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**Postdoctoral Prize in Acoustics**

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# EDITORIAL

Voici le numéro annuel d'*Acoustique canadienne* mettant l'accent sur les activités de notre association. Une part importante de ce cahier est consacrée aux informations concernant l'évolution de nos effectifs, les activités du Bureau et les dossiers assumés par les directeurs et les directrices, les prix attribués par l'Association ainsi que les activités du chapitre de Toronto dont les membres célèbreront bientôt son dixième anniversaire. On trouve en outre le programme du Symposium annuel et l'annuaire des membres. A remarquer également qu'un aîné parmi nos membres, le Dr. Thomas D. Northwood, a reçu les honneurs d'une association professionnelle prestigieuse. Le contenu non scientifique de ce numéro est d'une utilité évidente pour la plupart d'entre nous. Nous confirmant la vitalité de notre association, il nous démontre l'intérêt à y participer activement.

This is the annual issue of *Canadian Acoustics* which emphasizes the various activities of our Association. A large portion of this issue is devoted to information about the evolution of our membership, the activities of the Board of Directors and the responsabilities undertaken by the directors, the prizes awarded by the Association, and the activities of the Toronto Chapter whose members are about to celebrate his tenth anniversary. There is also the detailed program of the annual symposium and the membership directory. It is worth noticing that one of our senior member, Dr. Thomas D. Northwood, has been honoured by a prestigious professional association. The non-scientific content of this issue is certainly useful to most of us. Moreover, it confirms the vitality of our Association and the relevance of contributing actively to it.

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# RECOGNITION OF THE SPOKEN FRENCH ALPHABET USING A TWO-PASS DYNAMIC TIME WARP ALGORITHM

J-P. Cordeau and P. Mermelstein
INRS - Télécommunications
3, place du Commerce
Ile-des-Soeurs
Verdun,Québec
H3E 1H6

765-9999

## ABSTRACT

A dynamic time warp algorithm for isolated word recognition is adequate when the vocabulary consists of easily discriminable words. On the other hand, when the words are taken from a vocabulary whose elements are acoustically similar, specialized algorithms must be used to help the recognition task. The spoken French alphabet is composed of acoustically similar words that can be organized into 6 distinct classes. For recognizers working on such a data base, the words not recognized properly are always within-class words and a special recognition approach must be introduced to overcome these effects. In this paper, a two-pass algorithm is used to discriminate between members of the highly confusable sets [1]. The first pass is used to differentiate similar word classes, while the second pass uses a discriminant analysis to reliably separate within-class tokens. The second stage provides better discrimination, separating the words within each class through improved focus on the temporal and cepstral regions of greatest between-word variance. The improvement in discriminability is provided by a modified frame-specific weighting scheme. The error rate is reduced by 50 % (from 40 % to 20 % considering only the letters which cause some errors in the first pass) using this approach as compared to the direct one-step DTW algorithms.

## SOMMAIRE

La reconnaissance automatique de mots isolés par anamorphose temporelle (ou DTW) est un outil adéquat lorsque les mots dictés se distinguent facilement les uns des autres. Par contre, lorsque ces mots sont tirés d'une base de données à haut niveau de difficulté, où les mots sont acoustiquement semblables, un algorithme spécifique doit être employé pour faciliter la tâche. L'alphabet français est un vocabulaire qui se compose de lettres similaires que l'on peut regrouper en 6 classes distinctes. Les erreurs obtenues par les sytèmes de reconnaissance travaillant sur cette base de données sont uniquement dues à des fautes intra-classes. Pour pallier à cette carence, un système à deux étapes est introduit. La première étape est utilisée pour différencier les classes tandis que la seconde procède à une discrimination intra-classe, favorisant la séparation des lettres acoustiquement semblables. La deuxième étape améliore la discrimiation en pondérant davantage les coefficients utiles à la dissociation (les régions temporelle et cepstrale de grande variance) en modifiant légèrement la notion de distance entre la lettre test et la lettre de référence. Le taux d'erreur est diminué de moitié (de 40 % à 20 % en ne considérant que les lettres similaires) en utilisant cette méthode comparativement à une méthode d'anamorphose simple.

# I - INTRODUCTION

The theoretical problem for isolated word recognition (or IWR) is to discover the invariants in speech which occur when the same words are spoken by different (in speaker independant systems) or identical speakers (in speaker dependent systems). Although these variations are seldom perceived by human listeners, they can be seen by either a frequency or a time domain analysis. For two identical words spoken by the same speaker, there will be important acoustical changes in the waveforms due to the emotional state of the talker: one of the versions will be longer; the other will be louder; etc. An automatic recognition system must therefore compensate for these anomalies by focusing on the underlying phonetics of the words which are constant, and by neglecting other levels of information, wheter prosodic or aesthetic.

Dynamic time warping (DTW) algorithms have been used extensively for IWR and have undergone some refinement [2], [3]. In most cases, the improvements serve to speed up the algorithm or to take into account various problems due to the segmentation of word templates (constrained end point warp). DTW is based on four underlying principles [4]: 1) global variations are adequately treated by a nearly linear warp; 2) local variations can be treated through a dynamic approach where weights are used when the path deviates from its linear course; 3) each frame of the test utterance has the same importance and can be considered independent and 4) a uniquely defined distance measure is sufficient for the comparison of words in the search space. These four considerations have led to a multitude of straightforward pattern similarity measures which differ at some point in the comparison of the test and reference patterns (initialisation step, the dynamic approach or the warping techniques). However, all share the same problem which is related to the third and fourth assumptions cited above: the versatility of the DTW algorithms introduce difficulties for highly complex vocabularies.

A practical isolated or continuous word recognizer must have the flexibility to accept spelled words so as to allow a missclassification to be spelled out and be correctly recognized. This paper deals with the recognition of the spoken French alphabet and the accented letter $ET$ (é), a highly confusable set. It is composed of one-syllable words (except for $W$ and $Y$) often formed by a consonant and a vowel. The misclassified words can be organized into six distinct classes, each of them composed of acoustically similar letters, the other letters not included in $\Phi(1)$ to $\Phi(6)$ are unambiguous and are not included in the classes:

$$\Phi(1) = \{A, K\} = \{ \text{/a/,/ka/} \}$$
$$\Phi(2) = \{ET, B, C, D, G, P, T, V\} = \{ \text{/e/,/be/,/se/,/de/,/ʒe/,/pe/,/te/,/ve/} \}$$
$$\Phi(3) = \{I, J\} = \{ \text{/i/,/ʒi/} \}$$
$$\Phi(4) = \{U, Q\} = \{ \text{/y/,/ky/} \}$$
$$\Phi(5) = \{F, S\} = \{ \text{/ɛf/,/ɛs/} \}$$
$$\Phi(6) = \{M, N\} = \{ \text{/ɛm/,/ɛn/} \}$$

The phonetic transcription of the letters lead to two considerations: 1) the differences between the classes are mainly vocalic and 2) the within class differences come from adding or changing a consonant. Although isolated word recognizers have no problem distinguishing letters between classes, they all have difficulty discriminating between letters of the same class. A typical recognizer working on the comlete alphabet will have a 90 % recognition score, which will fall abruptly to 60 % considering only the six classes mentioned above.

The problem is the inability of the DTW to take into account the discriminating factors localized in time and frequency which differentiate one letter from another. The following paragraphs will consider only the second class, also known as the E-set, which accounts for most of the misclassifications.

The E-set has 8 letters composed of either a fricative followed by the vowel /e/ ($C$,$G$,$V$); a stop followed by the same vowel ($B$,$D$,$P$,$T$); or simply the vowel alone (for the accented letter $ET$ or é). Since DTW considers all parts of the utterance to be equally important, the region that represents the initial portion of the words, the only region which can distinguish them appart, has the same weight as the region representing the identical /e/ vowel at the end of the letter. Moreover, the vowel is responsible for more than 3/4 of the total duration of the letter, which further complicates the recognition task.

Besides the temporal considerations stated above, other time factors associated with the consonant tend to augment the misclassification of letters. The French plosives can be decomposed into 4 sections:

• a **silence** which corresponds the the total obstruction of the vocal tract. For the voiced stops the silence is accompanied by a voice bar, i.e energy in the low frequencies (100-300 Hz) that corresponds to glottal radiation.

• The **explosion** when the vocal tract opens which gives out a short burst of energy at frequencies which depend on the place of articulation.

• a **friction noise** coming from the turbulence near the obstruction and having a spectra similar to the one of the noise.

• **formant transitions** to the next phoneme.

The characteristics which distinguish the voiced stops from their unvoiced conterparts lie in the presence/absence of the voice bar; the duration of the friction noise; and the length of the voice onset time (or VOT). The latter corresponds to the time delay from the explosion to the begining of voicing (an increase in energy at all frequencies [5]). For the French stops /b/, /d/and /g/, the voicing precedes the burst and the VOT is thus assumed negative, whereas the plosives /p/, /t/and /k/are attributed positive VOT. Information about place of articulation (labial, alveolar and velar for /b//p/, /d//t/and /g//k/respectively) is found in the spectrum, although the burst duration is proportional to the inertia of the articulator (lips tend to move faster than the back of the tongue). For labial stops, the burst is weak since no pressure buildup is possible after the obstruction, and it is hard if not impossible to locate acurately in the frequency domain. For alveolar stops followed by the vowel /e/, it can be affirmed that the burst is higher in frequency for /t/ than for /d/, the former being located near 4 KHz and the latter near 3.6 KHz [6]. Moreover, both of the alveolar burst frequencies are higher than those of the velars ($\simeq$ 2.8 KHz). Studies have also confirmed that important discriminating factors are found in the formant transitions, from the plosive to the ensuing vowel. It then seems that static and dynamic features are both responsible for the correct recognition of all the stops found in the French phonetics [7] [8].

DTW recognizers cannot apply these concepts in a straightforward manner since the distance measure integrates, in the local difference between the reference and test frame, all the frequency information on a uniform basis. Furthermore, as we have seen, the discriminability is not uniform in time but rather concentrated in regions which correspond to phonetically important aspects of the sound.

An approach that permits one to focus on the spectral and temporal discriminating regions will be explained in section III. Section II will present the baseline recognizer, emphasizing its inability to take advantage of the discriminative features. Section IV will evaluate the data base, elucidate the parameters used in the front end of the system and explain how to obtain the final recognition score, while section V will summarize the results.

## II - DTW RECOGNIZER

All DTW algorithms work in the same fashion: a dilation/contraction of the time scale so that similar acoustic segments of the test speech and reference templates may correspond. If $R$ and $T$ are the parametric representations of two utterances, they can be described by a temporally ordered time index equal to the window length of the preprocessing stage and two indices $I$ and $J$ equal to the total duration of the letters:

$$R = R(1), R(2), ..., R(i), ..., R(I)$$
$$T = T(1), T(2), ..., T(j), ..., T(J)$$

where every R(i), T(j) is a feature vector in the cepstral parametric space (see section IV), $C_i$ being the $i^{th}$ cepstral coefficient out of a total of $Ncep$ used:

$$R(i) = \begin{pmatrix} C_1^{R(i)} \\ \cdots \\ \cdots \\ C_{Ncep}^{R(i)} \end{pmatrix}, T(j) = \begin{pmatrix} C_1^{T(j)} \\ \cdots \\ \cdots \\ C_{Ncep}^{T(j)} \end{pmatrix}$$

The time warp consists in eliminating the temporal differences $|I - J|$ in an optimal fashion. To accomplish this task we must define a distance measure between the reference and test frames. In this paper, the Euclidian distance is used for its simplicity and good performance [9]:

$$d_e(T(j), R(i)) = \sum_{l=1}^{Ncep} (C_l^{T(j)} - C_l^{R(i)})^2 \tag{1}$$

The alignment procedure finds an optimal path $C = \{c(k)\} = \{i(k), j(k)\}$ through the $< i - j >$ space $(0 < i < I; 0 < j < J)$ and computes the total distance score between the test word $T$ and every reference word $R$ by:

$$D(T, R) = \frac{\sum_k d_e(T(j(k)), R(i(k)))p(k)}{\sum_k p(k)} \tag{2}$$

where p(k) corresponds to the warping function defined by Sakoe [3].

$$p(k) = (i(k) - i(k-1)) + (j(k) - j(k-1)) \tag{3}$$

This function is chosen to constrain the path to follow a logical course, to oblige the words to be aligned in a sensible way (for example by disallowing a too steep or a too gentle warp). Equation (1) shows how a distance score is computed at every frame between the test and reference tokens. The metric considers each coefficient to be equally important; no part of the parametric space is emphasized more than another. Equation (2) shows how the individual distance scores are accumulated, treating every frame in an equivalent manner.

## III - THE DISCRIMINATION FUNCTIONS

If we plot the local distance $d_\epsilon(T(j(k)), R(i(k)))$ as a function of the warped time, we notice three types of behavior depending on the letters compared. The solid curve in Figure 1 shows the local distance between two pronunciations of the letter $A$. It shows a more or less uniformaly distributed function. The dashed curve is a comparison between letters of different classes ($A$ and $O$). The local distance score is also uniformaly distributed, but in this case, the function is larger for all frames than the within-letter function, thus showing dissimilarity for every frame. The last behavior reflects the local distance when letters of the same class are used as test and reference tokens ($K$ and $A$ respectively). We see that the dissimilarity is large only for the initial portion of the word, corresponding, presumably, to the presence vs. absence of the velar stop /k/.

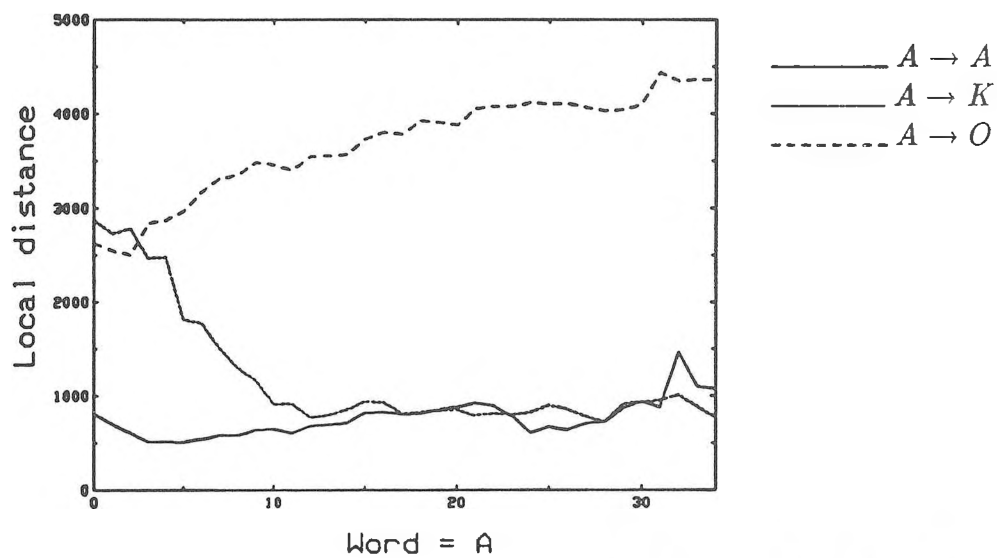


Fig. 1 Local distance for letters $A$,$K$ and $O$. $A \rightarrow A$ (solid), $A \rightarrow K$ (dotted) and $A - O$ (dashed).

Rabiner and Wilpon [1] uses this information to create temporal weights to encourage discrimination when the local distance depart from the within-letter scores (when the dashed and dotted curves are greater than the solid curve in Figure 1). To accomplish this task, they compute weight functions $w^t(k)$ for all within-class letters and integrate them in the computation of the local distance in the second stage to improve temporal discrimination:

$$w^t(k) = \frac{|\hat{d}_2^{RR'}(k) - \hat{d}_1^{RR}(k)|}{\sqrt{\sigma_{d_1}^2 + \sigma_{d_2}^2}} \qquad (4)$$

where $d_1$ and $d_2$ correspond to the means of local distances for within-letter and different but within-class letter respectively.

The main problem with such a scheme is that not all the letters in the French alphabet reveal the three different behaviors depicted in Figure 1. In some cases, when the normal speech variations are high for identical letters, there will be only two distinct behaviors and the local distance function will never be uniformaly distributed as in the solid curve. This is the case for most of the letters in the E-set: $d_e$ will reveal a large pulse for identical and different letters at the explosion and transition frames (Figure 2). For this reason, a discrimination function showing a behavior similar to that to the curves cannot be employed in a straightforward manner.

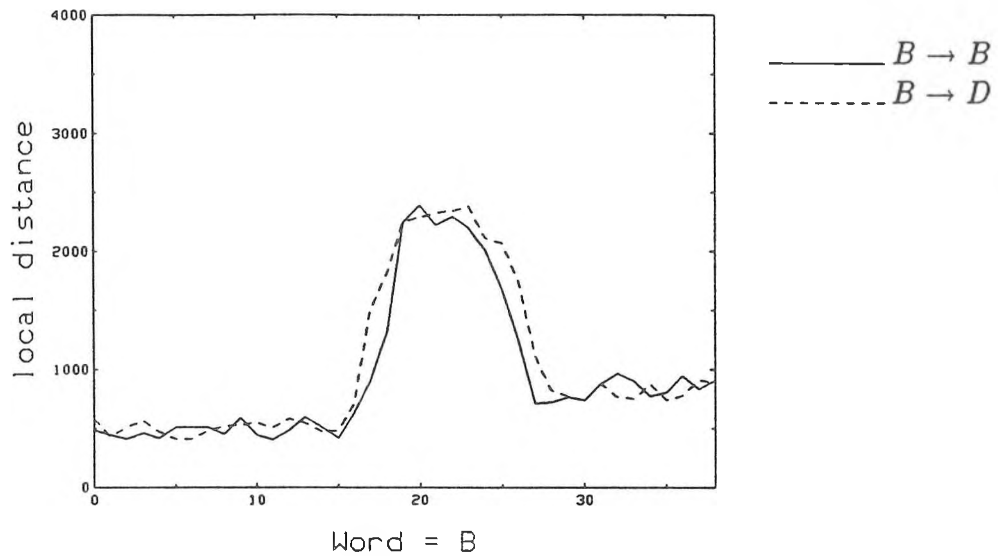


Fig. 2 Local distance for letters $B$ and $D$. $B \rightarrow B$ (solid), $B \rightarrow D$ (dashed).

Temporal indices are not enough to discriminate acurately between all the words in the six classes mentioned earlier: $R_1$ and $R_2$ will be very close to one another for the burst and transition frames of the stops. The probability of correct recognition will then approach 50 % for the whole letter since the ending vowel is also the same. To overcome this effect, non uniform weighting functions should depend not only on local differences distributed across time, but also on differences defined in the cepstral domain. To accomplish this cepstral discrimination, we can enlarge the scope of equation (4) by considering individual cepstral coefficients to be normally distributed and then obtain the cepstral weighting function as:

$$w_l^c(k) = \frac{|\hat{d}_2^{RR'}(k,l) - \hat{d}_1^{RR}(k,l)|}{\sqrt{\sigma_{d_1}^2 + \sigma_{d_2}^2}} \tag{5}$$

where $\hat{d}_2$ and $\hat{d}_1$ correspond to means of cepstral differences for different and identical letters respectively:

$$\hat{d}_1^{RR}(k,l) = \frac{1}{N_{d1}^2} \sum_{R} \sum_{R'=R} (C_l^{R(k)} - C_l^{R'(k)})^2 \tag{6}$$

$$\hat{d}_2^{RR'}(k,l) = \frac{1}{N_{d1} N_{d2}} \sum_{R} \sum_{R' \neq R} (C_l^{R(k)} - C_l^{R'(k)})^2 \tag{7}$$

The weight function may then be used in the distance metric discussed earlier to emphasize cepstral regions of interest:

$$d_e^c(T,R) = \sum_{l=1}^{Ncep} w_l^c(k) (C_l^{T(k)} - C_l^{R(k)})^2 \tag{8}$$

The functions $w_l^c(k)$ depend on two distinct groups of letters $R$ and $R'$ ($N_{d1}$ pronunciations of the letter $R$ and $N_{d2}$ pronunciation of the letter $R'$). They represent the weighting curves which discriminate in the temporal and cepstral space the two letters $R$ and $R'$. A high amplitude for a certain coefficient at a certain frame will mean increased discriminability in this region of the cepstral-time domain. Their computation can be made in many ways. For the temporal weights $w^t$, Rabiner and Wilpon uses a pre-recognition stage where all pairs of within-class tokens are employed. The problem with such a scheme is that the letters are not already aligned and the means $\hat{d}_1$ and $\hat{d}_2$ do not reflect the true averages. The problem is greater when considering individual cepstral coefficients since there is no frame averaging in equations (6) and (7). To overcome these effects, an alignment procedure is interposed between the first recognition and the second discrimination stage. It relies on the identification of the burst, and the alignment of the words prior and after the explosion for all the letters in the E-set that have a stop as their first phoneme. Once the tokens are aligned, the averages $\hat{d}_1$ and $\hat{d}_2$ are computed and $w_l^c$ can be calculated.

## IV - METHOD

The vocabulary used for testing consisted of the 26 letters of the French alphabet and the accented letter é. The speech data was obtained by 12 repetitions of each word by a male speaker. In all, 324 files were recorded and digitized at 16 KHz. Half of the files were used as reference templates and half as test data. A manual segmentation using a high resolution screen in the spectral and temporal domain was used to separate the letters from each other. The preprocessing stage consisted in obtaining $Ncep = 7$ mel frequency cepstral coefficient (MFCC) using an analysis window of 6.4 msec and a window length of 25.6 msec [10]($C_0$ was not used in the recognition stage).

The first pass consists of a straightforward recognition by a DTW algorithm. To take into account errors at the segmentation stage, an unconstrained end point algorithm is used, allowing every word a 38.4 msec (6 frames) translation. Rabiner and Wilpon uses a normalization process, representing the test and reference letters by a fixed number of temporally normalized frames. Although this process facilitates the recognition, it is done at the expense of destroying important frames useful for the second pass. All the reference letters which had a total score below a given threshold, here taken as the mean of total distance scores for identical letters, were passed to the alignment and second stage. If all the letters that are passed to the second stage are identical, the word is immediately recognized and no discrimination occurs. On the other hand, if the subset of reference tokens contain different letters, the second stage is used as shown in figure 3. In this example, 10 letters are passed to the second stage: three $B$, three $D$ and four $V$. The test word $T$ is thus assumed to be in one of these groups (i.e. $T \in \{B, D, V\}$). The word of each group that has the lowest distance score after the first pass is printed in boldface and is used in the second pattern similarity measure. The weights of Eq. (5) are obtained after the first recognition, considering only the letters which are close to the test word $T$ (in the example above, 10 letters are used). The number of tokens that take part in the computation of Eq. (6) and (5) ($Nd1$ and $Nd2$) depend on the number of letters passed to the second stage.

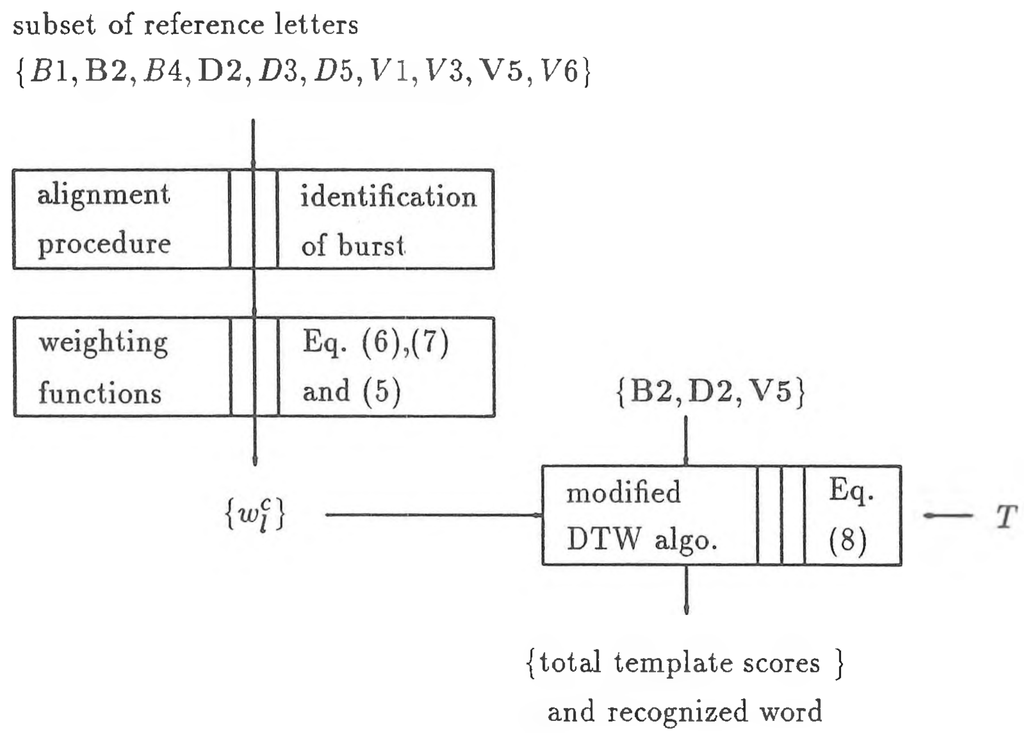


Fig. 3 The second stage of the recognizer.

## V - RESULTS

The representation in figure 4 shows the cepstral weighting curves obtained from the two letters $B$ and $D$ ($R' = D, R = B$ in equations (6) and (7)). The abscissa "x" represents the cepstral coefficient index, the "y" axis the frame index and "z" the amplitude of the functions. Firstly, we notice that the high amplitude regions are concentrated in time, that the maximum of discrimination happens at the $19^{th}$ frame, where the burst takes place. The curves fall off abruptly to zero because of the alignment of the tokens. Secondly, the plot shows that only the $C_1$, $C_2$, $C_3$ and $C_4$ coefficients are important for discrimination, the others have weak amplitudes for all the frames in the word. This signifies that there is a need for cepstral discrimination since the temporal curve $w^t$ would integrate at every frame the information of all the MFCCs into one factor.

The confusion matrices before and after discrimination are given in Tables 1 and 2.

They show that the cepstral discrimination achieves a 47 % reduction of errors when only the letters having some misclassification are taken into account. When only temporal discrimination is applied, with the $w^t$ functions, the number of errors drop from 19 to 16, bringing only a 15 % reduction in the error rate. The total recognition when the 162 test words are used passes from 88 % to 94 %. The discriminant analysis not only helps the recognition, but also clusters some letters together: the matrix found in table 2 has all its elements very close to the diagonal which is not the case with no discrimination. This fact is beneficial since it reduces the number of non-empty cells thus reducing the number of posibilities in the recognition process.

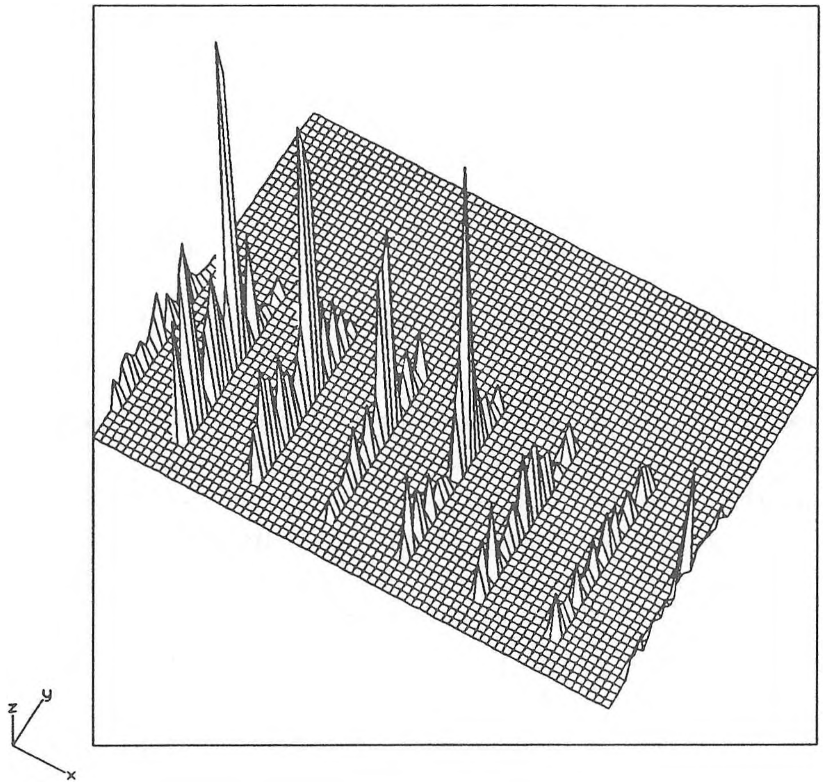


Fig. 4 Cepstral weighting curves for letters $B$ and $D$ in the cepstral domain; "x" is the cepstral coefficient index, "y" the frame (temporal) index and "z" the amplitude of the weight functions.

| | F | S | B | D | V | P | T | é | TO |
|---|---|---|---|---|---|---|---|---|---|
| F | 6 | - | | | | | | | 6 |
| S | 1 | 5 | | | | | | | 6 |
| B | | | 6 | - | - | - | - | - | 6 |
| D | | | 5 | 1 | - | - | - | - | 6 |
| V | | | 1 | 1 | 4 | - | - | - | 6 |
| P | | | - | - | - | 1 | 4 | 1 | 6 |
| T | | | 1 | - | - | 2 | 1 | 2 | 6 |
| é | | | - | - | - | 1 | - | 5 | 6 |
| ER | 0 | 1 | 0 | 5 | 2 | 5 | 5 | 1 | 19 |

Table 1 Confusion matrix without discrimination.

## VI - DISCUSSION

We have shown that cepstral discrimination can improve the recognition of isolated words when they are taken from a phonetically similar vocabulary. The speaker dependant, two pass system described briefly in this paper is superior by 50 % to the straightforward DTW recognizer. Although the system as it stands cannot be used as a speaker independant system (since the weights are very speaker sensitive), by producing reference templates that come from different speakers, the system can be used

| | B | D | V | P | T | ʻ | TO |
|---|---|---|---|---|---|---|---|
| B | 5 | 1 | - | - | - | - | 6 |
| D | 3 | 2 | 1 | - | - | - | 6 |
| V | - | - | 6 | - | - | - | 6 |
| P | - | - | - | 2 | 4 | - | 6 |
| T | - | - | - | 1 | 5 | - | 6 |
| ʻ | - | - | - | - | - | 6 | 6 |
| ER | 1 | 4 | 0 | 4 | 1 | 0 | 10 |

Table 2 Confusion matrix with alignment and cepstral discrimination.

by the different speakers that took part in the making of the templates since the computation of the weights are done after the first recognition stage, taking into consideration only the tokens similar the test letter. The algorithm described can be placed in parallel with another recognizer having a larger lexicon, where the unrecognized test tokens have to be spelled out. This would be done at the expense of increased perplexity and slower recognition. Although the two-pass pattern recognition approach is useful, some errors still occur: out of six utterances of the letter $P$, four were recognized as $T$, showing that further improvement is still needed. Changing the preprocessing stage, having either more cepstral coefficients or finer frequency parameters more suitable to the second stage analysis (critical band filter outputs for example) would help the accuracy of the process, but again at the expense of a larger computational load and an increase in memory requirements.

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# OVERVIEW ON ACOUSTICAL CALIBRATION AND STANDARDS

Dr. George S. K. Wong

Laboratory for Basic Standards
Division of Physics
National Research Council Canada
Ottawa, Ontario, Canada K1A 0R6

## ABSTRACT

The standard requirements for type testing, calibration and field-check of acoustical instruments and transducers are described, together with some calibration procedures and the implementation of traceability with an acceptable uncertainty. Factors which determine the calibration schedule or the frequency of calibration are discussed.

## SOMMAIRE

On décrit les besoins typiques pour l' étalonnage et la vérification (type et performance) d'instruments acoustiques et transducteurs, ainsi que quelques procédures d'étalonnage et la mise en pratique du raccordement avec une incertitude acceptable. Les facteurs déterminant le nombre d'étalonnage ou la fréquence d'étalonnage sont discutés.

## 1.0 INTRODUCTION

In the field of acoustical metrology one often encounters the following questions :

(1) **WHY** do we need calibration ?

(2) **HOW** does one select an acceptable calibration procedure to implement traceability with a finite uncertainty ? ; and

(3) **WHEN** or how often does an instrument need to be calibrated in order to maintain valid measurements with an acceptable calibration schedule ?

The aim of this article is to provide answers to the above questions such that the acoustics community can have a better understanding of the subject of acoustical calibration and standards.

## 2.0 CALIBRATION OF MEASURING INSTRUMENTS AND TRANSDUCERS

In order to have confidence in measurements, the overall measuring system should be calibrated from time to time in accordance with the requirements of a standard or an acceptable procedure.

When we examine the international and national standards on acoustical instruments, it is often difficult to differentiate between the following procedures :

(1) Type testing,

(2) Calibration, and

(3) Field-check, sometimes called "field calibration".

The truth is that almost none of the existing acoustical standards define the "test procedures" as stated in the above categories.

Let us clarify the above test categories :

## 2.1 Type testing

Type testing refers to tests which are essential to verify the design integrity of the instrument; such as :

(1) The directional characteristics of the microphone and the external shapes of sound level meters, which influence the sound diffraction pattern around the instruments, and

(2) Sensitivity to various environments, including mechanical vibrations and the effects of magnetic and electric fields.

The above type-tested instrument characteristics are very unlikely to change during the life of the instrument. Type testing is very expensive and time consuming; reputable manufacturers usually have their instruments type-tested before making final plans for manufacture.

## 2.2 Calibration

Calibration refers to test procedures which are usually performed in a laboratory. The tests are designed to monitor instrument operational performance which may change with the passage of time.

For example, in the case of sound level meters :

(1) The sensitivity and the frequency response of the microphone,

(2) The time-weighting (impulse, fast and slow responses) and the frequency-weighting ( A, B & C characteristics) of the instrument, and

(3) Linearity over the stated dynamic range, the uncertainty of the attenuators and the performance of the squaring circuit.

Calibration should be scheduled according to the amount of use and the operating time-span of the instrument.

## 2.3 Field-Check

A field-check is a relatively simple procedure which can be performed in situ, to give some indication of whether the instrument is operational. Field-checks are not intended to replace laboratory calibration procedures. In most cases, field-checks are performed with an acoustical calibrator which generates a known sound pressure level at a reference frequency, usually 1000 Hz. If necessary, acoustical calibrators which generate sound pressure levels at several frequencies can be used to check the frequency weighting response at discrete points.

In general, calibration is a means of assuring that the readings given by a particular instrument are valid and can be accepted for international trade or in a court of law.

## 3.0 CALIBRATION PROCEDURES AND TRACEABILITY

To select a suitable calibration procedure is not a simple matter. National and international acoustical standards give formal guidelines on calibration methods for acoustical instruments. Due to the rapid advancement of technology, acoustical standards published in recent years and those that exist in draft forms tend to "recommend" calibration methods, and specifically state that other test methods are acceptable as long as they can be shown to verify compliance with the requirements of the standards. For example, a manufacturer may replace the recommended procedures with several tests during the manufacturing phase, plus a simplified computerized check after assembly.

To implement traceability is a completely different matter. A calibration laboratory may have followed all the recommended test procedures and can fail to maintain or to provide proper traceability.

Some of the requirements for the implementation of traceability are as follows :

(1) Direct proof confirming that the particular reference device has been calibrated at a national laboratory or at an accredited laboratory.

(2) The recipient laboratory of the reference device has to demonstrate the capability to transfer the traceability, i.e. to calibrate other devices with an accepted uncertainty.

(3) The accredited laboratory should have the ability to determine whether its working standard device, i.e. the device used as the reference during calibration of other devices, requires verification.

(4) The accredited laboratory must maintain proper records on the calibration schedule of all reference devices or instruments; and to employ staff qualified for performing calibrations for which the laboratory is certified.

### 3.1 Implementation

Let us look more closely at the above, in order to determine what are the detailed requirements for the implementation of traceability :

(1) "Direct Proof" usually means a calibration certificate or a calibration report from a national laboratory or an accredited laboratory.

For accreditation in electrical measurements, calibrated instruments of the laboratory may include DC and AC voltmeters or generators of known voltages. However, for acoustical calibrations, laboratory microphones with known sensitivities, and reference sound sources with known sound pressure levels are essential.

From time to time, suggestions have been made that commercial apparatus used for reciprocity microphone calibration is able to perform absolute calibration of condenser microphones. It must be pointed out that the above commercial apparatus is unable to provide ABSOLUTE calibration.

The absolute reciprocity calibration of condenser microphones requires the measurement of a number of physical quantities, such as the DC polarising voltage, an electrical impedance which can be a capacitance or a resistance, and the ratios of AC voltages. Based on the knowledge of the above physical quantities and several physical constants such as the speed of sound and the ratio of specific heats, the absolute sensitivity of the microphone can be deduced.

In the case of a commercial reciprocity microphone calibration apparatus, it is not possible to calibrate the ability of the apparatus to assess individually each of the above physical quantities. If the commercial instrument can demonstrate that it is capable of obtaining the same result for a calibrated microphone, then the apparatus is acceptable as a means to implement traceability.

(2) Calibration for the implementation of traceability may exist in two general formats : (a) direct measurement and (b) by comparison.

As an example, the calibration of the linearity of a sound level meter can be performed as follows :

(a) With direct measurement, a sinusoidal signal with its amplitude changed between known levels is applied to the test instrument,

(b) With the comparison method, a sinusoidal signal with its amplitude changed to various levels, is applied simultaneously to the test instrument and a calibrated reference instrument, which can be a high-grade measuring amplifier.

The differences between the above two methods are that in the first case, the levels of the generator have to be known or calibrated, and in the second case, the reference instrument has to be calibrated. In both cases, proper calibration of the reference standards is essential.

(3) To achieve the ability to determine whether the laboratory reference devices need verification requires careful planning. The route chosen depends on the nature of the particular device and on the frequency of usage of the reference device.

Let us examine the case of the laboratory reference microphone; depending on the implementation technique, the calibration laboratory may require two calibrated reference microphones. For example :

(a) If the laboratory has a commercial reciprocity calibration apparatus, the self check procedure requires that the apparatus verify one of the reference microphones (the working standard) in order to provide some indication that the reciprocity apparatus is giving the correct answer. Depending on the frequency of usage, the answers given by the working standard and the reciprocity apparatus may have both drifted and, in the worse case, drifted in the same direction. Then the apparatus will give the "expected" result, which is incorrect. Under these circumstances, the second reference microphone (the second working standard), which is seldom used, is needed to verify the integrity of the system.

(b) If a comparison method is used to verify the sensitivity of microphones, the procedure involves the application of a stable sound pressure level to a reference microphone (the working standard) and then to the test microphone. Again, depending on the frequency of usage, the second reference microphone (the second working standard) may be needed as a back-up to ensure proper traceability.

The laboratory's aim in the achievement of a specific uncertainty of calibration, will dictate the requirements of the back-up system (which may not be a second working standard).

(4) The maintenance of continuous records on reference devices is relatively simple; however, to ensure proper staff training may be more difficult. There is a misconception that once a calibration procedure is taught to a technical person, he or she is "trained". In reality, a trained calibration person may require several years to acquire the expertise needed to sense that "something is wrong" and to be able to take proper precautions to discover and to rectify the source of the problem which may exist during calibration.

### 3.2 <u>Uncertainty</u>

During the planning for the implementation of traceability, it is necessary to have an uncertainty audit of the overall calibration system. Some of the sources of uncertainty can be summarized as follows :

(a) The uncertainty of the laboratory reference devices, such as the reference microphones (working standards),

(b) The uncertainty of the instruments used in the calibration procedure, eg. voltmeters and frequency counters,

(c) The uncertainty of the method used for the transfer of traceability, i.e. the calibration method itself, and

(d) Uncertainties due to external influences, such as temperature, barometric pressure and humidity; and those uncertainties due to data manipulation such as statistical processing of sampled readings, and human errors.

From the above, one may conclude that the uncertainty of any device calibrated by an accredited laboratory has to be higher than the working standard of that laboratory, and the uncertainty increases as the "chain" of traceability increases. It means that during each calibration or each transfer, the uncertainties listed in (b) to (d) have to be added to those in item (a).

Item (d) looks straight forward, but it is most difficult to eliminate without some effort. In most standards laboratories, environmental effects are usually dealt with by means of known corrections. One must apply corrections with caution, since the uncertainties in some corrections can be much higher than those related to the entire calibration process.

For example, in the case of the calibration of the pistonphone sound calibrator, the deviation of the barometric pressure from the standard atmosphere must be taken into consideration, and a correction is usually required. This means that the barometric pressure has to be assessed. If the barometer is unreliable, the uncertainty of the barometric correction can be much higher than the inherent uncertainty of the pistonphone.

National and international standards give guidelines to the accredited laboratories on the acceptable value of the uncertainty for instrument calibration. For example, the uncertainty of the sound pressure level generated by an IEC class 0 calibrator is specified to be ± 0.15 dB under the specified reference conditions. For a calibration laboratory, this means that the combined uncertainties of the reference microphone (with a typical sensitivity uncertainty of approximately 0.05 dB), and of the RMS voltmeter which measures the signal from the microphone, plus the uncertainty of the gain of the preamplifier, must not exceed 0.15 dB. In addition, allowances have to be made for environmental corrections.

## 4.0 CALIBRATION SCHEDULE

The selection of a calibration schedule to ensure proper traceability depends on : (1) The application and nature of the test device, (2) the acceptable penalty for failure of compliance, (3) the particular uncertainty expectation, and (4) the frequency of usage of the calibrated device.

(1) To demonstrate the extremes between the nature of various test devices, let us take the example of a laboratory standard microphone, which is a relatively stable transducer. If it is a reference standard device, it is seldom used; with proper handling, its sensitivity is not expected to change over relatively long periods, such as 6 to 12 months. Therefore the calibration schedule of a laboratory standard microphone can be 12 to 18 months if the calibration record confirms that the particular device has a history of stability.

On the other hand, in the case of a personal sound exposure meter which is used daily in a hostile environment, such as under ground in the mining industry, the instrument may require weekly calibration plus field-checks before and after daily usage in the field.

(2) In a manufacturing company, failure in the compliance to specifications may be of prime concern.

For example, a manufacturer of smoke detector fire alarms may intend to have its products tested for a 90 dB alarm sound level at a certain distance from the device. Every device is tested after assembly, and the factory produces 1000 units per day. Field calibration of the monitoring sound level meter may be required every hour, since deviation from specification, if discovered after only one day, may result in the rejection or the need to retest 1000 manufactured units.

(3) The magnitude of the expected uncertainty in the calibration will greatly influence the calibration schedule.

Take the example of a sound level calibrator which generates a sound pressure level of 94 dB at 1 kHz, with a specified uncertainty of ± 0.3 dB at the reference temperature. Under normal usage in an acoustics laboratory, the calibration schedule can be one year. If the expected calibration uncertainty is ± 0.15 dB, weekly calibrations may be required. The cost of calibration will encourage the use of the more precise pistonphone calibrator which has a better long term stability.

(4) The frequency of usage of the calibrated device is the prime factor in determining the calibration schedule.

For example, consider a sound level meter used by an acoustical consultant for daily noise surveys near an industrial complex. Assuming that the instrument is handled with care and the operator is knowledgeable enough to notice any unusual variations in sensitivity, one may accept daily field-checks, plus having the instrument calibrated every 6 to 9 months, as an acceptable calibration schedule. If the consultant has another means to verify some aspects of the performance of the instrument, then a longer period before re-calibration may be acceptable. Again, the history of calibration of the instrument is able to indicate instrument stability; and may warrant less frequent or more frequent calibrations.

As one can see from the above discussion, expert advice from a knowledgable acoustical consultant on instruments or advice from the national laboratory is often required to formulate acceptable plans and to ensure measurement reliability in a particular situation.

It is of interest to add that calibration laboratories, including national laboratories, can only state in the calibration report the performance of the test device (under laboratory conditions) when it was in the laboratory. The recipient of the test device is expected to have the capability to ensure that the calibration data still applies when the test device is received, before pressing the latter into service.

## 5. Accreditation

In Canada, the Calibration Laboratory Assessment Service (CLAS) was established by the National Research Council to form, in cooperation with the Standards Council of Canada (SCC), the Canadian Calibration Network (CCN). The CCN enables manufacturers across the country to gain easier access to a variety of calibration services traceable to national and international standards. For more details on accreditation criteria and requirements, one should contact the Standards Council of Canada or the Laboratory for Basic Standards of the National Research Council Canada.

In the United States, the National Voluntary Laboratory Accreditation Program (NVLAB), administered by the National Institute of Standards and Technology (NIST formerly NBS), accredits laboratories for specific tests, or types of tests, in certain product or service areas.

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## POSTDOCTORAL PRIZE

### PURPOSE

The CAA Edgar and Millicent Shaw Postdoctoral Prize in Acoustics is offered to a highly qualified candidate who has completed all formal academic and research training and who wishes to acquire up to two years supervised research experience in an established setting.

### QUALIFICATIONS

Candidates must hold a Ph.D. or equivalent degree, normally obtained within the two years preceding the competition. Preference will be given to those who are citizens or landed immigrants of Canada. The post-degree research experience must be related to some area of acoustics, psychoacoustics, speech communication or noise.

Candidates must be prepared to acquire supervised research experience in a setting other than the one in which their highest research qualification was earned.

Generally awards are tenable only in Canadian centres with established research programs. Requests for other venues will be considered.

Applicants should make their own arrangements to work at a research centre with an active research program.

Candidates who do not meet all the requirements enumerated above and who wish to explore the possibility of an exemption, should contact the president of CAA, in writing, well in advance of the due date for receipt of applications.

### STIPEND AND APPLICATION PROCEDURE

The prize is $3000 for full-time research for twelve months and may be held as a suplement to other private, provincial or federal awards.

Applicants must submit form CAA-89 and all supporting documentation to the Executive Secretary of CAA by **December 1**, for funding (if approved) effective on or after the following **September 15.**

Required supporting documents in form CAA-89 and guidelines for letters of reference are included in application instructions.

### SELECTION PROCESS

All applications will undergo a review by a Subcommittee named by the President and Board of Directors of the Canadian Acoustical Association.

To assess Postdoctoral Prize applications, the Subcommittee will consider the candidate's professional standing, her/his academic qualifications, evidence of proven or potential ability to conduct research, and the appropriateness of the centres in which he/she proposes to work.

The successful candidates will be notified in writing before April 30.

## CONDITIONS

Postdoctoral Prize recipients are required to devote themselves full-time to the objectives of the award.

Funds will be approved initially only for the first year of the award. Approval for the second year is conditional upon receipt, two months before the end of the first year of the award, of a brief progress report. This report should be prepared by the Fellow, and attested by his/her research supervisor.

It is not expected that a Postdoctoral Prize recipient will move from one centre to another during tenure of the award. If a move nonetheless becomes necessary, authority must be sought from the President and Board of Directors of CAA. Such requests must be accompanied by a letter from the Recipient's proposed new supervisor indicating acceptance, a letter from the former supervisor indicating that he or she is aware of the proposed transfer, and a revised page 1 of form CAA-89.

## FINAL REPORT

Postdoctoral Recipients are required to submit a final report upon the conclusion of their award, describing the results of their research and giving an outline of their future career plans.

## SPONSORSHIP/HOST DEPARTMENT

A candidate must be sponsored by a member of a research unit, who should include, in a confidential letter, an evaluation of the candidate's background in relation to the proposed research. A second letter of support will be required from the candidate's doctoral supervisor.

The obligation of the sponsor includes advice to Fellows in establishing themselves in the unit. In some cases the sponsor may also be required to provide laboratory facilities and material and technical support for the Fellow's research.

## CLOSING DATE

Completed applications and supporting letters must be received from the applicant by December 1. Decisions are announced before April 30.

THE CAA EDGAR AND MILLICENT SHAW POSTDOCTORAL PRIZE IN ACOUSTICS
Instructions for Applicants

THE ORIGINAL AND FIVE COPIES OF THE APPLICATION TO BE SUBMITTED.

The numbering of the notes below corresponds to the numbering of the relevant section on the application form.

1. Your surname and given names in full.

2. Your home or permanent mailing address.

3. Your present address or place to which correspondence should be directed (if other than the permanent address).

4. Your citizenship, whether a citizen of Canada or a national of another country and, if a landed immigrant, the date on which landed immigrant status was obtained.

Evidence of citizenship may be supplied but is not required at the time of application. Those who are offered awards may be required to confirm their citizenship as a condition of the award.

5. The name of the research or academic unit in which the award will be held.

6. The name of the proposed Sponsor.

7. A short project title or description of the subject of your proposed research.

8. The date on which you propose to take up (commence) the Prize.

9. List your academic and/or professional degrees and the institution from which they were obtained. Also note the discipline (major subject area) and the date (year) in which the degree or diploma was awarded.

10. Provide particulars of any previous or current postdoctoral experience, including any postgraduate employment. Indicate the institution, organization, or company where the position was held, the nature of the award or position, and the approximate duration of the award or appointment.

11. Provide the full, official title of your doctoral thesis.

12. List any publications or conference papers of which you are the author or co-author. Use a standard bibliographical form. An additional page may be appended, if required.

List any patents in which your are listed as a co-inventor, professional reports or similar substantial works.

Other contributions to scholarly communication, which are unique to particular disciplines, may be included.

The information provided will be judged in relation to your background and experience, the nature of the works, and the usual expectations of the discipline.

The length of the list is not, in itself, a determining factor.

13. Provide a description of the research project or program you propose to undertake.

The usual elements of a well developed research proposal should be present - a statement of the problem or topic of investigation, its significance (scholarly and/or practical), the approach and research methods, sources and resources required, and a work plan. The latter should set out specifically that which you expect to accomplish in the coming year.

If practical, discuss the proposed research with the Sponsor so as to ensure the required facilities and services are available and that library and other resources are adequate. Some modifications in the scope or design of the proposed work may result.

It is a shared responsibility of the Applicant and the Sponsor to ensure that the facilities and services are adequate to support the research.

14. Please give the names of those persons who have been asked to supply letters of reference. At least two references are required, neither of which may be the Sponsor. The Sponsor may be asked to provide a third (additional) letter of reference.

15. Provide copies of your academic transcripts or, if the degree granting institution does not issue transcripts, a certification of the doctoral degree. The transcripts need not be originals but if copies are supplied, originals will be required as a condition of any award.

Those who have not, at the time of application, completed their doctoral studies, will be required to provide evidence of the completion of the degree before taking up an award.

16. Sign and date the application, certifying that the information provided is true and correct.

17. The facility, service, and space requirements of the Applicant should be noted, together with the arrangements proposed to meet the needs.

18. The Sponsor and the head of the unit must sign the form indicating their preparedness to accept the Applicant as a Fellow in the unit and their willingness to provide the facilities, services and other assistance indicated.

## PROCEDURES

Applicant - After completing items 1. through 16., forward the form to the proposed Faculty Sponsor requesting her/him to attach a confidential letter of reference to be returned in a sealed and signed envelope.

Faculty Sponsor - Please consult with unit head with regard to the ability to provide the necessary facilities, service and space. If for any reason you are unable to sponsor the Applicant, the unit head should be consulted about possible alternative sponsors, and the Applicant advised whether the application will proceed.

Edgar & Millicent Shaw Postdoctoral Prize in Acoustics
Application

1. NAME:

2. PERMANENT ADDRESS

3. PRESENT ADDRESS

4. CITIZENSHIP:
( ) Canadian Citizen ( ) National of (Country): ____________________

( ) Permanent Resident of Canada (Landed Immigrant) since: ____________

5. RESEARCH UNIT WITHIN WHICH RESEARCH WILL BE CONDUCTED:

6. PROPOSED SPONSOR (NAME):

7. PROJECT TITLE OR SUBJECT OF PROPOSED RESEARCH:

8. PROPOSED DATE FOR COMMENCEMENT OF RESEARCH:

9. DEGREES AND DIPLOMAS HELD:

| Degree | Institution | Discipline | Date |
| --- | --- | --- | --- |

10. POST GRADUATE EXPERIENCE: (Please indicate any previous or current post graduate experience, including other fellowships or awards held, employment, or similar activities.)

11. TITLE OF DOCTORAL THESIS:

12. PUBLICATIONS AND/OR PATENTS: (Please list any publications or conference papers of which you have been first author or co-author.)

Edgar and Millicent Shaw Postdoctoral Prize in Acoustics
Application (continued) (SURNAME: )

13. PROPOSED RESEARCH: (Please provide, on these two pages only, a description of the research project or program you propose to undertake.)

13. PROPOSED RESEARCH (Continued):

Edgar and Millicent Shaw Postdoctoral Prize in Acoustics
Application (continued) (SURNAME: )

14. NAMES OF REFEREES (Supervisor and Sponsor):

15. ATTACHMENTS: ( ) Transcripts and/or ( ) Certification of Ph.D. degree
( ) Other awards applied for or held

16. DATE: SIGNATURE OF APPLICANT:

## THE ANNUAL CAA DIRECTORS' AWARDS

**RULES**

| | |
|---|---|
| AWARDS | Awards consist of a cash prize of $500. One of them is awarded for the best STUDENT PAPER and the other one is for the best PROFESSIONAL paper published in Canadian Acoustics. |
| ELIGIBILITY | All papers reporting new results or review or tutorial papers. "Point of view" and "technical notes" are not eligible. The first author should study or work in Canada. For students, the manuscript must be submitted within ONE year of obtaining the academic degree. CAA Directors are eligible for the professional prize but they will not evaluate their own paper. |
| PAPERS | Regulations regarding format and content of the paper can be found in Canadian Acoustics. |
| JUDGING | Eligible papers will be evaluated by CAA Directors and Officers according to a set of criteria. |
| REMITTANCE OF AWARDS | Winners will be announced at the Annual CAA meeting, and their names will be published in the first issue of Canadian Acoustics. of the New Year. |

## PRIX ANNUELS DES DIRECTEURS DE L'ACA

**REGLEMENTS**

| | |
|---|---|
| PRIX | Les prix consistent en une rémunération de 500$ chacun. L'un d'eux est attribué au meilleur article publié dans l'Acoustique Canadienne, l'autre pour le meilleur article rédigé par un-e PROFESSIONNEL-LE. |
| ELIGIBILITE | Tout manuscrit rapportant des résultats originaux ou faisant le point sur l'état des connaissances dans un domaine particulier. "Point de vue" et les "notes techniques" ne sont pas éligibles. Le premier auteur doit étudier ou travailler au Canada. Pour les étudiant-e-s, le manuscrit doit être soumis au plus tard un an après l'obtention du diplôme universitaire. Les Directeurs de l'ACA sont éligibles au prix de la catégorie professionnelle mais ne peuvent évaluer leur propre manuscrit. |
| MANUSCRIT | Les règlements concernant la présentation et le contenu du manuscrit sont mentionnés dans la revue Acoustique Canadienne. |
| EVALUATION | Les manuscrits éligibles seront évalués par les Directeurs et les membres de l'Exécutif de l'ACA selon les critères pré-établis. |
| REMISE DE PRIX | Les lauréats du concours seront annoncés à la réunion générale annuelle de l'ACA, tout comme la remise des prix. Cet événement sera relaté dans le premier numéro de l'année de la revue Acoustique Canadienne. |

# NEWS / INFORMATION

## CAA - TORONTO CHAPTER

### Report on the Vibration Measurements and Isolation Techniques meeting, Toronto, April 25, 1989.

The last meeting of the 1988 - 1989 season was devoted to vibration. Organized jointly by the Chapter and by the Society of Mechanical Engineers, the meeting had two speakers.

Mr. John Richter, the first of the speakers, gave an overview of the issues involved in heavy machinery vibration isolation. Among them, he explained the concept of support-critical and non-support-critical mountings. This concept was further developed through and audio-visual program on machine isolation aimed not only to prevent vibration transmission, but also to prolong the life of tools and machines alike.

The presentation ended with some considerations regarding cost-benefit analysis and life expectation from different vibration isolation pads.

The second speaker was Richard Haase, from Unisorb Inc. He started by a recapitulation of basic vibration isolation principles and techniques. Following, he discussed different approaches for solving practical problems. A long discussion followed, where technical characteristics of isolators were discussed as well as the ways how they are measured.

Both presentation were well received by the audience.

As in most occasions, facilities were made available by Ontario Hydro, while refreshements were provided by H. L. Blachford Ltd and Wilrep Ltd.

### 10th Anniversary Activities, 1989-90

The Toronto Chapter - CAA started in 1979, 10 years ago. For ten years it was acting both as a educational forum for members and non-members, as well as a meeting place, where people interested in Acoustics could meet five times a year.

The basic idea behing the creation of the Chapter, was the perceived need to meet more often than once a year at the Annual meetings of the CAA. We think that we did fulfill the goal. However the merit is not only ours - the Steering Committee. We have to thank all members that helped us to set up all our meetings, not to forget our speakers that spent time and effort to be with us.

We are looking forward many more years of educational, friendly meetings with all of you.

Here is the program for the next 1989-90 period.

| Date | Subject |
|---|---|
| Oct 3, 1989 | Highway Noise Barriers and Ornaments |
| Nov. 28, 1989 | Floating Floors |
| Jan 30, 1990 | Modern Instrumentation |
| Mar 27, 1990 | Joint session CAA & AES (Audio Engineering Society) |
| May 29, 1990 | Specialized Silencer Systems |

There are conversations under way with the OHAO (Occupational Hygiene Association of Ontario) for a joint one day seminar on occupational noise. We will keep you informed about further developments in that respect.

The session on Oct 3, the first of our program, will be also our 10th anniversary celebration. We hope that Grec Michel (B & K USA), who was one of the originators of the Toronto Chapter and a member of the original steering committee will be able to attend it.

A. Behar

## News from ASTM

(American Society for Testing Materials)

### Participants needed for three new ASTM task groups on Environmental Acoustics

Participants are needed for three new task groups formed by ASTM standards-writing Committee E-33 on Environmental Acoustics.

Subcommittee E33.05 on Research has formed a new task group on low frequency transmission loss measurement. The task group on low frequency transmission loss measurement. The task group is collecting information about the reliability and application of sound transmission loss measurements at frequencies below 100 Hz and seeks related data.

Two new task groups are also beign formed within Subcommittee E33.09 on Community Noise. The task group on criteria for ground-borne vibration measurement and assessment will develop a guide for the selection of ground-borne vibration criteria. The task group on acoustical characterization of discrete outdoor noise sources will develop a precision method for measuring the noise output of a single source on site.

All interested parties are welcome to participate. The next meeting of the task groups will be held during the October 23 - 25, 1989 standards development meetings of Committee E-33 in Long Beach, California. For more information, contact Richard M. Guernsey, R.M. Guernsey and Associates, P.O. Box 1517, Morristown, NJ 07960-1517, 201/267-7037; or Ray Sansone, ASTM, 1916, Race Street, Philadelphia, PA 19103, 215/299-5521.

Committee E-33 is one of 134 ASTM technical standards-writing committees. Organized in 1898, ASTM (American Society for Testing and Materials) is one of the largest voluntary standards development systems in the world.

**Thomas David Northwood named recipient of ASTM's Waterfall Award**

Thomas D. Northwood

Thomas D. Northwood, a resident of Ottawa, has been selected as the 1989 recepient of the Wallace Waterfall Award.

Committee E-33 on Environmental Acoustics honored Northwood April 12, at ASTM Headquarters in Philadelphia. He was cited for his significant contributions through his participation on the committee.

The Wallace Waterfall Award was established in 1975 by ASTM, in his memory, as a founding member of Committee C-20, predecessor to Committee E-33. The award is presented to a member of the committee with outstanding contributions to standardization in the acoustics field.

A native of Peterborough, Ontario, Canada, Northwood earned his B.A.Sc., M.A. and Ph. D. degrees from the University of Toronto, in engineering and physics. His professional career with the National Research Council of Canada began in 1940 as a research physicist of the Head, Noise, and Vibration Section. He was a specialist in building acoustics theory, measurements, and standards. He retired in 1979.

A member of ASTM for 36 years, Northwood has authored more than 50 papers related to sound insulation between dwellings, acoustics of churches, theaters, and the development of test methods and measurements of ground vibration. He is also the editor of the book "Benchmark Papers in Architectural Acoustics."

In addition to ASTM, Northwood is a member of the Association of Professional Engineers of Ontario; the Acoustical Society of America; the Canadian Acoustical Association (past president); and the Institute of Noise Control Engineering.

Committee E-33 on Environmental Acoustics is one of 134 ASTM technical committees. Organized in 1898, ASTM (American Society for Testing and Materials) is one of the larges voluntary standards development systmes in the world.

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## From another journal in acoustics.../D'un autre périodique en acoustique...

BULLETIN D'ACOUSTIQUE

ABSTRACTS from No 5, December 1988

### DETERMINATION OF THE ABSORPTION FACTOR BY A SOUND RAY METHOD
### Second Part: The effect of absorbent localization on the computation of the sound field
by J.J. EMBRECHTS, J. NEMERLIN and P. SAINT-MARD

In this paper, we analyse the behaviour of a sound ray method when it is applied to the computation of the sound field in a reverberant room with an absorbing sample. This behaviour has been found markedly different from classical theories (Sabine, Eyring). The conclusion of the study is that this behaviour comes from the fact that the sound ray program takes the real localization of the absorbing sample into account, whereas the other methods suppose that it is uniformly distributed on the walls of the test room. It is also explained why a 'sound level' approach is to be prefered to a 'reverberation time' approach in order to determine the absorption factor.

### ACOUSTICAL PROPERTIES OF THIN LAMINATED PLATES
by T. VO THANH and J. PELERIN

In a research program IRSIA - PHENIX WORKS, the 'laminated plate' technique has been used to enhance the acoustical properties of steel plates. The measurements procedures and the results of the test made on the laminated plates are described in this paper. The laminated plates show some significant advantages when they are compared to homogeneous steel plates with the same thickness: the coincidence dips are less important and the sound power levels radiated are weaker, due to their greater internal loss factor.

## Seminars and conferences

### Acoustical News

- **B & K Seminars 1989:**

| | | |
|---|---|---|
| September 13 - 14 | Saskatoon, Sask. | |
| September 19 - 20 | Halifax N.S. | |
| September 20 - 21 | Toronto, Ont. | |
| Qctober 10 - 11 | Edmonton, Alta | |
| October 24 - 26 | Ottawa, Ont. | |
| November 7 - 8 | Winnipeg, Man. | |
| December 4 - 5 | Vancouver, B.C. | (514) 659-8225 |

- **89 Conference on Noise.**

| | | |
|---|---|---|
| September 17 | Montreal, P.Q. | |

- **ASME**

| | | |
|---|---|---|
| Septermber 17 | 34E47th Str., NY, NY 10017 | |

- **Ind. Machinery and Noise Control Seminar**

| | | |
|---|---|---|
| September 26 - 27 | Toronto, Ont. | (416) 567-1500 |

- **89 IEEE Ultrasonic Symp.**

| | | |
|---|---|---|
| October 4 | Montreal, P.Q. | (212) 705-7890 |

- **89 CAA Ac. Week.**

| | | |
|---|---|---|
| October 16 | Halifax, N.S. | (902) 424-8888 |

- **INTER-NOISE 89**

| | | |
|---|---|---|
| December 4 - 6 | Newport Beach, CA, U.S.A. | (914) 462-6719 |

- **International Congress on Recent developments in Air & Structure Borne Sound and Vibration.**

| | | |
|---|---|---|
| March 6 - 8, 1990 | Auburn University, AL, U.S.A. | (205) 844-4820 |

# Ontario Hydro Round Table on Impulse noise hearing hazards measurement and protection

## 1.0 Introduction

Hearing hazards from impulse noises have been studied for many years. However, there is much less knowledge about effects from impulse noise compared to these from continuous noise. Basic hearing conservation issues, such as maximum allowable levels and protection from impulse noise are still a matter of research and debate.

Since impulse noise is of concern in the electrical generation industry, Ontario Hydro organized a one day round table where some of the above subjects were debated.

The attendance (by invitation only) was as follows:

| | |
|---|---|
| Alberto Behar | - Ontario Hydro, who acted as a host and organizer |
| Stan Forshaw and Brian Crabtree | - DCIEM |
| John Ershen | - Angevine Consultants |
| Hans Kunov | - University of Toronto |
| Raymond Hétu | - University of Montreal |
| Roger Hamernik | - State University of New York (SUNY), Plattsburg |
| Don Henderson | - SUNY, Buffalo |
| Robert Trépanier | - Bruel & Kjaer, Canada |
| Alain Quilliam | - Hydro Quebec |

The issues that were addressed were:

a) Which of the impulse noise characteristics are the most damaging to human ear.

b) How to measure them, and

c) How to measure impulse noise attenuation of hearing protectors.

A short summary of the discussions and some of the concepts that were debated is presented in this short communication.

## 2.0 Definition of Impulse noise

After a short discussion, it was concluded that:

a) There is no uniformity in the words "impulse" and "impact". Possibly, the best that can be said, is that "impulse" ("impulsive"?) is the nature of the sound, while "impact" is the way it is produced (as opposed to one produced by an explosion or reproduced by a loudspeaker), and

b) There is still not a uniform definition of impulse noise. NIOSH requires that the duration of the individual impulse be shorter than 0.5 sec. and the pause between two consecutive impulses be larger than 0.5 sec. for a noise to be defined as impulse. That definition is still accepted.

## 3.0 Most damaging characteristics of the impulse noise

Three short presentations on the subject were made by Raymond Hétu, Roger Hamernik and Don Henderson. Some of the conclusions were:

a) There is a critical exposure level above which the damage increases dramatically. This level varies considerably as a function of physical parameters of the impulses such as spectrum, duration and time parameters. It is not known yet how to predict the critical level including all of the above parameters.

b) The way impulses are presented (the temporal pattern) is another important factor. The equal energy theory is not valid above the critical level.

c) The noise spectrum is an important characteristic to be considered.

d) The influence of the background noise as well as of the acoustical reflex it not yet understood.

## 4.0 Measurement of the impulse noise

John Ershine and Robert Trépanier presented the issue of the measurement of impulse noise.

The choice of the microphone as well as the importance of the sound level meter were stressed. Issues such as the importance of the phase response of the measurement chain and the desire to be able to model mathematically the human ear were discussed. Finally, the possibility of measuring acoustical intensity as a means of knowing exactly how much of the acoustical energy reaches the timpanic membrane was presented.

Next issue to be discussed was the performance of the dosimeter with impulse noise. Dosimeters are now universally used to measure noise exposure to assess risk for hearing as well as for compliance with existing regulations. The various problems that arise when dosimeters are exposed to a mix of continuous and impulse noises are:

- the lack of standard for dosimeters, that will specify the response of dosimeter to different kind of noises,
- the location and orientation of the microphone on the wearers body,
- the fact that dosimeters are designed to process continuous or relatively slow level changing noises.

## 5.0 Measurement of hearing protectors

The measurement of the impulse noise attenuation provided by hearing protectors has been always extremely difficult. It has been performed by measuring TTS or (not that often) with cadavers.

Professor Kunov described an artificial head developed for DCIEM by a team from the University of Toronto and recently reported in the Journal of the ASA. One of its uses could be precisely, the measurement of hearing protectors. The head has artificial skin around the external ear as well as in the external ear canal. In such a way it can be used for ear muffs and ear plugs alike. The artificial head will be used by DCIEM to study the attenuation of hearing protectors, in terms of peak and energy reduction as a function of impulse spectrum.

## 6.0 Other Issues

Before the meeting ended the following issues were discussed:

a) There is very little research in progress in the field of impulse noise.

b) There is still a limited knowledge about the assessment of the impulse noise regarding hearing damage. As a result the existing hearing conservation regulations in Canada and in the US have appalling gaps regarding the issue of impulsive noise.

c) There are no standard methods for the measurement of impulse attenuation in hearing protectors.

The need for more research in this challenging field was stressed. The attendees were pleased to hear that Hydro-Quebec has signed a contract with the University of Montreal for the measurement of attenuation of hearing protectors. The artificial head created by the University of Toronto team will be used for this purpose.

All attendees expressed their satisfaction with the round table that did fulfill the expected goal: to put forward issues that are of concern and present an opportunity for a face-to-face discussion. A future meeting in a couple of years was also proposed.

A. Behar

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## News from...

Bell-Northern Research

An acoustic design methodology and electroacoustie computer-aided testing system have been developed for the design of high audio quality handsfree telephones.

For further information: Telesis 1989, Volume 16 number 1, pp. 34-43.

Bruël and Kjaer Canada

A new high precision studio microphone is introduced as Type 4012. This new microphone is a pre-polarized condenser design with a first order cardioid directional pattern because it comes equipped with a special 130-volt dual channel power supply to its preamplifier, it can handle up to 168 dB SPL before clipping occurs.

For further information: Andrew McKee, Bruël and Kjaer Canada Ltd., 90 Leacock Road, Pointe Claire, Qué. H9R 1H1. (514) 695-8225

Sweet's McGraw-Hill Information Services Company

Sweet's goup distributes enhanced second edition of electronic construction product database.

For further information: Raymond J. DeAngelo or Stuart Katz, McGraw-Hill Information Services Company (212) 512-3851

CANADIAN ACOUSTICAL ASSOCIATION
MINUTES OF THE BOARD OF DIRECTORS MEETING

March 12, 1989 - Ontario Hydro, 700 University Avenue
9:30 a.m., Mezzanine Floor, Room A, Toronto, Ontario

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Present: S.M. Abel
L. Brewster
A.J. Cohen
B. Dunn
T.F.W. Embleton
R. Hetu
N. Lalande
M.M. Osman
C. Sherry

Regrets: C. Andrew
G. Faulkner
J.G. Migneron
W.V. Sydenborgh

1. President's Introductory Remarks — Sharon Abel

The President welcomed the members of the Board present and read passages from letters received from the regrets.

2. Executive Secretary's Report — Moustafa Osman

The Secretary said that the 1989 renewal forms were sent out and many have been received with payment. He also mentioned that based on the unchanged membership fees for the last two years and the increase in the operating budget, the Board may wish to consider higher fees to be discussed at the October meeting.

3. Treasurer's Report — Sharon Abel

The President circulated a letter from the Treasure. The letter dealt with the status of CAA as a Charitable Organization. The Treasurer with the help of an accountant will present a proposed budget for the next fiscal year. A list of investments and their prize/award allocation was given.

A discussion ensued in the light of the fact that there was not a large amount of cash flow is available for operating cost. The President requested that all Board members should submit their needs for the proposed budget.

Finally it was reported that $3,626.66 was recouped from the $5,000 seed money given towards hosting ISO TC43 and ISO TC 29 meetings in Toronto October, 1988.

4. Editor's Report — Raymond Hetu

Current activities including the last issue of Canadian Acoustics (Vol. 17, No. 1) were discussed and was circulated.

There is a need to solicit more papers in areas of acoustics different from noise. A suggestion was made to send people on behalf of the editor to various CAA annual symposium session to solicit submissions. An attempt to use the new CAA logo on the journal front cover will be made as soon as feasible. The membership officer (Annabel Cohen) handed a new membership form to the Editor for inclusion in the journal. The President (Sharon Abel) stated that to date the total number of 1989 membership was 346 including 65 new members.

5. Membership Chairman's Report — Annabel Cohen

New membership form was circulated and the issue of receipts for new members was discussed.

Due to uncertainly regarding the amount of cash available as conveyed by the recent communication from the Treasurer, some membership office activities that require expenditures will have to be delayed till accounting is done.

6. Subcommittees on Prizes

a) Directors' Awards — Nicole Lalande

Some difficulties regarding this award were discussed (issue of cheques, signature on scroll, etc.). Some feedback was given on the draft procedure for evaluation of applications: there should be not ties, no scoring should appear under item 2 of the draft and the results should be normalized. Also eligible students should be residents of Canada and current paid members of the CAA.

b) Postdoctoral Prize — Bruce Dunn

A draft procedure on how to offer the prize was circulated and feedback was given. A final version is expected by the year end. A correction will be made to the last minutes of the General Meeting (October 6, 1988) to ensure that this is called a prize not an award. It was agreed that if the prize is not won in any specific year, the money should be left in the account, to accrue additional interest.

c) Bell prize — Raymond Hetu

Paul Mermelstein does not wish to chair a subcommittee to oversee the procedure for the prize. Consequently it was decided that Lynne Brewster will chair a subcommittee to provide guidelines on this graduate student prize.

d) Underwater Acoustics Prize — Annabel Cohen

This prize will not be offered next year. John Leggat and Harold Merklinger will be responsible for producing a guideline.

e) Canada Wide Science Award — Annabel Cohen

There will be $30 administration fee that has to be added to the award.

f) Student Presentations Prize — Sharon Abel

A form to be available prior to the next annual symposium was discussed. Winston Sydenborgh submitted some draft guidelines for consideration. Bruce Dunn will chair a subcommittee to provide guidelines for this prize.

7. Acoustic Week '88 — Sharon Abel

A report on the Toronto meeting was circulated. The objective of raising money for the CAA and the need to return profits from annual events were reiterated.

8. Report of Chairman for CAA '89, Halifax — Annabel Cohen

On behalf of Bob Cyr and the local organizing committee, Annabel Cohen gave a short report on the preparatory work for the meeting. The symposium will be on Wednesday and Thursday, October 18 and 19, 1989. The President suggested that the Board of Directors meeting be scheduled for 2:00-4:00 p.m. on Tuesday, October 17, 1989. The General Meeting will be held on Wednesday afternoon, and there will be a Closing Reception on Thursday afternoon at which winners of the awards will be announced.

9. Other Business

a) Travel Subsidies for Board Members — Sharon Abel

The President said that the Board members travelling from out of Province are entitled to some subsidy. Until the budget is reviewed, the same formula will apply as was in effect for 1988.

b) Honorary Members — Sharon Abel

This issue, first proposed by W. Sydenborgh, was discussed. It was felt that calling such members emeritus would be more appropriate. Eligibility requirements would be 10 years of membership and over 65 years of age. Such members would receive Canadian Acoustics free.

The meeting was adjourned at 1:15 p.m.

PREPARED BY:

M.M. Osman
CAA - Executive Secretary

MMO/bv

## CAA's YEAR IN REVIEW

Sharon M. Abel, Ph.D.
President, CAA

The focus of effort for your Board of Directors this past year has been the creation of variety of prizes to foster interest at the student level in the myriad disciplines of acoustics. Six subcommittes comprised of Directors and Members have been named to work out the details. The Directors Awards, long-standing in our association, are under the purview of Nicole Lalande (Quebec). These are two prizes of $500 each for the best papers published in Canadian Acoustics by a full Member and a Student of CAA. Bruce Dunn (Alberta) has agreed to chair two subcommittes, one for choosing the three best presented papers ($500 each) by students at the annual meeting and the second for judging the competition for the Edgar and Millicent Shaw Postdoctoral Prize in Acoustics ($3000/year for a maximum of two years). Two new graduates student prizes will shortly be available. These are for individuals working in the areas of speech and underwater acoustics and the subcommittes are chaired by Lynn Brewster (Saskatchewan) and Annabel Cohen (Nova Scotia). Annabel is also in charge of our Canada Wide Science Awards (3 prizes of $100 each) for high school students competing nationally with a project in any area of acoustics.

A special accolade goes to Winston Sydenborgh (Ontario) for chairing a successful annual meeting in Toronto last October. A highlight very much appreciated by those attending the banquet was the cello concert by Ofra Harnoy. Plans for CAA '90, Halifax are well in hand, thanks to Bob Cyr. Harold Forester has agreed to take on CAA '91, Montreal.

Closer to home Moustafa Osman and I have just completed our annual membership review for 1989. Tables 1 to 4 show the results of the analysis. As indicated in Table 1, our total number (398) remains about the same and most (85%) are Canadians. According to Table 2, Ontario is still the leading province with 50% of the Canadian membership. Based on the province subtotals, Quebec has the highest proportion of student members (20%), and this again is similar to previous outcomes. Most of our non-Canadian membership, described in Table 3, are either full members or subscribers (i.e., libraries or companies), and two-thirds are from the U.S.A. France and Great Britain are well represented, and we continue to hold interest as far away as Australia, West Germany, Hong Kong, Norway and the U.S.S.R.

Based on the information sheets we received, CAA members are involved in a wide range of endeavour. In only sixteen instances was Other one of the three choices, suggesting that our named categories generally matched professional interests. As shown in Table 4, noise still ranks highest, followed by shock and vibration, architectural acoustics and psychological and physiological acoustics. In spite of relatively small numbers in such areas as underwater acoustics, speech communication, and ultrasonics and physical acoustics, these are perceived internationally as areas of Canadian strength, as evidenced by the success of our 12th ICA satellite symposia and congress participation.

As we move toward our 10th anniversary year, the future looks terrific for the Canadian Acoustical Association. As countries go, our numbers may not be mighty, but we can boast a high level of active participation, as well as broad ranging expertise. We're working hard to entice and support fledgling acousticians and have been successful, I think, in enhancing our collective image. Exciting plans are on the drafting table: a bigger and better journal (thanks to Raymond Hetu), classier investments (thanks to Chris Andrew), new prizes (thanks to 12th ICA) and a stronger membership drive (thanks to Annabel Cohen). CAA is your professional association, support it. We badly need and will welcome your input. Annabel will happily provide tips on starting a small local chapter, Raymond will avidly review your news, views and recent scientific accomplishments and your local Directors will take any and all suggestions and complaints to our Board for serious consideration.

See you in Halifax!

## TABLE 1

### CANADIAN VS NON-CANADIAN CAA MEMBERSHIP (05/05/89)

| | Member | Student | Subscription | Sustaining | Subtotal |
|---|---|---|---|---|---|
| Canadian | 245 | 36 | 42 | 19 | 342 |
| Non-Canadian | 34 | 3 | 16 | 3 | 56 |
| **Subtotal** | 279 | 39 | 58 | 22 | 398 |

## TABLE 2

### DISTRIBUTION OF CAA MEMBERSHIP BY PROVINCE (05/05/89)

| | Member | Student | Subscription | Sustaining | Subtotal |
|---|---|---|---|---|---|
| British Columbia | 15 | 0 | 7 | 1 | 23 |
| Alberta | 24 | 1 | 2 | 2 | 29 |
| Saskatchewan | 2 | 0 | 0 | 0 | 2 |
| Manitoba | 8 | 0 | 2 | 0 | 10 |
| Ontario | 134 | 19 | 18 | 12 | 183 |
| Quebec | 37 | 11 | 8 | 4 | 60 |
| New Brunswick | 3 | 1 | 1 | 0 | 5 |
| Nova Scotia | 20 | 4 | 4 | 0 | 28 |
| P.E.I. | 0 | 0 | 0 | 0 | 0 |
| Newfoundland | 2 | 0 | 0 | 0 | 2 |
| **Subtotal** | 245 | 36 | 42 | 19 | 342 |

## TABLE 3

## DISTRIBUTION OF NON-CANADIAN MEMBERSHIP (05/05/89)

| | Member | Student | Subscription | Sustaining | Subtotal |
|---|---|---|---|---|---|
| Australia | 1 | 0 | 0 | 0 | 1 |
| Britain | 2 | 0 | 2 | 0 | 4 |
| France | 3 | 0 | 5 | 0 | 8 |
| W. Germany | 0 | 0 | 2 | 0 | 2 |
| Hong Kong | 1 | 0 | 0 | 0 | 1 |
| Norway | 2 | 0 | 0 | 0 | 2 |
| U.S.A. | 25 | 3 | 6 | 3 | 37 |
| U.S.S.R. | 0 | 0 | 1 | 0 | 1 |
| **Subtotal** | 34 | 3 | 16 | 3 | 56 |

## TABLE 4

## DISTRIBUTION OF MEMBERSHIP BY INTEREST

| Areas of Interest | Total |
|---|---|
| Architectural Acoustics | 147 |
| Electroacoustics | 77 |
| Ultrasonics and Physical Acoustics | 28 |
| Musical Acoustics | 46 |
| Noise | 214 |
| Psycho & Physiological Acous. | 94 |
| Shock & Vibration | 103 |
| Speech Communication | 69 |
| Underwater Acoustics | 31 |
| Other | 16 |

# Membership Directory / Annuaire 1989

The numbers that follows each entry refer to the areas of interest as coded below.
*Les nombres juxtaposés à chaque inscription réfèrent aux champs d'intérêt tels que codifiés ci-après.*

| Areas of interest | | Champs d'intérêts |
|---|---|---|
| Architectural acoustics | 1 | Acoustique architecturale |
| Electroacoustics | 2 | Electroacoustique |
| Ultrasonics | 3 | Ultrasons |
| Musical acoustics | 4 | Acoustique musicale |
| Noise | 5 | Bruit |
| Psycho and pysio- acousitcs | 6 | Psycho et physio-acoustique |
| Shock and vibration | 7 | Chocs et vibrations |
| Speech communication | 8 | Communication parlée |
| Underwater acoustics | 9 | Acoustique sous-marine |
| Other | 10 | Autre |

Duplicate entries means that more than one issue
is received by a member or subscriber

*Les inscriptions doubles signifient qu'un membre
ou un abonné reçoit plus d'un numéro*

Dr. Sharon M. Abel
Mount Sinai Hospital
600 University Ave., Suite 843
Toronto, Ontario
M5G 1X5
(416) 586-8278
Member 5, 6, 8

ACOUSTEC INC.
Dr. J.G. Migneron
106 Chaudiere
St. Nicolas, Quebec
G0S 2Z0
(418) 839-0101
Substaining 1,6

Acoutherm Insulation Ltd.
758 Dundas St. W.
Toronto, Ontario
M6J 1T8
(416) 363-2574
Subscription 1, 5, 7

ACOUVIB Experts
Mr. Vick J. Chvojka, D. Eng.
14 Place Mozart, Kirkland
P.O. Box 307, Station Beaconsfield
Montreal, Quebec
H9W 5T8
1989

Ms. M.P.B. Adams
Safety Dept.
INCO Ltd.
Thompson, Manitoba
R8N 0W9
(204) 677-5605
Member

Mr. R. Aggerholm
Ministry Of The Environment
985 Adelaide St. S.
London, Ontario
N6E 1V3
(519) 661-2200
Member

Dr. P. W. Alberti
Dept. of Otolaryngology
Suite 481
Mount Sinai Hospital
600 University Avenue
Toronto, Ontario
M5G 1X5
(416) 586-5143
Member 5, 6, 8

Dr. D.L. Allen
Vibron Limited
1720 Meyerside Drive
Mississauga, Ontario
L5T 1A3
(416) 670-4922
Member 1, 5, 7

Mr. Maurice Amram
Ecole Polytechnique
de Montreal
C.P. 6079, Succursale A
Montreal, Quebec
H3C 3A7
(514) 340-4572
Member 1, 5, 7

Mr. Chris Andrew
Transportation Planner
City of Calgary
P.O. Box 2100, Stn. M
Calgary, Alberta
T2P 2M5
(403) 268-1621
Member 5,

Mr. Graham Andrews
Boeing Canada, Dehavilland
Flight Test Building
Garratt Blvd.
Downsview, Ontario
M3X 2N5
Member 2, 5

Ms. Jean Andruski
#40, 4007-108 St.
Edmonton, Alberta
T6J 2L5
(403) 437-6647
Student 6, 8

Mr. Claude Archambault
11925 Suzor Cote
Montreal, Quebec
H3M 2J3
(514) 334-0004
Member 5

Mr. D. B. Archer
156 Lloyd Manor Road
Islington, Ontario
M9B 5K3
(416) 787-2461
Member 1, 2, 4

Mr. Jim Armstrong
M.A.P.A.O.
P.O. Box 1468
147 McIntyre St. W.
North Bay, Ontario
P1B 8K6
(705) 472-4140
Member 5, 7, 8

Mr. Horst Arndt
Unitron Industries Ltd.
20 Beasley Drive
P.O. Box 9017
Kitchener, Ontario
N2G 4J3
(519) 895-0100
Member 1, 2, 6, 8

Mr. Karl F. Arps
HUFCOR, Inc.
P.O. Box 591
Janesville, Wisconsin
U.S.A., 53547
(608) 756-1241
Member 1, 5, 8

Mr. A. F. Atamanchuk
Health Environmentalist
City of Winnipeg, Health Dept.,
280 William Avenue
Winnipeg, Manitoba
R3B 0R1
(204) 986-2388
Member 1, 5, 10

Mr. E.L. Attie
1335 Queen St.
Halifax, Nova Scotia
B3Z 2H6
(902) 428-4348
Member 5, 6, 8

Atlantic Acoustical Associates
P.O. Box 2520, DEPS
Dartmouth, Nova Scotia
B2W 4A5
(902) 425-0044
Subscription 1, 2, 5

Mr. B.W. Bailey
c/o Bruel & Kjaer Canada Ltd.
116 Russ Rd.
Grimbsby, Ontario
L3M 4E7
(416) 945-1900
Member 1, 2, 3

Ms. Denise Barbiero
Audiology
Mount Sinai Hospital
600 University Ave., #201
Toronto, Ontario
M56 1X5
(416) 586-5018
Member 2, 5,

Mr. Simon Bargetzi
Bargmes Ent. Canada Ltd.
P.O. Box 704
Golden, British Columbia
V0A 1H0
(604) 344-5344
Member 1, 5, 7

Barman Swallow Associates
1 Greensboro Dr., Suite 401
Rexdale, Ontario
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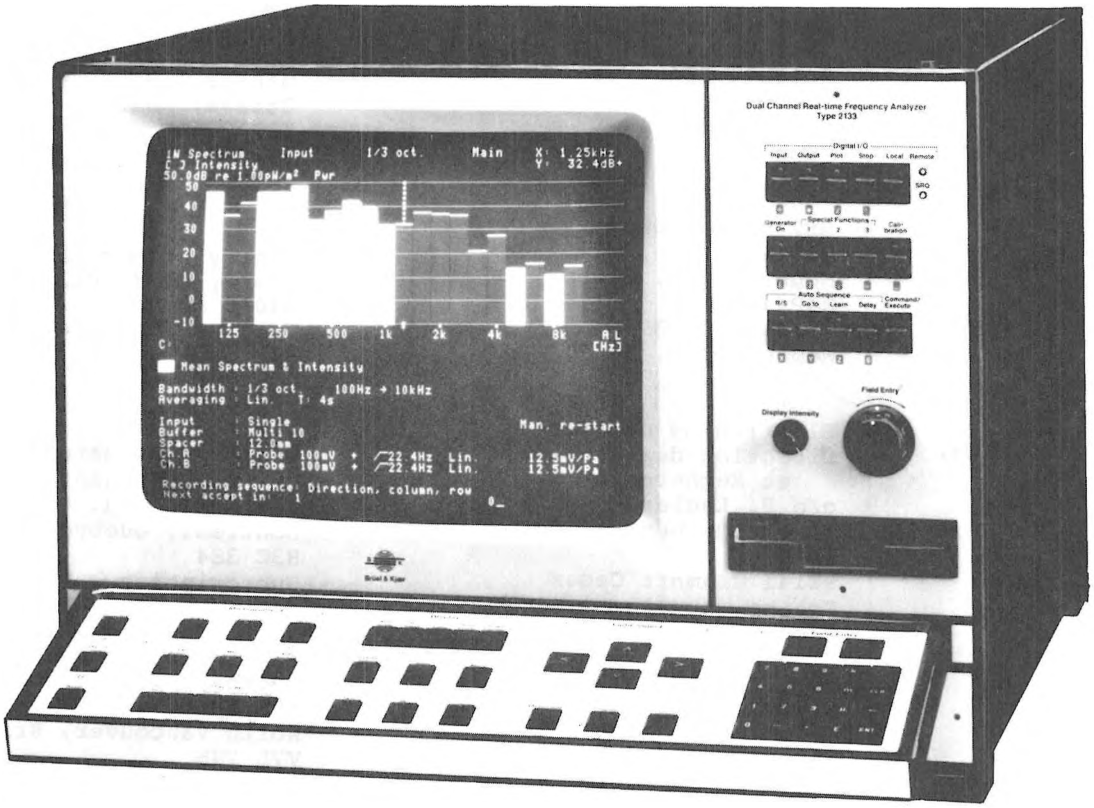


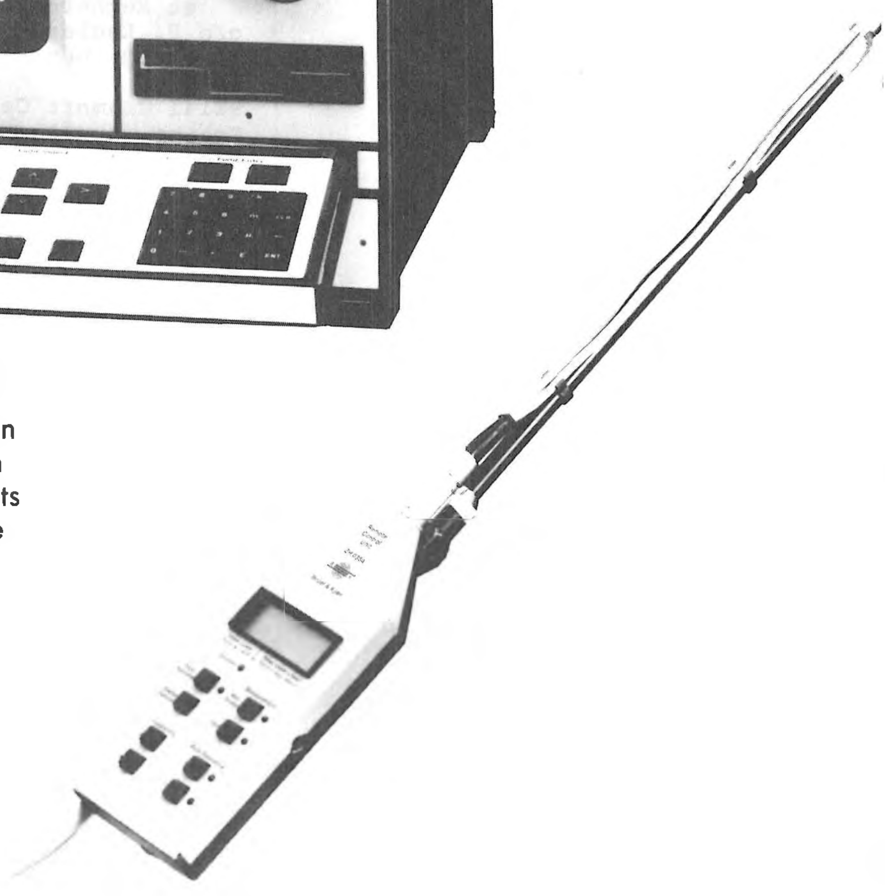

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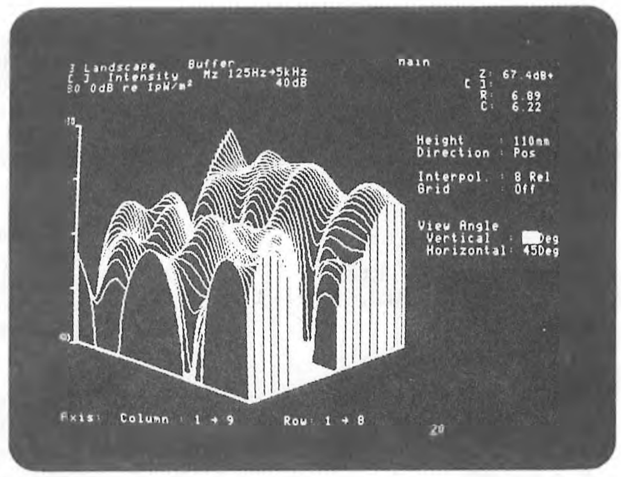

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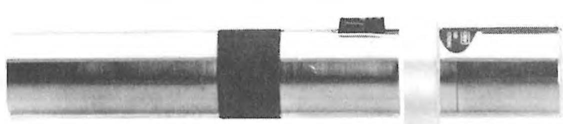

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(519) 972 7618
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12 Roslin Ave., South
Waterloo, Ontario
N22 2G5
(519) 885-4633
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Department of Psychology
University of Guelph
Guelph, Ontario
N1G 2W1
(519) 824-4120, ext. 3518
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34 West 17 Street
New York, New York 10011
U.S.A.
(212) 243-8600
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Inst. of Biomed. Engineering
University of Toronto
Toronto, Ontario
M5S 1A4
(416) 978-6170
Student

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University de Montreal
C.P. 6128, Succursale A
Montreal, Quebec
H3C 3J7
(514) 343-7672
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3420 ave Ellendale, Apt. 424
Montreal, Quebec
H3S 1W9
(514) 731-8196
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30 Charles St. W., Apt. 823
Toronto, Ontario
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(416) 920-2060
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Edmonton, Alberta
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Hamilton, Ontario
L8N 3Z5
(416) 525-9140
Member 7

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Inst. for Research
in Construction
Acoustics Section, Bldg. M-27
National Research Council
Montreal Road
Ottawa, Ontario
K1A 0R6
(613) 993-9749
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Halifax, Nova Scotia
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1111 Oak Street
Windsor, Ontario
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(519) 971-2727
Student 5,7

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2469 Callum Avenue
Mississauga, Ontario
L5B 2H8
(416) 848-8961
Member 1, 2, 5

Dr. L.K. Henrickson
School of Human Communication Dis.
Dalhousie University
5599 Fenwick Street
Halifax, Nova Scotia
B3H 1R2
(902) 424-7052
Student 1, 4, 6, 8

Dr. Raymond Hetu
Ecole d,orthophonie
et d'audiologie
Universite de Montreal
CP 6128, Succursale A
Montreal, Quebec
H3C 3J7
(514) 343-7559
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178 Dieppe Ave.
Pointe Claire, Quebec
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(514) 697-1964
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5 Delma Court
Georgetown, Ontario
L7G 4Z9
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Student 4, 6

Ms. M.H. Hodge
5321 Brody Drive, Apt. 204
Madison, Wisconsin 53705
U.S.A.
Student 6, 8

Dr. Murray Hodgson
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Sherbrooke, Quebec
J1K 2R1
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Mr. K.F. Hoffer
4186 Powderhorn Cresc.
Mississauga, Ontario
L5L 3B9
(416) 676-5416
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Mr. J.T. Hogan
Dept. of Linguistics
4-20 Assiniboia Hall
University of Alberta
Edmonton, Alberta
T6G 2E7
Member 4, 6, 8

Dr. Donald Hood
200-135 North Syndicate Ave.
Thunder Bay, Ontario
P7C 3V3
(807) 623-0322
Member 2, 5, 6,

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London, Ontario
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N. Vancouver, British Columbia
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(416) 265-4660
Member 1, 2, 4,

Mr. Gary Keay
236 Woodbriar Circle,
Calgary SW, Alberta
T2W 6B4
(403) 251-5807
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Mr. John S. Keeler
72 Margaret Ave. N.
Waterloo, Ontario
NJ2 3P9
(519) 885-3910
Member 1, 4, 5

Ms. Judy Keith
379 Wharncliffe Rd. North
London, Ontario
N6G 1E3
(519) 645-0519
Student 5, 6, 7, 8

Mr. Thomas Kelly
174 D'Auvergne
Gatineau, Quebec
J8T 1J7
(819) 568-3846
Member 5, 6, 10

Mr. Leslie G. Kende
105 Clifton Road
Toronto, Ontario
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Occupational Hygiene
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Calder Square
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State College, Pennsylvania
U.S.A. 16805
(814) 863-3214
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Mr. John W. Kopec
Riverbank Acoustical Labs
1512 Batavia Avenue
Geneva, Illinois
U.S.A. 60134
(312) 232-0104
Member 1

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Mechanical Research Dept.
Ontario Hydro
800 Kipling Avenue
Toronto, Ontario
M8Z 5S4
(416) 231-4111, ext. 6178
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Dr. Steven Kraemer
T.U.V. Rheinland
2901 Bayview Ave., #208
North York, Ontario
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95 Southill Drive
Don Mills, Ontario
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(416) 441-1998
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Edmonton, Alberta
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Delta, British Columbia
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8 Coldwater St. E., #4
Orillia, Ontario
L3V 1W3
(705) 327-7361,ext. 314
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Institute of Biomedical Eng.,
Rosebrugh Building
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3240 Goyer St. #27
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(514) 739-8800
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North York, Ontario
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Member 1, 5, 7

Ms. Reina J. Lamothe
Physics Department
Dalhousie University
Halifax, Nova Scotia
B3H 3J5
(902) 424-2337
Student 1, 3, 6

Dr. Nicole M. Lalande
Ecole d'orthophonie
et d'audiologie
Universite de Montreal
C.P. 6128, Succursale A
Montreal, Quebec
H3C 2J7
(514) 343-7867
Member 5, 6, 8

Mr. Tony LaPierre
P.O. Box 1604, Station M
Halifax, Nova Scotia
B3J 2Y3
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Mr. Michel Laporte
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Kanata, Ontario
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(613) 957-8460
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Defence Research Estab.
Atlantic
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Dartmouth, Nova Scotia
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Dr. D.A. Leitch
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Halifax, Nova Scotia
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(902) 425-1257
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M. Tony Leroux
8 Beauchemin
Baie-Comeau, Quebec
G4Z 2Y5
(418) 296-1423
Student 5, 6

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(519) 885-1211 ext. 3755
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14301 Middletown Lane
Westminster, California
U.S.A. 92683
(714) 898-9099
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St. John's, Newfoundland
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Subscription

Ms. A. Mareil
3205 Linton, Apt. 7
Montreal, Quebec
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(514) 739-7682
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11 Wincott Dr., Ste. 1014
Weston, Ontario
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56 Foreht Cres.
Aurora, Ontario
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6760 Campobello Road
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M. S. McDuff
3749 ave du Mont-Royal
Montreal, Quebec
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(514) 523-4764
Student 5, 6

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619-15th Street N.W.
Calgary, Alberta
T2N 2B1
(403) 294-7455
Member 2, 4, 8

Mr. Donald H. McKay
2110 23 Avenue, S. W.
Calgary, Alberta
T2T OW1
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90 Leacock Road
Pointe Claire, Quebec
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Audiol & Hearing Aid Assoc.
2340 W. 24th St.
Yuma, Arizona 85364
U.S.A.
(602) 783-6793
Member

Dr. John A. McNulty
Department of Psychology
Dalhousie University
Halifax, Nova Scotia
B3H 4J1
(902) 424-3429
Member 6, 8, 9

Mechanical Engineering Acoustics
and Noise Unit
Dept. of Mechanical Engg.
University of Alberta
6520-30 Street
Edmonton, Alberta
T6P 1J6
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Mr. Jorge Menyhart
3060 Blenheim Street
Vancouver, British Columbia
V6K 4J6
(604) 738-3382
Member 2, 5, 8

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44 Belgreen Ave.
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Ms. Kathryn Momtahan
Dept. of Psychology
Carleton University
Ottawa, Ontario
K1S 5B6
(613) 788-2707
Student 1, 6

Mr. Andre Mondoux
5655 De Marseilles
Montreal, Quebec
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(514) 251-7163
Member 1, 2, 3, 5, 6

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8 Rondeau Drive
Willowdale, Ontario
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4-32 Assiniboia Hall
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(416) 532-9372
Member 1, 6, 8

Mr. J. P. M. O'Keefe
10 Ridley Gardens
Toronto, Ontario
M6R 2T8
(416) 532-9372
Member 1, 6, 8

Mr. J.J. Olajos
Ministry of the Environment
139 George St. N.
Peterborough, Ontario
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Member

M. Pierre Olivier
830 Melancon, #305
St. Jerome, Quebec
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(514) 765-7824
Member 8

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Power Equipment, H13 A13
Ontario Hydro
700 University Avenue
Toronto, Ontario
M5G 1X6
(416) 592-4988
Member 1, 5, 7

Mr. Daniel Ouellet
G.A.U.S.
Dep. genie mecanique
Universite de Sherbrooke
Sherbrooke, Quebec
J1K 2R1
(819) 821-7144
Student 3, 5, 7

M. Pierre Ouimet
C.B.C. Engineering
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Montreal, Quebec
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Dept. of Physics
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Winnipeg, Manitoba
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1720 Meyerside Drive
Mississauga, Ontario
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Ottawa, Ontario
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Dr. Ramani Ramakrishnan
Ministry of Environment
250 Davisville Ave.
Toronto, Ontario
M4S 1H2
(416) 762-6093
Member 3, 5, 7,

Ms. Racansky
Inst. of Biomed. Engineering
University of Toronto
Toronto, Ontario
M5S 1A4
(416) 978-7772
Student

Ms. L. Rammage
530 North Eau Claire Ave.
Madison, Wisconsin
U.S.A. 53705
Student

Mr. Gunnar Rasmussen
c/o Bruel & Kjaer Canada Ltd.
1950 Merivale Rd., Unit 2
Ottawa, Ontario
K2G 5T5
(613) 225-7648
Member 1, 5, 7

Dr. L.A. Read
Dean, Arts & Science
Wilfrid Laurier University
75 University Ave., W.
Waterloo, Ontario
N2L 3C5
(519) 884-1970, Ext. 2220
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12th Flr. College Plaza
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Toronto, Ontario
M4V 1Y1
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Dept. of Mech. Engineering
University of New Brunswick
P.O. Box 4400
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E3B 5A3
(506) 453-4513
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Mr. C. Rollinson
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1950 Merivale Rd., Unit 2
Ottawa, Ontario
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185 Pickard Dr.
Keswick, New Brunswick
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Division of Physics, M36
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M5S 1A4
(416) 978-6170
Student

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London, Ontario
N6K 2N8
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Physics Dept.
Dalhousie University
Halifax, Nova Scotia
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Mount Sinai Hospital
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Toronto, Ontario
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1075 Brush Hill Lane
Lake Zurich, Illinois
U.S.A. 60047
(312) 546-8288
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Mr. A.D. Wallis
Daytona
Station Rd. Cross Gates
Scarborough UK
YO11 4LT
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Member 5

Mr. T. E. Walton
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Morrisburg, Ontario
K0C 1X0
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Dept. of Physics
University of Waterloo
Waterloo, Ontario
N2L 3G1
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Student 2, 4, 10

Dr. A. C. C. Warnock
Inst. for Res. in Constr. M-27
National Research Council
Montreal Road
Ottawa, Ontario
K1A 0R6
(613) 993-9370
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Surbrunnsgatan 6
S-11421 Stockholm
Sweden
(46) 8-150165
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Mr. L.A. Westlake
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(416) 965-8888
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Mr. E. A. Wetherill
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U.S.A. 94501
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V7L 1H4
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7 Amberglen Court
Holland Landing, Ontario
L0G 1H0
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Vibra-Sonic Control
4004 Gravely Street
Burnaby, British Columbia
V5C 3T6
(604) 294-9495
Member 1, 5, 7

Dr. G.S.K. Wong
Division of Physics
National Research Council
Montreal Road
Ottawa, Ontario
K1A 0R6
(613) 993-6159
Member 2, 3, 5,

Dr. Roland Wong
5142 Sunray Drive
Mississauga, Ontario
L5R 2V1
(416) 568-2242
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Mr. Norman Woo
4 Golfview Drive
Brampton, Ontario
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Dept. de Genie Mecanique
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T2P 3G4
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Human Communications Disorders
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5599 Fenwick St.
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B3H 1R2
(902) 424-7052
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10 Arlstan Drive
Downsview, Ontario
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## Canadian Acoustical Association/ L'Association Canadienne d'Acoustique

## ACOUSTICS WEEK HALIFAX '89

### October 16 - 19, 1989

### The Chateau Halifax, Halifax, Nova Scotia

**1900 Barrington Street, Scotia Square**
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**Tel: (902) 425-6700**

### Courses and Seminars, October 16 - 17

**Occupational Noise Exposure and Hearing Conservation, Oct. 16**
**Mechanical and Electrical System Noise Control, Oct. 16**
**Ocean Acoustics, October 16 - 17**
**Sound and Vibration Intensity Seminar, Oct. 16 - 17**

Complete information on courses and seminars has been mailed to all members. For more information contact Miss Margaret Cassidy, c/o Nova Scotia Power Corporation, P.O. Box 910, Halifax, Nova Scotia, Can. B3J 2W5 tel. (902) 428-6214

### Technical Symposium, October 18 - 19

Program details follow in Canadian Acoustics

### Exhibit, October 16 - 17

### Organizing Committee

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| Annabel J. Cohen | Technical Symposium Chair | (902) 424-8888 |
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### CANADIAN ACOUSTICAL ASSOCIATION
### Acoustics Week in Canada, October 16 - 19, 1989
### Chateau Halifax, Halifax, Nova Scotia

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Surname: ________________________________First Name and Initial__________________________

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**I enclose:**

***Courses (Oct. 16 - 17; details have been mailed to all members of the CAA)***

| | | | |
|---|---|---|---|
| Oct. 16-17 | Ocean Acoustics | ______ | $225 |
| Oct. 16-17 | Sound and Vibration Intensity Seminar | ______ | $225 |
| Oct. 16 | Mechanical and Electrical System Noise Control | ______ | $125 |
| Oct. 16 | Occupational Noise/Hearing Conservation | ______ | $100 |

***Technical Program (from evening Oct. 17 to Oct. 19 includes technical sessions, exhibits, opening and closing receptions, banquet and published Proceedings***

| | | |
|---|---|---|
| Registration fees | ______ | $120 CAA member |
| | ______ | add $25 if not a CAA member (membership dues are $20) |
| (Registration | ______ | $20 CAA student member (membership dues are $5) |
| fees for students | ______ | add $5 if a student and not a member |
| *excludes* banquet) | | |

Extra Banquet Ticket ______ $25 (price to increase to $30 at door)

Total ______ (Canadian dollars; Make cheques/money orders payable to Canadian Acoustical Association. Send to Miss Margaret Cassidy, Nova Scotia Power Corporation, P.O. Box 910, Halifax, Nova Scotia, B3J 2W5

**Please note:** Hotel reservations are to be made directly with the Chateau Halifax, 1900 Barrington St., Scotia Square, Halifax, Nova Scotia B3J 1P2, phone (902) 425-6700 (Toll free numbers 1-800-268-9411 [except Ont. and Que.] 1-800-268-9420 [Ont. & Que.] and 1-800-828-7447 [USA]. Less expensive accommodation is available at the YMCA: Write Eileen Barteau, YMCA, 1565 South Park St., P.O. 3024 South, Halifax, N.S., B3J 3H1 or phone (902) 422-6437.

***Please complete:*** I am interested in receiving information about the excursion to Baddeck in Cape Breton and the Alexander Graham Bell Museum, October 20 _______yes ________no

Check if application for membership is enclosed: ______ yes ________no

## Invitation to Attend the Technical Symposium of the 1989 Annual Meeting of The Canadian Acoustical Association/ l' Association Canadienne d' Acoustique

The Technical Symposium of the Canadian Acoustical Association/l'Association Canadienne d'Acoustique will take place at the Chateau Halifax, October 18 - 19, following two days of short courses. The Symposium consists of over 75 presentations in special plenary sessions, invited symposia, contributed papers, and contributed posters. As our annual meeting moves from city to city across Canada, different regional strengths and interests become apparent. At our meetings on the coasts we find a greater emphasis in the area of underwater acoustics. Each year, we also see new aspects of Canadian acoustics represented and this year we welcome a number of new participants from Newfoundland, the Bedford Institute of Oceanography, the Dalhousie School of Human Communication Disorders, the McGill Graduate Program in Sound Recording, to name only a few.

In keeping with its aims of fostering communication among people working in the field of acoustics and to deepen understanding in all areas of acoustics, special plenary sessions start each day of the Symposium. These sessions represent two very different specialities: Acoustical Remote Sensing of the Environment and Digital Sound Recording. They will be tutorial as well as relevant to peers. Because these areas impact on the lives of many individuals, the sessions should be of interest without necessarily being within one's own area of expertise. Much effort has gone into arranging these plenary sessions and plenary session participants have come from great distances in many cases, so it is hoped that all people attending the conference will take advantage of and enjoy these opportunities. It was decided by the local organizing committee to begin these sessions at **8:30 a.m.** so as to provide one hour and a half for each plenary session, time during the rest of the day for contributed papers, interaction over coffee breaks and lunch, and the business of the organization.

In order to attend the morning sessions on the first day of the Technical Symposium, it is likely that most out of town participants, who are not already attending courses, will arrive by Tuesday evening, October 17. There will be a reception with entertainment on Tuesday evening to which all participants are invited. This is a chance to renew acquaintances and develop new professional contacts as well as to relax before the two full days ahead.

Poster presentation has become a convenient mode for communicating new data at many scientific meetings. Those attending the conference are invited to view the posters which will remain on display throughout the meeting. Authors of posters will list the times at which they will be at their poster to meet with interested viewers.

The assistance of David Chapman (DREA), Dennis Phillips (Dalhousie) and Doug O'Shaughnessy (INRS-Telecommunications) is greatly appreciated for their organization of excellent invited symposia in Underwater Acoustics, Physiological Acoustics, and Speech, respectively.

Abstracts of papers were reviewed in general by two members of a local committee consisting of Fred Cotaras (Defence Research Establishment of the Atlantic), Phillip Doyle (Dalhousie School of Human Communication Disorders), Fred Guptill (Seastar, Bedford), Larry Henrickson (School of Human Communication Disorders, Dalhousie), Jin Meng (Engineering Physics, Technical University of Nova Scotia), John McNulty (Psychology, Dalhousie University), Marek Mieszkowski (Digital Recordings, Halifax), Dennis Phillips (Psychology and Otolaryngology, Dalhousie University), Les Russell (Technical University of Nova Scotia), A. M. Simpson (Physics, Dalhousie University),Peter Terroux (Consultant, Halifax), Gordon Whitehead (Nova Scotia Speech and Hearing Clinic, Halifax) and Edward Yang (Dalhousie School of Human Communication Disorders). In a few cases, other people were consulted. Where necessary, referees' comments were returned to the authors and abstracts were resubmitted. The assistance of this committee is greatly appreciated.

It has been customary for the Proceedings of the Annual Meeting of the Canadian Acoustical Association to be printed, however, this is the first year that full papers for the Proceedings are reviewed and edited (by members of the local committee and outside experts). Papers represent many fields of acoustics including physiological acoustics, psychoacoustics, musical acoustics, speech, architectural acoustics, underwater acoustics, and imaging. We are grateful to those who submitted papers and to reviewers who assisted in maintaining a high standard. Should you be unable to attend the meeting and wish to obtain a copy of the Proceedings, please xerox the form below and mail it as indicated. The Proceedings will be available at the time of the conference and are included in the registration fee.

The abstracts and schedule for the Technical Symposium follow. An attempt was made to avoid concurrent sessions in overlapping interest areas but this was not always possible. The order of presentations in some cases was governed by the need to accommodate judges of papers by students competing for awards.

Annabel J. Cohen
Technical Symposium Chair

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**Proceedings of the Canadian Acoustical Association Annual Meeting October 1989**

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Dalhousie University
Halifax, Nova Scotia
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# TECHNICAL SYMPOSIUM SUMMARY

## 1989 Meeting of the Canadian Acoustical Association
## Chateau Halifax, Halifax Nova Scotia

**Tuesday Evening 17 October**

Registration / Reception

**Wednesday Morning 18 October**

| | | |
|---|---|---|
| 8:30 | A. | Opening Plenary Session: Acoustical Remote Sensing of Weather and Air/Sea Interaction<br>David Farmer, Institute for Ocean Sciences, Sidney B. C.<br>Joe Scrimger, Jasco Research, Sidney B.C.<br>Fred Dobson, Bedford Institute of Oceanography, Dartmouth, N. S. |
| 10:00 | B. | Coffee / Poster Session (hearing conservation, physical acoustics etc.) / Exhibits |
| 10:30 | C. | Psychoacoustics: Papers on response to impulse noise, loudness, masking level difference, auditory warnings |
| | D. | Music: Papers on memory, reverberation preference, ear-training |
| | E. | Physical Acoustics: Papers on air jet mixing, propagation, semi-complex structures |

**Wednesday Afternoon, 18 October**

| | | |
|---|---|---|
| 1:30 | F. | Physiological Acoustics. Invited Symposium, Chair Dennis Phillips, Dalhousie University |
| 1:00 | G. | Underwater Acoustics. Invited Symposium, Chair, David Chapman, DREA |
| 1:30 | H. | Architectural Acoustics. Papers on room acoustics, test facilities, studio recording |
| 4:00 | | Annual General Meeting |

**Wednesday Evening, 18 October**

| | | |
|---|---|---|
| 6:00 | | Reception / Cash Bar |
| 7:00 | | Banquet |

**Thursday Morning, 19 October**

| | | |
|---|---|---|
| 8:30 | I. | Plenary Session: Digital Sound Recording<br>Marek Mieszkowski (organizer), Digital Sound Recording, Halifax<br>James McKay, University of Western Ontario<br>Robert Wannamaker, University of Waterloo<br>Wieslaw Woszczyk & Wayne Zelmer, McGill University |
| 10:00 | | Coffee / Poster Session (B. Continued) / Exhibits |
| 10:30 | J. | Biological Acoustics: Papers on whale, wolf, rat and seal vocalization and reception |
| | K. | Acoustical imaging: Structured session -- Papers on underwater and medical applications |
| | L. | Speech: Papers on phoneme perception and production, binaural processes, development |
| 11:45 | M. | Auditory Evoked potential: Papers on measurement in infants and in stroke patients |

**Thursday Afternoon, 19 October**

| | | |
|---|---|---|
| 1:30 | N. | Speech. Invited Symposium. Chair Douglas O'Shaughnessy, INRS-Telecommunications |
| | O. | Occupational Noise: Papers on standards, hearing protection devices, noise induced loss |
| | P. | Underwater Acoustics: Papers on ambient noise sensors, array design, bubble properties |
| 4:00 | | Reception and Awards Presentations |

## PROGRAM FOR THE TECHNICAL SYMPOSIUM OF

## The Annual Meeting of

## The Canadian Acoustical Association/ l'Association Canadienne d'Acoustique

**Chateau Halifax    Halifax, Nova Scotia    18-19 October 1989**

**WEDNESDAY MORNING, 18 OCTOBER, 1989    Bluenose Room    8:30 TO 10:00 A.M.**

**Opening Remarks 8:30**

Annabel J. Cohen, Technical Symposium Chair
Department of Psychology, Dalhousie University, Halifax, Nova Scotia B3H 4J1

### Session A. First Plenary Session
### Acoustical Remote Sensing of the Environment and Air/Sea Interaction

Fred Dobson, Moderator
Bedford Institute of Oceanography, P.O. Box 1006, Dartmouth, Nova Scotia B2Y 4A2

**Moderator's Introduction 8:35**

**8:40**

**A1. The role of acoustical methods in air-sea interaction studies.** David M. Farmer (Institute of Ocean Sciences, P. O. Box 6000, Sidney, B. C. V8L 4B2).

Transfer mechanisms occurring at the air-sea interface are profoundly important to our understanding of atmospheric and oceanic conditions and of global climate. The energetic environment at the ocean surface presents a special challenge to those who would measure and study these processes. How can an acoustical approach contribute? Both active and passive methods offer new insights on the physics of the air-sea interface. High frequency sonars can resolve not only the shape of the surface, but also the clouds of bubbles injected by breaking waves. Use of multiple frequencies leads to size determination of the bubbles which are relevant to studies of the exchange of gas between atmosphere and ocean; Doppler backscatter can be used to identify their motion and sidescan sonar can delineate their spatial patterns. Passive sonar makes use of the naturally occurring sound and a primary source of such signals comes from wave breaking. Analysis of the sound reveals the spatial density of breaking, the modulation of breaking by the group structure of the wavefield and certain peculiar effects caused by trapping of the sound in the near surface bubble field. The use of hydrophone arrays permits the location of individual breaking events in both space and time suggesting possibilities for testing models of wave-breaking and of its contribution to momentum transfer. Examples of both active and passive acoustical observations will be presented.

9:10

**A2. Underwater noise caused by precipitation.** Joseph A. Scrimger (JASCO Research Ltd., 9865 West Saanich Road, Sidney, B. C. Canada. V8L 3S1)

The characteristics of underwater noise in the ocean generated by precipitation is important to weather forecasters and oceanographers since it permits the detection and measurement of rain over the ocean by remote (i.e., buoyed or bottom-mounted) acoustic sensors. We have observed the character of the underwater noise generated by rain, hail, and snow in a lake. The spectrum of rain noise, for wind speeds below 1.5 m/s shows a peak at 13.5 kHz with a sharp cut-off on the low frequency side and a gradual fall-off (7dB per octave) on the high frequency side. Stronger winds smear the peak. Hail spectra show a rounded peak at 3.0 kHz with a gradual (roughly 11dB per octave) fall-off on both sides. The spectrum of snow noise is unique. More recent long term measurements, made of the west coast of British Columbia at Ucluelet, have permitted the development of a graphical picture of the dependence of oceanic rain noise on rain-rate and its interdependence on the weather controlling factor-wind. [Work supported by the Unsolicited Proposals Programme, DSS; Department of National Defence; Department of Fisheries & Oceans and Atmospheric Environment Service]

9:40

**A3. Discussant. Looking at ocean surface processes with acoustics.** Fred A. Dobson (Bedford Institute of Oceanography, Dartmouth, Nova Scotia B2Y 4A2).

**WEDNESDAY MORNING, 18 OCTOBER, 1989 Bluenose Room 10:00 TO 10:30 A.M.**

**Coffee, exhibits, posters**

**Session B. Poster Session 10:00 - 10:30**

The following posters will be displayed throughout the meeting and in particular during the coffee period each morning 10:00 - 10:30. Authors have indicated on their poster the time(s) during which they will be available to discuss their material and meet interested conference attendees.

**B1. The Implications of the Error to STS Ratio.** Bruce E. Dunn. (Department of Psychology, The University of Calgary, Calgary AB).

Dunn et al. [B.E. Dunn, M.P. Booth and T.M. Anderson, Acoustics '87, 98-107 (1987)] described the results of a simulation procedure for evaluating the use of significant threshold shifts (STS) in hearing conservation programs. Problems were apparent due to the interaction of real threshold changes with measurement error. The present study extends the work to make a more general statement about the relationship between the size of the significant shift and the size of the measurement error. It also relates the problem to the degree of correlation between the measurement error at adjacent frequencies. The data demonstrate that the greater the exposure level, the greater is the impact of the ratio of error to STS. However, it is also shown that for moderate ratios many of the false alarms are anticipatory false alarms under relatively high noise conditions. That is a large number of those identified should show an STS in a very few years given no error. The impact of correlated error is determined by both the degree of correlation and the error to STS ratio. The implications for cost effective measurement programs are discussed.

**B2. A field survey of the performance of a waveguide system in controlling transformer noise.** M. Amram and R. Lahlou, (Engineering Physics, Ecole Polytechnique of Montreal, C.P. 6079, Succursale A, Montreal, H3C 3A7).

The control of low frequency pure tones (120, 240, 360 Hz) emitted by transformers is difficult to achieve. In current practice a U shaped absorbant barrier can provide about 10 dBA insertion loss, while a complete enclosure, which ensures about 20 dBA, entails many technical and economic problems. Some workers (particularly in Sweden), engaged in active noise cancellation, have claimed success in controlling such noise with loudspeakers adequately situated along a network surrounding the transformer. For the past five years, a passive reactive device, precisely tuned on 120 Hz, and functioning on the same principle, has been developed at the Ecole Polytechnique of Montreal. After favorable predictions were obtained, both with a computer program and with scale model experiments (scales 1/20 and 1/4), a prototype has been built and installed in the field at the Station Chaudiere near Quebec City on top of a conventional soundblox U shaped barrier. Its performance has been evaluated in normal operating conditions and has shown, when compared to the same barriers with closed waveguides, an overall excess attenuation greater than 3dBA along a line of properties situated from 150 to 200 m away from the two protected transformers.

**B3. Design considerations for reducing acoustical interference in high quality microphones.** Wieslaw Woszczyk ( Graduate Programme in Sound Recording, Faculty of Music, McGill University, Montreal, Quebec).

Detailed measurements of several high quality studio microphones show a high degree of acoustic interference within microphone structure. This interference is due to various diffractive and reflective surfaces near the microphone diaphragm, and may become a source of large error in transduction. The microphone may measure parameters of the sound field with considerable error which depends on the type of microphone used and on the orientation of microphone in the sound field. The paper classifies microphone designs showing body types most prone to acoustical interference; it recommends proper microphone use in order to minimize interference effects; and it shows the magnitude of frequency response modification due to microphone interference. Frequency response curves measured with high resolution in frequency and in the angle of incidence show clearly the spectral effects of interference for several microphones.

**B4. A practical examination on the use of active sound absorbers to control standing waves in smaller listening rooms.** Wayne Zelmer (Faculty of Music, McGill University, Montreal, Quebec).

Small listening rooms generally have significant problems in the low frequency area (< 500 Hz) due to standing waves. The practical implementation and performance of an active absorber to control room modes (and hence nodes) is examined in both recording studio control room and home living room environments. An approach to measuring the standing waves within a room, and the display of the resulting information in the form of a "sound intensity map" is also illustrated.

**B5. Can auditory frequency control the direction of visual attention?** Ray Klein and Tim Juckes (Department of Psychology, Dalhousie University, Halifax, N.S. B3H 4J1).

Studies of cross-modality scaling, judgment and discrimination time suggest a phenomenal correspondence between auditory frequency and visual direction on the vertical meridian. This raises the possibility that visuo-spatial attention might be shifted in response to the pitch or pitch contour of an auditory stimulus. Tones of fixed frequency (250, 650 and 2500 Hz) and frequency glides (900 to 400 Hz and 700 to 1200) emanating from straight ahead had no effect on visual reaction time to luminance targets above and below the fixation point. This result suggests that the phenomenal correspondence (between pitch and location) does not involve reflexive control of visual orienting mechanisms. Work in progress manipulates the relationship between the direction of the frequency glides and the likelihood of the visual target appearing above or below fixation ( the relation can be congruent or incongruent). The results indicate that subjects can shift their visual attention in the congruent direction within about 500 msec while incongruent shifts are not observed within 1000 msec. This is consistent with the proposal that the phenomenal correspondence between pitch and location is mediated at the level of meaning.

**WEDNESDAY MORNING OCTOBER 18, 1989** **10:30 - 12:15 A.M.**

## Session C. Psychoacoustics

Sharon Abel, Chairperson
Mount Sinai Hospital
600 University Ave., Toronto, M5G 1X5

**10:30**

**C1. Individual differences in response to impulse noise: Equal loudness contours for high level narrow-band signals.** Bernadette Lepage, Hung Tran Quoc and Raymond Hetu (Groupe d'acoustique de l'universite de Montreal, C. P. 6128, Montreal, Quebec H3C 3J7).

A study was designed to analyse the variability of the ear response to the spectral content of high level impulse noise. The loudness of third-octave band impulses centered at 10 different frequencies between 1 and 8 kHz was measured with 20 normal hearing subjects, 10 males and 10 females. The loudness of the signals was adjusted to equal that of a reference third-octave band of white noise centered at 1 kHz presented at peak levels of 80, 85, 90, 95 and 100 dB SPL. With each signal, the adjustment procedure was reversed to counter the order of presentation bias. The resulting average equal loudness contours, expressed in terms of the energy level of the impulses, resembles those obtained with steady-state narrow-band noises. The maximum sensitivity is obtained at 3.15 kHz for both groups. No statistically significant difference was found between the results of the males and females although there was a tendancy of the females to show a larger difference between minimum and maximum sensitivity across frequency. The contours do not vary as a function of the sound level within the range tested. There was considerable inter-individual variability both in absolute loudness at a given frequency and in the shape of the equal loudness contours. These differences could very well account for part of the large individual differences observed in the auditory effects of impulse noise. [Work supported by the Institut de recherche en sante et securite du travail du Quebec]

10:45

**C2. Exposure to industrial noise at levels below 140 dB peak: a major threat to hearing.** Chantal Laroche and Raymond Hetu (Groupe d'Acoustique de l'Universite de Montreal, C. P. 6128 Succ. A, Montreal, Que, H3C 3J7)

All provincial and federal regulations (except Saskatchewan) set the highest allowable peak level for impulse nosie at 140 dB. In many of these regulations, the only other parameter taken into account is the number of impulses. These limits are derived from studies done many years ago on a limited set of exposure conditions. At that time, it was difficult to systematically vary the different physical parameters of impulses in order to study their effects on hearing. More recent data show that the temporal characteristics and the spectral content may contribute strongly to the noxiousness of impulses. Safe exposure to a large number of impacts/impulses that combine the most noxious features requires to limit the peak level 30 to 40 dB below the conventional 140 dB peak. Based on results from TTS studies conducted in our laboratory with human subjects, a provisional damage risk criterion for impulse noise is proposed for industrial exposures. It takes into account the overall energy level, the decay time, the spectral content and the number of impulses. Additional data need to be collected (in particular on the effect of temporal characteristics) in order to propose a simple and valid descriptor of noxiousness for all types of impulse noise. Exposure limits to impulse noise in the workplace should be revised, especially those which simply set a maximum permissable level of 140 dB peak. [Work supported by IRSST].

11:00

**C3. The quadratic difference tone, $f_2 - f_1$: Loudness increases with frequency.** Winston Baker and Mike Zagorski (Memorial University of Newfoundland, St. John's, Newfoundland, A1B 3X9).

While the combination tone, $2f_1 - f_2$, has received much attention, the difference tone (DT) $f_2 - f_1$, has not, because it had been "explained" as a mechanical non-linearity in the motion of the stapedial footplate. This "explanation" is called into question by an accidental observation of the first author who observed that the loudness of the difference tone increases as the frequencies of the driving tones, $f_1$ and $f_2$, increase while holding their difference, $f_2 - f_1$ constant. This result is not consistent with the usual explanation that the DT is a result of the quadratic term in the expansion of the transfer function, y=f(x), relating movement of the oval window, y, relative to the eardrum, x. Simple trigonometry shows that according to this explanation, the amplitude of the difference tone is related to the product of the amplitudes of the driving tones and not to their frequencies. Accordingly, a more comprehensive characterisation of stapedial motion will be presented.

11:15

**C4. Masking-level differences in the elderly.** M. Kathleen Pichora-Fuller and Bruce A. Schneider. (Department of Psychology, Erindale College, University of Toronto, Mississauga, Ont. L5L 1C6).

Masking-level differences (MLD's) were measured in young and old subjects at four different frequencies by introducing an interaural time delay in broadband masking noise. In the baseline condition, both the pure-tone signal and the broadband masking noise were diotic ($S_0N_0$). Thresholds in $S_0N_0$ were compared to thresholds in the experimental condition in which the tone was diotic but an interaural delay, *r*, was introduced in the noise ($S_0N_r$). The value of *r* was always 1/2 of the period of the pure-tone signal. Thresholds were significantly worse in the ability to detect signals in noise in the absence of interaural cues. MLD's for old subjects were also significantly reduced, indicating a

reduction in the ability to use binaural cues to detect signals in noise. The combined effect of these two losses in signal:noise resulted in the old subjects being 5dB less sensitive than young subjects in the $S_0N_r$ condition. The age-related reduction in the MLD was larger than that found when the typical antiphasic MLD paradigm was employed. Possible reasons for these results and implications for communication function will be discussed.

**11:30**

**C5. A putative NB (narrow band) filter model which explains the confusion of musical vibratos and tremolos also estimates delta I and delta f, and the temporal integration time.** Mike Zagorski (Memorial University of Newfoundland, St. John's, Newfoundland, A1B 3X9).

It had previously been reported that listeners were unable to distinguish musical vibratos and tremolos (5 Hz modulations of frequency and amplitude - FM and AM is the vibrato depth). This is true even though these same listeners could easily identify 5 Hz modulations as periodic pitch or loudness changes. Reported here is a narrow band filter model which accounts not only for this inability but also estimates difference thresholds for intensity and frequencyin terms of each other and estimates the temporal integration time as 200 ms. The relation of these putative filters to the critical band will be discussed.

**11:45**

**C6. Anaesthetist's responses to operating room monitor alarms.** G. Allen Finley (Department of Anaesthesia, Dalhousie University, Halifax, Nova Scotia, B3H 4J1) and Annabel J. Cohen (Department of Psychology, Dalhousie University, Halifax, Nova Scotia, B3H 4J1)

An increasing number and variety of electronic monitors are used in hospital operating rooms. Most of these are equipped with an auditory alarm which can be loud, insistent, or irritating, and thus is frequently disabled by the anaesthetist. Sixty-three anaesthetists attending a national conference rated the perceived urgency of ten common operating room alarm sounds. These ratings were compared with the urgency of the corresponding clincial situation as assessed by ten senior anaesthetists. Discrepancies between the clinical and perceived urgencies of several monitor alarms were observed. The anaesthetists at the conference were also tested for their ability to identify the alarm sound correctly. The overall correct identification rate was 36%, and only two monitors were correctly identified more than 50% of the time. The results of this study have implications for design and use of auditory alarms in hospital settings. [Work supported by NSERC].

**12:00**

**C7. An ergonomic analysis of the auditory alarm signals in the operating room and recovery room.** Kathryn L. Momtahan and Brian W. Tansley (Psychology Department, Carleton University, Ottawa, Ontario K1S 5B6).

An ergonomic analysis of the auditory alarms in a recovery room and operating room setting was carried out by (a) comparing the acoustic properties of the alarms and of the ambient noise in order to predict if masking of alarms could occur, (b) finding out how many alarms could be correctly identified by the recovery room nurses and anaesthetists working in these settings, and (c) correlating the results of (b) with the rank-ordering of these alarms according to their urgency. It was found that several of the alarms in both areas could mask other alarms in the same area. The nurses correctly identified a third of the alarms, the anaesthetists one-quarter. The anaesthetists significantly overestimated how many of the alarms they would be able to identify, at $p < .01$. The Spearman rank-order correlation coefficient for alarm urgency vs. the results of subject testing was not significant for the recovery room alarms, but was for the operating room alarms, at $p < .05$.

## Session D. Music Perception

Walter Kemp, Chairman
Department of Music, Dalhousie University
Halifax, Nova Scotia B3H 4J1

10:35

**D1. Preliminary data on a computerized ear-training system for the recognition of spectral parameters of sound.** Wieslaw Woszczyk and Rene Quesnel (Graduate Program in Music Recording, Faculty of Music, McGill University, 555 Sherbrooke St., Montreal, Quebec).

This is a report on a preliminary version of a computer controlled ear-training system designed specifically for aural identification and quantification of technical parameters of sound. The present version uses hardware and software allowing calibrated comparative evaluation of the sound frequency spectrum. The requirements, design considerations and the performance of this system are discussed. The implementation of the technical ear-training system will make it possible to calibrate and to measure the hearing acuity of musicians, composers, recording engineers, acousticians, subjects of listening tests, etc., for sound and its physical structure. While these professionals are often called on to make subjective (non-musical) judgments of sound and of its physical structure, little is known about their ability to make accurate or reliable judgments. The ear-training system proposed will allow them to objectively verify their hearing ability, and to train this ability until it becomes a more reliable tool for their profession.

10:55

**D2. Music Intelligibility: Reverberation preferences for audiences.** James R. McKay (Performance Department, Faculty of Music, University of Western Ontario, London, Ontario N6A 3K7) and Ted Grusec (Behavioural/Social Systems Research, Federal Department of Communications, Tunney's Pasture, Ontario).

McKay [Canadian Acoustics, 16, 94 (1988)] at the last meeting of the Canadian Acoustical Association discussed reverberation preferences for acoustical instruments. In that study, it was shown that different instrumentalists and musician-listeners have varying needs for reverberation ambiences during performances. The current study is a continuation of the previous work in which the reactions of audiences to ambient changes of reverberation for choir, symphonic band, chamber music groups, and solo instruments are documented. The psychophysical method used was that of magnitude estimation. The results show an ideal reverberation time for each of the groups studied.

11:15

**D3. Effects of tonality and contour in an interpolated pitch memory task.** Bradley Frankland and Annabel J. Cohen (Department of Psychology, Dalhousie University, Halifax, Nova Scotia B3H 4J1).

Tonality and contour are two aspects of structure which influence recognition of a short melody. The present paper examines the effects of these variables on memory for individual tones. Three groups of listeners differing in level of musical training (none, low and high) were instructed to compare the first and last tone of a 5-tone melody and to ignore the intervening 3-tone sequence. The first and last notes were either C6 or C#6 ( in all four combinations); the intervening sequence was either a C5 or a C#5 major or minor triad, yielding 16 different conditions of tonality relationship. Each triad was presented in six different permutations producing two "V" shaped patterns and four more complex "W" shaped patterns, considering all five tones of the melody. Performance increased with level of musical training. For both the low and high training groups, memory for the first tone decreased with increasing discrepancy between the first tone and the tonality implied by the sequence. For the high training group, there was evidence that "V" shaped contours led to higher performance than did "W" shaped contours when the tonality was clearly defined. The situation seemed to reverse when the tonality was less well defined. The low training group showed a similar but weaker pattern. This result facilitates our understanding of the interaction of tonality and sequential factors in music perception. [Work supported by NSERC].

11:35

**D4. Are musical expectancies prototype categories?** James Carlsen (Program in Systematic Musicology, DN-10, University of Washington, Seattle, Washington 98195).

This investigation examines in a musical context Rosch's [Cognitive Psychology, 7, 532-547 (1975)] contention that spatial judgments of psychological distance are comparable to the linguistic hedge data when dealing with temporal phenomena. It was believed that failure to demonstrate comparability in a preliminary study was due to the use of musical examples which were not sufficiently close to subject's prototypes. The presentation will report results of three experiments which address this problem.

## Session E. Physical Acoustics.

Leslie Russel, Chairman

Department of Mechanical Engineering
Technical University of Nova Scotia, Halifax, Nova Scotia

**10:30**

**E1. Acoustic augmentation of air jet mixing.** P. J. Vermeulen, V. Ramesh, Ching-Fatt Chin and Wai Keung Yu (Department of Mechanical Engineering, The University of Calgary, Calgary, Alberta. T2N 1N4).

Jet flow mixing is important to gas turbine type combustor processes. The mixing is that by steady gaseous jets with a confined gaseous crossflow. Such flows have been extensively studied as well as the mixing of a free, steady, axisymmetric jet with a stationary fluid. Jet entrainment is responsible for the mixing produced by a jet, and by *indirect* means it has been shown that entrainment is significantly increased for a pulsating jet. Acoustic control over jet flow mixing may therefore promote closer achievement of the design objectives for combustor jet mixing processes. To this end *direct* measurement of a pulsating air jet has shown an entrainment increase up to 6 times for 16 W driver power. Furthermore, acoustically exciting an air jet in a confined crossflow produced significant increases in jet spread, penetration (92% increase) and mixing. The jet mixing length was strongly reduced, and profound changes, associated with toroidal vortices, were produced in the jet-crossflow structure. The jet response was optimum at about 0.25 Strouhal number, and appears to saturate at high acoustic driver powers.

**10:50**

**E2. Non-destructive measurement of porous material propagation constants.** M. - J. Ross and Y. Champoux (G.A.U.S., Mechanical Engineering Department, Faculty of Applied Science, Universite de Sherbrooke, Sherbrooke, Quebec, Canada J1K 2R1)

Most often measurement of the propagation of sound in a material is carried out in a plane wave tube by comparing the amplitudes and phases of the sound pressures existing simultanteously at various points in the material. This method necessitates the cutting of samples which must fit as well as possible in the tube to avoid a coupling effect or inversely to prevent leaks. A non-destructive technique to measure propagation parameters is proposed. The method is based on the theory of sound radiation from a plane circular piston set in a flat baffle of infinite extent. By comparing two complex acoustic sound pressures over the baffle it is possible to obtain expressions for attenuation and phase parameters for waves travelling through the material. Experimentally, the method makes use of transmission measurements on large mats of material placed on the open end of a flanged pipe. One microphone is placed above the mat while the other is placed under it at the open end of the pipe. This method does not necessitate any cutting of material and many measurements can be made at different points on a given mat. Because of this, it will be possible to know the degree of variation of the measured propagation constant. It will also be possible, for example, to relate the homogeneity of the mat to the measurements. Samples of fibreglass thermal insulating materials have been used for the experiments. Thereby, the results could be compared with the well-known acoustic model of Delany and Bazley [Delany and Bazley, Appl. Acoust., 3, 105-116, (1970)].

11:10

**E3. Vibro-acoustic behaviour of semi-complex structures.** A. Berry (G.A.U.S., Dept Genie Mecanique, Universite de Sherbrooke, Sherbrooke, Qc. J1K 2R1).

The determination of the vibro-acoustic response of mechanical structures is a fluid-structure interaction problem. The fluid-structure interaction has been solved analytically for simple geometries only (beams, plates, shells). The practical guidelines for noise-control by changing the mechanical structure still remain unavailable. The methods used to solve a fluid-structure interaction problem may be divided in three different categories: analytical methods (Classical Modal Analysis), discretization methods (Finite Element Method) and heuristic methods (Statistical Energy Analysis). The Classical Modal Analysis was found the most suitable approach to solve the radiation of sound from semi-complex structures in air. A semi-complex structure is defined as a thin rectangular plate to which several types of mechanical elements can be attached: point-masses, contour-masses, point-stiffnesses, hollow cross-section stiffeners. A new theoretical treatment also allows general boundary conditions to be considered in the model [Berry, Nicolas and Guyader, Acoust. Soc. Am. Suppl. 1, **85**, S131, (1989)]. The resolution follows three main steps: (i) Construction of the Hamiltonian of the structure (ii) Extremalization of the Hamiltonian using a Rayleigh-Ritz method (iii) Reconstruction of the acoustical quantities from the vibratory quantities. The descriptors are the quadratic velocity of the structure, the radiated acoustical power and the radiation efficiency of the structure. Results will be presented and the practical interest of the approach will be discussed

**WEDNESDAY AFTERNOON 18 OCTOBER** **1:30 - 4:00 PM**

## Session F. Physiological Acoustics

### Invited Symposium

Dennis Phillips, Organizer and Chairman
Department of Psychology, Dalhousie University
Halifax, Nova Scotia B3H 4J1

**Chairman's Introduction--1:30**

### Invited Papers

1:35

**F1. Cochlear frequency selectivity: Manifestations and factors which cause degradation.** Robert V. Harrison. (Department of Otolaryngolgoy, The Hospital for Sick Children, 555 University Avenue, Toronto, Ontario M5G 1X8).

The frequency resolving power of the auditory system is essentially established at the cochlear level. Physiologically, frequency selectivity can be measured in a variety of ways, both at the single unit level and as derived from (compound) evoked potentials. The frequency selectivity of the cochlea is not fixed. In the normal cochlea, for example, the filtering properties show an amplitude non-linearity such that the frequency selectivity to high level signals is considerably reduced. Conversely, at threshold levels the mechanisms of frequency selectivity may be much sharper than at levels normally used, for example in communication. In addition, in many types of cochlear pathology, both reversible and chronic, there is usually a change in the frequency selectivity. This paper will outline physiological studies both in animals and in human subjects which explore the aforementioned variability of cochlear frequency selectivity.

2:00

**F2. Prediction of the response of auditory midbrain neurons to vocalizations on the basis of the response to simple stimuli.** Jos. J. Eggermont. (Department of Psychology, The University of Calgary, 2500 University Drive NW, Calgary, Alberta, T2N 1N4).

The auditory system is usually studied with simple stimuli such as continuous tones and tone-bursts and the response is characterized by tuning curve, period histogram and peri-stimulus time histogram. The response to ethologically more interesting sound such as speech or animal's vocalizations, especially for neurons in more central parts of the nervous system, appears not to bear too much resemblance to those for simple stimuli. In the present paper a procedure is outlined to predict responses of neurons in the auditory midbrain of the leopard frog to mating calls on the basis of the neural tuning curve and the modulation period histogram. From these neural characteristics two linear filters are constructed; one in the frequency domain and one in the temporal domain. Rectification and saturating nonlinear properties of the auditory system are incorporated as well as adaptation. It appears that the gross characteristics and some temporal fine-structure of the response to the mating call can be predicted. The procedure was applied to 7 neurons and the goodness-of-fit of the predicted result to the recorded response was quantified with the cross-correlation coefficient. Values between 0.34 and 0.68 were obtained. [Research supported by NSERC and Alberta Heritage Foundation for Medical Research].

2:25

**F3. Contribution of auditory cortex and brainstem structures to sound localization by the ferret (Mustela putorius).** Jack B. Kelly and Gerard L. Kavanagh. (Laboratory of Sensory Neuroscience, Department of Psychology, Carleton University, Ottawa, Ontario, K1S 5B6).

The ability of ferrets to localize sounds in space has been determined using behavioral techniques to obtain minimum audible angles for different positions in the horizontal plane. The functional contribution of central nervous system structures has been examined by comparing minimum audible angles before and after lesions of the auditory cortex, inferior colliculus or the superior olivary complex. Lesions of auditory cortex result in severe impairments in the ability to localize clicks or short duration noise bursts. Large bilateral lesions produce a near total incapacity for sound localization. Bilateral lesions produce a near total incapacity for sound localization. Bilateral lesions limited to the primary auditory cortex result in inability to localize sounds in the left and right lateral fields (60 degrees) but have relatively little effect on acuity around midline (0 degrees azimuth). Unilateral lesions of auditory cortex, either large lesions or lesions restricted to the primary auditory cortex, produce deficits in the contralateral field but have little or no effect on acuity in the ipsilateral field or around midline. Unilateral lesions of the inferior colliculus also produce severe sound localization deficits in the contralateral field. In addition they result in increased minimum audible angles around midline and within the ipsilateral sound field. In contrast unilateral kainic acid lesions of the superior olivary complex cause deficits predominantly in the ipsilateral field with accompanying impairments in both midline and contralateral field acuity. The data suggest a progressive contralateralization of auditory spatial representation from brainstem to cortex. (Work supported by NSERC).

**Coffee 2:50 - 3:05**

3:05

**F4. Factors shaping the spectral and temporal representation of sounds in the primary auditory cortex.** Dennis P. Phillips. (Departments of Psychology and Otolaryngology, Dalhousie University, Halifax, Nova Scotia, B3H 4J1).

This paper describes the results of several years of study in this laboratory of the neural factors that shape the expression of the place and temporal codes for sounds in the primary auditory cortex of anesthetized cats. The place code is expressed in the form of an orderly (tonotopic) spatial array of neurons, each of which is narrowly tuned to a characteristic frequency to which it is most sensitive. The excitatory response areas (pure-tone frequency-intensity conjunctions) of these neurons are often flanked by inhibitory ones, which confers sensitivity to signal amplitude and bandwidth on those neurons. Confronted with a spectrally complex acoustic event, these cells have response rates which appear to reflect the net balance of excitatory and inhibitory inputs activated by the sound. Their responses to steady-state tone and noise pulses are strikingly transient, suggesting that they respond to stimulus energy integrated over only the first few tens of ms at signal onset. The temporal code for a sound is expressed in the timing of spike discharges, since these will reflect the spacing of events in the sound. Our studies of the precision of spike timing in cortical cells reveals that they probably cannot support a temporal code for temporal frequencies in excess of about 100 Hz. These data constitute preliminary evidence on the time frame of cortical information processing.

3:30

**F5. Auditory evoked potentials in basic and clinical research.** John F. Connolly. (Departments of Psychology and Psychiatry, Dalhousie University, Halifax, NS B3H 4J1).

The different types of auditory evoked potentials and their applications in investigating the auditory system and its pathologies in humans will be reviewed. Early responses such as the frequency following response, the auditory brainstem response, middle latency responses and the 40-Hz response will be discussed in relation to possible generators and what they can tell us about the processing mechanisms in the human auditory system. Longer latency responses such as the temporal N1/T-complex, processing negativity, mismatch negativity and N400 will be evaluated for their ability to elucidate the processes involved in higher level processing of auditory information. Also, the relationship between acoustic and linguistic features of speech and evoked potentials will be discussed. Finally, several of the clinical applications of auditory evoked potentials will be discussed using examples to highlight the wide range of applications from conductive hearing loss to multiple sclerosis and schizophrenia.

## Session G. Underwater Acoustics

### Invited Symposium

David Chapman, Organizer and Chair
Defence Research Establishment of the Atlantic (DREA)
P.O. Box 1012, Dartmouth, Nova Scotia B2Y 3Z7

### Chairman's Introduction--1:00

### Invited Papers

**1:05**

**G1. Reflection of sound off deep water inhomogeneous fluid sediments.** Mike A. Ainslie, Chris H. Harrison. (YARD Ltd, Sema Group plc, Scientific House, 40-44 Coombe Rd., New Malden, Surrey, KT6 4BW, England).

Interpretation of sediment geoacoustic parameters, such as density and sound speed profiles, in terms of bottom loss, is a problem which frequently arises in ocean acoustics, especially if a ray theory solution is desired. A simple analytical technique is presented for converting such geoacoustic parameters into a reflection coefficient as a function of grazing angle and frequency. The method is of most use in deep water fluid sediments although shallow water is also discussed. The approximate bottom loss functions thus derived as compared with the results of an numerical model (SAFARI) for a number of cases of interest.

**1:30**

**G2. Low-frequency flextensional projectors.** Dennis F. Jones. (Defence Research Establishment Atlantic, P.O. Box 1012, Dartmouth, Nova Scotia, B2Y 3Z7).

A number of compact, lightweight, flextensional transducers have been constructed and tested at DREA. These low-frequency underwater sound sources include barrel-stave projectors, composite-shell projectors, free-flooded projectors and broad band dual-shell projectors. They can be used singly or in multiple element arrays. The acoustic radiation of these transducers has been analysed using an electroelastic finite element model. With weights ranging from 1 to 3 kg, these flextensionals can provide a minimum of 100 watts of acoustic power at many frequencies in the 600 Hz to 10 kHz band. Theoretical and experimental results will be presented.

**1:55**

**G3. A digital acoustic imaging system.** Donald C. Knudsen. (Knudsen Engineering Limited, Perth, Ontario, Canada, K7H 1H8).

This paper describes the development of a high performance imaging sonar system based on novel digital beamforming technology. The new sonar provides rapid access to a high-resolution, three-dimensional image field, scanning simultaneously in both azimuth and elevation, to produce a 'staring' image as well as the traditional range/bearing presentation. This capability is relevant to a number of important requirements, particularly forward-looking sonars for mine detection and identification, obstacle avoidance and under-ice navigation. The new digital beamformer operates on sampled data,

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and uses time delays rather than phase shifts for broadband signal capability. It also features dynamic, pulse-tracking focussing from within one aperture of the array. An imaging sonar system with a sixty-four channel digital beamformer has been constructed. A highly parallel, pipelined architecture is employed to obtain a processing rate of four million beam output samples per second, delayed and summed across sixty-four hydrophone channels. This paper describes the technology and presents results obtained with the new sonar system, including samples of imagery.

**2:25**

**G4. High-resolution acoustic profiling: Progress towards the indirect extraction of sediment property and paleoceanographic data.** Larry A. Mayer (Dept. of Oceanography, Dalhousie University, Halifax, N.S., B3H 4J1), Lester LeBlanc (Dept. of Ocean Engineering, University of Rhode Island), and Bob Courtney and Kate Moran (Bedford Institute of Oceanography).

The direct detection of sediment type, paleoceanographic, and paleoclimatic data has long been a goal of numerous users of marine seismic systems. Previous work has demonstrated that fine scale variations in the acoustic properties of marine sediments (impedance) contain detailed information on depositional processes and, in some environments, direct indications of past climatic states. Unfortunately, most high resolution subbottom profiling equipment is not quantitative, nor does it have the resolution (bandwidth) necessary to directly measure these fine-scale variations. Over the last few years a new, high-resolution profiling system has been develped to address these problems. This system (the Chirp Sonar) uses a swept-frequency FM pulse and pulse compression techniques to provide high-resolution with substantial subbottom penetration. The system is completely calibrated so that absolute energy values and (through the examination of spectral losses) sediment attenuation can be determined in real-time. To provide "ground truth" measurements for this system, a laboratory system has been built that measures both sediment velocity and attenuation on sediment cores returned from the seafloor. In addition, a series of algorithms have been developed that allow for the prediction of a range of sediment properties from those that can be measured acousticaily.

**2:45 - 3:05 Coffee**

**3:10**

**G5. The sound from different types of propeller cavitation.** N.C. Sponagle (Defence Research Establishment Atlantic, P.O. Box 1012, Dartmouth, NS, B2Y 3Z7, Canada).

This paper presents the results of a series of experiments designed to study the sound from different types of propeller cavitation. The five propellers used in the tests produced tip vortex, bubble, and sheet cavitation. The acoustic measurements were conducted in essentially free-field conditions beneath a moored barge in Halifax harbour. In this environment, it was possible to study the spectral density, directivity, and waveform of the cavitation sound. As well, measurements of the distribution of acoustic sources in the hydrodynamic flow were made using cross-correlation methods. These acoustic data area correlated with the dynamic behaviour of the cavitation as shown by photographic and analytic methods.

3:35

**G6. Numerical propagation models in underwater acoustics.** David J. Thomson (Defence Research Establishment Pacific, FMO Victoria, BC V0S 1B0).

The role of ocean acoustic modelling is to provide estimates of the spatial and temporal properties of the sound pressure field in an oceanic waveguide. This information is needed, for example, to assess sonar performance as a function of frequency for different source-receiver configurations and for different environmental conditions. The theoretical basis for acoustic modelling is the acoustic wave equation, which is too difficult to solve analytically for realistic applications. This has motivated the development of several computer models to solve the wave equation numerically and this paper will briefly survey four canonical solution techniques (ray, normal mode, fast field, parabolic equation). Numerical examples will be provided to show the relationships between the different computer models and to demonstrate the applicability of these models to underwater sound propagation problems. The suitability of using these models for propagation in air or across the air/ocean interface will be addressed. The rest of this paper will focus on recent developments in the parabolic equation (PE) method, including a description of CANAPES (CANadian Acoustic PE System), a high-speed, stand-alone computer and display system for making sonar performance predictions at sea.

WEDNESDAY AFTERNOON 18 OCTOBER 1989 1:30 - 4:00

## Session H. Architectural Acoustics

Peter Terroux, Co- Chairman
Peter Terroux, Consultant in Acoustics
P.O. Box 96, Halifax, Nova Scotia B3J 2L4

Thomas D. Northwood, Co-Chairman
140 Blenheim Dr.
Ottawa, ON K1L 5B5

**Chairman's Introduction--1:30**

**Contributed Papers**

1:35

**H1. Fully automated sound transmission loss test facility employing three dimensional intensity measurement.** R. W. Guy and M. Pancholy (Centre for Building Studies, Concordia University, 1455 de Maisonneueve Blvd. West, Montreal, Quebec, H3G 1M8).

The recently refurbished sound transmission loss facility of the Centre for Building Studies will be described. The facility consists of a reverberation chamber which is employed as the source room, and an anechoic chamber which acts as the reception space. The anechoic chamber wedges are in house constructed to a novel design. The 3D microphone probe is located on a fully automated scanning system which can locate the probe within a half a millimetre under software control over 2 x 2 metre plane in the plane of the test aperture. The control arrangements and subsequent data processing will be discussed.

**1:50**

**H2. Standard measurement of sound transmission through suspended ceilings.** R. E. Halliwell and J. D. Quirt (Acoustics Section, Institute for Research in Construction, National Research Council of Canada, Ottawa, K1A OR6, CANADA).

Sound transmission through the space above the suspended ceiling commonly limits insulation between offices where inter-office partitions do not extend above the suspended ceiling. This paper presents a detailed comparison of standard test methods for evaluating suspended ceiling performance. The IRC laboratory has been constructed so that it can readily be converted to satisfy requirements of ISO Standard 140 Part 9, or a corresponding ASTM draft standard, or the Acoustical Manufacturers' Association standard (AMA I-II) from which these descended. Characteristics of the test environment have been studied, and a series of suspended ceiling systems has been tested using all three standard methods. Significant differences and their causes will be discussed.

**2:05**

**H3. A one dimensional heuristic study model for sound transmission problems.** R. W. Guy (Centre for Building Studies, Concordia University, 1455 de Maisonneuve Blvd. West, Montreal, Quebec, H3G 1M8).

A program is described for the heuristic study of normal incidence airborne sound transmission phenomena through user selected layered systems. The program is a development of an earlier work [R. W. Guy, Canadian Acoustics, 12, 40-59, (1984)] and is designed to allow the appreciation of cause and effect in sound transmission with respect to many influences including panel mass and stiffness, panel multiple resonance, coincidence, mass-spring-mass, room resonance, panel damping, airborne wave damping and multiple layer interactions.

**2:20**

**H4. Principal parameters affecting intelligibility and modelisation in order to elaborate a new sonorisation system for Montreal's Olympic Stadium.** Jean-Gabriel Migneron et Dominique Leclerc (Laboratoire d'acoustique et Centre de recherches en amenagement et en developpement (CRAD), 1624 pavillon Felix-Antoine-Savard, University Laval, Ste-Foy, P.Q., G1K 7P4).

In addition to technical background noise, whose influence has been demonstrated by measurements of the RASTI index ("*Rapid Speech Transmission Index*"), and which is a function of the location in the stands, the parameter of the initial reverberation time EDT was measured at different points of the stadium, taking into account the relationship between source and receiver. Parallel research, effected in a large room with homogeneous initial reverberation time, showed that the decreasing speed of acoustical pressure could be measured in the very first decibels (EDT- 5 dB permitting a better correlation with the RASTI index than EDT-10 or -15); the RASTI index could then be modelled from the in-situ measurements of the EDT, for a future source of known directivity and location. The method carried out allowed a modelisation of high intelligibility level for the listeners nearest the speakers, with respect to the parameters (noise and reverberation influence) for the furthest seats.

2:35

**H5. Construction Practice and Acoustical Insulation for Condominum Buildings** Christian Martel et Jean-Gabriel Migneron (Laboratoire d'acoustique et Centre de recherches en amenagement et en developpement (CRAD), 1624 pavillon Felix-Antoine-Savard, Universite Laval, Ste-Foy, P. Q. G1K 7P4.)

Consequent to a CMHC subsidized research project on acoustical insulation of condominiums such as those recently constructed in the Quebec vicinity (according to a sample proportional with the most common construction types, for instance those with wooden, steel or concrete frames), we have been able to derive some indications for common walls and especially those built as dry partititions to meet a FSTC superior to 50, even 55 or 60. Some correlations have been established concerning the thickness and the mass (the latest being less accurate because of the modifications effected during construction). The same analysis has been done for the floors with less variance in the results. Concerning the impact noise, it is interesting to observe the lateral propagation in continuous floor plates (sometimes very important) and to show the influence of the floor finish on the FIIC's value.

**10 Minute Coffee Break 2:50 - 3:00**

3:00

**H6. The influence of diffuse wall reflections on room sound fields.** Murray Hodgson (Acoustics Section, Institute for Research in Construction, National Research Council, Ottawa K1A OR6).

In recent years considerable interest has been shown in the influence of diffuse surface reflection in rooms. With respect to industrial buildings, it has been proposed that such diffusion must be taken into account in prediction models in order accurately to predict noise levels at large source/receiver distances. With respect to performance spaces, it is considered that diffuse reflections improve the acoustic environment. Considerable effort has been made to include diffusely reflecting surfaces in new concert halls. In this paper a ray-tracing model, including variable surface diffusivity, is used to study the influence of diffuse wall reflections in three very different rooms -- one cubic, one highly disproportionate and one a simplified concert hall. It is found that making room surfaces diffusely reflecting has a similar effect to making them more absorptive-- room reverberation times and steady-state levels decrease. Results are also presented of predictions made of the effect of diffusion on the room free-path distribution and diffuseness, made to explain the first results. Conclusions are drawn with respect to accurate predition of sound fields in, and the optimal design of, industrial rooms and rooms for speech and music.

3:15

**H7. Acoustical considerations for instrument and microphone placement in rooms for music recording.** Wieslaw Woszczyk (Graduate programme in sound recording, Faculty of Music, McGill University, Montreal, Quebec).

Statistical, modal and transient properties of rooms are examined as the basis for analysis of sound transmission from instruments to microphones in recording. These are discussed in the context of the requirements of sound field regeneration in the recording-reproduction cycle, and in the context of perceptual requirements of the listener. Methods of selective sound-field reception through proper microphone/instrument placement in rooms are discussed. Also discussed are techniques of improving the reconstruction of the original sound field of the recording room in a playback room environment.

**3:30**

**H8. Acoustical surface techniques in optimizing control room monitoring environments.** John D. Klepko and Wayne Zelmer. (Graduate Program in Sound Recording, Faculty of Music, McGill University, Montreal, Quebec).

Often, recording studios install costly loudspeaker systems that possess a flat anechoic frequency response. Yet when integrated with the control room environment, this response is greatly altered. Other factors that are involved are the need for a wide, consistent listening area while maintaining accurate stereo imaging. The process of fine-tuning an actual control room using acoustical surface techniques to yield optimum results from the monitoring system will be discussed.

**3:45**

**H9. Intensifying room cues in recording through acoustical signal processing.** Wieslaw Woszczyk (Graduate Programme in Sound Recording, Faculty of Music, McGill University, McGill University, Montreal, Quebec)

The major shortcoming of stereo is its inability to acoustically replicate, or at least approximate, the full spherical envelopment of the listener by the room sound. Our binaural auditory system cannot intervene effectively in separating the direct sounds from the room response in stereo reproduction because all sounds arrive from the same area of space enclosed by the left and right loudspeakers. A better system of recording and reproduction would create a sound field at the ears of the listener which would permit the use of the listener's binaural capability. It would provide more intense cues of the original recording room that would enhance the realism of music presentation. The considerations for the appropriate recording system to accomplish this task, and the implementation of this sytem are the subjects of this paper.

**WEDNESDAY AFTERNOON OCTOBER 18, 1989** **Bluenose Room 4:00 - 5:30 PM**

**4:00**

**Canadian Acoustical Association Annual General Meeting**

**Sharon Abel, CAA President**
**Mt. Sinai Hospital, Toronto, Ontario**

**WEDNESDAY EVENING OCTOBER 18, 1989**

**6:00**

**Reception / Cash Bar**

**7:00**

**Banquet**

THURSDAY MORNING 19 OCTOBER, 1989 Bluenose Room 8:30-10:00 AM

## Session I. Plenary Session

## Digital Sound Recording

Marek Roland-Mieszkowski, Organizer and Chair
Digital Sound Recordings
5959 Spring Garden Road #1103
Halifax, Nova Scotia B3H 1Y5

**Chairman's Introduction 8:30**

**8:35**

**I1. Introduction to digital recording techniques.** Marek Roland-Mieszkowski (Digital Recordings, 5959 Spring Garden Road, Apt. 1103, Halifax, NS BeH 1Y5).

In recent years digital recording techniques have become very popular due to their many advantages over conventional analog techniques. The progress was possible due to the advances in microchip technologies, such as the ability to pack about 1,000,000. transistors in a single package and to provide fast A/D and D/A converters with resolution from 8 to 20 bits and sampling frequencies up to 10 GHz. Recent advances in digital information storage on hard disk (Winchester magnetic disk), optical CD - ROM, WORM (Write Once Read Many), WMRM (Write Many Read Many) - erasable optical disc and DAT (Digital Audio Tape) have lead to development of mass storage capabilities for audio signals at real time speeds. In this introduction, the principles of digital recording techniques will be presented. Comparisons will be drawn between analog and digital formats of storing acoustic data. Among topics to be discussed will be distortions in digital systems, dither, formats of coding and data storage, DSP (Digital Signal Processing), data compression algorithms, storage media, future development and research trends.

**8:50**

**I2. Report on recording experience in DACARY.** James R. McKay (Faculty of Music, University of Western Ontario, London, Ontario N6A 3K7).

In November of 1987, the Decoustics/ACS Centre for Acoustical Research at York was established. Using an Acoustic Control System 6000 to control reverberation, several live concert broadcast recordings and studio recordings have been made. The recording equipment is a pair of stereo microphones or a Calrec Soundfield and a Sony DAT 1000 (or 3000). With reverberation and equalization control in realtime/space microphones other than the central pair were deemed unnecessary. A detailed explanation of RT and equalization control of the ACS 6000 will be given with recorded examples.

**9:05**

**I3. Dithering to Eliminate Quantization Distortion.** Robert A. Wannamaker, Stanley P. Lipshitz and John Vanderkooy (Audio Research Group, University of Waterloo, Waterloo, ON N2L 3G1).

Practical digital storage and transmission systems require the representation of infinite precision analog information with finite bit-length binary words. The attendant loss of resolution introduces distortion into the signal unless appropriate preventive measures are taken. This paper will provide a survey of the "dithering" technique, in which a small additive dither noise is introduced into the signal before analog-to-digital conversion. It will be shown that with properly chosen noise characteristics it is possible to retain the resolution of the analog system and eliminate distortion in the output at the expense of a small decrease in output signal-to-noise ratio. It will also be seen that subsequent digital signal processing can destroy the benefits thus attained if truncation or rounding are applied to the results of internal arithmetic in order to yield an acceptable output wordlength. Application of a proper digital dither before the final length reduction will ensure that this does not occur. Spectral shaping of the dither to decrease the output noise audibility in audio applications will be explored. In addition, the imminent technology of noise-shaping converters will be discussed, and the possible role of dither in such systems examined.

**9:20**

**I4. Qualitative comparison of current capabilities of professional digital and analog recording -- a practical subjective and objective viewpoint.** Wieslaw Woszczyk and Wayne Zelmer (Graduate program in sound recording, Faculty of Music, McGill University, 555 Sherbrooke St., Montreal, Que).

While digital recording technology offers major sound quality improvement for an average consumer, the benefits of the new technology for the average professional user are debatable. To this day a great majority of professional recording studios work in the analog domain. The authors discuss the results of several measurements made on state of the art digital and analog recorders. The discussion shows that current digital recording is not better than analog in several important areas of performance. The often voiced claims of inferiority of digital sound quality compared to analog are also discussed.

**9:35 - 10:00**

**Demonstrations of digital audio examples**

**THURSDAY MORNING 19 OCTOBER, 1989** **10:00 - 10:30**

**Coffee, Exhibits, Posters (Poster Session B continued from Wednesday)**

## Session J. Biological Acoustics: Animal Vocalization and Reception
## Whales, wolves, seals and rats

Jack Terhune, Chairman
Department of Biology
University of New Brunswick, P.O. Box 5050
Saint John's, New Brunswick, E2L 4L5

### Contributed Papers

**10:30**

**J1. Determination of the vocal repertoire of the St. Lawrence Estuary population of beluga whale (*Delphiapterus leucas*).** Annick Faucher (Biology Department, Dalhousie University, Halifax, Nova Scotia, B3H 4J1).

To determine the vocal repertoire of the St. Lawrence Estuary population of beluga whales (*Delphinapterus leucas*), fifty hours of their underwater sounds were recorded during the summer of 1987. A sample of 689 vocalizations was used to determine different sound categories by making physical measurements of some acoustic variables. The vocal repertoire of these whales is best described as a graded continuum of whistles and pulsed sounds, although the sounds were classified into sixteen whistle contours and eight pulsed sound categories. This classification is similar to that made for vocalizations of belugas summering in Cunningham Inlet, Northwest Territories [B.L. Sjare and T.G. Smith, *Canadian Journal of Zoology*, 64, 407-415, (1986)]. There was a tendency for all sound categories of the St. Lawrence belugas to have a mean frequency and repetition rate ranges approximately 30-40% higher than the ones described for the arctic belugas. These differences in the vocal repertoire between the two populations might represent an adaptive response to differences in physical characteristics between the St. Lawrence Estuary and Cunningham Inlet.

**10:45**

**J2. Distinctive vocalizations from mature male sperm whales (*Physeter macrocephalus*).** Linda S. Weilgart and Hal Whitehead (Department of Biology, Dalhousie University, Halifax, N.S. B3H 4J1).

Groups of sperm whales (*Physeter macrocephalus*) were tracked acoustically off the Galapagos Islands between February and April 1985. In total, 716 hrs were spent in visual or acoustic contact with the whales, during which time vocalizations were recorded for 5 min/hr. Distinctive loud, ringing clicks, called "slow clicks" were highly correlated with the presence of mature male sperm whales. Slow clicks were distinguished from usual clicks by their slower repetition rate or interclick interval, their longer duration, and usually the presence of intensity peaks at about 1.8 and 2.8 kHz. Between clicks of individual males (identified by photographs of natural markings), there were differences both in interclick intervals and in the pattern of emphasized frequencies. These differences, however, were not distinct enough to allow one to reliably distinguish one male's clicks from those of another. It is hypothesized that slow clicks may be a sign of a mature or maturing males and may inform other sperm whales on the breeding grounds of its competitive ability and maturity.

11:00

**J3. Click rates from sperm whales.** **Hal Whitehead and Linda Weilgart** (Department of Biology, Dalhousie University, Halifax, N.S. B3H 4J1).

The rate of production of clicks by groups of sperm whales (*Physeter macrocephalus*) off the Galapagos Islands was dependent on two principal factors: the number of whales present and the behavioural state of the group. When the whales were in their principal (occupying about 80% of their time) behavioural state, diving deep for prolonged periods and usually being seen at the surface singly or in pairs, each whale made trains of clicks about 70% of the time with an interclick interval of about 0.5s. About 15% of the time the groups remained at or near the surface, with individual members forming clusters containing greater than 4 individuals, and being generally silent. Group behaviour was occasionally intermediate between these extremes with some whales silent at the surface in medium-sized clusters, and others clicking at depth. Click rate can be used as an indicator of the behaviour of sperm whales, the size of a group, and/or the number of groups present. The overall click rate, needed to calibrate acoustic censuses, was estimated to be 1.25 clicks/s/animal. Most available evidence suggests that the major function of the usual sequences of clicks heard from sperm whales is echolocation. (Work supported by NSERC).

11:15

**J4. Can seals alter the acoustical impedance of the outer and middle ears?** John M. Terhune (Department of Biology, University of New Brunswick, P.O. Box 5050, Saint John, NB E2L 4L5).

In-air audiograms (1-8 kHz) of two harbour seals (*Phoca vitulina*) indicate that one subject was 5 to 14 dB less sensitive in-air than underwater [Bertel Mohl, Journal of Auditory Research, 8, 27-38, (1968)] while another was 27 to 40 dB less sensitive in-air. A possible explanation for this difference may reside in the time it takes for cavernous tissues in the outer and middle ear to drain and/or the opening and closing of the seal's external auditory meatus. The less sensitive subject was only out of the water for 1-3 sec during the testing. Blood vascular and muscular manipulations may enable the seal to alter the acoustical impedance of its ears thus favouring enhanced sound reception in both air and water.

11:30

**J5. Spectrographic characterization of neonatal wolf pup vocalizations *(Canis lupus)* in the den.** Elizabeth M. Coscia, Dennis P. Phillips and John C. Fentress (Department of Psychology, Dalhousie University, Halifax, Nova Scotia, B3H 4J1).

Studies of the ontogeny of mammalian vocal communication systems are few in number. The development of the wolf vocal repertoire was examined in a litter of wolf pups during the first 35 days of life under semi-natural setting. Audio and video recordings were collected from inside a modified wolf den located within a 3.8 hectare wooded enclosure occupied by a captive wolf pack. The vocalizations recorded were analyzed spectrographically to trace changes in acoustic content with postnatal age. Wolf pups emit a wide variety of vocalizations that are distinguishable on the basis of their spectrographic structure. Taxonomy of vocalizations is based on multiple criteria. The neonatal sounds varied in harmonic structure, fundamental frequency, duration, frequency modulation, and time of first appearance. Harmonically-rich vocalizations present on day 1 were seen to lower in fundamental frequency with increasing age. Other, often non-harmonic vocalizations, were less common during the first 2 weeks but by the end of the first month had acoustic structures consistent with their being precursors to adult vocalizations.

**11:45**

**J6. The recording and analysis of rat ultrasonic vocalizations.** Catherine L. Ryan and Richard E. Brown (Psychology Department, Dalhousie University, Halifax, Nova Scotia, Canada B3H 4J1).

Studies of rodent behavior indicate that infants and adults of many species emit ultrasonic vocalizations (sounds above 20 kHz) which are an important form of communication in rodent social behavior [G. Sales & D. Pye. *Ultrasonic Communication by Animals.* Chapman & Hall (1974)]. There are many individual components to these ultrasonic calls and effects have been directed at detection and quantification of several parameters including rate, frequency, and duration. Because these calls occur beyond the audible range for humans, the detection and quantification of these calls presents a methodological challenge. A computer-compatible ultrasound converter, presently being used in this laboratory, allows for detection of ultrasonic vocalization across a broad band range and provides quantification of both rate and duration of these calls. This system has several advantages over other systems used in the past. It allows for detection across a wide frequency range and it provides an efficient method for measuring and compiling data on frequency, rate, and duration of ultrasounds. Additionally, the automation eliminates experimenter error due to manual scoring techniques. Data from infant rat recordings will be presented to illustrate the type of information which can be compiled by this computer-compatible ultrasound converter.

**12:00**

**Discussion**

**THURSDAY MORNING 19 OCTOBER, 1989** **10:30 - 11:45**

## Session K. Acoustical Imaging

**Structured Paper Session**

**10:30**

**K1. Effect of receiving element size on acoustical imaging.** Jin S. Meng and Hugh W. Jones (Department of Engineering Physics, Technical University of Nova Scotia, P.O. Box 1000, Halifax, N.S., B3J 2X4).

Digital acoustical imaging systems for non-destructive estimation and underwater viewing commonly make use of a two-dimensional array to detect holographic information. The size of receiving elements, however, affects the reconstructed images. In this paper, the amplitude compensation function of image and aliasing depression factor for element size are discussed. Simulations of receiving arrays of different element sizes demonstrate that large elements can reduce the aliasing effect to some extent, but the image needs to be compensated for intensity.

**10:50**

**K2. The Design of a Phased Array for Ultrasound Surgery.** John E. Aldrich* (Institute of Cancer Research, The Royal Marsden Hospital, Downs Road, Sutton, Surrey, England and Gail ter Harr. (*Cancer Treatment and Research Foundation of Nova Scotia, 5820 University Avenue, Halifax, Nova Scotia, B3H 2V7).

A non-invasive system will be described for the destruction of unwanted tissue such as tumour cells at depth within the body. The system was designed to provide heating at a focus of 14cm with the possibility of steering the focus 4cm in each direction. The effect of varying the number and size of elements in the array and the frequency of the ultrasound will be illustrated with two-dimensional amplitude distributions. The magnitude of the nonlinearity associated with high power levels will be described. Examples of possible clinical uses will be discussed.

**11:10**

**K3. The use of ultrasonic catheters in the diagnosis and treatment of human atherosclerosis.** G. A. Klassen, P. Marraccini, S. Jackson, H. Jones, L. Landini and A. L'Abbate (Maritime Heart Centre, Victoria General Hospital, Halifax, N. S. B3H 2Y9 and CNR, Institute of Clinical PHysiology, Pisa, Italy).

Ultrasonic devices have been used for imaging of dynamic structure for over 20 years. It is only recently that transducers have become available for imaging of the vascular structure of vessels. Current technology permits the mounting of a small transducer in a catheter to permit visualization of vessels of 5-6 cm in diameter (e.g., femoral artery). It can be demonstrated that low frequency ultrasound (28 Khz) may selectively dissolve atherosclerotic plaques. Such energy will result in perforation of the normal arterial wall if applied for 40-50 sec. Applications of shorter durations (20 sec) result in dissolved plaques if they do not distort the media. Longer exposures are required for dissolution of calcified plaques. The process appears to involve emulsification of the atherosclerotic material with minimal damage to normal arterial wall constituents. This method has advantages over balloon angioplasty or laser atherectomy which are destructive of the vessel wall constituents. Ultrasonic devices will play an increasing role in both the diagnosis and treatment of vascular disease.

**11:30**

Discussion

**THURSDAY MORNING 19 OCTOBER, 1989** **10:30 - 12:00**

## Session L. Speech

Phillip Doyle, Chair
School of Human Communication Disorders
Dalhousie University
Halifax, Nova Scotia B3H 1R2

**Contributed Papers**

**10:30**

**L1. Fine structure analysis of triadic interactions of mother, father and child.** Lynne C. Brewster. (SPARC, Room 15, Ellis Hall, University Hospital, Saskatoon, Saskatchewan, S7N 0X0).

Discourse analysis was performed on video tapes of mother, father and child taped during a meal. In all cases, the children had normal hearing on the day of the taping as established by standard audiometric measures. A variety of standard discourse parameters were measured. For this paper, the structure of pauses observed will be described since it has been suggested that the pause may be an index of the development of the turn taking process which is a critical component of communicative competence. Different states of development of this important language skill were demonstrated by measuring and comparing inter-speaker and intra-speaker silences for a variety of linguistic functions Interactive parameters will be examined for two families with children of 18 and 39 months respectively.

**10:45**

**L2. The role of Formant Transition Rates on the Discrimination and Articulation of /b/ and /w/ by the Elderly.** Elzbieta B. Slawinski and David J. Marieno. (Psychology Department, The University of Calgary, 2500 University Dr., Calgary, AB T2N 1N4).

Various studies indicate that criteria used by listeners for the discrimination of phonemes, based on the duration of speech segments, change with advancing age. The purpose of the present study was to investigate possible changes in perception and production of phonetic contrast - that of stop consonant /b/ versus glide /w/ - with age. Thirty-three subjects with normal hearing and belonging to three age groups (20-30, 50-60, 70-80 yrs. old) were tested. Ten synthesized CV syllables from the continuum /ba/ to /wa/ were used as stimuli in the identification test. Results of the identification task performed by elderly, showed that the boundary between two phoneme categories was shifted about 3ms toward shorter durations of formant transition, as compared to the perceptions of young people. The acoustical analysis of recorded syllables /ba/ and /wa/ indicate that speakers in the three age groups do not differ in the duration of their spoken transition /b/, however, they show significant difference in the duration of the /w/ transition. The elderly produce significantly shorter transitions than the young. (Work supported by The University of Calgary).

**11:00**

**L3. Modelling listeners' perception of synthesized /bVb/ stimuli.** Jean E. Andruski and Terrance M. Neary. (Department of Linguistics, University of Alberta, Edmonton, AB T6G 2E7).

Error patterns and rates of identification are similar for brief (40 ms) windowed portions taken from the beginning and end of vowels both in isolation and in /bVb/ syllables, even though formant measurements for the /bVb/ stimuli show substantial undershoot compared to the isolated vowels. [J. Andruski and T. Neary, J. Acoust. Soc. Am. 85: Suppl. 1, S86 (1986)]. Vowels synthesized with linear transitions based on fundamental and formant frequency measurements from two or four brief sections of the windowed /bVb/ stimuli are also well identified. (These sections correspond roughly to transition onset, initial vowel target, final vowel target and transition offset.) Listeners' error patterns for vowels based on these minimal measurements are similar to error patterns for the windowed, naturally produced syllables. Results from experiments comparing listeners' error patterns for these stimuli with error patterns predicted by logistic models of listener behaviour will be presented.

**11:15**

**L4. Stereo-Spin testing: including the binaural system in Spin (Speech Perception in babble Noise) testing.** Janice Forsey and Mike Zagorski. (Memorial University of Newfoundland, St. John's, NF, A1B 3X9).

The S-Spin Test was developed to compare the abilities of normal and hearing impaired people (with and without hearing aids). The conventional SPIN test is an improvement over speech audiometry (which in turn is an improvement over pure tone audiometry), in that the assessment of performance is

a simulacrum of a realistic task -- understanding speech in speech noise. It does not, however, account for the powerful advantage given to people with a functioning binaural system, because it employs diotic presentations -- the same stimulus for each ear. Tone in noise masking experiments show improvements of up to 15 dB with certain dichotic presentations over diotic presentations of otherwise identical stimuli. The work presented here 1) indicates a similar advantage of dichotic over diotic presentations for people with an effective binaural system and 2) illustrates the need for assessing the ability to hear speech by including the (perhaps residual) binaural system.

**THURSDAY MORNING OCTOBER** **11:40 - 12:30**

## Sesion M. Auditory Evoked Potentials

Walter Green, Chairman
School of Human Communication Disorders
Dalhousie University
Halifax, Nova Scotia B3H 1R2

**11:40**

**M1. Preliminary findings of bone conduction auditory brainstem response in at-risk infants.** Edward Y. Yang (School of Human Communication Disorders, Dalhousie University), George Mencher, Lenore Mencher (Nova Scotia Hearing and Speech Clinic), Michael Vincer (Grace Maternity Hospital), and Andrew Stuart (School of Human Communication Disorders, Dalhousie University).

The utilization of auditory brainstem response (ABR) in testing at-risk infants using air conduction ABR has been widely accepted as a clinical tool. The air conduction ABR in testing newborn infants, however, does not differentiate sensorineural pathology from conductive deficit. The present study employed the bone conduction technique to assist air conduction ABR, in identification of newborn infants with sensorineural hearing loss. Newborn infants at-risk of hearing loss were tested at neonatal period and follow up at 4 months of age. The diagnostic criteria were based on the normative data collected from 50 normal infants at the age of 3-4 days and 4 months. Findings in this study will be discussed regarding the justification in implementing bone conduction technique to supplement air conduction ABR in testing at-risk neonates. (Research supported by NHRDP).

**11:55**

**M2. Effect of bone vibrator placement on auditory brainstem response in newborn infants.** Andrew Stuart and Edward Y. Yang. (School of Human Comunication Disorders, Dalhousie University, Halifax, Nova Scotia, B3H 1R2) and Robert Stenstrom (Children's Hospital of Eastern Ontario, 401 Smythe St., Ottawa, Ontario K1H AL1).

Auditory brainstem response (ABR) can be elicited by vibratory stimulation at the temporal bone of newborn infants. The present study investigated the effect of various bone vibrator placement on the temporal area revealed by the ABR latencies in neonates. Twenty normal full term neonates were tested at 3-4 days post-parturition. ABR Wave V latencies were obtained from different post-auricular vibrator placements. It was found that significant ABR wave V latency shifts were observed with changes in vibrator placement. Implication of the findings will be discussed. (Research supported by NHRDP).

**12:10**

**M3. P300 in stroke patients.** P.W. Nance and E.R. Harrison (Dept. Medicine, Division of Physical Medicine and Rehabilitation, Dalhousie University, Halifax, NS, B3H 4K4).

Using the odd-ball paradigm, the P300 was tested in patients with ischemic cerebral vascular disease and normal age matched controls. Patients admitted into the study had a unilateral cerebral vascular accident (CVA). The groups were as follows: Left CVA, n=4, Right CVA, n=10 and normals, n=10. Active recording electrodes were place at the CZ and PZ loci, referenced to the ear lobes, A1+A2. A standard tone discrimination odd-ball testing method was used. The mean latencies of the P300 response for the groups were as follows: Left CVA = 325 +/- 25 ms (+/- 1 SD), Right CVA = 337 +/- 45 ms, normals = 315 +/- 20 ms. The mean response amplitudes were as follows: Left CVA = 7.5 +/- 3.5 microvolts, Right CVA = 11.9 +/- 5.5 microvolts and the normals = 12.5 +/- 2.5 microvolts. Statistically, the main group differences were a decreased amplitude in the Left CVA group compared to normals and a markedly increased latency and amplitude variability in the Right CVA group. In conclusion, these data are consistent with a previous report of the P300 response in stroke patients [Gummow et al., (1986)]. These observations support the idea that the right hemisphere contributes to temporal stability of the P300 response; whereas the left hemisphere contributes to the P300 response amplitude.

**THURSDAY AFTERNOON, 19 OCTOBER** **1:30 - 4:00**

**Session N. Speech**

**Invited Symposium**

Douglas O'Shaughnessy, Chair
INRS-Telecommunications
Montreal, Quebec

**Chairman's Introduction 1:30**

**Invited Papers**

**1:35**

**N1. Improving the quality of synthetic speech.** Douglas O'Shaughnessy. (INRS-Telecommunications, Universite du Quebec, Nuns Island, Quebec H3E 1H6).

Real-time systems which generate synthetic speech from general French or English text have existed for some years. Such speech is generally intelligible, but lacks naturalness. Inferior quality is usually due to inadequate modeling of three aspects of human speech production: coarticulation, intonation, and vocal-tract excitation. This presentation will examine current approaches to synthesis in these areas, discuss the compromises that are often made to simplify speech modeling, and suggest ways to improve synthetic speech quality. Coarticulation has been modeled by storing spectral transitions in diphone units, or in the form of phonetic rules. The former requires more memory and is less flexible in varying speaking rate, but tends to yield more natural spectral patterns than rule-based synthesis. Natural intonation depends in complex ways on linguistic aspects of the text to be spoken; most synthesizers use simplistic natural language analysis, which does not furnish enough information to adequately specify intonation. Most text-to-speech uses a periodic pulse excitation, which gives a mechanical tone to voiced synthetic speech. Excitation which is less periodic, e.g., multipulse patterns in LPC synthesis, may yield more natural quality, but is difficult to control in different phonetic environments. (Work supported by NSERC).

**1:55**

**N2. Linear Logistic Models for Speech Perception.** Terrance M. Nearey. (Department of Linguistics, University of Alberta, Edmonton, AB T6G 2E7).

Several recent models of speech perception and allied data analysis techniques have strong relations to logistic modeling techniques of Haberman [Haberman, S. Analysis of Quantitative Data, Academic Press (1979)]. These include the NAPP model and related discriminant analysis methods of Nearey and his colleagues [e.g., Nearey and Assmann, J. Acous. Soc. Am. 80, 1297-1308 (1986)] and the fuzzy logical models of Massaro and his colleagues [e.g., Massaro, D. and Oden, G., J. Acoust. Soc. Amer. 67, 996-1013 (1980)]. If these approaches are recast in linear logistic form, and models are restricted to the responses of individual listeners, the inference techniques associated with log-linear modeling become available. Furthermore, coefficient estimates can be interpreted as relative importance of multiple cues in signaling distinctions among phonetic categories. In the present study, logistic models are used to re-analyze a vowel categorization experiment described in Nearey ['Static, dynamic and relational factors in vowel perception.' J. Acoust. Soc. Am., (in press)]. Difficulties (and possible solutions) for the application of logistic models to repeated measures data are also discussed.

**2:15**

**N3. Discriminant Learning for Automatic Speech Recognition.** R. De Mori and Y. Normandin. (School of Computer Science, McGill University, Montreal, Quebec).

Automatic Speech Recognition (ASR) is based on models that have to be trained. While the model structure is usually decided by the designer, model parameters are estimated by mathematical procedures. Parameter estimation can take into account the competition between models and be based on the maximum discrimination among patterns of a training set belonging to different classes. Two methods are considered: Maximum Mutual Information Estimation (MMIE) and estimation of connection strengths in a Connectionist Model (CM). An algorithm with reduced learning complexity for MMIE will be presented as well as an effective algorithm for learning memory integration factors in CM with feedback. Results will be presented for the recognition of connected digits using MMIE on the T1/NBS database and for the recognition of phonetic features using CM and an ear model. The possibility of integrating the two models will be discussed in view of reducing the word error rate (actually 1%) on the speaker-independent recognition of connected digits.

**2:35**

**N4. Multiple Origins of Syllable Timing.** Eric Keller. (Departement de linguistique, UQAM, and Centre de Recherche, CHCN, 2465 Queen Mary, Montreal, PQ H3W 1W5).

Speech timing was examined with multiple correlational analyses. Inter-articulatory delay (i.e., tongue/vocal cord movement initiation in [kak]) and speech rate (i.e., consonant cycle in [kak]) were used as predictor variables, and four time segments of the syllable [kak] were used as dependent variables. Measurement involved single-beam ultrasound for tongue movements and acoustic records for evidence of vocal cord activity (Nsubj=11, Nobs=2222). Syllable onset duration was reliably predicted by the addition of inter-articulatory delay and speech rate, while the duration of the mid-portion of the syllable was mainly predicted by speech rate. Results were interpreted to support the hypothesis that speech production is regulated so as to satisfy multiple competing constraints involving, among others, a tradeoff between timing and perceptual clarity. The results integrate well with recent data that further substantiate the notion of such a tradeoff.

**2:55**

**N5. Recent Advances in Speech Coding for Communications.** Vladimir Cuperman. (Department of Engineering Science, Simon Fraser University, Burnaby, BC V5A 1S6).

Analysis-by-Synthesis techniques have emerged as a major approach for obtaining good quality digital speech at rates of 4.8 - 16 Kbit/s. Traditionally, an Analysis-by-Synthesis configuration includes a codebook and a forward adaptive synthesis filter. The parameters of the filter are adapted using known Linear Prediction techniques. The candidate waveforms stored in the codebook are filtered through the synthesis filter in order to choose the excitation waveform which will produce the best approximation of the corresponding speech segment. Then, the index of the best candidate and the parameters of the synthesis filter are transmitted to the receiver, which uses an identical codebook and synthesis filter to reconstruct the speech signal. The use of the forward prediction has two disadvantages: it requires transmission of side information, and it leads to an overall codec delay of 2-3 forward prediction frames. An alternative solution is the newly proposed Backward Prediction configuration. In a Backward Adaptive Analysis-by-Synthesis configuration the parameters of the synthesis filter are recovered by backward adaptation using as information only the string of the transmitted codebook indices. This is similar to what happens in the scalar case in ADPCM, and for this reason the first configuration of this type was called Vector ADPCM. Some of the key concepts in Analysis-By-Synthesis configurations, such as Vector Quantization, adaptive linear prediction, and noise feedback will be discussed.

**3:15**

**N6. Training new speech contrasts: Techniques and data from the second-language learning and speech pathology domains.** Donald G. Jamieson. (Speech Communication Laboratory, Department of Communicative Disorders, Elborn College, University of Western Ontario, London, Ontario N6G 1H1).

Some non-native speech sound contrasts are remarkably difficult for humans to acquire as adult, second-language learners. Jamieson and Morosan, [Perception & Psychophysics, 40, 205-215 (1986)] introduced a procedure which has been demonstrated to be effective in training some such speech contrasts in adult second language learners. Another potential application of the technique is with children who cannot produce certain sounds in their native language. Rvachew and Jamieson [Journal of Speech and Hearing Disorders, (in press)] have demonstrated that a proportion of such children have a perceptual disability which has some similarities to the perception of foreign speech contrasts. After reviewing the relevant published research, this presentation will describe new research relating to the learning of non-native speech contrasts by adults, and present new data which suggests that perceptual training can be remarkably effective in remediating functional articulation disorders in children who are trying to master the sounds of their native language. (Work supported by NSERC).

**3:35**

**Discussion**

## Session O. Occupational Noise and Standards

Hans Kunov
Insitute of Biomedical Engineering
Rosebrugh Building
University of Toronto
Toronto, Ontario M5S 1A4

### Contributed Papers

**2:00**

**01. International Standards Organization Technical Committees on Acoustic Activities -- 1989 Update.** Deirdre A. Morison (Bureau of Radiation and Medical Devices, Department of National Health and Welfare, Room 66, Health Protection Branch Building, Tunney's Pasture, Ottawa, Ontario K1A OL2).

An overview is given of current activities of ISO/TC43 "Acoustics", ISO/TC43/SC1 "Noise" and ISO/TC43/SC2 "Building Acoustics". Fields of interest in these committees being worked on by Canadian experts include hearing threshold measurements, audiometric techniques, hearing protectors, occupational noise measurement standards, sound propagation outdoors, sound intensity, and frequency weighting A for noise measurements. The progress made in these areas will be outlined including the way in which international and Canadian national standards are being harmonized. The relationship between American standards organization (ASECOS), international standards organizations including the International Electrotechnical Commission (IEC) and Canadian national standards organizations in the context of acoustics standards will be discussed.

**2:20**

**O2. Comparing the occlusion effect and attenuation of earplugs and earmuffs.** Michael Comeau, Larry Henrickson (Dalhousie University School of Communication Disorders) and Gordon Whitehead (Nova Scotia Hearing and Speech Clinic, Halifax, Nova Scotia, B3H 1R2).

Berger [JASA, 79, 1655-1687 (1986)] has suggested that the attenuation of hearing protection devices (HPDs) has most commonly been measured subjectively as shifts in sound field threshold that occur at relatively low sound pressure levels (SPLs). Alternatively, objective measurements such as the insertion loss using a probe microphone technique may be performed to characterize the attenuation of HPDs at higher SPLs. Berger has indicated that at higher SPLs both bone conduction and air conduction pathways contribute to sound transmission reaching the inner ear. Since bone conduction is known to be enhanced when the ears are occluded, the use of HPDs may introduce an appreciable occlusion effect. The present study measured the occlusion effect and attenuation for earplugs and earmuffs using both subjective and objective methods. The results of these measurements are presented and the relationship between the occlusion effect and attenuation is discussed. The results for attenuation for these HPDs are then compared to measurements of attenuation obtained on the KEMAR acoustic manikin.

**2:40**

**O3. Measurement of Noise from Communication Head-sets.** Hans Kunov (Institute of Biomedical Engineering, Rosebrugh Building, University of Toronto, Toronto, Ontario M5S 1A4).

The measurement of noise exposure from communication headsets and other sound sources in close proximity to the ear presents special problems. In-the-ear measurements give rise to errors due to the presence of probe tubes or microphones, and commonly available manikins have inadequate simulation of soft tissue in the ear canal and around the outer ear. Sound isolation of manikins is a concern, particularly when circum-aural (ear-muff) head-sets are used. A new method based on the use of an acoustic test fixture (ATF) is proposed. The ATF is a manikin head with many of the acousto-mechanical properties of the median human head. The method works for all types of head-sets. In order for the noise exposure data to be of use in regulatory applications, the method includes a transformation of the sound levels at the manikin ear drum position to equivalent diffuse field levels. Instantaneous as well as time-weighted averages can be measured. The latter can be averaged according to a 3 dB or 5 dB rule. Measurements were performed on insert, supra-aural, and circum-aural head-sets, in the field and in the laboratory. The proposed method was validated through probe microphone measurements, repeatability measurements, and loudness balance measurements [performed under contract with Labour Canada].

**3:00**

**O4. Simulations show that hearing aids may not always be effective in crowds.** Rick Hibbs and Mike Zagorski (Memorial University of Newfoundland, St. John's, NF, A1B 3X9).

Hearing aid wearers and the unaided hearing impaired often complain of being unable to understand or of having difficulty understanding conversations in crowds. In order to illustrate this phenomenon to hearing individuals, simulations of deafness and aided deafness were constructed. Data indicate that in certain cases, the simulated aided ear is less effective than an unaided impaired ear in terms of intelligibility and comfort.

**3:20**

**O5. The effects of public live-music performance on the human ear.** Marek Mieszkowski (Digital recordings, Halifax, Nova Scotia) and Gordon Whitehead (Nova Scotia Hearing and Speech Clinic, 5599 Fenwick St., 32nd Floor, Halifax, Nova Scotia, B3H 1R2).

Sound level measurement and analysis was completed during 22 live-music performances. The musical events occurred in a variety of business and public environments. All of the musicians involved used amplification equipment. Sound level measurement and analysis utilized precision sound level meters and dosimeters. The findings are related to existing Provincial Threshold Limit Values to assess potential negative impact on human hearing. Case histories and audiological assessments on musicians and technicians will be presented to substantiate conclusions drawn from the sound level measurement/Threshold Limit Value data. Recent and current hearing loss lawsuits involving musicians are discussed.

**3:40**

**Discussion**

THURSDAY AFTERNOON 19 OCTOBER, 1989 2:00 - 3:30

## Session P. Underwater Acoustics

Fred Guptill, Chair
Seastar, Dartmouth, Nova Scotia

### Contributed Papers

2:00

**P1. An ambient noise sensor for wind speed measurement.** Andrew J. Keast (METOCEAN Data Systems Limited, P. O. Box 2427, D.E.P.S., Dartmouth Nova scotia, Canada B2W 4A5).

An underwater ambient noise sensor/satellite transmitter combination is described that has applications in collecting acoustic data from remote locations. It consists of an ultra low noise remote hydrophone with integral preamplifier, up to 300m of cable and an electronics housing 4.5" in diameter and 5" long. The electronics package consists of programmable analogue filter boards with up to eight filter frequencies per board, a scanning integrating A/D converter, a digital processor and an ARGOS satellite transmitter. With the ARGOS system global coverage for data reporting together with position information is obtained. Data consists of up to 32 eight bit words representing the acoustic information.

2:20

**P2. Optimization of terminated parametric arrays.** Jacques Y. Guigne and Voon H. Chin. (Centre for Cold Ocean Resources Engineering, C-CORE, Memorial University of Newfoundland, St. John's, Nfld, A1B 3X5).

The terminated parametric array offers a narrow beam and broadband acoustic sound source with a low propagation frequency. The design of an optimised terminated parametric array, however, is not easily executed. This paper examines the constraints and produces useful design equations. Pressure expressions for the secondary frequency are developed in the context of the termination ranges. Expressions for the nearfield and farfield beamwidths are also given. The equation for the optimization are expressed in terms of the overall physical design parameters such as the required input power levels and the transducer radius.

2:40

**P3. Measurement of bubble properties using a multi-frequency sound field.** Robert A. Perron and Anthony A. Atchley (Physics Department, Naval Postgraduate School, Montery, CA 93943).

A problem of continuous interest in underwater sound propagation is the prediction of the scattering properties of bubbles. Two important parameters in this problem are the bubble's radius and damping coefficient. A method of measuring these parameters, which is a modification of a bubble sizing technique developed by V. L. Newhouse and P. M. Shankar [J. Acoust. Soc. Am. 75, 1473-1477 (1984)], is described. The method exploits the nonlinear, mixing property of resonant bubbles simultaneously exposed to sound fields of different frequencies. Sizes of single air bubbles in water determined from the dual frequency method are compared to rise-time sizing. For radii from 30 to 115 micrometers, these two methods are shown to agree with 1%. Rectified diffusion rates measured above, at and below threshold for an initial bubble radius of 50 micrometers in air-saturated water over a period of 700 sec were measured and the results demonstrate the reliability of the system. The potential of this device to measure damping coefficients is discussed. [Work conducted for the Naval Coastal Systems Center and funded by the Naval Postgraduate School.]

**3:00**

**P4. TBA**

**3:20**

**Discussion**

**THURSDAY AFTERNOON 19 OCTOBER 1989 — Bluenose Room 4:00 - 5:00**

**Closing Reception and Awards Ceremonies**

## Membership Application Form

Membership Applications received after August 15 will be processed for 1990, however, they will provide the advantage of the reduced member registration fees for the 1989 Halifax meeting.

NAME________________________________________________

ADDRESS______________________________________________

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Areas of Interest (Check up to three)

__ Architectural Acoustics

__ Engineering Acoustics

__ Musical Acoustics

__ Noise

__ Psychological/Physiological Acoustics

__ Shock and Vibration

__ Speech Communication

__ Underwater Acoustics

__ Other________________

Please enclose fees (includes subscription to **CANADIAN ACOUSTICS**). Please provide a separate cheque to facilitate processing.

(a) CAA Membership _____ $20.00 (Canadian dollars)
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If you are applying for student membership please ask a Faculty member to verify your status as a student by signing below:

Signature of Faculty Member__________________________________

Name of Faculty Member ____________________________________

College or University_______________________________________

**Send to**: Moustafa Osman, CAA Secretary, Ontario Hydro H13, 700 University Ave., Toronto, Ont. M5G 1X6

## Formulaire de demande d'adhésion

Si ce formulaire nous parvient avant le premier juin, vous recevrai les quatre numéros de l'*Acoustique canadienne* de l'année 1989. Les demandes d'adhésion reçues avant le premier août donnent droit aux deux dernier numéros de 1989. Les demandes reçues après le 15 août seront traitées pour l'année 1990, tout en donnant droit aux réductions de 1989 sur les frais d'inscription.

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