désir de s'occuper des sous-marins d'une plus grande distance.

Quelle est la valeur de la « basse » fréquence des sonars LFA?

Quand on parle de sonars actifs, le terme « basse » frequence s'applique à une vaste gamme de fréquences, étant donné qu'il existe plusieurs concepts de sonar LFA selon l'application. Les sonars actifs conventionnels fonctionnent à une gamme allant de 3 000 à 30 000 Hz (ou cycles par seconde). Si l'on compare au clavier d'un piano, on se référera aux notes qui se trouvent à l'extrême droite et au-delà. Bien qu'il n'y ait pas de définition universelle pour les sonars actifs à « basse » fréquence, ceux-ci fonctionnent à une fréquence quelconque au-dessous de 3 000 Hz, selon le fabricant. Les « notes » des LFA se situent autour du milieu du clavier du piano et vers la gauche. Plus la fréquence est basse, plus les sources sonores et les baies de matériel électronique doivent être grandes. Les sonars LFA à la plus basse fréquence, les plus grands et les plus puissants, sont ceux qu'on propose pour la surveillance des bassins océaniques. Ces sonars exigent généralement des navires spécialement conçus que probablement seules les grandes puissances maritimes peuvent se permettre.

Qu'est-ce qui est unique dans les sonars LFA?

Dans l'immédiat, un sonar LFA doit convenir aux navires existants. En outre, la « furtivité » d'un navire de guerre est considérée comme sa meilleure défense. Suivant la transmission d'un sonar actif, on repère immédiatement sa présence, aussi n'utilisera-t-on probablement les sonars LFA que lorsqu'il y a nécessité absolue. Pour cette raison, le système LFA que RDDC conçoit est un sonar *tactique* ayant une portée de détection supérieure à celle des sonars actifs courants mais très inférieure aux longues portées de détection des systèmes LFA que l'on envisage pour la *surveillance* des océans.

Qu'est-ce que le TIAPS?

Un sonar intégré actif et passif retient les avantages d'un sonar passif tout en offrant en même temps une option de devenir actif au besoin. RDDC, l'agence de recherché et de développement au sein du ministère de la Défense nationale, est à étudier cette technologie dans le cadre du projet du sonar remorqué intégré actif et passif ou TIAPS (Towed Integrated Active-Passive Sonar).

Quelles sont les propriétés de la source sonore utilisée pour le TIAPS?

Le niveau de sortie de la source du TIAPS LFA ne dépasse pas celui des sonars actifs montés en coque qu'on utilise déjà. La fréquence centrale varie – généralement entre deux octaves environ au-dessus du do central. Les impulsions typiques des sonars comprennent un ton « pur » à hauteur constante et un ton balayage qui monte et baisse suivant une étroite gamme de fréquences. Un navire remorque la source à une profondeur variable déterminée par les conditions et la profondeur de l'eau.

Est-ce que la source du TIAPS LFA menace la vie marine?

L'intérêt des médias a beaucoup été attiré par le danger potentiel que les sonars présentent à la vie marine, entre autres les baleines. Récemment, les préoccupations se sont focalisées en grande partie sur sonars actifs à basse fréquence de recherche de la Marine des É.U. et sur les sources sonores utilisées pour le projet de la tomographie acoustique des océans (ATOC). On ne sait pas encore exactement comment les sons (faibles ou forts) peuvent nuire aux mammifères marins, bien qu'il soit évident qu'une source sonore placée trop près de l'oreille de tout animal pourrait être nuisible. La zone dangereuse où les oreilles et d'autres tissus peuvent être endommagés se trouve près de la source. Plus la source est grande, plus le danger est énorme. À de faibles niveaux, le son peut ne pas nuire physiquement à une créature mais il peut la surprendre ou camoufler ses communications sonores. Consciente du mal qu'on peut faire aux mammifères, RDDC effectue le projet TIAPS avec la diligence prescrite par la *Loi canadienne sur l'évaluation environnementale*.

Comment les chercheurs gèrent-ils le risque écologique?

Notre approche de la gestion du risque écologique posé par le sonar LFA consiste à nous informer sur les problèmes, à élaborer des méthodes d'essai qui minimisent l'impact et à veiller à ce que ces méthodes soient suivies pendant les essais.

Au stade de la planification, on choisit les lieux d'essais de façon à minimiser la possibilité de contact avec les mammifères marins. Dans les cas où notre navire de recherche doit traverser dans un endroit reconnu vulnérable sur le plan écologique, les transmissions acoustiques sont interdites.

Nous effectuons de la vigie soutenues et tenons un registre des apparitions de mammifères.

Quand c'est possible, nous procédons à une écoute acoustique en utilisant nos propres dispositifs d'écoute sous-marins. Cette écoute acoustique nous permet également de détecter d'autres sources naturelles de bruits soudains comme les volcans sous-marins, les tremblements de terre et même les icebergs.

Nous ne procédons pas aux essais si nous détectons des mammifères marins.

Lorsque nous commençons les essais, nous augmentons graduellement le niveau sonore du sonar sur une période de 30 minutes, ce qui permet à tous les mammifères de quitter l'endroit avant que les essais se fassent intégralement.

Nous consultons les chercheurs principaux afin de déterminer le niveau sonore requis des sonars, individuellement, selon le besoin : si un test peut être effectué à un niveau inférieur plutôtqu' au niveau de sortie intégral, nous réduisons le niveau au minimum nécessaire.

Si nous détectons des mammifères marins entrant dans la zone, nous arrêtons la transmission.

En essayant de mieux comprendre la vulnérabilité des mammifères marins, les scientifiques de RDDC collaborent avec des unités de recherche des universités, du gouvernement et du secteur privé des États-Unis, du Royaume-Uni, de l'Italie et de l'Australie. Ils contribuent à certains aspects de recherche sur la détection acoustique et la localisation des mammifères marin.

Conclusion

Les sous-marins représentent toujours une menace potentielle pour toutes les marines du monde et, jusqu'à présent, le sonar est la meilleure contremesure qui soit. RDDC poursuit un projet de R & D visant à étudier un nouveau concept prometteur de sonar actif et passif, incluant une capacité tactique active à basse fréquence. RDDC se rend compte que l'utilisation de sonars est susceptible de nuire à la vie sous-marine, et elle est consciente des préoccupations du public à ce sujet. En assumant sa responsabilité envers la Marine, elle reconnaît la double tâche qu'elle doit accomplir : minimiser l'impact environnemental et appliquer la diligence nécessaire.

James Theriault et David Chapman sont tous deux des scientifiques de la Défense travaillant au Centre de recherches pour la défense Atlantique, à Dartmouth, Nouvelle-Écosse. James a étudié les mathématiques appliquées à l'université de Dalhousie (M.Sc. 1985), tandis que David a étudié la physique à l'université de la Colombie-Britannique (M.Sc. 1977), et ils ont tous deux beaucoup publié sur la théorie, l'expérimentation et la modélisation des phénomènes acoustiques sous-marins. Ils travaillent actuellement au projet TIAPS, assumant respectivement le poste d'analyste de projet et de gestionnaire de projet.

NEWS / INFORMATIONS

CONFERENCES

The following list of conferences was mainly provided by the Acoustical Society of America. If you have any news to share with us, send them by mail or fax to the News Editor (see address on the inside cover), or via electronic mail to desharnais@drea.dnd.ca

2001

3-7 December: 142nd Meeting of the Acoustical Society of America, Ft. Lauderdale, FL. Contact: Acoustical Society of America, Suite 1NO1, 2 Huntington Quadrangle, Melville, NY 11747-4502; Tel: 516-576-2360; Fax: 516-576-2377; Email: asa@aip.org; Web: asa.aip.org

2002

21-23 February: National Hearing Conservation Association Annual Conference, Dallas, TX. Contact: NHCA, 9101 E. Kenyon Ave., Ste. 3000, Denver, CO 80237; Tel.: 303-224-9022; Fax: 303-770-1812; Email: nhca@gwami.com; Web: www.hearingconservation.org/index.html

4-8 March: German Acoustical Society Meeting (DAGA 2002), Bochum, Germany. Contact: J. Blauert, Institute of Communication Acoustics, Ruhr-Universität Bochum, 44780 Bochum, Germany; Fax: +49 234 321 4165; Web: www.ika.ruhr-uni-bochum.de

10-13 March: Annual Meeting of American Institute of Ultrasound in Medicine, Nashville, TN. Contact: American Institute of Ultrasound in Medicine, 14750 Sweitzer Lane, Suite 100, Laurel, MD 20707-5906; Tel.: 301-498-4100 or 800-638-5352; Fax: 301-498-4450; Email: conv_edu@aium.org; Web: www.aium.org

8-11 April: 6th Congress of the French Acoustical Society, joint with the Belgian Acoustical Society, Lille, France. Contact: Société française d'acoustique, 23 av. Brunetière, 75017 Paris, France. Web: www.isen.fr/cfa2002

27-30 May: Joint Meeting: Russian Acoustical Society and Conference on Ocean Acoustics, Moscow, Russia. Contact: Yu. A. Chepurin, P.P. Shirshov Institute of Oceanology, Russian Academy of Sciences, Nakhimovsky Prospekt 36, 117851 Moscow, Russia; Fax: +7 095 124 5983; Web: rav.sio.rssi.ru/Ixconf.html

3-7 June: 143rd Meeting of the Acoustical Society of America, Pittsburg, PA. Contact: Acoustical Society of America, Suite 1NO1, 2 Huntington Quadrangle, Melville, NY 11747-4502; Tel: 516-576-2360; Fax: 516-576-2377; Email: asa@aip.org; Web: asa.aip.org

4-6 June: 6th International Symposium on Transport Noise and Vibration, St. Petersburg, Russia. Contact: East-European Acoustical Association, Moskovskoe Shosse 44, St. Petersburg 196158, Russia; Fax: +7 812 127 9323; Email: noise@mail.rcom.ru

CONFÉRENCES

La liste de conférences ci-jointe a été offerte en majeure partie par l'Acoustical Society of America. Si vous avez des nouvelles à nous communiquer, envoyez-les par courrier ou fax (coordonnées incluses à l'envers de la page couverture), ou par courrier électronique à desharnais@drea.dnd.ca

2001

3-7 décembre: 142e recontre de l'Acoustical Society of America, Ft. Lauderdale, FL. Info: Acoustical Society of America, Suite 1NO1, 2 Huntington Quadrangle, Melville, NY 11747-4502; Tél: 516-576-2360; Fax: 516-576-2377; Courriel: asa@aip.org; Web: asa.aip.org

2002

21-23 février: Conférence annuelle de l'Association nationale de la conservation de l'audition, Dallas, TX. Info: NHCA, 9101 E. Kenyon Ave., Ste. 3000, Denver, CO 80237; Fax: 303-770-1812; Courriel: nhca@gwami.com; Web: www.hearingconservation.org/index.html

4-8 mars: Rencontre de la Société allemande d'acoustique (DAGA 2002), Bochum, Allemagne. Info: J. Blauert, Institute of Communication Acoustics, Ruhr-Universität Bochum, 44780 Bochum, Germany; Fax: +49 234 321 4165; Web: www.ika.ruhr-uni-bochum.de

10-13 mars: Rencontre annuelle de l'Institut américain des ultrasons en médecine, Nashville, TN. Info: American Institute of Ultrasound in Medicine, 14750 Sweitzer Lane, Suite 100, Laurel, MD 20707-5906; Tél.: 301-498-4100 ou 800-638-5352; Fax: 301-498-4450; Courriel: conv_edu@aium.org; Web: www.aium.org

8-11 avril: 6e Congrès combiné de la Société française d'acoustique et de la Société belge d'acoustique, Lille, France. Info: Société française d'acoustique, 23 av. Brunetière, 75017 Paris, France. Web: www.isen.fr/cfa2002

27-30 mai: Rencontre combinée: Société russe d'acoustique, et Conférence sur l'acoustique océanique, Moscou, Russie. Info: Yu. A. Chepurin, P.P. Shirshov Institute of Oceanology, Russian Academy of Sciences, Nakhimovsky Prospekt 36, 117851 Moscow, Russia; Fax: +7 095 124 5983; Web: rav.sio.rssi.ru/Ixconf.html

3-7 juin: 143e rencontre de l'Acoustical Society of America, Pittsburg, PA. Info: Acoustical Society of America, Suite 1NO1, 2 Huntington Quadrangle, Melville, NY 11747-4502; Tél: 516-576-2360; Fax: 516-576-2377; Courriel: asa@aip.org; Web: asa.aip.org

4-6 juin: 6e Symposium international sur le bruit et vibrations des transports, Saint-Pétersbourg, Russie. Info: East-European Acoustical Association, Moskovskoe Shosse 44, St. Petersburg 196158, Russia; Fax: +7 812 127 9323; Courriel: noise@mail.rcom.ru

10-14 June: Acoustics in Fisheries and Aquatic Ecology, Montpellier, France. Contact: D.V. Holliday, BAE SYSTEMS, 4669 Murphy Canyon Road, Suite 102, San Diego, CA 92123-4333, USA; Web: www.ices.dk/symposia/

15-17 July: ACTIVE 2002 — 2002 International Symposium on Active Control of Sound and Vibration, Southampton, UK. Contact: Stephen J. Elliott, Institute of Sound and Vibration Research, Southampton University, University Road, Highfield, Southampton SO17 1BJ, United Kingdom; Tel.: +44 23 8059 2384; Fax: +44 23 8059 3190; Email: sje@isvr.soton.ac.uk; Web: www.isvr.soton.ac.uk/ACTIVE2002

19-21 August: Inter-Noise 2001 — 31st International Congress and Exposition on Noise Control Engineering, Dearborn, MI. Contact: Inter-Noise 2002 Congress Secretariat, Dept. Mechanical Engineering, Ohio State University, 206 West 18th Avenue, Columbus, OH 43210-1107, USA. Email: peersen.1@osu.edu; Web: www.internoise2002.org

19-23 August: 16th International Symposium on Nonlinear Acoustics (ISNA16), Moscow, Russia. Contact: O. Rudenko, Physics Department, Moscow State University, 119899 Moscow, Russia; Email: isna@acs366b.phys.msu.su

26-28 August: 2nd Biot Conference on Poromechanics, Grenoble, France. Contact: J.-L. Auriault, Laboratoire 3S, Domaine Universitaire, BP53, 38041 Grenoble, France. Fax: +33 4 76 82 70 43; Web: geo.hmg.inpg.fr/biot2002

16-21 September: Forum Acusticum 2002 (Joint EAA-SEA-ASJ Meeting), Sevilla. Fax: +34 91 411 7651; Web: www.cica.es/aliens/forum2002

2-6 December: Joint Meeting: 9th Mexican Congress on Acoustics, 144th Meeting of the Acoustical Society of America, and 3rd Iberoamerican Congress on Acoustics, Cancun, Mexico. Contact: Acoustical Society of America, Suite 1NO1, 2 Huntington Quadrangle, Melville, NY 11747-4502; Tel: 516-576-2360; Fax: 516-576-2377; Email: asa@aip.org; Web: asa.aip.org/cancun.html

2003

7-9 April: WESPAC8, Melbourne, Australia. Web: www.wespac8.com

8-13 June: XVII International Evoked Response Audiometry Study Group Symposium, Puerto de la Cruz, Tenerife, Canary Islands, Spain. Fax: +34 922 27 03 64; Web: www.ierasg-2003.org

1-4 September: Eurospeech 2003, Geneva, Switzerland. Contact: SYMPORG SA, Avenue Krieg 7, 1208 Geneva, Switzerland; Fax: +41 22 839 8485; Web: www.symporg.ch/eurospeech2003

2004

5-9 April: 18th International Congress on Acoustics (ICA2004), Kyoto, Japan. Web: ica2004.or.jp

10-14 juin: Acoustique des pêches et écologie aquatique, Montpellier, France. Info: D.V. Holliday, BAE SYSTEMS, 4669 Murphy Canyon Road, Suite 102, San Diego, CA 92123-4333, USA; Web: www.ices.dk/symposia/

15-17 juillet: ACTIVE 2002 — Symposium international 2002 sur le contrôle actif du bruit et des vibrations, Southampton, Royaume-Uni. Info: Stephen J. Elliott, Institute of Sound and Vibration Research, Southampton University, University Road, Highfield, Southampton SO17 1BJ, United Kingdom; Tél.: +44 23 8059 2384; Fax: +44 23 8059 3190; Courriel: sje@isvr.soton.ac.uk; Web: www.isvr.soton.ac.uk/ACTIVE2002

19-21 août: Inter-Noise 2001 — 31e Congrès international et exposition sur le génie du contrôle du bruit, Dearborn, MI. Info: Inter-Noise 2002 Congress Secretariat, Dept. Mechanical Engineering, Ohio State University, 206 West 18th Avenue, Columbus, OH 43210-1107, USA. Courriel: peersen.1@osu.edu; Web: www.internoise2002.org

19-23 août: 16e Symposium international sur l'acoustique non-linéaire (ISNA16), Moscou, Russie. Info: O. Rudenko, Physics Department, Moscow State University, 119899 Moscow, Russia; Courriel: isna@acs366b.phys.msu.su

26-28 août: 2e Conférence de Biot sur la Poro-mécanique, Grenoble, France. Info: J.-L. Auriault, Laboratoire 3S, Domaine Universitaire, BP53, 38041 Grenoble, France. Fax: +33 4 76 82 70 43; Web: geo.hmg.inpg.fr/biot2002

16-21 septembre: Forum Acusticum 2002 (Rencontre conjointe EAA-SEA-ASJ), Séville. Fax: +34 91 411 7651; Web: www.cica.es/aliens/forum2002

2-6 décembre: Rencontres combinées: 9e Congrès mexicain d'acoustique, 144e rencontre de l'Acoustical Society of America, et 3e Congrès ibéro-américain d'acoustique, Cancun, Mexique. Info: Acoustical Society of America, Suite 1NO1, 2 Huntington Quadrangle, Melville, NY 11747-4502; Tél: 516-576-2360; Fax: 516-576-2377; Courriel: asa@aip.org; Web: asa.aip.org/cancun.html

2003

7-9 avril: WESPAC8, Melbourne, Australie. Web: www.wespac8.com

8-13 juin: XVII Symposium international du Groupe expérimental sur l'audiométrie des potentiels évoqués, Puerto de la Cruz, Tenerife, Iles Canaries, Espagne. Fax: +34 922 27 03 64; Web: www.ierasg-2003.org

1-4 septembre: Eurospeech 2003, Genève, Suisse. Info: SYMPORG SA, Avenue Krieg 7, 1208 Geneva, Switzerland; Fax: +41 22 839 8485; Web: www.symporg.ch/eurospeech2003

2004

5-9 avril: 18e Congrès international sur l'acoustique (ICA2004), Kyoto, Japon. Web: ica2004.or.jp

The Canadian Acoustical Association
l'Association Canadienne d'Acoustique

PRIZE ANNOUNCEMENT

A number of prizes, whose general objectives are described below, are offered by the Canadian Acoustical Association. As to the first four prizes, applicants must submit an application form and supporting documentation to the prize coordinator before the end of February of the year the award is to be made. Applications are reviewed by subcommittees named by the President and Board of Directors of the Association. Decisions are final and cannot be appealed. The Association reserves the right not to make the awards in any given year. Applicants must be members of the Canadian Acoustical Association. Preference will be given to citizens and permanent residents of Canada. Potential applicants can obtain full details, eligibility conditions and application forms from the appropriate prize coordinator.

Edgar and Millicent Shaw Postdoctoral Prize in Acoustics

This prize is made to a highly qualified candidate holding a Ph.D. degree or the equivalent, who has completed all formal academic and research training and who wishes to acquire up to two years supervised research training in an established setting. The proposed research must be related to some area of acoustics, psychoacoustics, speech communication or noise. The research must be carried out in a setting other than the one in which the Ph.D. degree was earned. The prize is for $3000 for full-time research for twelve months, and may be renewed for a second year. Coordinator: Sharon Abel, Mount Sinai Hospital, 600 University Avenue, Toronto, ON M5G 1X6. Past recipients are:

1999	*Jingnan Guo*	*University of British Columbia*	*2001*	*Frank Russo*	*Queens University*

Alexander Graham Bell Graduate Student Prize In Speech Communication and Behavioural Acoustics

The prize is made to a graduate student enrolled at a Canadian academic institution and conducting research in the field of speech communication or behavioural acoustics. It consists of an $800 cash prize to be awarded annually. Coordinator: Don Jamieson, Department of Communicative Disorders, University of Western Ontario, London, ON N6G 1H1. Past recipients are:

2000	*Janna Rieger*	*University of Alberta*	*2001*	*Ian Wilson*	*University of British Columbia*

Fessenden Student Prize in Underwater Acoustics

The prize is made to a graduate student enrolled at a Canadian university and conducting research in underwater acoustics or in a branch of science closely connected to underwater acoustics. It consists of $500 cash prize to be awarded annually. Coordinator: David Chapman, DREA, PO Box 1012, Dartmouth, NS B2Y 3Z7.

2000	*Vanessa Corre*	*University of Victoria*	*2001*	*Anna-Liesa Lapinski*	*University of Victoria*

Eckel Student Prize in Noise Control

The prize is made to a graduate student enrolled at a Canadian academic institution pursuing studies in any discipline of acoustics and conducting research related to the advancement of the practice of noise control. It consists of a $500 cash prize to be awarded annually. The prize was inaugurated in 1991. Coordinator: Murray Hodgson, Occupational Hygiene Programme, University of British Columbia, 2206 East Mall, Vancouver, BC V6T 1Z3.

2000	*Lillian Ciona*	*University of Western Ontario*	*2001*	*Eva-Marie Nosal*	*University of British Columbia*

Directors' Awards

Three awards are made annually to the authors of the best papers published in *Canadian Acoustics*. All papers reporting new results as well as review and tutorial papers are eligible; technical notes are not. The first award, for $500, is made to a graduate student author. The second and third awards, each for $250, are made to professional authors under 30 years of age and 30 years of age or older, respectively. Coordinator: Kathy Pichora-Fuller, University of British Columbia, Vancouver, BC.

Student Presentation Awards

Three awards of $500 each are made annually to the undergraduate or graduate students making the best presentations during the technical sessions of Acoustics Week in Canada. Application must be made at the time of submission of the abstract. Coordinator: Karen Fraser, CN Rail, Toronto ON , Tel: (416) 217-6466.

The CAA Underwater Acoustics and Signal Processing Student Travel Subsidy

Two $250 awards or one $500 award are made annually to university students traveling to national or international conferences to give oral or poster presentations on underwater acoustics and/or signal processing. The award winners will be selected on a first-come, first served basis. Applications must be received on or before September 30 and apply to attendance at conferences within the following 12 months.

Coordinator: Dave Stredulinsky, DREA, PO Box 1012, Dartmouth, NS B2Y 3Z7.

The Canadian Acoustical Association
l'Association Canadienne d'Acoustique

ANNONCE DE PRIX

Plusieurs prix, dont les objectifs généraux sont décrits ci-dessous, sont décernés par l'Association Canadienne d'Acoustique. Pour les quatre premiers prix, les candidats doivent soumettre un formulaire de demande ainsi que la documentation associée au coordonnateur de prix avant le dernier jour de février de l'année durant laquelle le prix sera décerné. Toutes les demandes seront analysées par des sous-comités nommés par le président et la chambre des directeurs de l'Association. Les décisions seront finales et sans appel. L'Association se réserve le droit de ne pas décerner les prix une année donnée. Les candidats doivent être membres de l'Association. La préférence sera donnée aux citoyens et aux résidents permanents du Canada. Les candidats potentiels peuvent se procurer de plus amples détails sur les prix, leurs conditions d'éligibilité, ainsi que des formulaires de demande auprès du coordonnateur de prix.

Prix Post-Doctoral Edgar et Millicent Shaw en Acoustique

Ce prix est attribué à un(e) candidat(e) hautement qualifié(e) et détenteur(rice) d'un doctorat ou l'équivalent, qui a complèté(e) ses études et sa formation de chercheur, et qui désire acquérir jusqu'à deux années de formation supervisée de recherche dans un établissement reconnu. Le thème de recherche proposée doit être relié à un domaine de l'acoustique, de la psycho-acoustique, de la communication verbale ou du bruit. La recherche doit être menée dans un autre milieu que celui où le candidat a obtenu son doctorat. Le prix est de $3000 pour une recherche plein temps de 12 mois avec possibilité de renouvellement pour une deuxième année. Coordonnatrice: Sharon Abel, Mount Sinai Hospital, 600 University Avenue, Toronto, ON M5G 1X6. Les récipiendaires antérieur(e)s sont:

1999	*Jingnan Guo*	*University of British Columbia*	*2001*	*Frank Russo*	*Queens University*

Prix Étudiant Alexander Graham Bell en Communication Verbale et Acoustique Comportementale

Ce prix sera décerné à un(e) étudiant(e) inscrit(e) dans une institution académique canadienne et menant un projet de recherche en communication verbale ou acoustique comportementale. Il consiste en un montant en argent de $800 qui sera décerné annuellement. Coordonnateur: Don Jamieson, Department of Communicative Disorders, University of Western Ontario, London, ON N6G 1H1. Les récipiendaires antérieur(e)s sont:

2000	*Janna Rieger*	*University of Alberta*	*2001*	*Ian Wilson*	*University of British Columbia*

Prix Étudiant Fessenden en Acoustique Sous-marine

Ce prix sera décerné à un(e) étudiant(e) inscrit(e) dans une institution académique canadienne et menant un projet de recherche en acoustique sous-marine ou dans une discipline scientifique reliée à l'acoustique sous-marine. Il consiste en un montant en argent de $500 qui sera décerné annuellement. Coordonnateur: David Chapman, DREA, PO Box 1012, Dartmouth, NS B2Y 3Z7.

2000	*Vanessa Corre*	*University of Victoria*	*2001*	*Anna-Liesa Lapinski*	*University of Victoria*

Prix Étudiant Eckel en Contrôle du Bruit

Ce prix sera décerné à un(e) étudiant(e) inscrit(e) dans une institution académique canadienne dans n'importe quelle discipline de l'acoustique et menant un projet de recherche relié à l'avancement de la pratique en contrôle du bruit. Il consiste en un montant en argent de $500 qui sera décerné annuellement. Ce prix a été inauguré en 1991. Coordonnateur: Murray Hodgson, Occupational Hygiene Programme, University of British Columbia, 2206 East Mall, Vancouver, BC V6T 1Z3.

2000	*Lillian Ciona*	*University of Western Ontario*	*2001*	*Eva-Marie Nosal*	*University of British Columbia*

Prix des Directeurs

Trois prix sont décernés, à tous les ans, aux auteurs des trois meilleurs articles publiés dans l'*Acoustique Canadienne.* Tout manuscrit rapportant des résultats originaux ou faisant le point sur l'état des connaissances dans un domaine particulier sont éligibles; les notes techniques ne le sont pas. Le premier prix, de $500, est décerné à un(e) étudiant(e) gradué(e). Le deuxième et le troisième prix, de $250 chacun, sont décernés à des auteurs professionnels âgés de moins de 30 ans et de 30 ans et plus, respectivement. Coordonnateur: Kathy Pichora-Fuller, University of British Columbia, Vancouver, BC.

Prix de Présentation Étudiant

Trois prix, de $500 chacun, sont décernés annuellement aux étudiant(e)s sous-gradué(e)s ou gradué(e)s présentant les meilleures communications lors de la Semaine de l'Acoustique Canadienne. La demande doit se faire lors de la soumission du résumé. Coordonnateur: Karen Fraser, CN Rail, Toronto ON, Tel: (416) 217-6466.

Subvention des frais de déplacement pour les étudiants en Acoustique Sous-Marine et Traitement du Signal - Association Canadienne d'Acoustique.

Deux bourses de 250 $ et une bourse de 500 $ sont attribuées chaque année à des étudiants d'université qui se rendent à une conférence nationale ou internationale pour y présenter un article ou un poster dans le domaine de l'acoustique sous-marine et/ou du traitement du signal. Ces bourses sont attribuées aux tous premiers étudiants qui en font la demande. Les candidatures doivent parvenir avant le 30 septembre de l'année en cours et doivent concerner une conférence qui se tient dans les 12 mois suivants.

Responsable: Dave Stredulinski, DREA, P.O. Box 1012, Dartmouth, NS B2Y 3Z7

Canadian Acoustical Association
l'Association Canadienne d'Acoustique

2001 PRIZE WINNERS / RÉCIPIENDAIRES 2001

Edgar and Millicent Shaw Postdoctoral Prize in Acoustics
Prix Post-Doctoral Edgar et Millicent Shaw en Acoustique

Frank Russo, Queens University

"Effects of music exposure on prosodic perception"

Alexander Graham Bell Prize in Speech Communication and Behavioural Acoustics
Priz Alexander Graham Bell en Communication Verbale et Acoustique Comportementale

Ian Wilson, University of British Columbia

"Variability in Articulation"

Fessenden Student Prize in Underwater Acoustics
Prix Étudiant Fessenden en Acoustique Sous-marine

Anna-Liesa Lapinski, University of Victoria

"Geoacoustic Inversion Using an Adaptive Hybrid Algorithm"

Eckel Student Prize in Noise Control/ Prix Étudiant Eckel en Contrôle du Bruit

Eva-Marie Nosal, University of British Columbia

"Novel room-acoustical prediction model"

Directors' Awards / Prix des Directeurs

Professional ≥30 years / Professionel ≥30 ans:

John O'Keefe and John Bradley

"Acoustical renovation of the Orpheum, Vancouver - I. Measurements prior to renovation."

Professional ≤ 30 years / Professionel ≤ 30 ans:

Christian Giguere, Sharon Abel and Robert Arrabito

"Binaural technology for application to active noise reduction communication headsets: Design considerations."

Student / Étudiant(e):

Nicole Collison, University of Victoria

"A comparison of modal decomposition algorithms for matched-mode processing"

STUDENT AWARDS / PRIX ÉTUDIANT

Maxime Bolduc, University of Sherbrooke

"Experimental characterization of SEA damping loss factor"

Jay Detsky, University of Waterloo

"SYMEAS program for acoustical modeling of muffler systems"

Terence Miranda, University of British Coumbia

"Temporally jittered speech produces PI-PB rollover in young normal-hearing listeners"

CANADA WIDE SCIENCE FAIR AWARD IN ACOUSTICS

Jasmine Tait, Sir Robert Borden High School, Ottawa, Ontario

"A Comparison of Acoustic Effects of Two Stopper and Crown Systems in the Modern Flute"

CONGRATULATIONS / FÉLICITATIONS

Invitation to Attend the Annual Meeting of the Canadian Acoustical Association, 2002

Acoustics: Bridge to the Future. Inspired by the unique locale of the Province of Prince Edward Island (PEI) and its recently completed Confederation Bridge, the theme of Acoustics Week in Canada 2002 emphasizes links in the various disciplines of acoustics. For example, close to the site of this next Annual Meeting, models of vibrational modes contributed to the final design of the 13 km bridge from PEI to New Brunswick. In a research station housed inside the bridge, acoustical work continues to monitor vibrations in relation to weather conditions. In the same way that knowledge of acoustics enabled the safe construction and maintenance of the Confederation Bridge, knowledge of acoustics helps forge new paths in domains as diverse as human communication, mapping the seabed, and the aerospace industry. The Annual Meeting of the Canadian Acoustical Association (CAA) builds and reinforces bridges between sub-disciplines of acoustics, over geographical boundaries, and across acoustical and non-acoustical fields.

Contributions from *all* fields of the science of sound are welcome for the CAA meeting, including but not limited to: Architectural Acoustics, Engineering Acoustics/Noise Control, Physical Acoustics/Ultrasound, Musical Acoustics/Electroacoustics, Psychological Acoustics, Physiological Acoustics, Shock/Vibration, Hearing Sciences, Hearing Conservation, Speech Sciences, Underwater Acoustics, Signal Processing/Numerical Methods, and Education in Acoustics.

The short abstract should be prepared and sent (for receipt by May 31, 2002) in accordance with the instructions printed in this issue of *Canadian Acoustics*. Abstracts will be peer reviewed and will be printed and posted. Direct on-line submission will also be available through the conference web-site. For those without access to e-mail, digital files on diskette or paper copy should be mailed to either technical program co-coordinator. The voluntary 2-page proceedings paper is due August 14. This deadline will be strictly enforced to meet the publication schedule of the proceedings issue of the journal *Canadian Acoustics.*

Proposals for Special Sessions on a particular topic in acoustics are welcome. Contact Annabel Cohen or David Stredulinsky soon if you wish to organize a special session.

Student participation in Acoustics Week in Canada is strongly encouraged. **Awards** are available to students whose presentations at the conference are judged to be particularly noteworthy. To qualify, students must apply by enclosing an Annual Student Presentation Award form with their abstract. Students presenting papers may also apply for a travel subsidy to attend the meeting if they live at least 100 km from Charlottetown. To apply for this subsidy, students must submit an Application for Student Travel Subsidy. Forms are also available on the web-site.

Accommodation. The Delta Hotel located in downtown Charlottetown PE will provide accommodation and meeting space (http://www.deltaprinceedward.pe.ca). The special (double/single occupancy) room rate for delegates is $109.00 per night. This rate applies to several days prior and after the conference (including the following Thanksgiving weekend). To reserve accommodation, please contact the hotel directly by telephone (1-800-268-1133; Fax 1-902-566-1745) and mention the CAA meeting. You may also contact Jason Clark directly (jclark@deltahotels.com, 902-894-1237, fax 902-566-1746). The reservation cut-off date is August 27, 2002. After these dates, the special rates are subject to availability. Several other hotels for every budget are located within walking distances from the conference site. For details, check the PEI tourist web site: http://www.gov.pe.ca/visitorsguide/

Workshops/Seminars. As a tradition, several half-day and full-day workshops may be offered Oct. 8, the day before the technical program and exhibition begins, giving opportunity for continuing education in acoustics. If you are interested in giving a workshop, please contact the convener. An IRC/NRC full day seminar "Containing Fire and Sound: Challenges and Solutions" is now scheduled. It focuses on design tradeoffs to deal effectively with both fire resistance and sound insulation between units in multi-family buildings. (Contact Dave.Quirt@nrc.ca, tel: 613-954-1495).

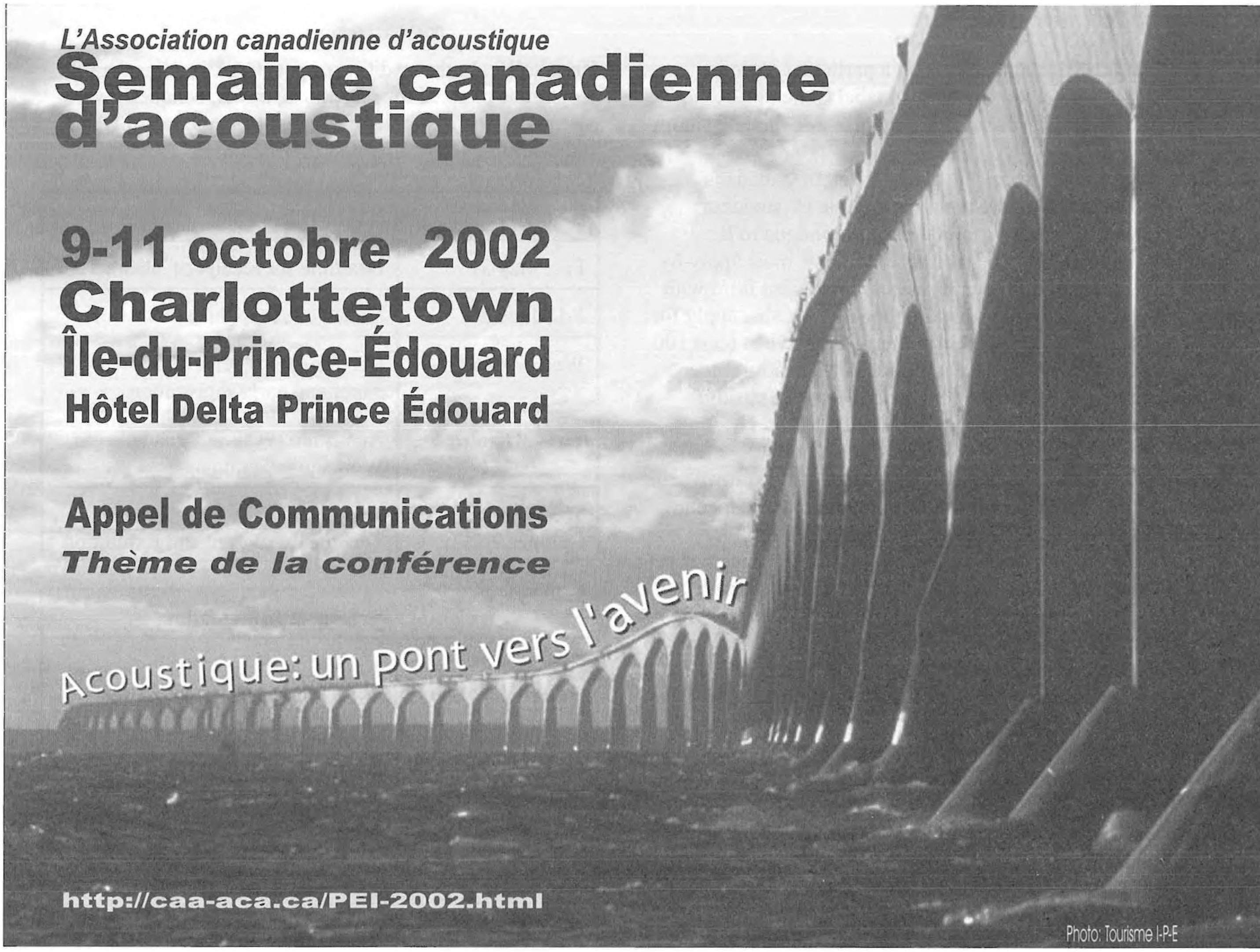
Exhibits. An exhibition of the latest technologies in acoustics and vibration equipment, materials and software will take place Wed. and Thurs. Oct. 9-10. Exhibitors will be well integrated into the conference setting and featured in a special session of the conference program. Sponsorship by exhibitors of nutrition breaks and/or lunches is also welcome. (Contact the conference convener or Teresa Drew).

Canadian Standards Acoustics. Canadian Standards Association Committee Z107 in Acoustics and Noise Control will hold a meeting (organizer: Cameron Sherry, Cwsherry@aol.com). All welcome.

Hospitality. In the tradition of past CAA meetings, a full program is planned for receptions, meals, banquet, award ceremony, and a sample of the best Prince Edward Island and Maritime hospitality and entertainment.

Important Dates 2002	
Fri., May 31	Deadline for receipt of abstracts
Fri., June 28	Notice of acceptance of abstracts
Wed., August 14	Deadline for receipt of summary paper and early registration
Tues., October 8	Acoustics Week in Canada begins: Workshops/Seminars
Wed.-Fri. October 9-11	Acoustics Week in Canada: Technical Program and Exhibition

Contact Persons & Information	
Convener **Annabel Cohen**	acohen@upei.ca Dept. of Psychology Univ. Prince Edward Island 550 Univ. Ave Charlottetown, PE C1A 4P3 (902) 628-4325 FAX: (902) 628-4359
Co-coordinator Technical Program **David Stredulinsky**	stredulinsky@drea.dnd.ca DREA 9 Grove St. Dartmouth NS B2Y 3Z7 (902) 426-3100 x352 FAX: (902) 426-9654
Program Secretariat **Reina Lamothe**	rlamothe@upei.ca Dept. of Psychology Univ. Prince Edward Island (902) 628-4331 tel FAX: (902) 628-4359
Exhibits **Teresa Drew**	tdrew@jacqueswhitford.com Jacques, Whitford & Assoc. 3 Spectacle Lake Drive Dartmouth, NS B3B 1W8 (902) 468-7777 FAX: (902) 468-9009
Audio Visual **Robert Drew**	rdrew@upei.ca Dept. of Psychology (902) 628-4331 FAX: (902) 628-4359
Web-site address	http://caa-aca.ca/PEI-2002.html



Invitation à participer

La réunion annuelle de l'Association canadienne de l'acoustique, Charlottetown 2002

Acoustique: Un pont vers l'avenir. Inspiré par l'unique situation de la province de l'Île-du-Prince-Édouard (ÎPÉ) et le Pont de la Confédération qui fut récemment complété, le thème de la semaine d'acoustique au Canada 2002 souligne les liens entre les disciplines variées de l'acoustique. Par exemple, situé non loin du site de cette prochaine réunion annuelle de l'ACA, des modèles de modes de vibrations ont contribué au plan final du pont de 13 km qui rejoint l'IPÉ au Nouveau-Brunswick. Le travail en acoustique se poursuivent dans la station de recherches située dans l'intérieur du pont où les vibrations sont analysées en correspondance avec les conditions climatiques. De la même façon que nos connaissances en acoustique ont put faciliter la prudente construction et entretien du pont de la Confédération, nos connaissances en acoustique facilitent la création de nouvelles directions dans des domaines aussi divers que la communication humaine, la caractérisation du fond de la mer, et l'industrie aérospatiale. La réunion annuelle de l'Association canadienne d'acoustique crée et renforce les liens entre les sous-disciplines de l'acoustique à travers les frontières géographiques et entre les domaines acoustiques et non-acoustiques.

Les contributions de toutes les disciplines de la science du son seront les bienvenues pour la réunion de l'ACA, incluant mais non limitées à: l'acoustique architecturale, le génie acoustique et contrôle du bruit, l'acoustique physique et l'ultrason, l'acoustique musicale et l'électro-acoustique, la psycho-acoustique, l'acoustique physiologique, les chocs et vibrations, l'audiologie, la science du langage, l'acoustique sous-marine, le traitement du signal et les méthodes numériques, et finalement l'éducation en acoustique.

Les résumés seront préparés et envoyés (pour être reçus avant le 31 mai 2002) suivant les instructions incluses dans ce numéro d'Acoustique canadienne. Les résumés seront examinés par un pair et publiés. Les soumissions par courrier électronique seront disponibles sur le site web. Pour ceux qui n'ont pas accès au courrier électronique, les documents digitaux sur disquette ou papier devront être envoyés à l'un des co-présidents du programme technique. Les sommaires optionnels de 2 pages devront Ltre soumis avant le 14 août 2002. Cette échéance sera strictement respectée afin de pouvoir publier le programme dans les actes d'Acoustique canadienne.

Les propositions pour des sessions spéciales sur un sujet particulier en acoustique sont les bienvenues. Contactez Annabel Cohen ou David Stredulinsky si vous désirez organiser une session spéciale durant la conférence.

La participation des étudiants à la conférence de l'ACA 2002 est fortement encouragée. Des **prix** seront accordés aux étudiants dont la présentation à la conférence aura été jugée particulièrement remarquable. Afin d'être éligibles à ces prix, les étudiants doivent remplir le formulaire du Prix Annuel de Présentation Étudiante. Ce formulaire devrait être envoyé avec le résumé. Les étudiants qui habitent dans une région suffisamment éloignée de Charlottetown (plus de 100 km) et qui désirent présenter leur article à la conférence, peuvent également faire application pour une subvention de voyage, afin de défrayer leurs frais de déplacement. Les formulaires sont disponibles sur le site web.

Logement. L'Hôtel Delta Prince Édouard (http://www.deltaprinceedward.pe.ca) situé à Charlottetown ÎPÉ fournira l'hébergement et les salles de réunion. Le prix spécial de chambre (double ou simple) pour les délégués est de 109$ par nuit. Ce prix s'applique aussi pour plusieurs jours avant et après la réunion, y compris la fin de semaine de l'action de grâce. Pour réserver une chambre, s'il-vous-plaît contactez l'hôtel directement (1-800-268-1133; Fax 1-902-566-1745) et mentionnez la réunion de l'ACA. Vous pouvez aussi contacter Jason Clark directement (jclark@deltahotels.com, 902-894-1237; fax: 902-566-1746). Les réservations doivent être faites avant le 27 août 2002. Après cette date, le tarif préférentiel sera sujet à la disponibilité des chambres. Pour d'autres hôtels et auberges, près du site de la conférence, visitez le site web de la ville de Charlottetown (http://www.gov.pe.ca/visitorsguide/).

Ateliers. Suivant la tradition, plusieurs ateliers (demi- ou pleine-journée) pourront être offerts le jour précédent le début des programmes scientifiques et techniques. Si vous êtes intéressé à présenter un atelier, S.V.P. contactez la présidente de la conférence. Un atelier pleine-journée sera offert par IRC/CNRC intitulé "Containing Fire and Sound: Challenges and Solutions". L'atelier porte sur les compromis apportés au design pour améliorer la résistance au feu et l'insonorisation entre les unités de domiciles multi-familiaux. (Personne contact: Dave.Quirt@nrc.ca, tel: 613-954-1495)

Exposants. Une exposition portant sur les dernières technologies entourant l'équipement, l'instrumentation, les matériaux, et les logiciels reliés aux domaines de l'acoustique et des vibrations, sera ouverte mercredi-jeudi (9-10 oct.). Les exposants seront intégrés à la conférence et seront mis en vedette durant une session spéciale du programme. La commandite des périodes de pauses alimentaires et/ou de déjeuners est également invitée. (Contactez Annabel Cohen ou Teresa Drew).

Normes canadiennes en acoustique. Une rencontre du normes canadiennes en acoustique Z107 est organisée par Cameron Sherry (cwsherry@aol.com). Tous sont invités.

L'hospitalité. Suivant la tradition des conférences passées, un programme social sera organisé avec des réceptions, des repas, un banquet, une cérémonie de remise de prix et des exemples d'hospitalité et de divertissement de l'Île-du-Prince-Édouard et des Maritimes.

Dates à retenir	
vendredi, 31 mai	Date limite pour la soumission des résumés
vendredi, 28 juin	Avis pour les résumés approuvés
mercredi, 14 août	Date limite pour la soumission des articles-sommaires et l'inscription à l'avance
mardi, 8 octobre	Semaine canadienne d'acoustique 2002 - Ateliers
mercredi-vendredi 9-11 octobre	Semaine canadienne d'acoustique 2002 programme technique et exposition (9-10)

Personnes contacts	
Présidente de la conférence **Annabel Cohen**	acohen@upei.ca Dept. de Psychologie U. de l'Île-du-Prince-Édouard Charlottetown, PE C1A 4P3 (902) 628-4325 (902) 628-4359 (fax)
Co-président du programme technique **David Stredulinsky**	stredulinsky@drea.dnd.ca DREA 9 Grove St. Dartmouth, NS B2Y 3Z7 (902) 426-3100 x352 (902) 426-9654 (fax)
Secrétaire du programme **Reina Lamothe**	rlamothe@upei.ca Dept. de Psychologie, UPEI (902) 628-4331 (902) 628-4359 (fax)
Exposition **Teresa Drew**	tdrew@jacqueswhitford.com Jacques, Whitford & Assoc. Ltd. (902) 468-7777 (902) 468-9009 (fax)
Audio-visuel **Robert Drew**	rdrew@upei.ca (902) 628-4331 (902) 628-4359 (fax)
Site web	**http://caa-aca.ca/PEI-2002.html**

Canadian Acoustical Association
Minutes of the Annual General Meeting
02 October 2001

Alliston, Ontario

Present: 37 voting members of the Association

Meeting called to order at 1:04 p.m.

Minutes of the 28 September 2000 Annual General Meeting were approved as written in the December 2000 issue of Canadian Acoustics. (Moved by A. Behar, seconded by S. Abel, carried).

President's Report

J. Bradley reported that Industry Canada approved the proposed by-law changes effective 01 October 2000. In general, the affairs of the Association are good but not ideal. Although membership is up significantly, revenues from investments are down due to low interest rates on term instruments. More detail will be given in the subsequent reports.

Secretary's Report

T. Nightingale was very pleased to report that there was a significant increase in membership which can be primarily attributed to the new members gained at the Sherbrooke Conference. The total of all paying categories is 391.

One month of FY01/02 (01 Sept. through 31 Aug.) has passed and other than routine membership and database management there have been no significant activities.

The Secretarial operating cost for FY00/01 was $1236, which is comparable to previous years despite including a $110 charge to register the CAA domain name and a redirect. The costs were itemized in an attachment presented to the Board.

The Secretary announced that he would not be seeking reelection.

There is approximately $160 dollars in the Secretarial Account. These funds will be transferred to the new Secretary and the account closed.

(Acceptance of the Secretary's report was moved by M. Cheesman, seconded by H. Forester, carried).

Treasurer's Report

The Treasurer reported that $25k had been transferred from the operating account to the capital account as requested by the Board so that a higher yield could be achieved. Interest rates are very low and many term instruments are up for reinvestment. Revenues from investments will be down over previous years. The SPIF donation and the surplus from the Sherbrooke Conference were significant sources of income in FY00/01 but similar events could not be expected in the future. Actual expenses for FY00/01 followed the budget presented at the last Board and Annual General Meeting. In FY01/02 an operating shortfall is expected due to lower return on investments and increased journal costs.

After lengthy discussion of the amount of additional revenue needed to avoid a deficit situation the Treasurer moved, "A modest increase in the membership and subscription fees should be implemented as well as an increase in sustaining subscriptions and advertising. The following increases would be effective immediately: Membership increased from $50 to $55, Student Membership increased from $10 to $15, Direct and Indirect Subscriptions increased from $50 to $55, Sustaining subscriptions increased from $150 to $250 with a hotlink from the CAA website to that of the subscriber, full page advertisements would increase from $200 to $250 per page per issue prorated on size." The motion was seconded by M. Cheesman, and approved by all.

(Acceptance of the Treasurer's report was moved by D. Stredulinsky, seconded by R. Ramakrishnan, carried).

Editor's Report

R. Ramakrishnan reported on plans to increase the frequency of Canadian Acoustics from four to six times a year. While the number of papers and articles might support publishing the journal six times a year, revenue from membership and subscriptions, (even given the proposed increase) would be insufficient unless there was a substantial increase in advertising revenue. Several options were discussed to reduce publication costs these included limiting the number of pages in an issue, publishing the journal in electronic format such as pdf and mailing CD-ROMS to members or in a web-based format accessible only to our members. Increasing revenue from the journal focussed on selling more advertisements and the need for a person dedicated to this task. Volunteers are sought.

The discussion on journal format continued and an informal poll was taken to assess the desire of the membership, 11 persons favoured printed format, 9 persons preferred the CD format, while 7 preferred a wed-based electronic format. There is no intention to change the format of Canadian Acoustics at the present time.

(Acceptance of the Editor's report was moved by S. Abel, seconded by, D.Giusti carried).

Award Coordinator's Report

It was reported that all awards would be given this year. The recipients will be announced at the luncheon of the final day of the Conference. [For a listing of the recipients please see the minutes of the 200 September 30 Board of Director's Meeting listed in this issue].

Past and Future Conferences

2000 Sherbrooke: Alain Berry and Nouredine Atalla were congratulated on the very successful conference that realized a surplus of $13k.

2001 Toronto: D. Giusti thanked the local Committee as well as Ramani Ramakrishnan for his work in publishing the summary papers in the Journal.

2002 Charlottetown: A. Cohen announced the conference will be held 8-10 October. Organization is well underway with the venue booked and the Committee meeting in Halifax next week. The first call for papers will appear in the December issue of Canadian Acoustics.

2003 Western Canada: J. Bradley announced that the conference would likely be held in Edmonton.

CAA Website

D. Stredulinsky reported that the new website at www.caa-aca.ca has been operational for some time. There was some general discussion regarding what material and information should/could be placed at the site. Suggested items included announcements for jobs, students wanted, Ph.D. and M.Sc. thesis topics, and general items of interest. H. Forester suggested a listing of noise by-laws for each province and/or municipality and was invited to form a committee to collect and forward noise by-laws to the webmaster.

Nominations

C. Sherry announced that by reason of term limitation or resignation the following positions will need to be filled: Director (D. Whicker), Director (D. DeGagne) and Secretary (T. Nightingale). On behalf of the Nominating Committee, C. Sherry moved that Corjan Buma be elected as Director, Megan Hodge be elected as Director and D. Quirt be elected as Secretary. There were no nominations from the floor. A. Behar seconded the motion and all were in favour. The three were elected by acclamation.

Other Business

R. Ramakrishnan thanked T. Nightingale for his work as Secretary for the past five years.

Adjournment

D. Giusti moved to adjourn the meeting, seconded by M. Cheesman, carried. Meeting adjourned at 2:00 p.m.

Canadian Acoustical Association
Minutes of the Board of Directors Meeting
30 September 2001

Alliston, Ontario

Present: N. Atalla, J. Bradley, M. Cheesman, D. Giusti, T. Nightingale, K. Fraser, T. Kelsall, K. Fuller, R. Ramakrishnan, D. Stredulinsky

Regrets: D. DeGagne, J. Hemingway, D. Whicker.

Meeting called to order at 5:05 p.m.

Minutes of the 16 June Board of Director's meeting were approved as written in the September 2001 issue of Canadian Acoustics. (Moved by R. Ramakrishnan, seconded by D. Giusti, carried).

President's Report

J. Bradley reported that we have made significant progress with our web site which will be reported by D. Stredulinsky and that the R. Ramakrishnan has investigated the feasibility of increasing the frequency of journal publication.

Secretary's Report

T. Nightingale was very pleased to report that there was approximately a 13% increase in membership (including non-voting journal subscriptions) which can be primarily attributed to the new members gained at the Sherbrooke Conference. The total of all paying categories is 391.

One month of FY01/02 (01 Sept. through 31 Aug.) has passed and other than routine membership and database management there have been no significant activities.

The Secretarial operating costs for FY00/01 were $1236, which is comparable to previous years despite including a $110 charge to register the CAA domain name and a redirect. The costs were itemized in an attachment presented to the Board.

The Secretary announced that he would not be seeking re-election at the October 2001 AGM

There is approximately $160 dollars in the Secretarial Account. These funds will be transferred to the new Secretary and the account closed. To ensure that the new Secretary has sufficient funds to conduct normal Association business until the Board next meets it was requested that a cheque for $500 be issued to the new Secretary after election at the October 2001 AGM.

(Acceptance of the Secretary's report was moved by T. Kelsall, seconded by D. Giusti, carried).

Treasurer's Report

The Treasurer provided a copy of the accountant's audit for FY00/01 in which the total assets of the Association were up by about $28k over the year before. This increase reflects the significant surplus from the 2000 Sherbrooke Conference and the substantial donation from the NATO Signal Processing Institute Fund.

In the FY01/02 budget the Treasurer projected a deficit of approximately $5k which was attributed to significantly lower yield on term investments and higher journal printing costs. Several options to avoid a possible deficit situation were discussed at great length. These included a fee increase, reducing publication costs by offering the journal on CD-ROM or in electronic format at our webs site, and an increase in advertising rates (which have remained constant for several years now). The Board agreed the best solution would be a modest increase in both membership fees and advertising rates. D. Giusti moved that the following proposition be brought before the Membership at the AGM for their consideration and subsequent vote, "Effective for the calendar year 2002, the fee for membership will be $55 (up from $50), student membership will be $15 (raised from $10), fee for both direct and indirect subscriptions will be $55 (raised from $50), and sustaining subscriptions be $250 (raised from $150), and $250 for full-page advertisements (raised from $200)". D. Stredulinsky seconded the motion after it was agreed that CAA would provide a hot link from our website to those of the sustaining subscribers. All were in favour and the motion carried.

J. Bradley agreed to write a letter explaining the need for the fee increase. This letter would be distributed to the membership with their 2002 invoices.

(Acceptance of the Treasurer's report was moved by D. Stredulinsky, seconded by R. Ramakrishnan, carried).

Editor's Report

R. Ramakrishnan reported that the cost of publishing the journal (four times and with unlimited page count) in FY00/01 was approximately $20k. While the number of papers and articles might support publishing the journal six times a year, revenue from membership and subscriptions, (even given the proposed increase) would not be sufficient unless there was a substantial increase in advertising revenue. Currently there is nearly $8k in accounts receivable for placed advertising. After much discussion it was agreed that recruiting a person to solicit advertising is a very high priority. T. Kelsall and D. Giusti identified possible candidates and volunteered to contact these persons.

The possibility of publishing Canadian Acoustics as an e-journal, available either on CD-ROM or at the CAA website to members only, was discussed again at length. It was suggested that the issue be brought before the membership for general discussion.

Partnering with other Canadian acoustical associations (such as the Canadian Association of Audiologists) by allowing them access to Canadian Acoustics for publications, announcements, etc. was discussed. In such an arrangement CAA would receive funds from partner organizations to cover increased printing costs. R. Ramakrishnan and K. Fuller agreed to contact potential partners to assess the feasibility and report to the Board at the spring meeting.

(Acceptance of the Editor's report was moved by D. Giusti, seconded by, T. Kelsall carried).

Past and Future Conferences

2000 Sherbrooke: A full report had already been issued from this very successful conference.

2001 Toronto: D. Giusti, reported on the difficulties associated with organizing a conference. Attendance was expected to be about one hundred with break-even or a slight surplus being achieved.

2002 Charlottetown: A. Cohen announced the conference will be held 8-10 October and that the venue has been booked. The first announcement will appear in the December issue of Canadian Acoustics.

2003 Western Canada: Calgary or Edmonton were mentioned as possible locations. John Bradley to follow-up.

Award Coordinator's Report

K. Fuller reported that all awards would be given this year. The recipients will be announced at the luncheon of the final day of the Alliston Conference. They are:

Directors Awards:

Nicole Collison and Stan Dosso, "A comparison of modal decomposition algorithms for matched-mode processing"

Christian Gigure, Sharon Abel and Robert Arrabito, "Binaural technology for application to active noise reduction communication headsets: Design considerations."

John O'Keefe and John Bradley, "Acoustical renovation of the Orpheum, Vancouver – I. Measurements prior to renovation."

Fessenden Student Prize in Underwater Acoustics

Anna-Liesa Lapinski, University of Victoria, "Geoacoustic Inversion Using an Adaptive Hybrid Algorithm"

Eckel Prize in Noise Control

Eva-Marie Nosal, University of British Columbia, "Novel room-acoustical prediction model"

Alexander Graham Bell Prize

Ian Wilson, University of British Columbia, "Variability in Articulation"

Student Presentation Awards

Maxime Bolduc, "Experimental characterization of SEA damping loss factor"

Jay Detsky, "SYMEAS program for acoustical modeling of muffler systems"

Terence Miranda, "Temporally jittered speech produces PI-PB rollover in young normal-hearing listeners"

Shaw Postdoctoral Award

Frank Russo, Queens University, "Effects of music exposure on prosodic perception"

Youth Science

Jasmine Tait, Ottawa, "Improving the acoustics of the flute." Jasmine also won the silver medal in Junior Engineering.

There was discussion regarding the following:

Hetu Award: The Committee rejected the Board's suggestion to name the best student presentation at the annual conference after Reymond Hetu, instead they wished it to be a book prize given to an undergraduate for a project and report in acoustics. It is hoped that the revised awards brochure to be circulated in 2002 will include this award.

Underwater Student Travel Subsidy: Approximately $10k was received from the Signal Processing Institute Fund to help support student travel to a conference where they will present their research work relating to signal processing or underwater acoustics. The award will be available for the first time in September 2002. The awards brochure will have more information.

Awards Brochure: The revised awards brochure will be based on the existing one-page format but with an announcement page that can be posted on a bulletin board. The CAA web address will be featured prominently, as it will the source for the application forms. K. Fuller is responsible and will find a volunteer to provide the French translation.

K. Fuller will forward the revised brochure to the Secretary who will e-mail copies to all CAA members with an e-mail address.

CAA Website

D. Stredulinsky reported that the new website has been operational for some time and thanks should be given to Francine Descharnais for her work in translating the English pages into French. An index page for Canadian Acoustics has been added. R. Ramakrishnan agreed to maintain the database of authors, titles and pages of back issues. The Board thanked D. Stredulinsky for his very hard work on this important initiative.

The Secretary agreed to forward electronic copies of the minutes of Board and Annual General Meetings, where available.

International Meetings

Rumours had been suggesting that Vancouver might be the site of the 2005 INTERNOISE conference. Since CAA had not been contacted, J. Bradley will write to President of International INCE requesting clarification and more information.

Other Business (Nominations)

By reason of term limitations or resignation the following positions will need to be filled: Director (D. Whicker), Director (D. DeGagne) and Secretary (T. Nightingale).

Adjournment

D. Giusti moved to adjourn the meeting, seconded by T. Kellsal, carried. Meeting adjourned at 9:40 p.m.

Special Action Items Arising from the Meeting

J. Bradley

Write letter to International INCE regarding INTERNOISE meetings in Canada.

Write letter explaining the need for the modest fee increase.

Contact possible organizers in Alberta for the 2003 conference.

D. Giusti

Contact suitable person to solicit Journal advertising. Report findings at the Spring Board meeting.

K. Fuller

Update the Awards Brochure and have it translated into French. Circulate to Board Members.

T. Nightingale

Forward copies of the Board and AGM Minutes to D. Stredulinsky for posting at the website.

R. Ramakrishnan

Contact other Canadian acoustical associations regarding a possible partnership and sharing or the journal and/or conferences. Report findings at the Spring Board meeting.

The Canadian Acoustical Association
l'Association Canadienne d'Acoustique

MEMBERSHIP DIRECTORY 2000 / ANNUAIRE DES MEMBRES 2000

The number that follows each entry refers to the areas of interest as coded below.

Le nombre juxtaposé à chaque inscription réfère aux champs d'intérêt tels que condifés ci-dessous

Areas of interest		Champs d'intérêt
Architectural acoustics	1	Acoustique architecturale
Engineering Acoustics / noise Control	2	Génie acoustique / Contrôle du bruit
Physical Acoustics / Ultrasonics	3	Acoustique physique / Ultrasons
Musical Acoustics / Electroacoustics	4	Acoustique musicale / Electroacoustique
Psycho- and Physio-acoustics	5	Psycho- et physio-acoustique
Shock and Vibration	6	Chocs et vibrations
Hearing Sciences	7	Audition
Speech Sciences	8	Parole
Underwater Acoustics	9	Acoustique sous-marine
Signal Processing / Numerical Methods	10	Traitement des signaux / Méthodes numériques
Other	11	Autre

Adel A. Abdou
King Fahd University of Petroleum & Minerais
Architectural Engineering Dept.
P.O. Box 1917,Dharan 31261, Saudi Arabia
+966 (03) 860-2762;
FAX:+966 (03) 860-3785
adel@dpc.kfupm.edu.sa
Member, 1,2,10

Dr. Sharon M. Abel
Defence & Civil Ins. Of Environ. Medicine
Human Factors of Command Systems Section
PO box 2000
1133 Sheppard Ave. W
Toronto, ON Canada M3M 3B9
(416) 635-2000
FAX: (416) 635-2013
sharon.abel@dicem.dnd.ca
Member, 5,6,8

ACO Pacific Inc.
2604 Read Ave.
Belmont, CA USA 94002
(650) 595-8588
FAX: (650) 591-2891
acopac@acopacific.com
Sustaining Member

Acoutherm Insulation Ltd.
745 Garyray Drive
Weston, ON Canada M9L 1R2
(416) 744-0151
FAX: (416) 744-6189
Member, 1,5,7

Mr. Roger Arkwright
Owens Corning Canada Inc
R.R. #5 Orangeville, ON
Canada L9W 2Z2
(877) 942-0548
FAX: (877) 942-0456
roger.arkwright@owenscorning.com
Member

Acquisitions Unit (DSC-AO)
British Library
Boston Spa
Wetherby - W Yorks LS23 7BQ, England
Indirect Subscriber

Aercoustics Engineering Limited
Barman & Associates
50 Ronson Drive, Suite 127
Rexdale, ON Canada M9W 1B3
(416) 249-3361
FAX: (416) 249-3613
Sustaining Member, 1,2,3,4,6,10

Bill Aird
Canadian Transportation Agency
15 Eddy Street
Hull, QC Canada K1A 0N9
Member

Mourad Akamil
Laval University
Dept. Mechanical Engineering
C.P. 2208, Succ. Terminus
Québec, QC Canada G1K 7P4
Member

Jean-Luc Allard
SNC/Lavalin Environment Inc.
Noise and Vibration Control
2271 Fernand-Lafontaine Blvd.
Longueuil, QC Canada J4G 2R7
(514) 651-6710
FAX: (514) 651-0885
allaj@snc-lavalin.com
Sustaining Member

Dr. D.L. Allen
Vibron Limited
1720 Meyerside Dr.
Mississauga, ON Canada L5T 1A3
(416) 670-4922; FAX: (416) 670-1698
Member, 1,5,7

Celse-kafui Amédin
Université de Sherbrooke
G.A.U.S., Dép. génie mécanique
2500 boul. Université
Sherbrooke, QC Canada J1K 2R1
(819) 821-7157; FAX: (819) 821-7163
celse-kafju.amedin@gme.usherb.ca
Member

Mr. Chris Andrew
Senior Acoustics Specialist
City of Toronto
Air Quality Improvement Branch
City Hall, 100 Queen St.
20th Fl., East Tower
Toronto, ON Canada M5H 2N2
(416) 392-0792; FAX: (416) 392-1456
candrew@city.toronto.on.ca
Member, 1,5

James R. Angerer
105 Florentia St.
Seattle, WA USA 98109
(206) 655-0975
james.r.angerer@boeing.com
Member, 1,6,8

Mr. Horst Arndt
Unitron Industries Ltd.
20 Beasley Drive
P.O. Box 9017
Kitchener, ON Canada N2G 4X1
(519) 895-0100; FAX: (519) 895-0108
Member, 2,6,8

G. Robert Arrabito
DCIEM
P.O. Box 2000
1133 Sheppard Ave. West
Toronto, ON Canada M3M 3B9
(416) 635-2033; FAX: (416) 635-2104
robbie@dciem.dnd.ca
Member, 5,9

ASFETM
3565 rue Jarry Est
Bureau 202
Montréal, QC Canada H1Z 4K6
(514) 729-6961; 888-lasfetm; FAX: (514) 729-8628
Member

S. Assaf
Straco, SA
Compiègne, France 60200
Member

Marc Asselineau
Peutz & Associes
34 rue de Paradis
F-75010 Paris, France
+33 1 45230500
FAX: +33 1 45230504
asselino@worldnet.fr
Sustaining Member, 1,4,5

Noureddine Atalla
Université de Sherbrooke
G.A.U.S., Dép. génie mécanique
2500 boul. Université
Sherbrooke, QC Canada J1K 2R1
(819) 821-7102
Member, 5,7,9

Youssef Atalla
1464, rue Choquette
Sherbrooke, QC Canada J1K 3B8
(819) 821-8000ext3106
yatalla@linus.gme.usherb.ca
Student, 2,8,9

Yiu Nam Au-Yeung
22 Edinburgh Dr.
Richmond Hill, ON Canada
L4B 1W3
(905) 764-8465
FAX: (905) 764-8465
Member, 1,5,7

Pascal Audrain
Université de Sherbrooke
G.A.U.S., Dép. génie mécanique
2500 boul. Université
Sherbrooke, QC Canada J1K 2R1
Member

K. Avval
MTII / Polyfab
7391 Pacific Circle
Mississauga, ON Canada L5T 2A4
Member

Mohamed Bahoura
Université du Québec à Chicoutimi
ERMETIS, DSA
555, boul. Université
Chicoutimi, QC Canada G7H 2B1
Member

Jeffery S. Bamford
1196 McCraney Street East
Oakville, ON Canada L6H 4S5
(416) 691-3839; FAX: (416) 465-9036
jBamford@EngineeringHarmonics.com
Member, 2,10,11

Olivier Bareille
Ecole Centrale de Lyon
Laboratoire de Tribologie et Dynamique des Systẽmes (UMR 5513 CRNS)
36 av. Guy de Collongue
Eculy Cedex, France 69131
Member

Laura Bateman
2834 Henderson Road
Victoria, BC Canada V8R 5M2
abateman.uvic.ca
Student

Mr. Alberto Behar
45 Meadowcliffe Dr.
Scarborough, ON Canada M1M 2X8
(416) 265-1816; FAX: (416) 265-1816
behar@sympatico.ca
Member, 1,5,8

Stephen W. Bennett
4317 Cliffmont Rd.
North Vancouver, BC Canada V7G 1J6
(604) 929-6942
Member, 1,5
Elliott H. Berger
Aero Company
Box 2020
Southbridge, MA USA 01550
Member

Lucie Bériault
Régie régionale santé & services sociaux Montérégie
Centre de documentation
1255, rue Beauregard
Longueuil, QC Canada J4K 2M3
(514) 928-6777ext4137;
FAX: (514) 928-6781
l.beriault@rrsss16.gouv.qc.
Member, 2,5,7,8

Serge Bérubé
Décibel Consultants Inc.
265 boul. Hymus, bureau 2500
Pointe-Claire, QC Canada
H9R 1G6
Member

Olivier Beslin
Université de Sherbrooke
G.A.U.S., Dép. génie mécanique
2500 boul. Université
Sherbrooke, QC Canada J1K 2R1
(819) 821-7157
FAX: (819) 821-7163
olivier.beslin@gme.usherb.ca
Member

Steven Bilawchuk
2228 Brennan Court
Edmonton, AB Canada T5T 6M3
(780) 492-4259
FAX: (780) 492-2200
sdb@ualberta.ca
Student, 1,2,10

Christian Bissonnette
851 Baron
St-Jérôme, QC Canada J7Y 4E1
(450) 436-2433
FAX: (450) 436-8495
christia.bissonnette@soucy-group.com
Member, 2,6,10

Mr. J. Blachford
H.L. Blachford Ltd.
977 Lucien l'Allier
Montréal, QC Canada H3G 2C3
(514) 938-9775; FAX: (514) 938-8595
jblach@blachford.ca
Member, 5

Olivier Blazière
Dalimar Instruments Inc.
193 Joseph Carrier
Vaudreuil-Dorion, QC Canada J7J 5V5
Member

Stephen Bly
Radiation Protection Bureau
Room 228A, 775 Brookfield Rd.
Ottawa, ON Canada K1A 1C1
(613) 954-0308; FAX: (613) 941-1734
sbly@hpb.hwc.ca
Member, 3,5

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Maxille Bolduc
Université de Sherbrooke
Faculté de génie
2500 boul. Université
Sherbrooke, QC Canada J1K 2R1
(819) 821-8000ext3151
mbolduc@mecano.gme.usherb.ca
Student, 2,4,10

Eugene H. Bolstad
51 Arcand Drive
St. Albert, AB Canada T8N 5V1
(780) 458-3140; FAX: (780) 458-1560
Courtesy Sub, 1,5

Martin Bouchard
University of Ottawa
School of Information Technology &
Engineering161 Louis Pasteur, Room A-337
P.O. Box 450, Station A
Ottawa, ON Canada K1N 6N5
Member

Ovila Bouchard
Société d'électrolyse et de chimie Alcan
Ltée
Service Environnement Santé Québec
C.P. 1500, Ed. 1
Jonquière, QC Canada G7S 4L2
Member

Alex Boudreau
Université de Sherbrooke
G.A.U.S., Dép. génie mécanique
2500 boul. Université
Sherbrooke, QC Canada J1K 2R1
Member

Mr. J.W. Boutilier
1143 Upper Paradise Road
Hamilton, ON Canada L9B 2N3
Member, 1,2,5

Mr. P.G. Bowman
Union Gas Ltd.
P.O. Box 2001, 50 Keil Dr. North
Chatham, ON Canada N7M 5M1
(519) 436-4600ext2873
FAX: (519) 436 5292
pbowman@uniongas.com
Member, 5

Jeff Boyczuk
McGill University
School of Communication Sciences and
Disorders
1266 Pine Avenue West
Montreal, QC Canada H3G 1A8
(514) 398-4135; FAX: (514) 398-8123
bwhe@musicb.mcgill.ca
Student, 5,7,8

J.S. Bradley
National Research Council Canada
Institute for Research in Construction
Acoustics Lab., Building M-27
Ottawa, ON Canada K1A 0R6
(613) 993-9747; FAX: (613) 954-1495
john.bradley@nrc.ca
Member, 1,2,4

Dr. A.J. Brammer
National Research Council Canada
Institute for Microstructural Science
Bldg. M-36
Ottawa, ON Canada K1A 0R6
(613) 993-6160; FAX: (613) 952-3670
Member, 5,6,7

David Brennan
Martec Ltd.
Suite 400, 1888 Brunswick Street
Halifax, NS Canada B3J 3J8
Member

Dawn Brommer
920 Hamel Rd
Hamel, MN USA 55340
(763) 478-9600; FAX: (763) 478-2431
dawn@maxxon.com
Member

Bruno Brouard
Laboratoire d'Acoustique de l'Université du
Maine
Institut d'Acoustique et de Mécanique
UMR CNRS 6613 - Av. O. Messiaen
Le Mans Cedex, France 72085
Member

Mr. David W. Brown
Brown Strachan Assoc.
Two Yaletown Sq., 1290 Homer St.
Vancouver, BC Canada V6B 2Y5
(604) 689-0514; FAX: (604) 689-2703
Member, 1,5,7

Joris Brun-Berthet
Ecole de technologie supérieure
Génie mécanique, Bureau 2140
1100 Notre Dame Ouest
Montréal, QC Canada H3C 1K3
(514) 396-8800ext7692
FAX: (514) 396-8530
joris@mech.stsmtl.ca
Student, 2,6,10

Paulin Buaka
Université de Sherbrooke
G.A.U.S., Dép. génie mécanique
2500 boul. Université
Sherbrooke, QC Canada J1K 2R1
Member

Mr. Claudio Bulfone
531 - 55A St.
Delta, BC Canada V4M 3M2
(604) 943-8224
FAX: (604) 666-3982
bulfonc@tc.gc.ca
Member, 1,5,7

Corjan Buma
10408 - 36 Ave.
Edmonton, AB Canada T6J 2H4
(403) 435-9172
FAX: (403) 435-9172
bumacj@superiway.net
Member, 1,4,5

Todd Busch
Acentech Incorporated
200-1429E Thousand Oaks Blvd.
Thousand Oaks, CA USA 91362
(805) 379-4778
FAX: (805) 379-1797
beowulf0@earthlink.net
Member

Mr. Angelo J. Campanella
Campanella Assoc.
3201 Ridgewood Drive
Columbus, OH USA 43026-2453
(614) 876-5108
FAX: (614) 771-8740
acampane@postbox.acs.ohio-state.edu
Member, 1,3,5

William J. Cavanaugh
Cavanaugh Tocci Assoc Inc.
3 Merifield Lane
Natick, MA USA 01760
(978) 443-7871
FAX: (978) 443-7873
cta@cavtocci.com
Member, 1,5,6

Mr. Yvan Champoux
Université de Sherbrooke
Dép. de génie mécanique
Faculté des sciences appliquées
Sherbrooke, QC Canada J1K 2R1
(819) 821-8000ext2146
FAX: (819) 821-7163
yvan.champoux@gme.usherb.ca
Member, 1,2,5

N. Ross Chapman
University of Victoria
School of Earth & Ocean Sciences
P.O. Box 3055
Victoria, BC Canada V8W 3P6
Member, 9

Mr. David M.F. Chapman
Defence Research Establishment Atlantic
P.O. Box 1012
Dartmouth, NS Canada B2Y 3Z7
(902) 426-3100
FAX: (902) 426-9654
dave.chapman@drea.dnd.ca
Member, 9,4

Brian Chapnik
HGC Engineering
Plaza One, Suite 203
2000 Argentia Rd.
Mississauga, ON Canada L5N 1P7
(905) 826-4044
FAX: (905) 826-4940
chapnik@me.me.utoronto.ca
Member, 2,5,7

Marie-Louise Charbonneau
Société d'électrolyse et de chimie Alcan
Ltée
C.P. 1500, Ed. 1
Jonquière, QC Canada G7S 4L2
Member

Mr. Marshall Chasin
34 Bankstock Dr.
North York, ON Canada M2K 2H6
(416) 733-4342
Member, 2,5,6

M. Cheesman
University of Western Ontario
Dept. of Communication Sciences and Disorders
Faculty of Health Sciences
Elborn College
London, ON Canada N6G 1H1
(519) 279-2111, ext. 8283
FAX: (519) 661-3805
cheesman@audio.hhcru.uwo.ca
Member, 5,7,8

Mr. Li Cheng
Université Laval
Dept. de génie mécanique
Fac. des sciences et de génie
Québec, QC Canada G1K 7P4
(418) 656-2199; FAX: (418) 656-7415
li.cheng@gmc.ulaval.ca
Member, 5,7

Mark Cheng
Vancouver International Airport Authority
P.O. Box 23750 Airport Postal Outlet
Richmond, BC Canada V7B 1Y7
mark_cheng@yvr.ca
Member

Chief Editor
Acoustics Australia
Acoustics Australia Lib.
Australian Def. Force Academy
Canberra, ACT 2600 Australia
Courtesy Sub

Dr. W.T. Chu
National Research Council Canada
Institute for Reserach in Construction
Acoustics Lab., Building M-27
Ottawa, ON Canada K1A 0R6
(613) 993-9742
FAX: (613) 954-1495
chu@irc.lan.nrc.ca
Member, 1,5,7

Wladyslaw Cichocki
University of New Brunswick
Dept. of French
Fredericton, NB Canada E3B 5A3
(506) 453-4651
FAX: (506) 453-3565
cicho@unb.ca
Member, 8

Lillian Ciona
1181 Melton Dr.
Mississauga, ON Canada L4Y 4A9
lgciona@julian.uwo.ca
Student, 2,5,7

CISTI M-20 Bldg. Branch
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(905) 374-5200; FAX: (905) 374-1157
jcodring@niagarafalls.acres.com
Member, 5,7

Dr. Annabel J. Cohen
University of Prince Edward Island
Dept. of Psychology
Charlottetown, PE Canada
C1A 4P3
(902) 628-4331; FAX: (902) 628-4359
annabel@ernie.psyc.upei.ca
Member, 4,6,8

Nick Coleman
Canadian National Railway
1 Administration Road
Concord, ON Canada
Member

Nicole Collison
Defence Research Establishment Atlantic
9 Grove St., PO Box 1012
Dartmouth, NS Canada B2Y 3Z7
collison@drea.dnd.ca
Member, 3,9,10

Robert J Collum
25170 - 28th Avenue
Aldergrove, BC Canada V4W 2R2
(614) 607-7044; FAX: (604) 607-6669
rjcollum@ussi.com
Member, 1,2

Vincent Cotoni
Ecole Centrale de Lyon
LTDS - UMR CNRS 5513
36, av. Guy de Collongue, B.P. 163
Ecully Cedex, France 69131
Member

J.E. Coulter Associates Ltd.
211-1210 Sheppard Ave. E
Toronto, ON Canada M2K 1E3
(416) 502-8598; FAX: (416) 502-3473
jcoulter@idirect.com
Sustaining Member, 1,5,7

Dany Couture
Bombardier Aerospace
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123 Garrat Blvd., MS N 18-06
Downsview, ON Canada M3K 1Y5
Member

C S I, I 894
Direction Mediatheque - Phys
30 av Corentin Cariou
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Indirect Subscriber

CSST, Centre de Doc.
1199 rue de Bleury, 4e
C.P. 6067, Succ. Centre-Ville
Montréal, QC Canada H3C 4E2
Direct Subscriber

Dr. Lola Cuddy
Queen's University
Dept. of Psychology
Kingston, ON Canada K7L 3N6
(613) 545-6013
FAX: (613) 545-2499
cuddyl@psyc.queensu.ca
Member, 4,5,7

Dr. Gilles Daigle
National Research Council Canada
Inst. for Microstructural Science
Ottawa, ON Canada K1A 0R6
Member, 3,5

Dalimar Instruments Inc.
193, Joseph Carrier
Vaudreuil-Dorion, QC Canada
J7V 5V5
(514) 424-0033
FAX: (514) 424-0030
dalimar@mlink.net
Sustaining Member, 1,4,5

Nicolas Dauchez
Technopole Université
Centre de Transfert de Technologie du Mans (CTTM)
Le Mans, France 72000
Member

Davidson & Associates Inc.
392, rue Principale
Saint Joval, QC Canada J0R 1R0
(450) 227-4248
FAX: (450) 227-1613
Direct Subscriber, 1,2,6

Dr. Huw G. Davies
University of New Brunswick
Dept. of Mechanical Engineering
P.O. Box 4400
Fredricton, NB Canada E3B 5A3
(506) 453-4513
FAX: (506) 453-5025
davies@unb.ca
Member

Peter Davis
Faszer Farquharson & Associates Ltd.
304-605 1st Street S.W.
Calgary, AB Canada T2P 3S9
(403) 508-4996
FAX: (403) 508-4998
ffa@internode.net
Member, 2,4,5

Jack L. Davis
6331 Travois Crescent NW
Calgary, AB Canada T2K 2S8
(403) 290-7365; FAX: (403) 290-7227
Member, 2,7

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Jean-Claude Debus
Institut Supérieur d'Electronique du Nord
Dép. Acoustique, 41, boul. Vauban
Lille Cedex, France 59046
Member

Stéphane Dedieu
Hitel Corporation
350 Legget Dr., P.O. Box 13089
Kanata, ON Canada K2K 2W7
Member

David DeGagne
Alberta Energy and Utilities Board
640 - 5th Ave. SW
Calgary, AB Canada T2P 3G4
(403) 297-3200; FAX:(403) 297-3520
degagd@mail.eub.gov.ab.ca
Member, 10

Professeur J. Dendal
Univ. de Liège, Serv. d'Ac. App.
Bulletin d'Acoustique, SartTilman (B.28)
Liege, B 4000 Belgique
Courtesy Sub

Mark Derrick
HFP Acoustical Consultants Corp.
#1140, 10201 Southport Rd. SW
Calgary, AB Canada T2W 4X9
(902) 259-6600; FAX: (403) 259-6611
Member

Francine Desharnais
Defence Research Establishment Atlantic
P.O. Box 1012
Dartmouth, NS Canada B2Y 3Z7
(902) 426-3100x219
FAX: (902) 426-9654
desharnais@drea.dnd.ca
Member, 9

Jay Detsky
42 Misty Crescent
Toronto, ON Canada M3B 1T3
Student

Terry J. Deveau
3 Shore Road
Herring Cove, NS Canada B3V 1G6
(902) 468-3007ext209;
FAX: (902) 468-3009
deveau@seimac.com
Member, 3,9,10

B. Craig Dickson
Speech Technology Research
1623 McKenzie Ave., Suite B
Victoria, BC Canada V8N 1A6
(250) 477-0544; FAX: (250) 477-2540
craig@speechtech.com
Member, 7,12

Ait-Ali-Yahia Djaffar
Pratt & Whitney Canada
Dept. Analytical Systems
1000 Marie-Victorin (01SR4)
Longueuil, QC Canada J4G 1A1
Member

Stan Dosso
University of Victoria
School of Earth and Ocean Sciences
P.O. Box 3055
Victoria, BC Canada V8W 3P6
(250) 472-4341; FAX: (250) 721-6200
sdosso@uvic.ca
Member, 9,10,11

Paul Downey
CSR Industries Inc.
33 Craighurst Avenue
Toronto, ON Canada M4R 1J9
(416) 440-1094; FAX: (416) 440-0730
pcd@regupol.com
Sustaining Member, 1,2,6

Teresa Drew
Jacques, Whitford & Associates Ltd.
3 Spectacle Lake Dr.
Dartmouth, NS Canada B3B 1W8
(902) 468-7777; FAX: (902) 468-9009
tdrew@jacqueswhitford.com
Member

Jan Eckstein
Industrial Health Foundation Inc.
34 Penn Circle West
Pittsburgh, PA USA 15206
Courtesy Sub

Prof. M. David Egan
P.O. Box 365
Anderson, SC USA 29622-0365
(864) 226-3832
Member, 1,2,5

Dr. Jos J. Eggermont
University of Calgary
Dept. of Psychology
2500 University Drive NW
Calgary, AB Canada T2N 1N4
(403) 220-5214; FAX: (403) 282-8249
eggermon@acs.ucalgary.ca
Member, 6,8

Ahmed Aki El-khateeb
8b- Shakh Olish St
Ibn Sender Sq.
Post Code 11331
Cairo, Egypt
archoo@link.net
Student

Gilles Elhadad
5715 Kincourt
Cote St Luc, QC Canada H4W 1Y7
(514) 487-7159
FAX: (514) 487-9525
Member, 1,5

Dr. Dale D. Ellis
Defence Research Establishment Atlantic
P.O. Box 1012
Dartmouth, NS Canada B2Y 3Z7
(902) 426-3100ext. 104
FAX: (902) 426-9654
ellis@drea.dnd.ca
Member, 3,9

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Library, 2nd Level
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Edmonton, AB Canada T5P 4C5
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FAX: (403) 987-2282
fabrawall@fabra-wall.ab.ca
Direct Subscriber, 1,5,10

James Farquharson
Faszer Farquharson & Associates Ltd.
304-605 1st Street S.W.
Calgary, AB Canada T2P 3S9
(403) 508-4996
FAX: (403) 508-4998
ffa@internode.net
Member, 1,2,4

Clifford Faszer
Faszer Farquharson & Associates Ltd.
304-605 1st Street S.W.
Calgary, AB Canada T2P 3S9
(403) 508-4996
FAX: (403) 508-4998
ffa@internode.net
Member, 1,2,6

Dr. M.G. Faulkner
University of Alberta
Dept. of Mechanical Engineering
Edmonton, AB Canada T6G 2G8
(403) 492-3446
FAX: (403) 492-2200
Member, 1,5,7

Mr. James L. Feilders
Jade Acoustics Inc.
545 N Rivermede Rd., Suite 203
Concord, ON Canada L4K 4H1
(905) 660-2444
FAX: (905) 660-4110
jade_acoustics@compuserve.com
Member, 1,5,7

D. Fiorina
Treves-Cera
5, rue Emile Arques, B.P. 204
Reims Cedex 2, France 51686
Member

Raymond Fischer
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Billerica, MA USA 01821
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noise@tiac.net
Member

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Indirect Subscriber

Peter J. Flipsen
University of Tennessee
Dept. of Audiology & Speech Pathology
425 South Stadium Hall
Knoxville, TN USA 37996
(865) 974-0354; FAX: (865) 974-1439
pflipsen@utk.edu
Member, 5,7,8

Olivier Foin
Bombardier Transport
1101 Parent
St-Bruno, QC Canada J3V 6E6
Member

John Foley
Polytec Pi Inc.
212-23 Midstate Drive
Auburn, MA USA
Member

John E.K. Foreman
1717 Ohillbrook Cresc.
London, ON Canada N5X 2Z5
(519) 672-3689; FAX: (519) 672-3689
jforma2@julian.uwo.ca
Member, 1,2,5

Harold Forester
1434 Franklin Dr.
Laval, QC Canada H7W 1K6
(450) 681-2333; FAX: (450) 681-2354
forester@ican.net
Member, 1,5,7

Mr. Stanley Forshaw
3958 Sherwood Rd.
Victoria, BC Canada V8N 4E6
(250) 721-4075
Member, 8

Dr. Claude R. Fortier
State of the Art Acoustik Inc
43-1010 Polytek St.
Ottawa, ON Canada K1J 9J3
(613) 745-2003
FAX: (613) 745-9687
Member, 1,2,5

Mr. Leslie Frank
HFP Acoustical Consultants Corp.
10201 Southport Rd. SW, #1140
Calgary, AB Canada T2W 4X9
(403) 259-3600; FAX: (403) 259-4190
les@hfpacoustical.com
Member, 1,5,6

Karen Fraser
Canadian National Railway
8th Floor, 277 Front St. West
Toronto, ON Canada M5V 2X7
karen.fraser@cn.ca
Member

Ron Freiheit
Wenger Corp.
555 Park Dr.
Owatonna, MN USA 55060
(507) 455-4100; FAX: (507) 455-4258
rwenger@pan.com
Member, 1,4,5

M.K. Fuller
University of British Columbia
Audiology & Speech Sciences
5804 Fairview Ave.
Vancouver, BC Canada V6T 1Z3
(604) 822-4716; FAX: (604) 822-6569
kpf@audiospeech.ubc.ca
Member, 6,8

W. Robert J. Funnell
McGill University
Dept. of BioMedical Engineering
3775 rue University
Montréal, QC Canada H3A 2B4
(514) 398-6739
FAX: (514) 398-7461
r.funnell@med.mcgill.ca
Member, 5

Mr. V. Gambino
Aercoustics Eg. Ltd.
127-50 Ronson Dr.
Rexdale, ON Canada M9W 1B3
(416) 249-3361
vgambino@aercoustics.com
Member, 1,2,5

Dr. Robert Gaspar
Spaarg Engineering Limited
Noise and Vibration Analysis
822 Lounsborough Street
Windsor, ON Canada N9G 1G3
(519) 972-0677
FAX: (519) 972-1811
gasparr@engn.uwindsor.ca
Member, 1,5,7

Mr. Wm. Gastmeier
HGC Engineering Ltd.
Plaza One, Suite 203
2000 Argentia Rd.
Mississauga, ON Canada L5N 1P7
(905) 826-4044
FAX: (905) 826-4940
bgastmeier@hcgengineering.com
Member, 1,5,7

Roch Gaudreau
Soucy Baron Inc.
851 Baron
St-Jérome, QC Canada
Member

Frank Gerdes
Institute of Ocean Sciences
P.O. Box 6000
Sidney, BC Canada V8L 4B2
(250) 363-6587
FAX: (250) 363-6789
gerdi@uvic.ca
Student, 3,9

Sebastien Ghinet
Université de Sherbrooke
Dép. génie mécanique
2500 boul. Université
Sherbrooke, QC Canada J1K 2R1
(819) 821-8000ext3152
FAX: (819) 821-7163
sghinet@linus.gme.usherb.ca
Student, 1,2,10

Bryan Gick
University of British Columbia
Dept. of Linguistics
E270 - 1866 Main Mall
Vancouver, BC Canada V6T 1Z1
(604) 822-4817
FAX: (604) 822-9687
gick@interchange.ubc.ca
Member, 8

Mr. Hazem Gidamy
S.S. Wilson & Assoc.
307-9011 Leslie Street
Richmond Hill, ON Canada L4B 3B6
(905) 707-5800
Member, 1,5,7

Mr. Philip Giddings
Engineering Harmonics
29A Leslie Street
Toronto, ON Canada M4M 3C3
(416) 691-3839; FAX: (416) 691-9013
pgiddings@engineeringharmonics
.com
Member, 1,2,6

Christian Giguere
Université d'Ottawa
Programme d'audiologie et d'orthophonie
545 King-Edward
Ottawa, ON Canada K1N 6N5
(613) 562-5800ext3071
FAX: (613) 562-5256
cgiguere@uottawa.ca
Member, 5,7,8

Layton Gilroy
Defence Research Establishment Atlantic
P.O. Box 1012
Dartmouth, NS Canada B2Y 3Z7
Member

Dalila Giusti
Jade Acoustics Inc.
203-545 N Rivermede Rd.
Concord, ON Canada L4K 4H1
(905) 660-2444; FAX: (905) 660-4110
jade_acoustics@compuserve.com
Member, 1,5,7

Blaise Gosselin
Hydro-Quebec
Ligne, Cable et environnement
800 de Maisonneuve est, 21e etage
Montréal, QC Canada H2L 4M8
(514) 840-3000ext5134
FAX: (514) 840-3137
gosselin.blaise@hydro.qc.ca
Sustaining Member

Mr. Manfred W. Grote
ARCOS Acoustical Cons. Ltd.
101 - 1400 Kensington Rd. NW
Calgary, AB Canada T2N 3P9
(403) 283-1191
FAX: (403) 283-1125
arcos@oanet.com
Member, 1,2,5

Roberto Guadagno
Brampton Audiology
106-36 Vodden St. E
Brampton, ON Canada L6V 4H4
(905) 874-1170
FAX: (905) 874-4785
Member, 5,7,8

Dr. Jingnan Guo
University of Western Australia
Dept. Mech. & Mat. Eng.
Nedlands, Australia WA 6907
(08) 93801806
FAX: (08) 93801024
jing@mech.uwa.edu.au
Member, 1,2,10

Dr. A. Guran
Institute for Structronics
275 Slater Street, 9th Floor
Ottawa, ON Canada K1P 5H9
(613) 562-5800ext4253
FAX: (613) 562-5149
guran@magma.ca
Member, 2,6,9

Dr. R.W. Guy
Concordia University
C.B.S.
1455 de Maisonneuve W.
Montréal, QC Canada H3G 1M8
(514) 848-3191
FAX: (514) 848-7965
guy@cbs.engr.concordia.ca
Member, 1,5

Joseph Hall
McMaster University
Dept. Mechanical Engineering
JHE-316
Hamilton, ON Canada L8S 4L7
(905) 878-9696
FAX: (905) 572-7944
halljw@mcmaster.ca
Student, 2,6,11

M.A. Hamdi
DAVI, University of Technology of Compiègne
B.P. 233
Compiègne Cedex, France 60206
Member

Jean-Francois Hardy
1206 de la Sapinière
Cap-Rouge, QC Canada G1Y 1A2
(418) 659-2385
jfhardy@hotmail.com
Student, 1,4

Dr. David I. Havelock
National Research Council Canada
IMS, Acoustics & Sig. Proc. Grp.
Bldg. M-36, Montreal Road
Ottawa, ON Canada K1A 0R6
(613) 993-7661;
FAX: (613) 952-3670
david.havelock@nrc.ca
Member, 10

HGC Engineering
Howe Gastmeier Chapnik Ltd.
Plaza One, Suite 203
2000 Argentia Rd.
Mississauga, ON Canada L5N 1P7
(905) 826-4044;
FAX: (905) 826-4940
Sustaining Member

Rick Hedges, P.Eng
SPL Control Inc.
1400 Bishop St.
Cambridge, ON Canada N1R 6W8
(519) 623-6100; FAX: (519) 623-7500
rhedges@splcontrol.com
Member, 5

Mr. John Hemingway
1203 Upper Village Dr
Mississauga, ON Canada L5E 3J6
(905) 949-0915
FAX: (905) 949-0915
jrh@mail.globalserve.net
Member, 1,5,7

M. Salem Hertil
3 Kenyon Avenue
Wrexham, Wales, United Kingdom LL11 2SP
Student, 1,2,6

Carolyn Higgins
405, 8149 - 111 St.
Edmonton, AB Canada T6G 2P1
(780) 432-5216
chiggins@ualberta.ca
Student, 7,8

Mr. Ralph K. Hillquist
RKH Consults Inc.
P.O. Box 38
Benzonia, MI USA 49616
(616) 882-0234
FAX: (616) 882-0234
hillquis@benzie.com
Member, 1,5,6

Ms. Angela Hitti
Cambridge Scientific Abstracts
7200 Wisconsin Ave.
Bethesda, MD USA 20814
Courtesy Sub

Anne-Christine Hladky-Hennion
IEMN, Dép, ISEN
41 boul. Vauban
Lille Cedex, France 59046
Member

Megan Hodge, Ph.D.
University of Alberta
Speech Pathology & Audiology
Rm 2-70 Corbett Hall
Edmonton, AB Canada T6G 2G4
(403) 492-5898
FAX: (403) 492-1626
megan.hodge@ualberta.ca
Member, 8

Bill Hodgetts
407 Baker St.
London, ON Canada N6C 1X8
(519) 438-6509
bill.hodgetts@sympatico.ca
Student, 7,8

Dr. Murray Hodgson
University of British Columbia
Occupational Hygiene Programme
2206 East Mall, 3rd Fl.
Vancouver, BC Canada V6T 1Z3
(604) 822-3073
FAX: (604) 822-9588
hodgson@mech.ubc.ca
Member, 1,5

Mr. J.T. Hogan
University of Alberta
Dept. of Linguistics
4 20 Assiniboia Hall
Edmonton, AB Canada T6G 2E6
(403) 492-3480
FAX: (403) 492-0806
Member, 4,8

Dr. David Holger, Editor
Noise Control Engineering Journal
Iowa State University, College of Engineering
104 Marston Hall
Ames, IO USA 50011-2151
Courtesy Sub

Mr. Brian Howe
HGC Engineering
Plaza One, Suite 203
2000 Argentia Rd.
Mississauga, ON Canada L5N 1P7
(905) 826-4044
FAX: (905) 826-4940
bhowe@hgcengineering.com
Member, 1,5,7

Lin Hu
Forintek Canada Corp.
319 rue Franquet
Ste-Foy, QC Canada G1P 4R4
(418) 659-2647; FAX: (418) 659-2922
Member, 1,2,3

Daniel Hutt
Defence Research Establishment Atlantic
P.O. Box 1012
Dartmouth, NS Canada B2Y 3Z7
(902) 426-3100ext218
FAX: (902) 426-9654
daniel.hutt@drea.dnd.ca
Member, 9,10

IAPA
Information Centre
250 Yonge St., 28th Fl.
Toronto, ON Canada M5B 2L7
(416) 506-8888
FAX: (416) 506-8880
Direct Subscriber

Najib Ichchou
Ecole Centrale de Lyon
Dép. MSGMGC
LTDS UMRS CNRS 5513
36 av. Guy de Collongue
Ecully Cedex, France 69130
Member

Inspec Bin 335
B883-P
P.O. Box 830703
Birmingham, AL USA 35283-0703
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Integral DX Engineering Ltd.
907 Admiral Ave.
Ottawa, ON Canada K1Z 6L6
(613) 761-1565; FAX: (613) 729-4337
Sustaining Member, 1,5,7

Prof. Nickolay I. Ivanov
Baltic State Technical University
P.O. Box 08A9
1st Krasnoarmeyskaya St., 1
198008, St. Petersberg, Russia
+7.812.110.1573
FAX: +7.812.316.1559
noise@mail.rcom.ru
Courtesy Sub

Jade Acoustics Inc.
203-545 N Rivermede Rd.
Concord, ON Canada L4K 4H1
(905) 660-2444; FAX: (905) 660-4110
Sustaining Member

Carol Jaeger
105 - 975 Chilco St.
Vancouver, BC Canada V6G 2R5
(604) 669-8120
FAX: (604) 669-8127
cj@ieee.org
Student, 7,8,10

Taha Jaffer
University of Toronto
Institute of Biomaterials & Biomedical Engineering
27 King's College Circle
Toronto, ON Canada M5S 1A1
Member

Dr. Donald G. Jamieson
University of Western Ontario
Hearing Health Care Res. Unit
Elborn College
London, ON Canada N6G 1H1
(519) 661-3901
FAX: (519) 661-3805
jamieson@audio.hhcru.uwo.ca
Member, 2,6,8

Luc Jaouen
Université de Sherbrooke
Groupe dácoustique & vibrations
Dép génie mécanique
Sherbrooke, QC Canada J1K 2R1
(819) 821-8000ext3152
luc.jaouen@gaus.gme.usherb.ca
Student, 2,6,10

Dr. Yan Jia
Vienna International Centre
c/o CTBTO, P.O. Box 1250
A-1400 Vienna, Austria
Member, 3,6,9

Mr. R.B. Johnston
International Hearing Aids Ltd.
349 Davis Road
Oakville, ON Canada L6J 5E8
(905) 845-8892; FAX: (905) 845-7380
Member, 2,6,8

Véronique Joly
Office des Transports du Canada
15, rue Eddy, Pièce 1926
Ottawa, ON Canada K1A 0N9
Member

Dr. H.W. Jones
18 Eastland Close
West Cross, Swansea, Glamorgan, Wales
United Kingdom SA3 5NU
Member, 1,3,5

J.P. Environmental Products Inc.
P.O. Box 816, Station C
Kitchener, ON Canada N2G 4C5
(519) 662-3220; FAX: (519) 662-3223
jpenviro@golden.net
Direct Subscriber, 1,5,7

S Kandaswamy
I.I.T. Madras, Building Technology Div
Dept of Civil Engineering
Chennai-600036, India
0091-44-4892870; FAX: 0091-44-8261848
kanda_swamy@hotmail.com
Student, 1,2,6

Jose A. Karivelil
Alcan
Box 1500
Jonquiere, QC Canada G7S 4L2
(418) 699-2111ext 6664
FAX: (418) 699-2993
jose_karivelil@alcan.com
Member, 5,7

Stephen E. Keith
Radiation Protection Bureau, Health Canada
Acoustics Unit, Non-ionizing Radiation Section
Rm 228, 775 Brookfield Rd., 6301B
Ottawa, ON Canada K1A 1C1
(613) 941-8942
FAX: (613) 941-1734
skeith@hpb.hwc.ca
Member, 1,2,5,7,10

Mr. Thomas Kelly
185 Clearview Avenue
Apartment 1007
Ottawa, ON Canada K1Z 6R9
(613) 563-5576
FAX: (613) 563-7889
kellytj@navcanada.ca
Member, 2,3,5

Tim Kelsall
Hatch Associates Ltd.
Sheridan Science & Technology Park
2800 Speakman Dr.
Mississauga, ON Canada L5K 2R7
(905) 403-3932
FAX: (905) 855-8270
tkelsall@hatch.ca
Sustaining Member, 1,5

Tim Kelsey
Eckel Industries of Canada Ltd.
P.O. Box 776, 15 Allison Ave.
Morrisburg, ON Canada K0C 1X0
Member

Mr. Leslie G. Kende
105 Clifton Road
Toronto, ON Canada M4T 2G3
(416) 489-3193
FAX: (416) 440-6973
Member, 1,5,7

Andrew Khoury
Bruel & Kjaer International
90 chemin Leacock
Pointe-Claire, QC Canada H9R 1H1
(514) 695-8225; FAX: (514) 695-4808
andrew.khoury@bksv.com
Member

Niranjan Reddy Konepally
1609-1650 rue Lincoln
Montreal, QC Canada H3H 1H1
konepally@onebox.com
Student

Mr. John J. Kowalewski
Ontario Power Technologies
800 Kipling Avenue, KB 223
Toronto, ON Canada M8Z 6C4
(416) 207-6178; FAX: (416) 231-5862
kowalewj@ont.hydro.on.ca
Member, 1,2,6

Dr. Steven Kraemer
T.U.V. Rheinland
1-344 Sheppard Ave. E
North York, ON Canada M2N 3B4
(416) 733-3677; FAX: (416) 733-7781
kraemer@tuv.com
Member, 1,2,5

Mr. C.A. Krajewski
95 Southill Drive
Don Mills, ON Canada M3C 2H9
(416) 440-3590
FAX: (416) 440-6973
Member, 1,2,6

Krish Krishnappa
National Research Council Canada
Institute for Aerospace Research
Bldg. M-7
Ottawa, ON Canada K1A 0R6
(613) 993-2469
FAX: (613) 990-3617
kirsh.krishnappa@nrc.ca
Member

Kelly Kruger
Alberta Infrastructure Building
Property Development
6950 - 113 Street, 3rd Floor
Edmonton, AB Canada T6H 5V7
Member

Mr. Verne Kucy
The Corporation of Delta
4500 Clarence Taylor Cr.
Delta, BC Canada V4K 3E2
(604) 946-3281
FAX: (604) 946-3240
Member

Hans Kunov
University of Toronto
Inst. Biomedical Engineering
Rosebrugh Bldg.
Toronto, ON Canada M5S 3G9
(416) 978-6712
FAX: (416) 978-3417
kunov@ibme.utoronto.ca
Member, 5,7,10

Andre L'Esperance
Université de Sherbrooke
Dept. Mechanical Engineering
2500 University Blvd.
Sherbrooke, QC Canada J1K 2R1
(819) 821-7102
FAX: (819) 821-7163
andre@sulu.gme.usherb.ca
Member

Pierre Lamary
ISMCM-CESTI
Lab de Structures, Acoustique & Rhéologie
3 rue Fernand Hainaut
93400 Saint Ouen, France
Member

Christian Langlois
Université de Sherbrooke
Dép. Génie mécanique
Groupe d'acoustiques
2500, boul. Université
Sherbrooke, QC Canada J1K 2R1
(819) 564-3004
FAX: (819) 821-7163
christian.langlois@sympatico.ca
Student, 2,3,6,9,10

Anna-Liesa Lapinski
1330 Vimy Place
Victoria, BC Canada V8S 1C6
(250) 472-4342
a_lipinski@hotmail.com
Student, 3,9,10

Robby Lapointe
Bombardier Aerospace
123 Garratt Blvd. MS N 18-06
Downsview, ON Canada M3K 1Y5
Member

Dr. Chantai Laroche
Universite d'Ottawa.
Ecole des Sciences de la réadaptation
Prog. d'audiologie et d'orthophonie
Pavillon Guindon
3062-451 chemin Smyth
Ottawa, ON Canada K1H 8M5
(613) 562-5800ext3066
FAX: (613) 562-5428
claroche@uottawa.ca
Member, 5,6,8

Philippe Le Bec
Treves-Cera
5, Emile Arques, B.P. 204
Reims Cedex 2, France 51686
Member

Estelle Leboucher
Université de Sherbrooke
Dép. de génie mécanique
2500 boul. Université
Sherbrooke, QC Canada J1K 2R1
(819) 821-8000ext3106
FAX: (819) 821-7163
elebouch@gaus.gme.usherb.ca
Student, 2,3,6

Gaétan Lecours
Bombardier Produits Récréatifs Inc.
555, rue de la Montagne
Valcout, QC Canada J0E 2L0
Member

Louis Lefebvre
Bombardier
565 de la Montagne
Valcourt, QC Canada J0E 2L0
(450) 532-2211; FAX: (450) 532-6333
Member, 2,6,10

Gilles Leroux
Decibel Consultants Inc.
2500-265 boul. Hymus
Pointe-Claire, QC Canada H9R 1G8
Member

Tony Leroux
Université de Montréal
Ecole d'orthophonie & d'audiologie, Fac. Médecine
C.P. 6128, Succ. Centre-Ville
Montréal, QC Canada H3C 3J7
(514) 343-2499; FAX: (514) 343-2115
tony.leroux@umontreal.ca
Member, 5,6,8

Chi-Nin Li
8720 Delaware Road
Richmond, BC Canada V7C 4Y3
(604) 970-6896
clia@sfu.ca
Student, 8

Library
Defence Research Establishment Atlantic
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Dartmouth, NS Canada B2Y 3Z7
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Mr. A.D. Lightstone
Valcoustics Canada Ltd.
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Richmond Hill, ON Canada
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Dr. Stanley P. Lipshitz
University of Waterloo
Dept. of Applied Mathematics
Waterloo, ON Canada N2L 3G1
(519) 885-1211ext3755
FAX: (519) 746-4319
spl@audiolab.uwaterloo.ca
Member, 2,3,6

Alexander P. Lorimer
7 Bent Oak Circle
Mississauga, ON Canada L5N 4J2
(905) 542-2796
Member, 1,5,7

Reginald W. Low
Sound Concepts Canada Inc.
599 Henry Avenue
Winnipeg, MB Canada R3A 0V1
(204) 783-6297
FAX: (204) 783-7806
Member, 1,2,7

Thierry Loyau
Université de Sherbrooke
G.A.U.S., Dép. génie mécanique
2500 boul. Université
Sherbrooke, QC Canada J1K 2R1
Member

Mr. David Lubman
14301 Middletown Lane
Westminster, CA USA 92683
(714) 898 9099
FAX: (714) 373-3050
Compuserve: 711703306
Member, 1,4,5

Mr. G.C. Maling (Jr.), Editor
Noise/News
Arlington Br.
P.O. Box 2469
Poughkeepsie, NY USA 12603
Courtesy Sub

Denise Mallette
I.R.S.S.T. - Informathèque
11e étage
505 boul de Maisonneuve O
Montréal, QC Canada H3A 3C2
(514) 288-1551; FAX: (514) 288-6097
mallette.denise@irsst.qc.ca
Member

Christian Martel
Octave Acoustique Inc.
277 boul. Jacques Cartier
Shannon, QC Canada G0A 4N0
(418) 844-3338; FAX: (418) 844-3338
Direct Subscriber, 1,2,4

Patrice Masson
3755 Impériale
Rock Forest, QC Canada J0L 2S0
(819) 821-8000ext3106
FAX: (819) 821-7163
patrice.masson@mge.usherb.ca
Member, 2,3,6,10

Mr. Nigel Maybee
12 Woodmont Pl. SW
Calgary, AB Canada T2W 4N3
(403) 238-5199; FAX: (403) 259-4190
nigel@hfpacoustical.com
Member, 5

Dr. W.G. Mayer
Georgetown University
Physics Department
JASA
Washington, DC USA 20057
Courtesy Sub

Wendy McCracken
Headwaters Health Authority
310 Macleod Trail
High River, AB Canada T1V 1M7
(403) 938-4911
FAX: (403) 938-2783
Member, 1,3,5

Jason McCrank
HFP Acoustical Consultants Corp.
1140, 10201 Southport Rd. SW
Calgary, AB Canada T2W 4X9
(403) 259-6600
FAX: (403) 259-6611
jason@hfpacoustical.com
Member, 1,2,5

James McKay
University of Western Ontario
Faculty of Music, Talbot College
London, ON Canada N6A 3K7
(519) 661-3784
jrmckay@julian.uwo.ca
Member

Bill McMurray
Canadian National
935 de La Gauchetière St. West
Montréal, QC Canada H3B 2M9
Member

Zita McRobbie
Simon Fraser University
Linguistics Dept.
Burnaby, BC Canada V5A 1S6
(604) 291-5782
FAX: (604) 291-5659
zita_mcrobbie@sfu.ca
Member, 7,8

Mr. T. Medwedyk
Group One Acoustics Inc.
1538 Sherway Dr.
Mississauga, ON Canada L4X 1C4
(416) 896-0988; FAX: (416) 897-7794
goa@interlog.com
Direct Subscriber, 1,4,7

Garfield Mellema
Defence Research Establishment Atlantic
P.O. Box 1012
Dartmouth, NS Canada B2Y 3Z7
(902) 426-3100ext252
mellema@drea.dnd.ca
Member

Jean-Mathieu Mencik
Université de Sherbrooke
GAUS, Génie mécanique
2500 boul. Université
Sherbrooke, QC Canada J1K 2R1
(819) 821-8000ext3179
jean.mathieu.mencik@gaus,gme.usherb.ca
Student, 2,3,6

Sid-Ali Meslioui
Pratt & Whitney Canada Corp
1000 Marie-Victorin (01PA4)
Longueuil, QC Canada J4G 1A1
(450) 647-7339
sid-ali.meslioui@pwc.ca
Member, 1,2,10

Andy Metelka
Novel Dynamics Test Inc.
R.R. #2
13652 Fourth Line, Halton Hills
Acton, ON Canada L7J 2L8
(519) 853-4495
FAX (519) 853-3366
metelka@aztec-net.com
Sustaining Member, 2,6,10

David S Michaud
University of Ottawa
VNR Building, Room 108
11 Marie Curie
Ottawa, ON Canada K1N 6N5
(613) 562-5800ext4210
FAX: (613) 562-5356
microdialysis@hotmail.com
Student, 5,7

Philippe Micheau
Université de Sherbrooke
G.A.U.S., Dép. génie mécanique
2500 boul. Université
Sherbrooke, QC Canada J1K 2R1
Member

Dr. J.G. Migneron
Acoustec Inc.
103-1381 rue Galilée
Québec, QC Canada G1P 4G4
(418) 682-2331
FAX: (418) 682-1472
information@acoustec.qc.ca
Sustaining Member, 1,2,6

Mr. C.A. Mihalj
Marshall Macklin Monaghan
80 Commerce Valley Dr. E
Thornhill, ON Canada L3T 7N4
(905) 882-1100ext275
FAX: (905) 882-0055
mihalja@mmm.ca
Member, 1,2,6

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Indirect Subscriber

Ministère des Transports
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Montréal, QC Canada H3L 3T1
Indirect Subscriber

Terence T Miranda
3868 Lefran Rd
RR 2 Cobble Hill, BC Canada
V0R 1L0
(250) 743-6615
terencetmiranda@hotmail.com
Student, 1,5,7

Luc G. Mongeau
Purdue University
School of Mechanical Engineering
1077 Herrick Laboratories
West Lafayette, IN
USA 47907-1077
Member

Flavien Montagne
Soucy Baron Inc.
851 Baron
St-Jérome, QC Canada
Member

Dr. Thomas Moore
Queen's University
Dept. of Mechanical Engineering
Kingston, ON Canada K7L 3N6
(613) 545 2582; FAX: (613) 545-6489
moore@me.queensu.ca
Member, 5,7

M. Michel Morin
MJM Conseillers en Acoustique Inc.
440-6555 Cote des Neiges
Montréal, QC Canada H3S 2A6
(514) 737-9811
FAX: (514) 737-9816
mjm@videotron.ca
Sustaining Member, 1,2,4

Mrs. Deirdre A. Morison
Health Canada, Health Care Policy Division
Health Policy & Communications Br
Policy and Consultation Branch
P.L. 0910D
Ottawa, ON Canada K1A 0K9
(613) 946-5108; FAX: (613) 957-9733
deirdre_morison@hc-sc.gc.ca
Member, 3,5,10

Geof Morrison
Simon Fraser University
Dept of Linguistics
Burnaby, BC Canada V5A 1S6
(604) 421-5720; FAX: (604) 427-5720
gsm@sfu.ca
Student, 8

Mr. David L Moyer
Riverbank Acoustical Labs
IIT Research Institute
1512 S Batavia Avenue
Geneva, IL USA 60134
(630) 232-0104
FAX: (630) 232-0138
Member, 1,5

Dana Murphy
Trent University
Dept. of Psychology
Peterborough, ON Canada
K9J 7B8
Member

Sylvain Nadeau
Siemens Canada Limited
Automotive Systems
1020 Adelaide Street South
London, ON Canada N6E 1R6
Member

Ann Nakashima
12925 - 104 Ave
Surrey, BC Canada V3T 1T6
(604) 584-5108
naka_ann@yahoo.com
Student, 1,2,10

National Library of Canada
Canadiana Acquisitions Division
and Legal Deposit Office
Ottawa, ON Canada K1A 0N4
Courtesy Subs

Vernon Neilsen
200-28 Auriga Dr
Ottawa, ON Canada K2E 8A5
(613) 225-5648
FAX: (613) 225-6066
vn@rwdi.com
Member, 1,2,6

Nelson Industries Inc.
Corporate Research Dept.
P.O. Box 600
Stoughton, WI USA 53589-0600
(608) 873-4370
Sustaining Member, 2,5,7

Jessica Newton
3239 West 24th Avenue
Vancouver, BC Canada V6L 1R8
(604) 742 0025
jassmin17@yahoo.com
Student, 1,4,5

Charles Tsun-Kei Ng
Ground Floor
33 Lyttelton Rd.
Hong Kong
(852) 2398 3260
charlestkng@yahoo.com
Member, 1,2,6

Mr. Phat Nguyen
Produits Acoustiques PN Inc.
9210 Place Picasso
St-Léonard, QC Canada H1P 3J8
(514) 946-6299
FAX: (514) 993-6299
pnguyen@colba.net
Member, 1,5,7

M. Jean Nicolas
G.A.U.S., Université de Sherbrooke
Dép. de génie mécanique
Sherbrooke, QC Canada J1K 2R1
(819) 821-6905
FAX: (819) 821-7163
jean.nicolas@gme.usherb.ca
Member, 5,10

Dr. T.R.T. Nightingale
National Research Council Canada
Institute for Research in Construction
Bldg. M-27
Ottawa, ON Canada K1A 0R6
(613) 993-0102
FAX: (613) 954-1495
trevor.nightingale@nrc.ca
Member

Michael Noble
BKL Consultants Ltd.
308-1200 Lynn Valley Road
North Vancouver, BC Canada
V7J 2A2
(604) 988-2508
FAX: (604) 988-7457
noble@bkla.com
Member, 1,2,4

Mr. Blake Noon
Eckel Industries of Canada Ltd.
P.O. Box 776
Morrisburg, ON Canada K0C 1X0
(613) 543-2967
FAX: (613) 543-4173
eckel@eckel.ca
Sustaining Member, 1,5

Northern Illinois University
Periodicals Department
University Libraries
Dekalb, IL USA 60115
Indirect Subscriber,

Eva-Marie Nosal
5640 Yalta Place
Vancouver, BC Canada V6T 2C2
(604) 822-1997
eva-marie@math.ubc.ca
Student, 1,2,4,10

Colin Novak
1518 Bruce Ave.
Windsor, ON Canada N8X 1X9
(519) 253-7193
novakl@uwindsor.ca
Student, 1,2,6

Oliver Nwankwo
Collins and Aikman Aujtomotive Interior
Systems
47785 West Anchor Court
Plymouth, MI USA 48170-2456
Member

Mr. John O'Keefe
Aercoustics Engineering Ltd.
127-50 Ronson Drive
Rexdale, ON Canada M9W 1B3
(416) 249-3361
FAX: (416) 249-3613
jokeefe@aercoustics.com
Member, 1

Xavier Olny
Ecole Nationale des Travaux Publics de
l'Etat
DGCB URA CNRS 1652
2 rue Maurice Audin
Vaulx-en-Velin Cedex
France 69518
Member

Henrik Olsen
ATCO Noise Management
1243 McKnight Blvd NE
Calgary, AB Canada T2E 5T1
(403) 292-7416
FAX: (403) 292-7816
holsen@atconoise.com
Member, 1,2,3

Donald Olynyk
9224-90 Street
Edmonton, AB Canada T6C 3M1
(403) 465-4125
Member, 1,2,5

Donald M. Onysko
1019 Buckskin Way
Gloucester, ON Canada K1C 2Y8
(613) 824-2371; FAX: (613) 824-8070
onysko@istar.ca
Member, 6

Dr. John C. Osier
Defence Research Establishment Atlantic
P.O. Box 1012, 9 Grove Street
Dartmouth, NS Canada B2Y 3Z7
(902) 426-3100ext119
FAX: (902) 426-9654
osler@drea.dnd.ca
Member, 9

OZA Inspections Ltd.
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Grimsby, ON Canada L3M 4G5
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oza@the-oza-group.com
Sustaining Member, 7,10

Aykut Ozdemir
Faszer Farquharson & Associates Ltd.
304-605 1st Street S.W.
Calgary, AB Canada T2P 3S9
(403) 508-4996; FAX: (403) 508-4998
ffa@internode.net
Member, 2,4,5

Kevin Packer
Faszer Farquharson & Associates Ltd.
304-605 1st Street S.W.
Calgary, AB Canada T2P 3S9
(403) 508-4996
FAX: (403) 508-4998
ffa@internode.net
Member, 2,4,5

Gilles Pagé
Alcan
1200 Avenue Dupont Nord
Alma, QC Canada
Member

Mr. Thomas Paige
Vibron Ltd.
1720 Meyerside Drive
Mississauga, ON Canada L5T 1A3
(905) 677-4922; FAX: (905) 670-1698
vibron@myna.com
Member, 1,2,5

Raymond Panneton
Université de Sherbrooke
G.A.U.S.
Dép de génie mécanique
Sherbrooke, QC Canada J1K 2R1
Member

Stéphane Paquay
Université du Liège au Sart Tilman
LTAS - Dynamique des Structures
Chemin des Chevreuils 1 (B52)
Liège, Belgium B-4000
Member

Mr. Richard Patching
Patching Associates Acoustical Engineering
105-6815 8th St. NE
Calgary, AB Canada T2E 7H7
(403) 274-5882; FAX: (403) 295-0732
patching@internode.net
Member, 1,5,7

Martin Pelletier
5018 Gabriel
Rock Forest, QC Canada J1N 2H2
(819) 821-8000ext3152
FAX: (819) 821-7163
martin.pelletier@gaus.gme
Student, 2,3,10

Mr. R. Pemberton
16 Pineglen Cres.
Nepean, ON Canada K2E 6X9
(613) 727-8116; FAX: (613) 727-8318
pemberp@algonquinc.on.ca
Member, 1,5,7

Scott L Penton
650 Woodlawn Rd W
Guelph, ON Canada N1K 1B8
(519) 823-1311; FAX: (519) 823-1316
slp@rwdi.com
Member, 2,6,10

Mr. Richard J. Peppin
Scantek, Inc.
5012 Macon Rd.
Rockville, MD USA 20852
(301) 770-3863
FAX: (301) 770-3979
peppinR@asme.org
Member, 1,5,7

Dr. P. Phillips
409 - 285 Loretta Ave. S.
Ottawa, ON Canada K1S 5A5
(613) 567-8533
Member, 4,6

Michel Picard
7495 Thibault
Brossard, QC Canada J4W 2P2
(514) 343-7617
FAX: (514) 343-2115
michel.picard@umontreal.ca
Sustaining Member, 1,5,7

Claire Piché
9663 Basile-Routhier
Montréal, QC Canada H2C 2C1
(514) 388-1009
FAX: (514) 388-2179
mobili-son@sympatico.ca
Student, 1,2,4

R. Pichevar
Université du Québec à Chicoutimi
555 boul. de l'Université
Chicoutimi, QC Canada G7H 2B1
Member

Dr. J.E. Piercy
National Research Council Canada
Inst. For Microstructural Sciences
Bldg. M-36
Ottawa, ON Canada K1A 0R6
(613) 749-8929
FAX: (613) 952-3670
jepiercy@cyberus.ca
Member, 3,5,6

Claude D. Pigeon
8396 av. Du Mail
Anjou, QC Canada H1K 1Z8
(514) 990-0459
claude.d.pigeon@sympatico.ca
Student, 1,2

Dominic Pilon
Université de Shertrooke
Fac. Génie, Dép. Génie mécanique
2500 University Blvd.
Sherbrooke, QC Canada J1K 2R1
(819) 821-7144
FAX: (819) 821-7163
dominic.pilon@gaus.gme.usherb.ca
Student, 2,3,10

Linda Polka
McGill University
Sch of Communication Sciences and Disorders
1266 Pine Ave. West
Montréal, QC Canada H3G 1A8
(514) 398-7235; FAX: (514) 398-8123
cztg@musica.mcgill.ca
Member, 7

Jean-Jacques Poulain
Lilly Services S.A.
Parc scientifique de Louvain-la-Neuve
Rue Granbonpré no. 11
Mont-Saint-Guibert, Belgium 1348
FAX: (82) 10 476422
hh,poulain@lilly.com
Member, 1,2,6

Dr. S.E. Prasad
Sensor Technology Ltd.
P.O. Box 97, 20 Stewart Road
Collingwood, ON Canada L9Y 3Z4
(705) 444-1440
FAX: (705) 444-6787
eprasad@sensortech.ca
Member, 2,3,9

Dalton Prince
H.L. Blachford Ltd.
2323 Royal Windsor Dr.
Mississauga, ON Canada L5J 1K5
(905) 823-3200
FAX: (905) 823-9290
amsales@blachford.ca
Member, 1,2,6

Daniel P. Prusinowski
745 Warren Drive
East Aurora, NY USA 14052-1913
(716) 652-9979
FAX: (716) 652-7227
Member, 1,2,5

Dr. J.D. Quirt
National Research Council Canada
Institute for Research in Construction
Acoustics Lab., Bldg. M-27
Ottawa, ON Canada K1A 0R6
(613) 993-9746; FAX: (613) 954-1495
dave.quirt@nrc.ca
Member, 1,2,5

Dr. Ramani Ramakrishnan
27 Ashmount Crescent
Toronto, ON Canada M9R 1C8
(416) 248-9896; FAX: (416) 243-1733
rramakri@acs.ryerson.ca
Member, 1,5,7

Hans J. Rerup
H.J. Rerup Consulting Inc.
67 Frid Street
Hamilton, ON Canada L8P 4M3
(905) 521-0999; FAX: (905) 521-8658
Member

Fernando Ribas
J.L. Richards & Associates Limited
864 Lady Ellen Place
Ottawa, ON Canada K1Z 5M2
(613) 728-3571; FAX: (613) 728-6012
mail@jlrichards.ca
Sustaining Member, 1,2,7

Werner Richarz
70 Roxborough Lane
Thornhill, ON Canada L4J 4S9
(416) 249-3361; FAX: (416) 249-3613
wricharz@aercoustics.com
Member, 2,3

Stéphane Rigobert
Laboratoire des sciences de l;habitat
DGCB/URA CNRS 1652, E.N.T.P.E.
2 rue Maurice Audin
Vaulx-en-velin Cedex
France 69518
Member

Mr. Matias Ringheim
Kilde Akustikk A/S
P.O. Box 229
N 5701 Voss, Norway
(47) 5652-0460
FAX: (47) 5652-0479
matias.ringheim@kilde-akustikk.no
Member, 1,5,6

Dr. R.J. Rogers
University of New Brunswick
Dept. of Mechanical Engineering
P.O. Box 4400
Fredericton, NB Canada E3B 5A3
(506) 447-3106; FAX: (506) 453-5025
rjr@unb.ca
Member, 5,7

Tom Rose
Rose Associates
117 Red Oak
Flower Mound, TX USA 75028
(972) 539-7000
FAX: (972) 539-6139
Member, 1,5,7

Guy Rouleau
Université de Sherbrooke
G.A.U.S., Dép. génie mécanique
2500 boul. Université
Sherbrooke, QC Canada J1K 2R1
Member

RoweCom France
I 894
(BNF/LIBRES-A/PARIS / 22392823)
SCE EXPRESS CAFS
91763 Palaiseau Cedex, France
Indirect

Marta Ruiz
Pratt & Whitney Canada
Dept. of Analytical Systems
1000 Marie-Victorin
Longueuil, QC Canada J4G 1A1
Member

Frank A. Russo
Queen's University
Acoustics Lab.
Department of Psychology
Kingston, ON Canada K7L 3N6
(613) 545-2490; FAX: (613) 545-2499
russof@pavlov.psyc.queensu.ca
Student, 4,5,7,8

Mr. Wm. D. Ruth
HEARing MEasurements Co. Ltd.
27 Strathearn Ave., Unit 2
Bramalea, ON Canada L6T 4V5
(905) 791-428; FAX: (905) 791-3055
bruth@netcom.ca
Member, 5

James G. Ryan
6135 Lariviere Cr.
Gloucester, ON Canada K1W 1C6
Member, 4,7,11

Dr. M.P. Sacks
Tacet Engineering Ltd.
111 Ava Road
Toronto, ON Canada M6C 1W2
(416) 782-0298; FAX: (416) 785-9880
Sustaining Member, 1,5,7

Claude Sauvageau
Centre de recherche industrielle du Québec
8475, ave. Christophe-Colomb
Montréal, QC Canada H2M 2N9
(514) 383-1550(506)
FAX: (514) 383-3234
csauvag@mtl.criq.qc.ca
Member, 2,6,10

Scantek Inc.
916 Gist Ave.
Silver Spring, MD USA 20910
(301) 495-7738
FAX: (301) 495-7739
scantek@erols.com
Sustaining Member, 1,2,5

Stefan Schoenwald
Richard-Wagner-Strasse 6A
Bad Neustadt/Saale
Germany D-97616
09771/97290
stefan.schoenwald@gmx.de
Student, 1,2,6

Mr. Henri Scory
IRSST
505 Maisonneuve Ouest
Montréal, QC Canada H3A 3C2
(514) 288-1551
FAX: (514) 288-9399
scory.henri@irsst.qc.ca
Member, 3,5,7

Dr. Richard C. Seewald
University of Western Ontario
Elborn College
Communicative Disorders
London, ON Canada N6G 1H1
(519) 661-3901
FAX: (519) 661-3805
Member, 2,6,8

Franck Sgard
Laboratoire des sciences de l;habitat
DGCB/URA CNRS 1652, E.N.T.P.E.
2 rue Maurice Audin
Vaulx-en-velin Cedex
France 69518
Member

Dr. Edgar A.G. Shaw
Researcher Emeritus
National Research Council Canada
IMS, Room 1014, M-36
Ottawa, ON Canada K1A 0R6
(613) 993-6157
FAX: (613) 952-3670
Member, 2,5,6

Mr. Neil A. Shaw
Ozone Sound Eng. Ltd.
P.O. Box 619
Topanga, CA USA 90290-0619
(310) 455-2221
FAX: (310) 455-0923
menlo@compuserve.com
Member, 1,2,4

Cameron W. Sherry
Enviro Risque Inc.
78 Lucerne
Pointe Claire, QC Canada H9R 2V2
(514) 426-8720
FAX: (514) 426-8719
cwsherry@aol
Member, 1,5

P.J. Shorter
Vibro-Acoustic Sciences, Inc.
310-12555 High Bluff Drive
San Diego, CA USA 92130
Member

Davor Sikic
Jade Acoustics Inc.
203-545 North Rivermede Dr.
Concord, ON Canada L4K 4H1
(905) 660-2444
FAX: (905) 660-4110
jade_acoustics@compuserve.com
Member, 1,5,7

Ms. Elzbieta B. Slawinski
University of Calgary
Dept. of Psychology
2500 University Drive NW
Calgary, AB Canada T2N 1N4
(403) 220-5205
FAX: (403) 282-8249
eslawins@acs.ucalgary.ca
Member, 6,8

Nicholas A. Smith
University of Toronto at Scarborough
Division of Life Sciences
Scarborough, ON Canada
M1C 1A4
(416) 281-7979
FAX: (416) 287-7642
nichoias@psych.utoronto.ca
Student, 4,5,7

Connie So
5184 Sherbrooke St.
Vancouver, BC Canada V5W 3M4
kiso@sfu.ca
Student, 8

Don J. South
Faszer Farquharson & Associates Ltd.
304-605 1st Street S.W.
Calgary, AB Canada T2P 3S9
(403) 508-4996
FAX: (403) 508-4998
ffa@internode.net
Member, 2,4,5

Ibrahima Sow
Université de Sherbrooke
Génie mécanique
2500 boul. Université
Sherbrooke, QC Canada J1K 2R1
(819) 821-7144
FAX: (819) 821-7163
isow@vulcain.gme.usherb.ca
Student, 2,6,10

Spaarg Engineering Limited
Noise and Vibration Analysis
822 Lounsborough St.
Windsor, ON Canada N9G 1G3
(519) 972-0677
FAX: (519) 972-0677
gasparr@engn.uwindsor.ca
Sustaining Member, 1,5,7

State of the Art Acoustik Inc.
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Ottawa, ON Canada K1J 9J3
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Robert D. Stevens
HGC Engineering
Plaza One, Suite 203
2000 Argentia Rd.
Mississauga, ON Canada L5N 1P7
(905) 826-4044
FAX: (905) 826-4940
rstevens@hgcengineering.com
Member, 1,4,5

Mr. John Stevenson
WCB of BC, Prev Div
8100 Granville St.
Richmond, BC Canada V6Y 3T6
(614) 276-3100
FAX: (604) 276-3247
a1a38024@bc.sympatico.ca
Member, 1,2,5

Dr. Michael R. Stinson
National Research Council Canada
Inst. for Microstructural Sciences
Building M-36
Ottawa, ON Canada K1A 0R6
(613) 993-3729; FAX: (613) 952-3670
mike.stinson@nrc.ca
Member, 3,5,6

Ron Stockermans
30 Allenby Dr.
Stillwater Lake, NS Canada B3Z 1G6
(902) 427-0550ext8466
ronstox@ureach.com
Member, 4,9,10

Mr. Robert A. Strachan
Brown Strachan Assoc.
Two Yaletown Sq., 1290 Homer St.
Vancouver, BC Canada V6B 2Y5
(604) 689-0514; FAX: (604) 689-2703
Member, 1,5,7

Mr. D.C. Stredulinsky
32 John Cross Dr.
Dartmouth, NS Canada B2W 1X3
(902) 426-3100; FAX: (902) 426-9654
stredulinsky@drea.dnd.ca
Member, 1,5,7

Megha Sundara
McGill University
School of Communication Sciences & Disorders
1266 Pine Avenue West
Montreal, QC Canada H3G 1A8
(514) 398-8496
FAX: (514) 398-8123
msunda@po-boxmcgill.ca
Student, 5,7,8

John C. Swallow
John Swallow Associates
250 Galaxy Boulevard
Etobicoke, ON Canada M9W 5R8
(416) 798-0522; FAX: (416) 213-1079
Sustaining Member

Jasmine Tait
245 McClellan Rd
Ottawa, ON Canada K2H 8N6
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6659 Ordan Dr.
Mississauga, ON Canada L5T 1K6
(905) 612-4000
FAX: (905) 612-8999
info@silex.com
Sustaining Member, 2,6,7

Dr. John M. Terhune
University of New Brunswick
Dept. of Biology
P.O. Box 5050
Saint John, NB Canada E2L 4L5
(506) 648-5633; FAX: (506) 648-5650
terhune@unbsj.ca
Member, 6,8,9

Mr. Peter Terroux
Atlantic Acoustical Associates
P.O. Box 96, Stn M
Halifax, NS Canada B3J 2L4
(902) 425-3096; FAX: (902) 425-0044
peteraaa@istar.ca
Member, 1,2,5

Philippe-André Tetrault
Pratt & Whitney Canada
Dept. of Analytical Systems
1000 Marie-Victorin
Longueuil, QC Canada J4G 1A1
Member

George H. Thackray
Greater Toronto Airports Authority
Lester B Pearson Int Airport
P.O. Box 6031
Toronto AMF, ON Canada L5P 1B2
(905) 676-5417; FAX: (905) 676-3483
Member, 1,5

Stan Thompson
Novel Dynamics Inc.
19 Morgans Grant Way
Kanata, ON Canada K2K 2G4
Member

Brandon Tinianow
Johns Manville T.C.
10100 West Ute Ave.
Littleton, CO USA 80127
(303) 978-6737
FAX: (303) 978-3123
tinianow@jm.com
Member, 1,2,4

Ian Toms
48 Prince Charles Dr.
Charlottetown, PE Canada C1A 3C2
(902) 629-1557
idtoms@hotmail.com
Student, 4

Dr. Laurel Trainor
McMaster University
Dept. of Psychology
1280 Main St. W.
Hamilton, ON Canada L8S 4K1
(905) 525-9140ext23007
FAX: (905) 529-6225
ljt@mcmaster.ca
Member, 4,5,8

Lee Ann Tremblay
4060 Maple St.
Petrolia, ON Canada N0N 1R0
ltremblay@julian.uwo.ca
Student

Prof. B. Truax
Simon Fraser University
School of Communication
Burnaby, BC Canada V5A 1S6
(604) 291-4261; FAX: (604) 291-4024
truax@sfu.ca
Member, 2,4,5

Man-Chun Tse
Pratt & Whitney Canada
Dept. of Analytical Systems
1000 Marie-Victorin
Longueuil, QC Canada J4G 1A1
Member

Helen J Ule
1258 Aubin Rd
Windsor, ON Canada N8Y 4E5
(519) 948-7302
FAX: (519) 275-4740
ule@mnsi.net
Student, 2,6

J. Ulicki
Xscala Sound & Vibration
Suite 516
234 - 5149 Country Hills Blvd. NW
Calgary, AB Canada T3A 5K8
(403) 274-7577
FAX: (403) 274-7694
jim.ulicki@specristech.com
Member, 1,5,7

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30167 Hannover, Germany
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Chatham, ON Canada N7M 5L1
(519) 354-4270; FAX: (519) 354-4193
frank@indmetalfab.com
Sustaining Member, 5,7,10

Tony Venditti
Association Sectorielle
Fabrication d'Equipement de Transport et
de Machines; 202-3565 Jary est
Montréal, QC Canada H1Z 4K6
Member

Vibro-Acoustics
727 Tapscott Rd
Scarborough, ON Canada M1X 1A2
(416) 291-7371
Sustaining Member

Jérémie Voix
Ecole de technologie supérieure Dép génie
mécanique, 1100 Notre-Dame Ouest
Montréal, QC Canada H3C 1K3
(514) 396-8800ext7692
FAX: (514) 396-8530
jvoix@mec.etsmtl.ca
Student, 2,7,10

Alexander von Stetten
Faszer Farquharson & Associates Ltd.
304-605 1st Street S.W.
Calgary, AB Canada T2P 3S9
(403) 508-4996; FAX: (403) 508-4998
ffa@internode.net
Member, 2,4,5

A.D. Wallis
Cirrus Research PLC
Acoustic House, cBridlington Rd.
Hunmanby, N Yorks, England Y014 0PH
(723) 863723; FAX: (723) 891742
Member, 5

Dr. A.C.C. Warnock
National Research Council Canada
Institute for Research in Construction
Acoustics Laboratory, Bldg. M-27
Ottawa, ON Canada K1A 0R6
(613) 993-9370; FAX: (613) 954-1495
alf.warnock@nrc.ca
Member, 1,5,7

Mr. D.E. Watson
H.L. Blachford Ltd.
2323 Royal Windsor Dr.
Mississauga, ON Canada L5J 1K5
(905) 823-3200
FAX: (905) 823-9290
dewatson@hlb.blachford.ca
Sustaining Member, 5

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118-5200 Dixie Road
Mississauga, ON Canada L4W 1E4
(905) 624-3919
FAX: (905) 624-3926
info@wccl.com
Sustaining Member

Mr. Ewart A. Wetherill
28 Cove Road
Alameda, CA USA 94502
(415) 391-7610
FAX: (415) 391-0171
paoletti@compuserve.com
Member, 1,2,5

Douglas J. Whicker
PH3 - 410 Carnarvon Street
New Westminster, BC Canada V3L 5N9
(604) 525-5528
whicker@bkla.com
Member, 1,2,5

Mr. Ronald G. White
7 Amber Glen Court
Holland Landing, ON Canada L9N 1J6
(416) 675-3983
FAX: (416) 675-5546
Member, 1,4,5

Terence Williams
Williams de Hoog D'Ambrosio Architects
102-2957 Jutland Road
Victoria, BC Canada V8T 5J9
(250) 384-2400
FAX: (250) 384-7893
Member

Hugh Williamson
Hugh Williamson Assoc. Inc.
12 Maple Lane
Ottawa, ON Canada K1M 1G7
(613) 747-0983
FAX: (613) 747-4514
hugh_williamson@msn.com
Member, 1,6

Wilrep Ltd.
1515 Matheson Blvd. E, Unit C 10
Mississauga, ON Canada L4W 2P5
(905) 625-8944; FAX: (905) 625-7142
Sustaining Member

Mr. Keith Wilson
Owens-Corning Canada Inc.
42 Johnson Street
Orillia, ON Canada L3V 7R9
(800) 988 5269; FAX: (800) 989 8298
keith.wilson@owenscorning.com
Sustaining Member, 1,2

Ian Wilson
523 E 10th Street
North Vancouver, BC Canada V7L 2E7
(604) 904-2234
iwilson@direct.ca
Student, 8

Jean-Luc Wojtowicki
Université de Sherbrooke
G.A.U.S., Dép. génie mécanique
2500 boul. Université
Sherbrooke, QC Canada J1K 2R1
Member

Mr. Chris N. Wolfe
Vibra-Sonic Control
& Materials Handling Ltd.
4004 Gravely Street
Burnaby, BC Canada V5C 3T6
(604) 294-9495; FAX: (604) 294-8033
cwolfe@vibra-sonic.bc.ca
Member, 1,5,7

Dr. G.S.K. Wong
National Research Council Canada
Inst. for Nat. Meas. Stds.
Building M-36
Ottawa, ON Canada K1A 0R6
(613) 993-6159; FAX: (613) 990-8765
george.wong@nrc.ca
Member, 2,3,5

Roland Woodcock
Advanced Acoutics Group
Lear Technologies, LLC, N. American Technol. Ctr
21557 Telegraph Road
Southfield, MI USA 48034-4248
(248) 447-5411; FAX: (248) 447-1512
rwoodcock@lear.com
Member, 1,2,3

Richard G. Wright
HFP Acoustical Consultants Corp.
1140-10201 Southport Road, S.W.
Calgary, AB Canada T2W 4X9
(403) 259-3600; FAX: (403) 259-4190
richardw@hfpacoustical.com
Member, 2,11

Weixiong Wu
Allee, King, Rosen & Fleming, Inc.
Env. Planning & Consultants
117 East 29th Street
New York, NY USA 10016
(212) 340-9774; FAX: (212) 213-3191
weixiong_wu@akrf.com
Member, 1,2

Victoria Young
University of Toronto, Acoustics Lab.
Inst. Biomaterials & Biomedical Engg.
27 King's College Circle
Toronto, ON Canada M5S 1A1
Member

Pearlie Yung
#1003 - 330 Rathburn Road West
Mississauga, ON Canada L5B 3Y1
(905) 896-0319
pearlie@vcn.bc.ca
Member, 1,2,5

Wenhao Zhu
National Research Council Canada
Bldg. M-36, Room 1004 M,
1500 Montreal Road
Ottawa, ON Canada K1A 0R6
Member

INSTRUCTIONS TO AUTHORS FOR THE PREPARATION OF MANUSCRIPTS

Submissions: The original manuscript and two copies should be sent to the Editor-in-Chief.

General Presentation: Papers should be submitted in camera-ready format. Paper size 8.5" x 11". If you have access to a word processor, copy as closely as possible the format of the articles in Canadian Acoustics 18(4) 1990. All text in Times-Roman 10 pt font, with single (12 pt) spacing. Main body of text in two columns separated by 0.25". One line space between paragraphs.

Margins: Top - title page: 1.25"; other pages, 0.75"; bottom, 1" minimum; sides, 0.75".

Title: Bold, 14 pt with 14 pt spacing, upper case, centered.

Authors/addresses: Names and full mailing addresses, 10 pt with single (12 pt) spacing, upper and lower case, centered. Names in bold text.

Abstracts: English and French versions. Headings, 12 pt bold, upper case, centered. Indent text 0.5" on both sides.

Headings: Headings to be in 12 pt bold, Times-Roman font. Number at the left margin and indent text 0.5". Main headings, numbered as 1, 2, 3, ... to be in upper case. Sub-headings numbered as 1.1, 1.2, 1.3, ... in upper and lower case. Sub-sub-headings not numbered, in upper and lower case, underlined.

Equations: Minimize. Place in text if short. Numbered.

Figures/Tables: Keep small. Insert in text at top or bottom of page. Name as "Figure 1, 2, ..." Caption in 9 pt with single (12 pt) spacing. Leave 0.5" between text.

Line Widths: Line widths in techincal drawings, figures and tables should be a minimum of 0.5 pt.

Photographs: Submit original glossy, black and white photograph.

Scans: Should be between 225 dpi and 300 dpi. Scan: Line art as bitmap tiffs; Black and white as grayscale tiffs and colour as CMYK tiffs;

References: Cite in text and list at end in any consistent format, 9 pt with single (12 pt) spacing.

Page numbers: In light pencil at the bottom of each page.

Reprints: Can be ordered at time of acceptance of paper.

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Soumissions: Le manuscrit original ainsi que deux copies doivent être soumis au rédacteur-en-chef.

Présentation générale: Le manuscript doit comprendre le collage. Dimensions des pages, 8.5" x 11". Si vous avez accès à un système de traitement de texte, dans la mesure du possible, suivre le format des articles dans l'Acoustique Canadienne 18(4) 1990. Tout le texte doit être en caractères Times-Roman, 10 pt et à simple (12 pt) interligne. Le texte principal doit être en deux colonnes séparées d'un espace de 0.25". Les paragraphes sont séparés d'un espace d'une ligne.

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