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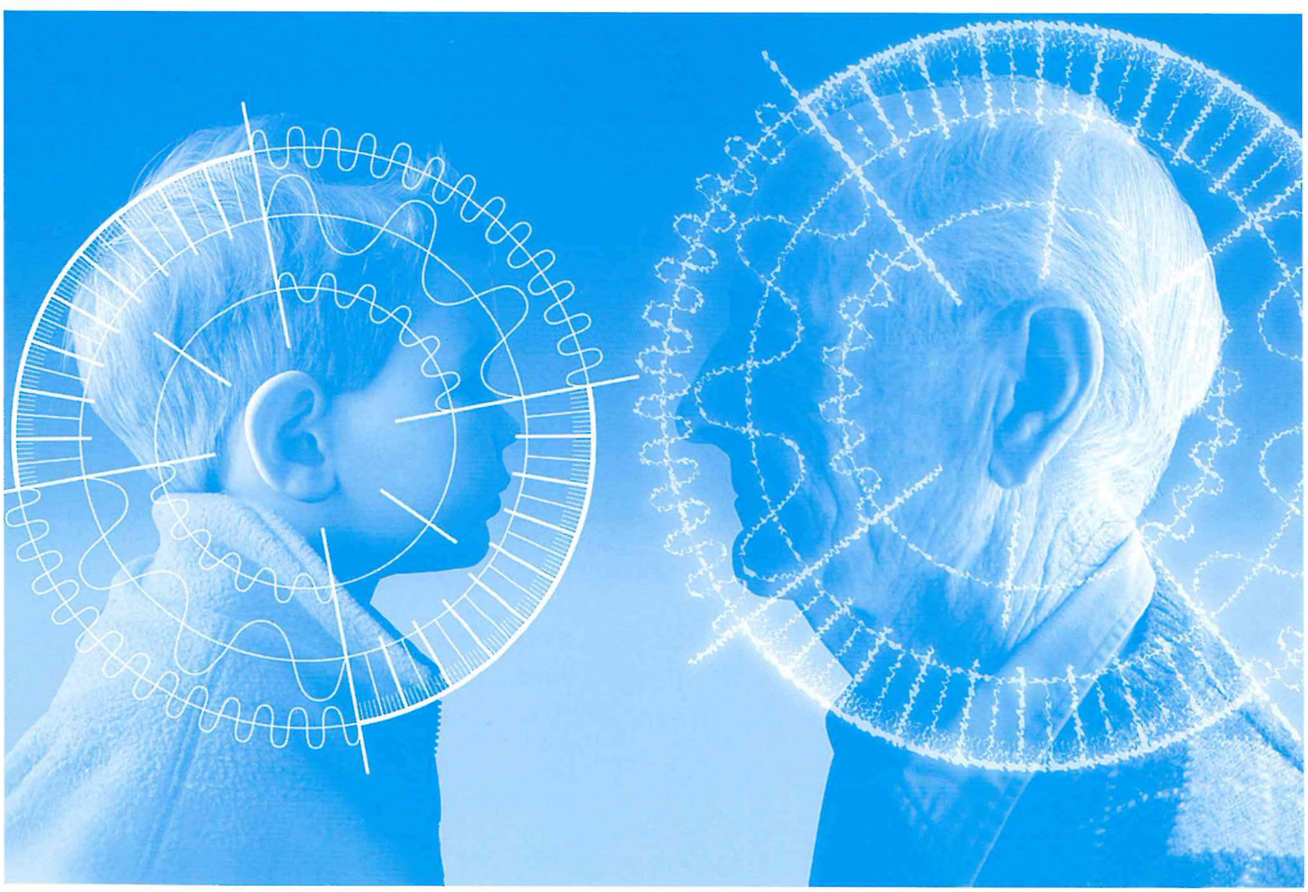

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EDITORIAL / ÉDITORIAL

I would like to discuss some proposed changes that are underway in the journal. You would have noticed a new format for our Sustaining Subscriber list. I am sure you agree that the back cover looks much nicer. We request our sustaining subscribers to read their items carefully and send us any corrections.

The CAA Executive has been talking about increasing the number of journals from four per year to six per year, somewhat akin to the Noise Control Engineering Journal. We will be looking into the financial aspects of this proposal. We would like to receive your feedback. The workload for Editor-in-Chief would be manageable after we cross the initial teething period. Of course, the onus is on all of you to write those articles, case studies and other such materials that keep the journal breathing. If the collective membership of the association decides that six journals per year would be useful, I would be very willing to undertake the venture.

The above proposal brings me, next, to the role of the Associate Editors. If we are going to become a strong regional journal that caters to the need of Canadian Acousticians, we need a mixture of research articles, case studies, news items of interest and descriptions of the diverse acoustical community in a small (population wise) but a vast land of ours. That means the original three roles I envisaged for the Associate Editors have to become that much more focused. I am happy to report that a few of the Associate Editors have provided exemplary assistance to Chantal Laroche and myself. Let me reiterate these three roles: (a) be a conduit to get articles in his/her field (either by writing one article per year or getting a colleague to write one); (b) be a liaison between the Editors and the authors, i.e., get the articles reviewed and revised and submit the final revised version of the accepted article for publication; and (c) obtain news items and/or assist our News Editor, Francine Desharnais, to obtain news items such as theses abstracts, Lab/Research Facility descriptions and other news of interest. I will be calling on the current editorial board and priming them to take an active role in the journal activities. Currently, the journal is run by the four main editors and I would like to thank my three colleagues for the yeoman service provided by them.

Finally, we had published a series of letters (mostly solicited) on the decibel notation and a letter by R. A. Strachan in the December 2000 issue (Vol. 28, No.4, 2000) outlining a new method of describing sound pressure. We hope we have stirred your curiosity and now we wait patiently to receive your comments. Pick up those pens and send me your letters.

Je voudrais discuter quelques changements en cours proposés dans le journal. Vous auriez remarqué un nouveau format pour notre liste d'abonnés de soutien. Je suis sûr que vous êtes d'accord que la couverture derrière est beaucoup plus belle. Nous invitons nos abonnés de soutien à lire leurs éléments soigneusement et à nous envoyer les corrections possibles.

Le directeur de l'ACA avait parlé d'une augmentation du nombre de journaux de quatre à six par an, quelque peu semblable au journal ''Noise Control Engineering Journal". Nous examinerons les aspects financiers de cette proposition. Nous voudrions recevoir vos commentaires. La charge de travail pour l'éditeur en chef serait gérable après une période initiale de démarrage. Naturellement, la responsabilité est sur tout de vous, pour écrire ces articles, études de cas et autres propos qui permettent au journal de respirer. Si les membres de l'association décident que six journaux par an seraient utiles, je serais très disposé à entreprendre cette tache.

Avec la proposition ci-dessus, il faudrait revoir la rôle des éditeurs d'associé. Si nous allons devenir un important journal régional qui approvisionne les besoins des acousticiens canadiens, nous avons besoin d'une variété d'articles de recherches, d'étude de cas, des nouvelles et des descriptions de la communauté acoustique diverse parmi (une petite population de sage) sur une vaste terre qui est la notre. Cela signifie que les trois rôles initiaux que j'ai envisagé pour les éditeurs associés doivent devenir beaucoup plus focalisés. Je suis heureux de constater que quelque uns des éditeurs associés ont fourni une aide exemplaire à Chantal Laroche et moi-même. Laissez-moi réitérer ces trois tâches: (a) devenir un canal d'acheminement d'articles dans son domaine (en écrivant un article par an ou en obligeant un collègue à en écrire un); (b) faire une liaison entre les éditeurs et les auteurs, c.-à-d., obtenir les articles déjà passés en revue et révisés et de soumettre la version finale révisée pour publication; ou (c) obtenir des nouvelles et/ou d'aider notre éditeur de nouvelles, Francine Desharnais, pour en obtenir dans des thèmes tels que : abrégés de thèses, description des moyens des Laboratoires d'étude et recherche et autres. J'inviterai le bureau de rédaction actuel à prendre un rôle actif dans les activités de journal. Actuellement, le journal est géré par les quatre principaux éditeurs et j'aimerais remercier mes trois collègues pour le travail fourni.

En conclusion, nous avions édité une série de lettres (la plupart sollicitées) sur la notation du décibel et une lettre par R. A. Strachan, dans l'issue de décembre 2000 (vol. 28, No.4, 2000), décrivant les grandes lignes d'une nouvelle méthode descriptive de la pression acoustique. Nous espérons que nous avons sollicité votre curiosité et nous attendons patiemment vos commentaires. A vos stylos, envoyez-moi vos lettres.

AGE-RELATED CHANGES IN PERCEPTION OF TONES WITHIN A STREAM OF AUDITORY STIMULI: AUDITORY ATTENTIONAL BLINK

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ABSTRACT

This research explored the immediate perceptual/cognitive consequences of an attended-to tonal stimulus within a stream of tonal stimuli. Previous results have suggested that processing information about a tone within a stream of tones presented at a rate of 11 tones/s can modify perception of subsequent tones. The results of the current study suggest that perception of subsequent tones is also a function of age.

SOMMAIRE

Cette recherche explore les consequences perceptuelles cognitives, a court liees a la perception d'un son present a l'interieur d'un ensemble de stimulations tonales. Les resultats anterieurs suggeraient que le traitement d'informations comprises dans un ensemble sonore, dont le taux est de 11 sons par seconde, pouvait modifier la perception de sons qui suivent. Les resultats de la presente etude suggerent que la perception des sons subsequents est aussi fonction de l'age.

1. INTRODUCTION

Our environment forces us to detect important information embedded in a background of continuously changing distracters. In spite of the many sounds simultaneously or successively entering the auditory system, listeners can readily focus attention on priority stimuli and analyze their properties in considerable details, often at the expense of less relevant inputs [3]. Thus, when attempting to manage the vast array of information available to listeners in their everyday world, one can selectively attend to, and process particular aspects of input, usually to the exclusion of other aspects [18]. This suggests that the consequences of focusing attention on the processing of multiple stimuli whether simultaneous or sequential, is a function of selective attention [16].

This research explored the immediate perceptual and cognitive consequences of an attended-to tonal stimulus within a stream of tonal stimuli. Performance decrements in identification or detection of sound-probe (P) following identification or detection of sound-target (T) in the experimental (dual-task) condition with preserved P identification or detection in the control (single task) condition, defines the presence of an auditory Attentional Blink.

Massaro and Kahn (1973) studied the selective focusing to an attended-to sound and its consequences on the processing of a precedent sound. They found that young adults' recognition (identification) of an earlier-presented auditory stimulus (probe) improved with increases in the silent interval between the probe and the following masking stimulus (target). They also found that within the studied range of intervals (0 ms-500 ms) target identification remained poor. The results of their study indicated that the processing of an auditory stimulus is affected not only by backward masking but also by the focusing of attention on the processing of later stimuli. Poorer recognition of auditory stimuli was found not only when they were followed by the same modality stimuli, but also cross-modally, when auditory stimuli were followed by visual stimuli. Massaro and Kahn concluded, "the perceptual process of recognition requires some central processing capacity. When this processing capacity is demanded elsewhere, recognition is lowered, although not interfered with completely" ([18] p. 58). Previous studies have also examined the effects of attention when targets are followed rather than preceded by probes. In particular, the selective focusing on an attended-to stimulus (target) and the immediate consequences on subsequent stimuli (probes) within a stream of stimuli has been extensively studied in the visual domain using Rapid Serial Visual Presentation (RSVP) techniques (e.g., [25]). Typically, Rapid Serial Visual Presentation entails the computer presentation of 15 to 25 items, such as letters, digits, pictures, or words, at rates of about 6 to 20 items/s. Participants are instructed to make judgments (usually detection or identification responses) to one target (T) or probe (P) or target and probe (P) in the stream of items. A key feature such as color or brightness distinguishes target and probe. The well documented finding is that when a target and probe (T and P) are separated by intervals of approximately 500 ms or less. The ability to identify P is reduced, a phenomenon known as the Attentional Blink [25]. Shapiro and Raymond (1994) demonstrated that the Attentional Blink reflects neither the masking of the P, nor memory limitations surrounding it, nor the time required to switch from the processing of T to the processing of P. They suggested that the Attentional Blink most likely reflects the operation of attentional mechanisms. The Attentional Blink appears relatively robust as it has been observed in cross-modal (auditory-visual) tasks as well [1]. Arnell and Jolicoer suggested that the Attentional Blink could be observed among stimuli when their processing is demanding and has to be performed within a very limited time. In agreement with Massaro and Kahn (1973), Arnell and Jolicoer also concluded that the identification of a stimulus requires a central, amodal attentional framework, perhaps because in cross-modal tasks, selective attention would operate at a post-categorical level.

Similar performance decrements in the recognition or identification of a probe (i.e., P) have also been demonstrated in the auditory domain [1, 10, and 15]. These studies have shown that an auditory stimulus embedded within a stream of stimuli can modify perception of subsequent stimuli. Goddard, Issak, and Slawinski (1998) found that the magnitude (as measured by the percentage of the performance decrement in the dual-task compared to the single-task) of the modified perception due to the auditory Attentional Blink was greater for listeners with normal vision than for congenitally blind listeners. Most recently, it has been found that auditory Attentional Blink magnitudes are greater than visual Attentional Blink magnitude [11]. Taken together, the results of these studies suggest that fundamental differences may exist between auditory and visual Attentional Blinks. Thus, despite the fact that Attentional Blinks emerge across modalities, the mechanisms which control the Attentional Blink within these modalities can be different [10; 11; 20].

Exactly when selection occurs during attentional process (early versus late) has become one of the most contentious and continuing controversies among psychologists. It has been stated that attentive behavior is the result of limitations in the capacity of any realizable perceptual system [29], which reflects a control of the amount of information that can be attended to and processed by the system. The early selection model of attention suggests that it is possible to select inputs before stimuli have been fully identified and hence, this model suggests that attention operates precategorically. A late selection model in contrast claims that attentional processes do not alter the way that stimuli are processed by the sensory-perceptual system, and attention operates postcategorically (after identification or categorization of stimuli) [e.g., [7], [9], [26]).

It has previously been suggested that the Attentional Blink reflects an inhibitory mechanism designed to suppress attention to subsequent stimuli (e.g., P) until target (T) processing is complete [25]. Indeed, we have interpreted our auditory Attentional Blink within this attentional inhibition framework. Our interpretation is supported by physiological research on selective attention, which has indicated that the focusing on relevant at the expense of irrelevant information is processed differently in auditory and visual domain [14]. In addition, Banks, Roberts, and Cirani, (1995) have previously suggested that because auditory selective attention is not aided by any analogue of visual fixation, attentional inhibition should be more pronounced in audition than in vision. Our experimental findings [11] accord nicely with Banks et al. view.

As the ability to process auditory information presented at high rates deteriorates markedly with increasing age [24; 30], it is possible that the elderly might be more susceptible to the auditory Attentional Blink when listening to time-compressed speech relative to young listeners. Indeed, the elderly process discrete pure-tone stimuli at a slower rate than young listeners, and show reduced ability to process spectral and temporal cues in rate-altered speech [23]. Elliott, Hammer, Scholl and Wasowicz (1989) have found that older adults required larger spectral differences and/or longer duration segments than did young adults in order to discriminate frequency transitions, just as older adults required larger acoustic differences to discriminate consonant-vowel syllables that differ in the place-of-articulation. It has been postulated that the speed at which rapidly changing spectral cues must be processed may not only exceed the channel capacity of the aging adult, but may overload the cognitive system as well [22]. In consonance with above mentioned studies, self-reported hearing disability among older populations is highly correlated with experienced difficulties in the discrimination of phonemes, when temporal acoustical cues have to be used [27]. Thus, temporally demanding auditory tasks appear to be particularly challenging for older adults.

Separating important information from irrelevant information within complex tasks requires considerable attentional resources, as relevant signals must be enhanced, and irrelevant signals suppressed or inhibited [29]. According to declining capacity theories of attention, processing resources available for cognitive task performance deteriorate with age, particularly for tasks that require considerable attention [4]. Indeed, research on aging has demonstrated that age-related changes in the perception of speech can be partially explained by changes in information processing due to an age-related decline in the efficiency of inhibitory functioning, and therefore in preventing irrelevant information from entering working memory [5; 6; 13]. Thus, various lines of evidence suggest that older listeners, when attempting to recognize a sound that is embedded within a stream of rapid sequences of sounds, might be more affected by the presence of the stream sounds than younger listeners (e.g., [4]; [10]; [20]; [30]).

The findings of the above-mentioned studies in addition to a paucity of investigations on age-related changes in the auditory Attentional Blink motivated us to explore these phenomena as a function of age. The goal of the present study was to investigate age-related changes in the processing of tones and the immediate perceptual/cognitive consequences on the detection and identification of subsequent tonal stimuli embedded in a sequence of distracting tones. Previous results have demonstrated that processing information about a tone within a stream of tones presented at a rate of 11/s by young individuals can modify their perception of subsequent tones [11]. We predicted that this perceptual modification would be greater for older adults.

2. METHODS

2.1 Participants

Eleven young adults (mean = 21.2 years old) and 11 older community dwelling adults (mean = 66.8 years old) participated in the study. All subjects were screened for normal hearing (i.e., 15 dB HL or better for audiometric frequencies from 500 Hz to 8000 Hz), lack of middle ear and/or neurological problems, and Canadian English as their first and native language.

2.2 Stimuli

Stimuli were generated using SoundEdit 16 Software implemented on a PowerMac computer with a sampling rate of 44 kHz. One hundred sixty eight Rapid Auditory Presentation streams of 25 tones were randomly chosen from a set of stimuli within the range of 1000 Hz to 2500 Hz, in 10 Hz multiples. Tones of frequencies 1500 Hz (pitch=low), 2000 Hz (pitch=medium), and 2500 Hz (pitch=high) were reserved for targets and probes, which in the experimental condition were increased in sound pressure level by 10 dB SPL, relative to stream tones. Furthermore, a difference between the frequency allocated to the target and probe, and the frequency of the closest preceding or following sound was at least 500 Hz. Presentation of one stream of tones lasted 2245 ms. All "stream tones" were of equal SPL. The duration of all tones was 85 ms, including 5 ms on- and off-ramping, and the Inter-Stimulus Interval (ISI) was 5 ms. The Stimulus Onset Asynchrony (SOA) therefore, was 90 ms and became a unit of the experiment at which the auditory Attentional Blink was measured. Target (T) occurred equally often at a position "n" within the stream of tones (n=5, 9, or 13). Probe (P) occurred equally often at positions n+1, n+2, ... n+5, n+6, corresponding to SOAs of 90, 180, 270, 360, 450, 540, and 630 ms respectively and never occurred at the last position of a tonal stream.

Figure 2. Experimental condition's paradigm. T- target and P-probe (only 11 are presented out of 25 stimuli)

In the experimental condition (dual-task condition), the sound pressure level of the T was increased on 50% of the trials (streams), while the sound pressure level of the P had higher level than that of stream stimuli on all trials (streams). This design enabled us to measure a rate of false alarms. The control condition (single-task condition) was identical to the experimental condition except that the sound pressure level of T was not higher on any of trials (i.e., was equal in sound pressure level to the stream tones). The frequency of T and P were never the same in any given stream, and all T/P com-

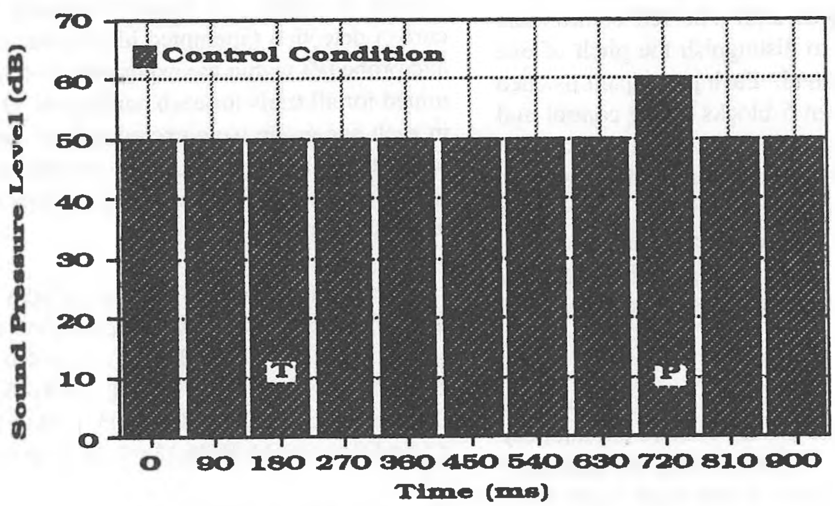

Figure 1. Control condition's paradigm. T - target and P - probe (only 11 are presented out of 25 stimuli)

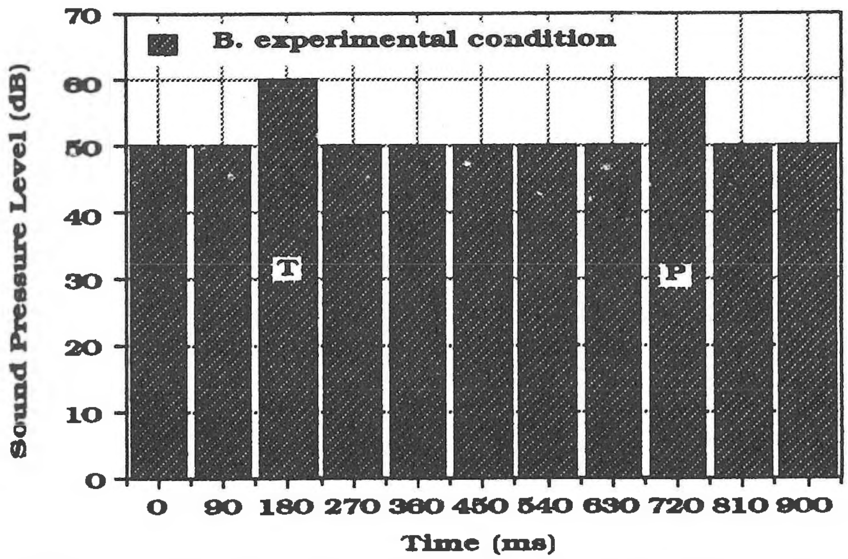

Figure 2. Experimental condition's paradigm. T- target and P-probe (only 11 are presented out of 25 stimuli)

binations of frequencies (e.g., high/low, high/medium, low/high, etc.) were counterbalanced across SOAs. The general paradigm for the control and experimental conditions are shown in Figure 1 and Figure 2, respectively. These figures depict a particular case of presentation, when a target (T) occurs at a 3rd position and the probe (P) occurs at a position # 9 of a tonal stream. Stimuli at positions #12 to #25 are not displayed.

2.3 Procedure

Stimuli were delivered by loudspeakers placed in a distance of 60 cm from behind of listeners' ears. The sound pressure level (SPL) of the stream stimuli at listener's ears was equal to 50 dB SPL, while the sound pressure level of targets and probes was 60 dB SPL, as measured by Bruel and Kjaer Sound Pressure Level Meter Type 2218. Listeners were tested individually in an acoustically shielded room. At the beginning of a testing session each participant was exposed to the target and probe sounds until s/he felt comfortable with the task, and was able to distinguish the pitch of one sound from that of another sound. Each participant listened to 84 streams divided between 5 blocks in the control and experimental condition. Both the experimental and control tasks were counterbalanced across participants. Listeners were asked to identify a pitch associated with any tone of higher sound pressure level that they heard (low, medium, high) and respond verbally after listening to the stream of tones (unspeeded response). Participants' responses were collected by an experimenter.

The same participants were exposed to visual stimuli, in order to explore the mechanisms that control the auditory and visual Attentional Blink. Visual stimuli, the procedure associated with visual task as well as obtained results were previously described in the study by Goddard and Slawinski (1999).

3. RESULTS

3.1 Identification of Targets and Probes within the Control and Experimental Conditions.

Listeners were not able to identify targets and probes above a chance level, and thus, the percentage of correct P identification within the control condition and T and P within the experimental condition were not determined for trials when targets were detected correctly.

3.2 Detection of target within a control and experimental condition

Percentage of correct detection (attempted identification) of a probe (P) within the control condition and percentage of correct detection (attempted identification) of the target (T) and probe (P) within the experimental condition were determined for all trials for each participant. Data from one adult in each age group were excluded from data due to a higher percentage of false alarms than established criteria (10% or less of false alarms). Thus, analyzed data included 10 adults in each age group.

The three-way mixed ANOVA revealed a main effect of: Age ($F(1,18)=13.02$, $p<0.05$), Condition ($F(1,18)=76.25$, $p<0.05$), and SOA ($F(6,13)=17.59$, $p<0.05$), and significant interactions: Condition x Age ($F(1,18)=6.35$, $p<0.05$), Condition x SOA ($F(6,13)=19.03$, $p<0.05$), as well as Age x Condition x SOA ($F(6,13)=3.06$, $p<0.05$).

Figure 3 and 4 display the mean percentage of trials

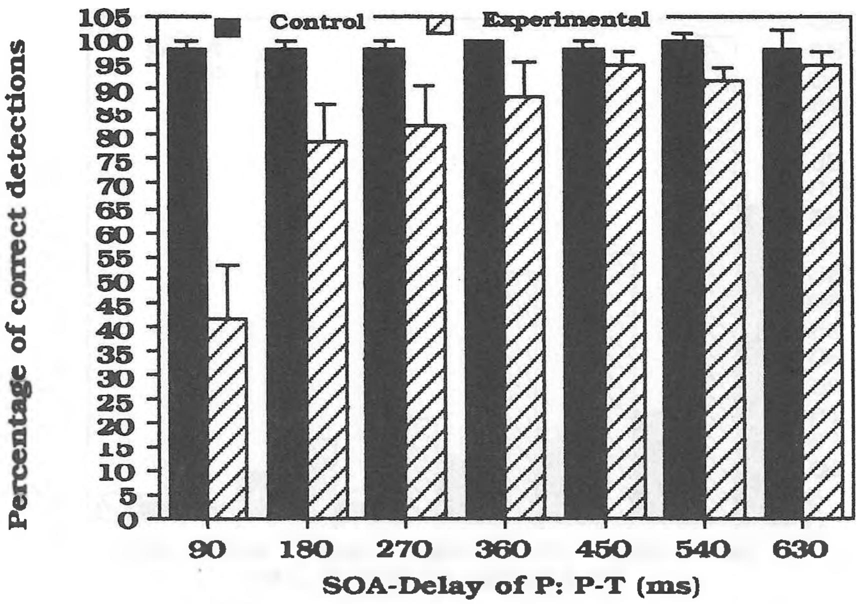

Figure 3. The mean percentage of correct detection of the probe (P)) as a function of SOA obtained by young adults within control and experimental condition (see text).

Standard errors are presented as error bars. Please notice a lacl of variability at 360 ms within the control condition.

(streams) on which participants correctly detected (attempted to identify) the probe as a function of the interstimulus SOA in the control and experimental conditions. Figure 3 displays the mean percentage of correct detection obtained by young adults, and Figure 4 displays the results for older adults.

In the control condition (single-task condition), younger adults correctly detected the probe for all interstimulus (target-probe) SOAs on 97.8% ($\underline{SD}$ = 6.4%) of trials and older adults correctly detected the probe on 93.3% ($\underline{SD}$ = 10.3%) of all trials. While both age groups were very good at detecting a single tone of higher sound pressure level in a stream of distracters, the percent correct detection was slightly, but significantly better ($\underline{t}$ (138) = 2.89, $\underline{p} < 0.05$) for younger adults compared to older adults. In the experimental condition (dual-task condition), by contrast, probe detection when the target was present and detected averaged 81.4% ($\underline{SD}$ = 26.5%) for younger adults, and 61.9% ($\underline{SD}$ = 32.4%) for older adults, across all interstimulus (target-probe) SOAs.

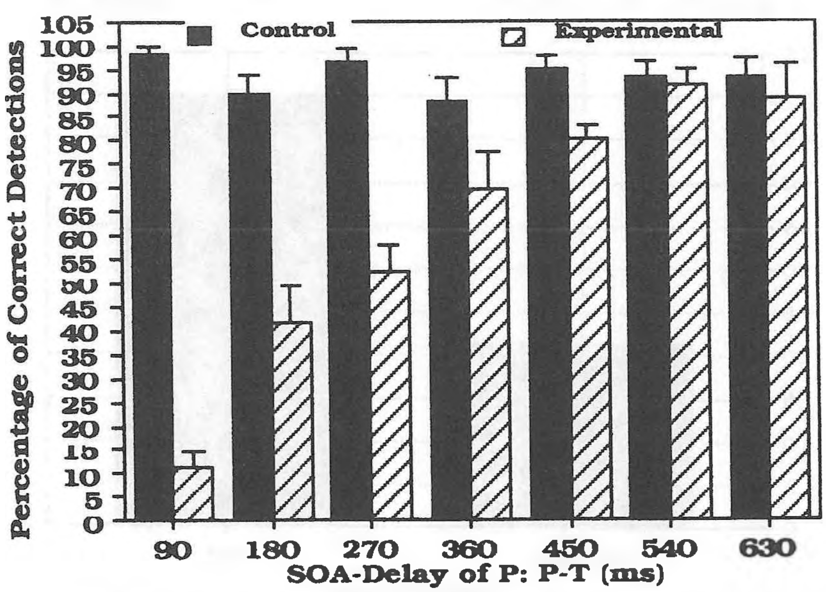

Figure 4. The mean percentage of correct detection of the probe (P) as a function of SOA obtained by old adults within control and experimental condition (see text).

Standard errors are presented as error bars.

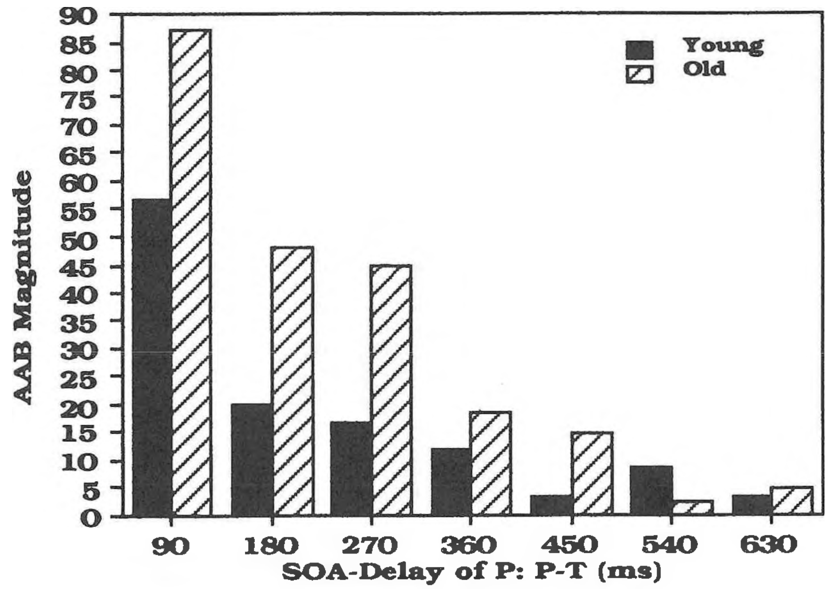

Figure 5. Magnitude of auditory Attentional Blink for young and old listeners.

Again, the overall percent correct detection was significantly better for younger adults than for older adults in the experimental condition (t (138) = 2.16, $p<0.05$). In particular, post hoc comparisons conducted at a Bonferonni adjusted alpha of 0.025 revealed a significant difference between age groups at $p<0.025$, and at SOA's of 90 ms ($t(18)=3.91$), 180 ms ($t(18)=4.38$), 270 ms ($t(18)=2.08$), 360 ms ($t(18)=4.32$), and 450 ms ($t(18)=2.75$). Multiple paired comparisons revealed that both younger and older participants' P detection was significantly lower (p's <0.05) in the experimental than in the control condition when P appeared at interstimulus (target-probe) SOAs of 90, 180, 270, and 360 ms. In addition, older adults also had significantly poorer detection at the 450 ms SOA in the experimental rather than in the control condition.

At longer interstimulus (target-probe) SOAs, from 450 ms and 540 ms to 630 ms for younger and older participants, respectively, P detection in the experimental condition averaged 93.9% for the younger adults and 89.8% for older adults. These values did not differ significantly from either group's overall P detection in the control condition.

Thus, group differences emerged at interstimulus (target-probe) SOAs of 90, 180, 270, 360, and 450 ms. At these SOAs, younger adults' percent correct detections were sig-

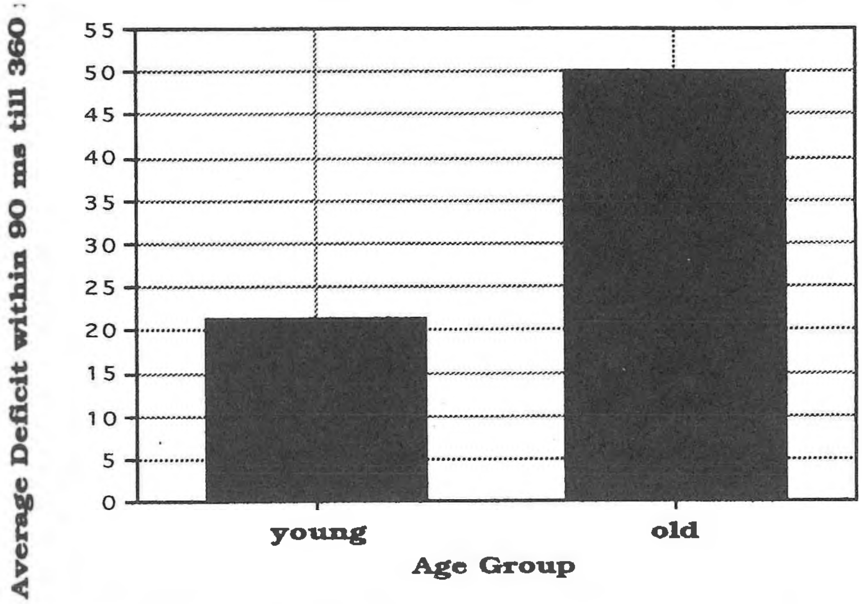

Figure 6. Information processing deficit about detection of the probe averaged across 90 ms, 180 ms, 270 ms, and 360 ms SOAs for young and old listeners.

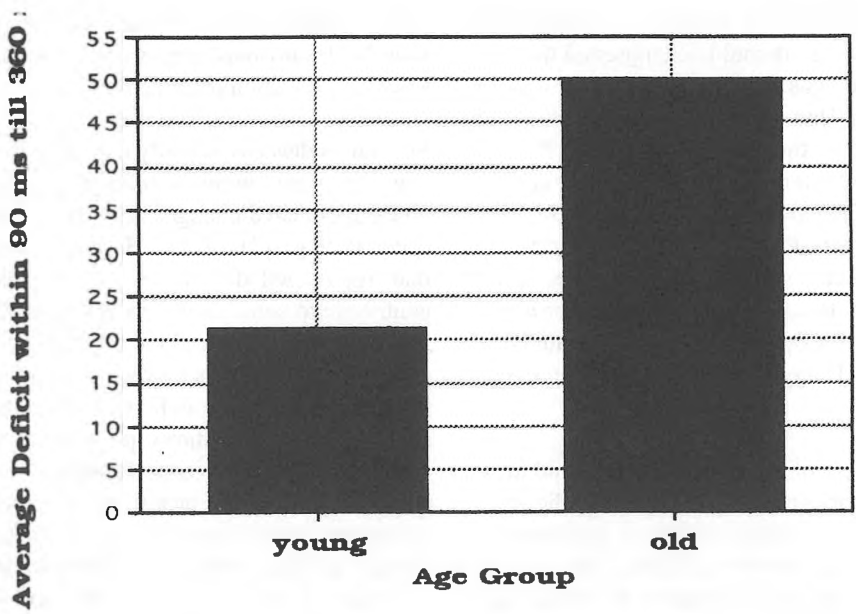

Figure 7. Variability in correct probe detection within experimental and control condition as a function of SOA. Parameters are age groups.

Please notice that variability = 0 in the control condition for the young group at SOA = 360 ms.

nificantly better than those of older adults (ps < 0.05). At the 540 and 630 ms SOAs however, the two groups' performances did not differ (ps > 0.05). False alarm rates ranged from 0% to 9% for both younger and older adults (averaging 2.3% and 1.8%, for younger and older adults respectively), and did not differ as a function of either group or condition (ps>0.05).

3.3 Auditory Attentional Blink Magnitude

Auditory Attentional Blink (AAB) magnitude for each of age group was determined by averaging the difference in percent correct detection between the single and dual task conditions for each individual in each task for SOAs of 90 ms to 630 ms inclusively. Figure 5 illustrates these differences graphically for both age-groups. A t-test (t (78)=3.50, p<0.05) revealed that older adults (M=51.7%, SD=34.4%) demonstrated a significantly "deeper" auditory Attentional Blink magnitude, averaged across four SOA's (90, 180, 270, and 360 ms) than younger adults (M = 28.3%, SD = 30.5%). Figure 6 illustrates these differences graphically for both age-groups.

3.4 Variability in Correct Target Detection

Both age groups demonstrated greater variability in correct probe detection within experimental condition relative to that within control condition. In particular greater variability was observed for SOAs 90 ms, 180 ms, 270 ms. and 360 ms. Thus, greater variability occurred at these same SOAs at which auditory Attentional Blink was observed. Figure 7 depicts this difference between conditions and age groups. However, strict interpretations of the variability data warrant caution due to the ceiling effects in the control condition, especially for younger adults (e.g., SOA=360 ms), and for floor effects in the experimental condition for older adults.

4. DISCUSSION

This study explored the differences between young and old adults in the auditory Attentional Blink. In order to avoid potential modality differences in attentional dynamics (processing auditory stimuli while relying on their visual images) this study included stimuli that were not associated with time-compressed spoken letters and/or digit names. It has been shown that time-compressed speech can easily distort temporal acoustical speech cues and can be perceived differently by older and younger adults [27]. In the present experiment, we used pure tones to establish an auditory Attentional Blink.

Our results are consistent with Jolicoer (1999), who also found the Attentional Blink with pure tones, albeit in a cross-modal task. The identification task in this study became an attempted identification task in which participants were able to detect targets and probes but they were not able to identify them. Therefore the attempted-identification task has become a modified detection task. Thus, the subsequent discussion addresses this task as a detection task. However, a presence of the auditory Attentional Blink and potential differences that emerge between detection and identification tasks requires further clarification. The results of this study revealed an auditory Attentional Blink among both older and younger adults and confirmed the presence of a previously demonstrated auditory Attentional Blink in a normal and congenitally blind population. It could be suggested that the auditory Attentional Blink, observed in the study was due to energy masking of P by T. However, the auditory Attentional Blink, cannot be explain by the energy masking of P by T because listeners were able to detect 2 tones at near ceiling accuracy in the absence of stream tones, even when these tones were separated by ISI of 5 ms. In addition, our previous findings that congenitally blind listeners relative to listeners with normal vision demonstrate an improved processing of stimuli efficiency reflected by a smaller auditory attentional magnitude [12] suggest that auditory Attentional Blink can be modified.

In agreement with a variety of studies that have found age-related changes in inhibitory tasks (e.g., [13], [19]) the ability to selectively attend to an auditory stimuli in the presence of similar distracting stimuli, appears to decline with age and may result from losses in the ability to inhibit the processing of irrelevant stimuli. Consequently, it might be expected that older listeners may demonstrate greater magnitudes in the auditory Attentional Blink compared to younger listeners, and as well, that the duration of the auditory Attentional Blink would be longer. Indeed, observed differences in the auditory Attentional Blink between age groups supports the notion of less efficient inhibitory mechanisms in older adults. Moreover, our previous findings [12] that congenitally blind listeners, relative to listeners with normal vision, demonstrated a smaller auditory Attentional Blink magnitude suggests that the auditory Attentional Blink is modifiable. By extension then, the efficiency with which attentional inhibition is deployed, differs across populations.

Consistent with Raymond, Shapiro, and Arnell (1992) we interpreted the auditory Attentional Blink as reflecting an inhibitory attentional mechanism, which suppresses the allocation of attention to subsequent stimuli (e.g., probe) until the target has been processed. Younger adults' detection of P was less affected by processing information about T compared to older adults and it is possible that the detection of P by younger listeners was facilitated by efficient inhibition. It might be that detection of sounds by older adults was more affected (less inhibited) by a temporal vicinity of other sounds than that of young adults. In particular, performance decrements in detection of sound immediately following the attended sound (T) was more pronounced among old than young adults.

It has been demonstrated that the greatest deficit in detection of tones for both age groups occurs in the closest temporal vicinity of the target (T). This would suggest an early selection process, which could be due to an inhibitory mechanism [25] and can reflect a deficit in perceptual processing. However, inhibitory mechanisms can operate in either modality independent or modality-specific ways, as suggested by several researchers who have studied prepulse inhibition, backward masking, negative priming and rapid serial visual presentation (e.g., [20]).

Several studies have clearly indicated that younger and older adults process auditory information in a similar fashion when age-related changes in hearing ability were taken into account, (e.g., [21]; [28]). However, while it is conceivable that age-related differences in pure-tone sensitivity could contribute to some of the observed performance differences between younger and older adults, it is unclear how differences in pure-tone sensitivity alone could account for the differential performance deficits seen in the experimental versus the control conditions, particularly at short SOAs. The current study compared performances of younger and older adults who were characterized by similar normal hearing (pure-tone sensitivity). Therefore, differences between age groups' auditory Attentional Blink which emerged when P followed T (90, 180, 270, 360, and 450 ms) cannot be explained by different hearing abilities of younger and older listeners.

The results of Jolicoer's study (1999) suggest that a cross-modal Attentional Blink occurs within a central, amodal attentional framework. The findings of his study support those of Massaro and Kahn's study (1973) in that identification of a sound can interfere with a processing of other stimulus (sound) in a close temporal vicinity and that it requires central processing.

However, the differences between these studies require a thorough consideration. Massaro and Kahn studied the influence of the attended sound on the recognition (identification) of an earlier sound. Both sounds were identical in pitch but different in quality and duration. Furthermore, both sounds were separated by a variable blank interval, and they were the only sounds to which listeners were exposed. Thus, these sounds were not embedded within any of stream stimuli, which are required in order to demonstrate the visual Attentional Blink [25]. Massaro and Kahn have also reported that identification of the attended sound (target) deteriorated in a presence of the earlier sound (probe). However, deterioration in T identification performance was not dependent upon the duration of the blank interval. Therefore, these results would suggest that the presence of other stimuli (sounds) between a target and probe is necessary in order to demonstrate the auditory Attentional Blink, although this remains an empirical question.

Attempts to address identification of T and P in the current study were not successful. Despite the near-ceiling identification observed during practice session, participants were unable to correctly identify the pitch of targets and of probes in the presence of the stream stimuli. Leek, Brown, and Dorman (1991) found that a discriminability of tones embedded within a tonal stream requires a higher frequency difference limen than in a case of a single tone. In the current study relative difference limen (df/f) was, at most, between 0.2 and 0.33. In an absence of data for a given difference limen that is sufficient for the discrimination of a target and/or probe from surrounding tones on a basis of frequency, it is highly probably that the chosen frequency differences in the current study, were insufficient to identify targets and/or probes according to pitch. Thus, while the 10 dB sound pressure level difference between the sound pressure level of targets or probes and the level of tones within a stream allowed participants to discriminate the targets and probes from surrounding stream tones, it did not provide a sufficient information for target identification.

Nevertheless, even in the absence of accurate identification, all of participants demonstrated an auditory Attentional Blink. In light of both those findings, and of our previous findings which showed that a) auditory and visual Attentional Blink magnitudes are different and b) that auditory task performance was not correlated with visual task performance [11] we conclude that modality specific attentional mechanisms can govern the Attentional Blink and further, that this mechanism operates early to modify subsequent perception.

It should be noticed that the conclusions of this research were based on the results obtained for presentation rate of 11 tones per second. How the rate presentation and the frequency of T relative to the frequency of P affect performance remains an empirical question.

5. REFERENCES

1. Arnell, K.M., & Jolicoer, P. (1999). The Attentional Blink across stimulus modalities: Evidence for central processing limitations. "Journal of Experimental Psychology: Human Perception and Performance", 25, 630-648.
2. Banks, W.P., Roberts, D., & Cirani, M. (1995). Negative priming in auditory attention. "Journal of Experimental Psychology: Human Perception and Performance", 21, 1354-1361.
3. Bregman, A.S. (1990). Auditory Scene Analysis: The perceptual organization of sound. Massachusetts Institute of Technology.
4. Botwinick, J. (1985). Aging and behavior. Springer Verlag.
5. Carlson, M.C., Hasher, L., Connelly, S.L., & Zacks, R.T. (1995). Aging, distraction, and the benefits of predictable location. "Psychology and Aging", 10, 427-436.
6. Connelly, S.L., Hasher, L., & Zacks, R.T. (1991). Age and reading: The impact of distraction. "Psychology and Aging", 6, 533-541.
7. Deutsch, D. (1982). The Psychology of Music. Academic Press Inc..
8. Elliott, L.L., Hammer, M.A., Scholl, M.E., & Wasowicz, J.M. (1989). Age differences in discrimination of simulated single-formant frequency transitions. "Perception and Psychophysics", 46, 181-186.
9. Hougton, G., & Tipper, S.P. (1994). Inhibitory mechanisms in selective attention. In D. Dagenbach & T.H. Carr (Eds.) Inhibitory Processes in Attention, Memory, and Language. San Diego: Academic Press. (pp. 53-112).
10. Goddard, K.M. (1998). The Attentional Blink in Audition and Vision: An early Selection Model of Selective Attention Revised. Unpublished Master's Thesis. University of Calgary.
11. Goddard, K.M. & Slawinski, E.B. (1999). Modality specific attentional mechanisms can govern the Attentional Blink. "Canadian Acoustics", 27, 98-99.
12. Goddard, K.M., Isaak, M.I., & Slawinski, E.B. (1998). The auditory Attentional Blink in a congenitally blind population. "Journal of Acoustical Association of America" Conference Proceedings, Seattle, WA., 2333-2334.
13. Hasher, L., & Zacks, R.T. (1988). Working memory, comprehension and aging: A review and a new view. In Bower, G.H. (Ed.), The Psychology of Learning and Motivation: Advances in research and theory, 22, 193-224. Academic Press.
14. Hillyard, S.A., Mangun, G.R., Woldorff, M.G., & Luck, S.J. (1997). Neural systems mediating selective attention. In Gazzaniga, M.S. (Ed.) Cognitive Neurosciences, MIT Press.
15. Jolicoer, P. (1999). Restricted attentional capacity between sensory modalities. "Psychonomic Bulletin and Review", 6, 87-92.
16. Kinchla, R.A. (1992). Attention. "Annual Review of Psychology", 43, 711-742.
17. Leek, M.R., Brown, M.E., & Dorman, M.F. (1991). Informational masking and auditory attention. "Perception and Psychophysics", 50, 205-214.
18. Massaro, D.W. & Kahn, B.J. (1973). Effects of central processing on auditory recognition. "Journal of experimental Psychology", 97, 51-58.
19. McDowd, J.M., & Filion, D.L. (1992). Aging, selective attention and inhibitory processes: A psychophysiological approach. "Psychology and Aging", 7, 65-71.
20. McDowd, J.M., & Oseas-Kreger, D.M. (1991). Aging, inhibitory processes, and negative priming. "Journal of Gerontology: Psychological Sciences", 46, P340-P345.
21. Murphy, D.R., McDowd, J.M., & Wilcox, K.A. (1999). Inhibition and aging: Similarities between younger and older adults as revealed by the processing of unattended auditory information. "Psychology and Aging", 14, 44-59.
22. Newman, C.W., & Spitzer, J.B. (1983). Prolonged auditory processing time in the elderly: Evidence from a backward paradigm. "Audiology", 22, 241-252.
23. Parnell, M.M., & Amerman, J.D. (1979). Age and decoding of coarticulatory cues. "Journal of Speech and Hearing Research", 22, 433-445.
24. Price, P.J., & Simon, H.J. (1984). Perception of tempo-

ral differences in speech by "normal-hearing" adults: Effects of age and intensity. "Journal of Acoustical Society of America", 76, 405-410.
25. Raymond, J.E., Shapiro, K.L., & Arnell, K.M. (1992). Temporary suppression of visual processing in an RVSP task: An Attentional Blink? "Journal of Experimental Psychology: Human Perception and Performance", 18, 849-860.
26. Shapiro, K.L. & Raymond, J.E. (1994). Temporal allocation of visual attention: Inhibition of interference? In D. Dagenbach & T.H. Carr (Eds.), Inhibitory Processes in Attention, Memory, and Language. New York: Academic Press.
27. Slawinski, E.B., Hartel, D.M., & Kline, D.W. (1993). Self-reported hearing problems in daily life throughout adulthood. "Psychology and Aging", 8, 552-561.
28. Slawinski, E.B. & Scharf, B. (1998). Effects of tonal masker uncertainty on detection. "Journal of Acoustical Association of America" Conference Proceedings, Seattle, WA., 2347-2348.
29. Tsotsos, J.K. (1997) Limited capacity of any realizable perceptual system is a sufficient reason for attentive behavior. "Consciousness and Cognition", 6, 429-436.
30. Wingfield, A. (1975). Acoustic redundancy and the perception of time-compressed speech. "Journal of Speech and Hearing Research", 18, 96-104.

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ACTIVE CONTROL OF AN OFF-AXIS NOISE SOURCE

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ABSTRACT

A multi-channel active-noise-control system can been used to create a large quiet zone in free-space when the noise source is on the symmetry axis of the control system. In this study, the efficiency of a multi-channel active-noise-control system is investigated numerically for the case of a noise source located at off-axis positions. It was found that both the location and the size of the quiet zone change significantly with the off-axis location of the noise source. The control system is still able to construct a large area of wavefront matching, and create a large quiet zone, when the off-axis shift of the noise source is within this range. There exists an off-axis range for which an optimally pre-arranged multiple-channel control system remains optimized. This range is expressed analytically in terms of the wavelength at the frequency of interest, and of the configuration of the control system.

SOMMAIRE

Un système multi-canaux de contrôle actif du bruit peut créer une grande zone de silence en champ libre quand la source sonore est située sur l'axe principal du système. Dans cette étude-ci, on étudie numériquement l'efficacité d'un système de contrôle actif dans le cas d'une source déplacée de l'axe principal. On a trouvé qu'et la position et la forme de la zone de silence changent nettement avec le déplacement de la source. Il existe une gamme de déplacement pour laquelle un système multi-canaux, optimisé au préalable, demeure optimal. Tant que le déplacement reste dans cette gamme, le système de contrôle est encore capable de créer une grande zone d'adaptation des fronts d'onde. Cette gamme peut être définie analytiquement en fonction de la longeur d'onde et de la configuration du système.

1. INTRODUCTION

Active control of noise in open environments has been studied extensively recently. It has been found that the control efficiency is strongly influenced by the config-uration of the control system.[1-3] However, in this previous research the optimal strategies and configurations of the control system were investigated for arrangements where the primary source was always fixed at the centre, or on the central axis, of the control system. In practical applications, there are cases when the primary noise source cannot be fixed at an on-axis position, or even at any specific location; examples are in the active control of moving noise sources and of multiple noise sources.

When the noise source moves, the noise field changes with the movement of the noise source. The efficiency of the control system is limited by both the controller and the configuration of the control system. There have been recent attempts to control moving primary sources by using a multi-input and multi-output (MIMO) active-noise-control system.[4-5] However, these previous studies were mostly focused on the controller, and examined if it was able to adapt to the changes resulting from the movement of the primary source. The limitation of the control-system configuration - i.e., whether a control system is still effective when the primary source moves to an off-axis location - has not been analyzed.

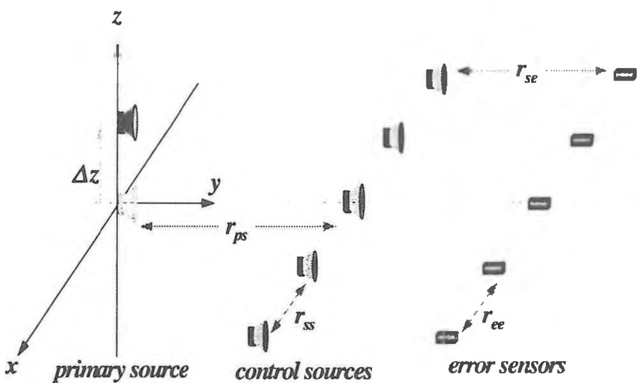


Fig. 1. MIMO local-control system arranged in two parallel lines.

For the analysis presented here, the efficiency limitation of a MIMO local-control system in the case of an off-axis noise source is studied by examining whether an optimally arranged control system is still effective at creating a large area of quiet zone. In the following discussion, the controller of the control system is assumed to be able to adapt to the change in the primary sound field. The efficiency of the control system is examined with respect to two measures: the total power-output increase and the size of the quiet zone.[2-3]

2. SYSTEM DESCRIPTION

In most studies of multi-channel active local control in free-space, the number of control sources is usually chosen to be the same as that of the error microphones[1-3]. With such a setup, the control sources are able to drive the sound pressures at the error microphones to zero, and a quiet zone can be created in the area around the error microphones. A multi-channel active local-control system in open space, in which the N control sources and N error microphones are equally distributed in two parallel lines, is shown in Fig. 1. The spacings of the control sources and error microphones are equal – i.e., $r_{ss} = r_{ee}$. The sound pressures at the error microphones can be minimized (theoretically, to zero) if the strengths of the N control sources are chosen as,

$$\mathbf{q}_s = -\mathbf{Z}_{se}^{-1}\mathbf{Z}_{pe} q_p \tag{1}$$

where q_p is the strength of the primary source, $\mathbf{q}_s$ is a column vector of source strengths for the N control sources, $\mathbf{Z}_{se}$ is an $N \times N$ matrix of acoustical transfer impedances from the N control sources to the N error microphones, and $\mathbf{Z}_{pe}$ is a column vector of acoustical transfer impedances from the primary source to the N error microphones. Then the total radiated acoustical power of the system, which is the summation of the power outputs of

$$W_T = \frac{1}{2}\left\{ |q_p|^2 Z_0 + \mathbf{q}_s^H \operatorname{Re}(\mathbf{Z}_{ss})\mathbf{q}_s + q_p^* \operatorname{Re}(\mathbf{Z}_{ps}^T)\mathbf{q}_s + q_p \mathbf{q}_s^H \operatorname{Re}(\mathbf{Z}_{ps}) \right\}, \tag{2}$$

where $Z_0 = \omega^2 \rho_0 / 4\pi c_0$, in which ω is the angular frequency, ρ_0 the air density and c_0 the sound speed. $\mathbf{Z}_{ss}$ is the $N \times N$ transfer-impedance matrix between the N control sources; $\mathbf{Z}_{ps}$ is the column vector of transfer impedances between the primary source and the N control sources. The principle of acoustical reciprocity applies in this discussion – i.e., $\mathbf{Z}_{sp} = \mathbf{Z}_{ps}^T$. For active local-control strategies in free space, the total power output of the system always increases after the control. This means that the control sources generate the sound power required to control the primary sound field locally. As a result, when the control system creates quiet zones in some desired areas, it increases the sound pressure in other areas. The total sound pressure at any position after control is the summation of the primary and control sound pressures at this position, given by,

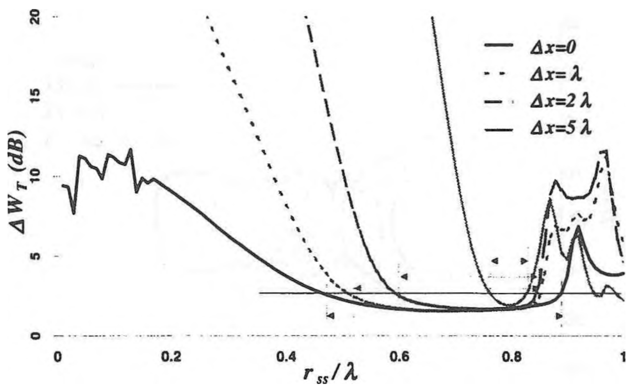
$$P_T = P_p + P_s = q_p Z_{pr} + \mathbf{q}_s \mathbf{Z}_{sr}, \tag{3}$$

where Z_{pr} and $\mathbf{Z}_{sr}$ are the transfer impedances from the primary source and control sources to the observation position, respectively.

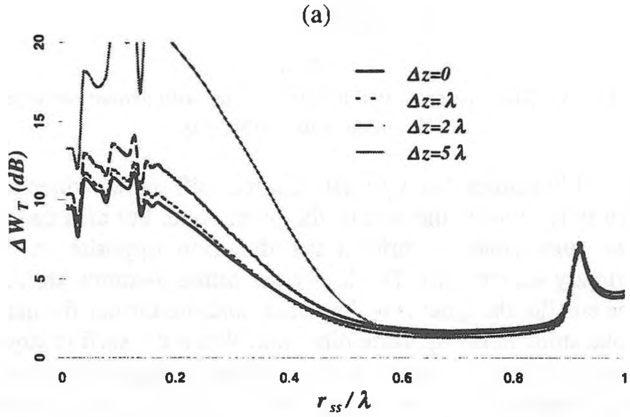
The optimal design of the local-control system involves arranging the control system to create the largest possible quiet zone which, at the same time, undergoes the least increase of total power output. The optimal design has been found to be very sensitive to, and also very important in defining, the control efficiency of the system.[2-3]

It has been found that when the primary source is on the central axis of the control system – i.e., at the origin in Fig. 1 – there always exists an optimal range of spacing between adjacent control sources and adjacent error microphones of the control system. The upper and lower limits of the optimal range are given analytically in Reference 2. The performance of the control system is very sensitive to the sensor/actuator configuration and, therefore, these configurations need to be strictly observed when designing a multiple-channel local-control system in free space.

However, it is not known if the MIMO control system is still effective when the primary noise source is placed at, or moves to, off-axis positions, as also shown in Fig. 1. In the following discussion, the performance of the control system is examined for cases when the primary source is at both an on-axis position, as well as at several off-axis positions. The objective is to extend the MIMO control system to cases when the primary source is at off-axis positions, or even to the case of moving noise sources.



(a)



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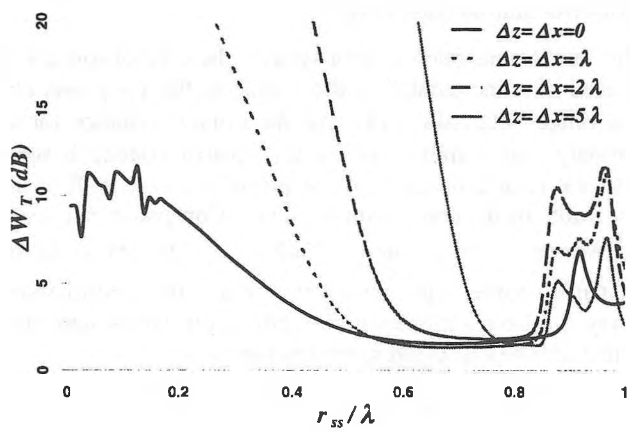

(c)

Fig. 2. Total power-output increase of the control system with primary-source shifts in: (a) x direction only; (b) z direction only; and (c) both x and z directions.

3. EFFECT ON TOTAL POWER OUTPUT

The total power output of the multiple-channel control system can be calculated using Eq. (2). It is obviously a function of the control-system configuration, the wavelength of the noise, and the location of the primary noise source with respect to the control system. The total sound-power-output increase after control is defined as,

$$\Delta W_T = 10\log(W_T / W_0), \tag{4}$$

where $W_0 = |q_p|^2 Z_0 / 2$ is the sound-power output of the primary source alone when the control system is off.

Examination of the total power-output increase has been done for various system configurations and various primary-source off-axis positions. Numerous numerical-simulation results indicate that there always exists an optimal range, or a range of lower power-output increase, even when the primary source shifts away from the original position. This optimal range varies with the primary-source shift.

For the control system shown in Fig. 1, the primary source has shifted some distance in the x direction and/or the z direction. The shifts are referred to as Δx and Δz, respectively. A typical control system, with 11 control sources and 11 error microphones, is illustrated as an example. The distance from the primary source to the control-source array is r_{ps}=2λ, and the distance between the control-source array and the error-microphone array is r_{se}=5λ.

Fig. 2 shows the change in the increase of total sound-power output caused by the control system as a function of the spacing of the control sources r_{ss} for different primary-source shifts. The power-output increase for the system without primary-source shift (corresponding to Δx=0 and Δz=0), which has an optimal-spacing range from 0.45λ to 0.89λ according to Ref. 2, is also shown for comparison.

Fig. 2 shows that there still exists a range of low power-output increase, though it varies with the primary-source shift. When the primary source shifts some distance in the x direction away from the central axis of the control system, both the upper and lower limits of the optimal range change. Fig. 2(a) shows this change for three primary-source shifts: Δx=λ, 2λ and 5λ. The optimal ranges are reduced in comparison with the case without the shift (Δx=0). The optimal range recedes at both the upper and lower ends, but mostly at the lower end. The larger the primary-source shift is, the narrower the optimal range becomes. When the primary-source shift is Δx=5λ, the optimal range becomes very narrow – around r_{ss}=0.8λ. On the other hand, the optimal range remains about the same for the case when the primary-source shift is in the z direction only, as shown in Fig. 2(b). The range of low power-output increase decreases when the primary source shifts in both the x and z directions. Fig. 2(c) shows that the range reduction is very similar to that of the case illustrated in Fig. 2(a), which implies that the effect of primary-source shift on the power-output increase results mainly from the primary-source shift in the x direction.

It is shown in the following section that the decrease of low power-output range due to the off-axis shift reduces the ability of the control system to create a large quiet zone significantly.

4. EFFECT ON THE QUIET ZONE

The quiet zone created by the control sources depends mainly on the wavefront matching between the primary field and the control field. When the primary source moves, the wavefront matching between the primary and control fields changes, and so do the size and location of the quiet zone created by the control system. Analysis of the power-output increase indicates that a notable range of low power-output increase still exists when the primary source shifts, though it may become very narrow as the primary source moves further away from the central axis. However, it is shown in this section that when the primary source shifts a certain distance from the central location in a certain direction, the control system may not be able to create a quiet zone, even if it is still arranged in the range of low power-output increase. A large area of wavefront matching between the primary field and the field generated by the control-source array cannot be obtained when the primary-source shift is too large.

The sound-pressure attenuation in the space due to the control system is defined as,

$$\Delta P = 20\log(|P_T|/|P_p|), \qquad (5)$$

where P_T is the total sound pressure in the space after the control, and P_p is the sound pressure generated by the primary source only when the control system is off, as defined in Eq. (3). The effect of the primary-source shift on the quiet zone is discussed separately for the previous system.

The previous control system with 11 channels is again taken as an example, to demonstrate the effect of a primary-source shift on the quiet zone. The spacing of the control sources and of the error microphones is chosen as r_{ss}=0.8λ, which corresponds to the arrangement giving the lowest increase of total power output, as shown in Fig. 2(a). The effect of the primary-source shift on the quiet zone will be discussed for three conditions: primary-source shift in the x direction only; in the z direction only; and in both the x and z directions.

4.1 Primary-source shift in the *x* direction only

The quiet zones created in an x-z plane by the system with three different primary-source shifts – Δx=2λ, 4λ and 5λ – in the x direction only are presented in Fig. 3. The above-described 11-channel control system with r_{se}=5λ, r_{ss}=0.8λ and r_{ps}=2λ is taken for demonstration. The shaded area shown in Fig. 3 for comparison is the quiet zone created by the control system without primary-source shift.

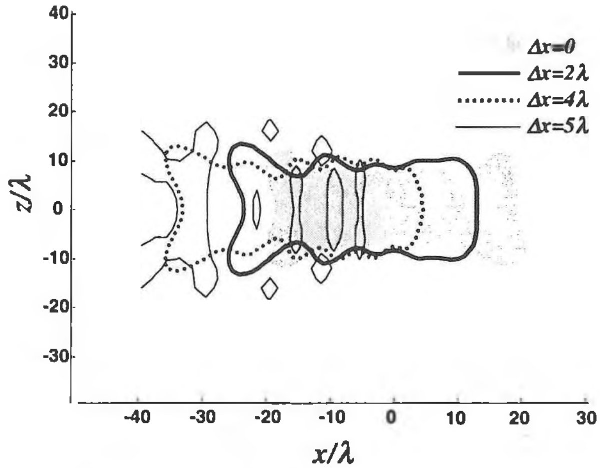

Fig. 3. Quiet zones created by the system, with primary-source shifts in the x direction only.

Fig. 3 illustrates that a primary-source shift in the x direction not only reduces the size of the quiet zone, but also causes the quiet zone to shift in the direction opposite to the primary-source shift. The larger the primary-source shift is, the smaller the quiet zone becomes, and the further the quiet zone shifts in the opposite direction. When the shift is larger than a critical distance (Δx>4λ in this example), the quiet zone disappears, even though the spacings of the control sources and error microphones are still within the low power-output-increase range.

For the demonstrated control system, the control sources are placed in a line parallel to the x axis, in the x-y plane, over the range $-4\lambda \le x \le 4\lambda$. Note that the critical distance for the primary-source shift is 4λ for the control system; it seems that the critical distance of the primary-source shift is half the width of the control-source array. Computational results for various control systems (N=2, 3, $\cdots$, 21) show that the distance between the primary source and the control-source array r_{ps} also contributes to the critical primary-source shift, which can be expressed approximately as,

$$\Delta x_C \cong w_{1/2}(1+\frac{r_{ps}}{20\lambda}), \qquad (6)$$

where $w_{1/2}=(N-1)r_{ss}/2$ is half the width of the control-source array. This means that the control system is still effective at creating a quiet zone when the primary-source shift is within the range defined by the critical primary-source shift – i.e., $-\Delta x_c \le \Delta x \le \Delta x_c$.

4.2 Primary-source shift in the *z* direction only

While the control system is still able to create a quiet zone with the primary-source shift along the x axis, the quiet zone disappears very quickly when the primary source shifts in the z direction. The contour plots of the quiet

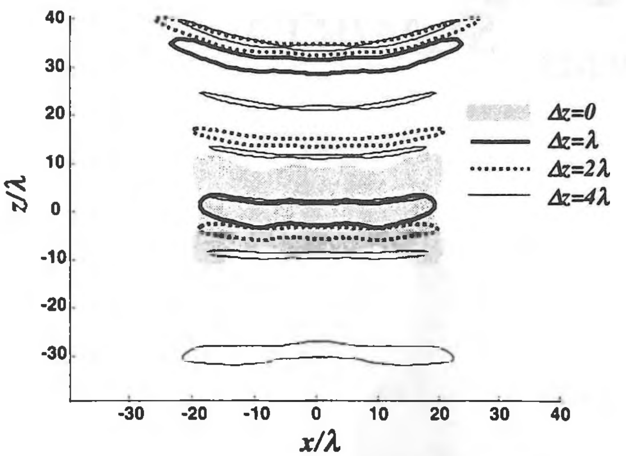

Fig. 4. Quiet zones created by the system, with primary-source shifts in the z direction only.

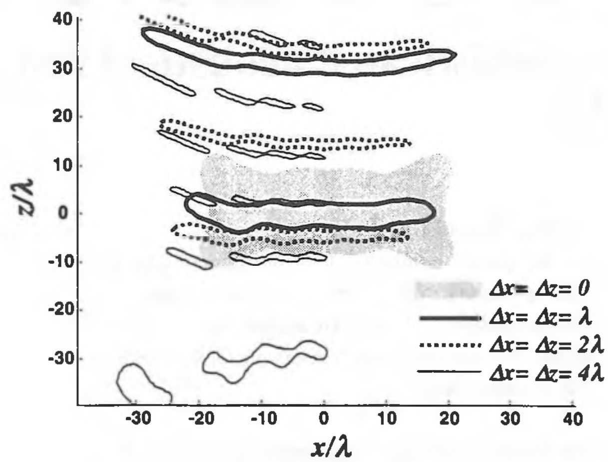

Fig. 5. Quiet zones created by the system, with primary-source shifts in both the x and z directions.

zones resulting from the primary-source shifts are shown in Fig. 4, in which the primary source shifts to $\Delta z=\lambda$, 2λ and 4λ. It can be seen that a large area of quiet zone in the space is replaced by several narrow quiet zones, and that these narrow quiet zones are separated in the z direction.

4.3 Primary-source shift in both x and z directions

The contour plots of the quiet zones created by the control system with primary-source shifts in both the $+x$ and $+z$ directions are shown in Fig. 5. Three shifts – $\Delta x=\Delta z=\lambda$, $\Delta x=\Delta z=2\lambda$ and $\Delta x=\Delta z=5\lambda$ – are discussed as examples. Similar to the case of primary-source shifts in the z direction only, a large quiet zone is now replaced by several narrow quiet zones, even though the shift is small – for example, only one wavelength. Unlike the case of primary-source shifts in the z direction only, these narrow quiet zones also shift in the $-x$ direction.

5. SUMMARY

A pre-arranged optimal MIMO control system can still create a large area of quiet zone if the primary source moves within a limited range in front of the control system. The critical primary-source off-axis shift described by Eq. (6) indicates that the maximum primary-source shift is mainly determined by the length (or size) of the control- source array. This can be increased by either increasing the number of control channels or by maximizing the length (or width) of the control-source array. The further the primary source shifts away from the central axis of the control system, the narrower the range of low power-output increase becomes, the further the quiet zone shifts in the direction opposite to the primary noise-source movement (if there still is a quiet zone), and the narrower the effective frequency band becomes. These conclusions also pertain limitations of the MIMO control-system efficiency in the case of moving noise sources.

6. ACKNOWLEDGMENTS

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7. REFERENCES

1. S. E. Wright and B. Wuksanovic, "Active control of environmental noise," *J. Sound Vib.* **190**(3), 565-585 (1996).

2. Jingnan Guo, Jie Pan and Chaoying Bao, "Actively created quiet zones by multiple control sources in free space," *J. Acoust. Soc. Am.* **101**(3), 1492-1501 (1997).

3. Jingnan Guo and Jie Pan, "Further investigation on actively created quiet zones by multiple control sources in free space," *J. Acoust. Soc. Am.* **102** (5), 3050-3053 (1997).

4. A. Omoto, T. Matsui and K. Fujiwara, "The behaviour of an adaptive algorithm with a moving primary source," *J. Acoust. Soc. Jpn.* (E) **19** (3), 211-221 (1998).

5. K. Uesaka, H. Ohnishi, K. Hachimine, M. Nishimura and K. Ohnish, "Active control of sound from a moving source," *Active 97*, Budapest, Hungary, 1125-1134 (1997).

6. P. Nelson and S. Elliott, Active control of noise, Academic Press Limited, San Diego (1992).

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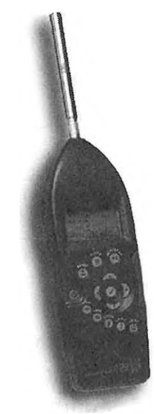

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SURVEILLANCE ARRAYS FOR SHALLOW WATER: COMPARISON OF PLANAR VS. LINE BOTTOMED ARRAYS

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ABSTRACT

A number of different array architectures, including horizontal and vertical line arrays and planar arrays, are currently being developed for shallow water applications. An objective of the work is to assess the performance of the different array architectures. To achieve this the arrays were tested during a sea trial (RDS-2) that took place in the Timor Sea in November 1998. This paper compares the broadband detection performance of two designs of array, a planar array (Octopus) and a Horizontal Linear Array (ULRICA HLA), at the RDS-2 site. Noise statistics and signal threshold levels presented here are obtained from ambient noise data. Significant differences in the dependence of threshold on azimuth are shown between the Octopus and ULRICA arrays and are attributed to the different geometries and hence beampatterns of the arrays. Signal data, obtained from a submerged sound source, are used in conjunction with the noise data to determine detection performance at a range of source levels. The results indicate that the detection performance of 16 element ULRICA and Octopus arrays is comparable at the RDS-2 site.

SOMMAIRE

Il y a plusieurs différentes architectures de réseau, des réseaux linéaires horizontaux, verticaux ainsi que des réseaux plans, qui sont présentement en voie de développement pour des applications en eaux peu profondes. Un objectif de ce travail est d'évaluer la performance des réseaux ayant des architectures différents. Pour accomplir ceci des réseaux on été mis à l'épreuve durant un essai en mer (RDS-2) qui a eu lieu dans la mer de Timor en novembre 1998. Ce traité compare la performance de détection à large bande de deux types de réseaux, un réseau plan (Octupus) et un réseau horizontal linéaire (ULRICA) au site RDS-2. Les statistiques de bruits et les niveaux de seuil des signaux présentés ici on été obtenus de données de bruit ambiant. Des différences significatives de la dépendance du seuil sur l'azimuth sont démontrées entre le réseau Octopus et ULRICA. Ces différences sont attribuées aux géométries distinctes et par conséquent la mise en forme de faisceau des réseaux. Les données du signal, obtenu d'une source acoustique submergée, sont utilisées en conjonction avec les données de bruit pour déterminer la performance de détection pour une gamme de niveau d'émission. Les résultats obtenues au site RDS-2 inidquent que la performance de détection des réseaux à 16 éléments ULRICA et Octopus sont comparables.

INTRODUCTION

A collaborative program of work on Rapidly Deployable Systems (RDS) is currently taking place under the Technical Cooperation Program (TTCP). The object of the work is to demonstrate the concept of RDS. This includes building and testing prototype RDS arrays, demonstration of packaging and deployment, developing processing algorithms and an accurate modeling capability for RDS systems. Part of the work is to assess the performance of different architectures of RDS arrays deployed in shallow water.

A sea trial, RDS-2, was performed in November 1998 in the shallow water of the Timor Sea [1]. A number of different RDS systems were deployed by the participant nations including a planar Octopus array, ULRICA arrays that can either be configured as horizontal or vertical line arrays, a large aperture horizontal array (ULITE) designed for matched field processing, and various environmental sensors.

A set of experiments was performed to determine the detection performance of the different systems. One objective is to compare the detection performance of the Octopus planar array and the ULRICA Horizontal Linear Array (HLA) array at the RDS-2 site. This paper presents some of those results.

Noise statistics and threshold levels were obtained from a section of ambient noise data recorded at similar times on both arrays. Different signals were transmitted from a submerged source at a number of ranges from the receivers. These signals were attenuated to correspond to different source levels and then injected into the noise data from different beams. The broadband detection performance of the two arrays is evaluated and compared. Results are presented using two different constant false alarm rate (CFAR) threshold settings: 1) based on setting individual threshold levels in each beam and 2) on setting a single omni-directional threshold level. Conclusions are given concerning the analysis.

OCTOPUS PLANAR ARRAY

The experimental Octopus array is under development by SPAWAR Systems Center in San Diego, US. This acoustic array is an autonomous, bottom mounted, planar disk. The array consists of eight arms containing 16 hydrophones. The array weighs approximately 100 kg in air and has an outside diameter of 5.5 m. The hub of the array is a pressure housing containing the data recording system. The retrieval system is mounted on the top of the pressure housing.

The hydrophone sensitivity is –135 dB V/μPa and the array's frequency response is 40-1200 Hz. The recording system consists of an analog to digital card installed in a computer with 16 channels of 16 bit A/D with a sample rate of 3005 Hz and 8 gigabytes of storage.

The deployment procedure consists of booming the array over the water, lowering it into the water, letting the free flood areas fill, and then releasing the array. The array free falls to the bottom. Average time for a deployment takes 10 to 15 minutes.

The retrieval system consists of a pop-up buoy, which has a submersible light, VHF radio beacon, and a radar reflector. The primary release is acoustically commanded from the surface via a transponder. The secondary release is a timed burn wire release that can be set in one-hour increments. The buoy is then released from the array, floats to the surface, but is still attached by a line to the array. This line is then used to pull the array to the surface. The array is reattached to the boom and hoisted on to the deck of the boat.

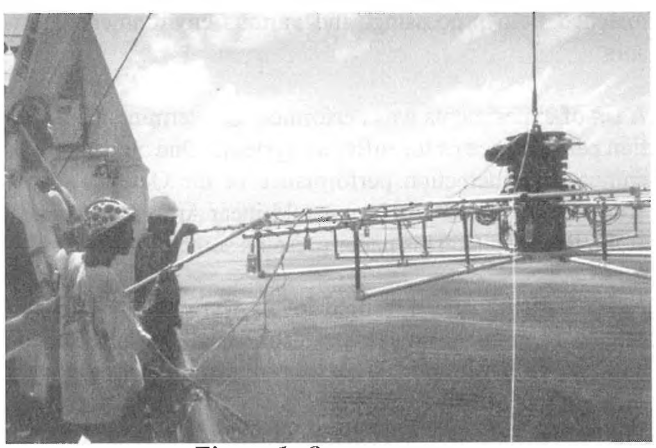

Figure 1 Octopus array.

Figure 1 shows the Octopus array being deployed. The eventual fleet system would be a low cost, lightweight, air deployed array consisting of between 16 and 32 sensors.

ULRICA HLA

The ULRICA array is under development at DERA Winfrith in the UK. It is a lightweight, low cost, deployable array system that can be configured as either a horizontal or vertical array [2]. The ULRICA array is autonomous and can either be programmed prior to deployment or remotely from the trials ship via an acoustic link. A photograph of the ULRICA array and the Octopus array prior to deployment is shown in figure 2.

The array contains 32 omni-directional Benthos AQ4 hydrophone sensors with a sensitivity of -201 dB re 1 V/μPa. The nominal spacing of the hydrophones is 1.25 m. However, since the HLA is not rigid, sensor positions must be determined after deployment. The ULRICA array contains an electrical cable, to which the sensors are attached, and a separate Kevlar strain member. The sensors are interfaced to a PC unit housed in a two piece pressure housing weighing 65 kg. A Benthos acoustic release mechanism is attached to a small buoy to enable recovery. Lead weights are attached to the cabling and close to the sensor casings in the horizontal arrays to increase the specific gravity.

Experimental results are presented in this paper from two separate deployments of ULRICA arrays. Ambient noise measurements were obtained from array (HLA05) deployed 19 km from the trials site. Signals transmitted from a submerged projector were recorded on array (HLA09) deployed at the trials site.

After the deployment of each array, the sensor positions

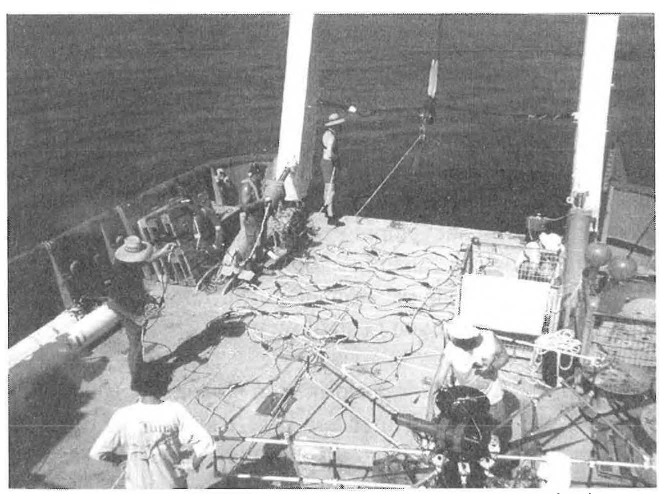

Figure 2 ULRICA and Octopus arrays on deck

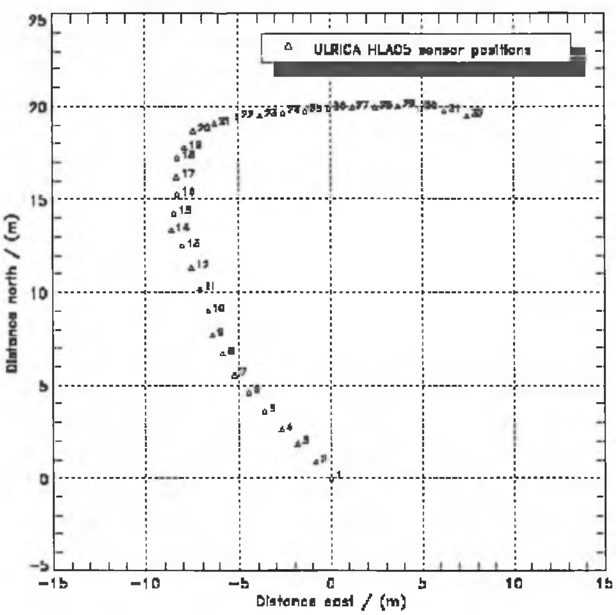

Figure 3 Location of sensors in ULRICA HLA05

were determined from experimental data [2]. The trials ship *Pacific Conquest* circled each array at a distance of 500 m and provided a broadband source of noise. The sensor positions were determined by measuring the phase response between pairs of hydrophones and applying a least squares fit to the data. The positions of the source were obtained from GPS.

Figure 3 shows the estimated sensor positions in ULRICA HLA05 relative to the first sensor in the array. The array is in the shape of a boomerang. The mean sensor spacing is 1.13 m. ULRICA HLA09 was also not straight and the shape was similar to that of HLA05. In the analysis considered in this paper, sensor positions were taken into consideration and shape corrected beamforming was applied.

THE EXPERIMENT

A set of experiments was performed to evaluate the detection performance of the different RDS systems. An Octopus array and a horizontal ULRICA array (HLA09) were deployed close together at the trials site. The water depth was 105 m. The seabed was very flat, with a slope of less than 4 m over a range of 9 km. A sound source, the Sonar Research Projector (SRP), was deployed to a depth of 50 m from the *Southern Surveyor*, one of the trials ships.

The SRP was used to generate several narrow band and broadband signatures whilst the trials ships were in a quiet state. Recordings were obtained at seven locations at different ranges from the arrays. Results are presented here at two ranges, 4.27 km (denoted as test PD5), and 9.0 km (test PD8).

A sequence of recordings was made for each projector location. Each signal was transmitted continuously for 5 minutes. Two sets of narrow band tones were transmitted; a quiet narrow band spectrum denoted NB1 and a louder spectrum NB2. NB1 contained source levels representative of current and future threat signatures while NB2 contained narrow band signatures at the maximum output of the projector. Two broadband spectra were transmitted, a quiet spectrum BB1 and a higher spectrum level BB2. Ambient noise was also recorded while the trials ships were in a quiet state.

Only short sections of ambient data were recorded during the PD sequences. The ambient noise recordings were insufficiently long to provide a good estimate of the noise distribution. A separate experiment was performed to obtain ambient noise data over an extended period. An Octopus array and a horizontal ULRICA array (HLA05) were deployed 19 km to the NNW of the trials site. Ambient noise conditions were recorded over 2 days.

THE NOISE

The ambient noise used in the analysis was obtained between 00:00 CST and 04:20 CST on November 6, 1998. Ambient noise conditions were relatively quiet during this period and the wind speed was from 5 to 7 knots. The band average level of about 61 dB SPL is consistent with wind speed noise. However, biological noise was in evidence sporadically. In the ULRICA case, the noise section was 27 minutes sampled continuously, starting at 00:00 CST. In the Octopus case, the noise section consisted of 64 seconds every 5 minutes over 3 hours 20 minutes, starting at 01:00 CST.

Neither data from the ULRICA array or the Octopus array were shaded in the space domain prior to beamforming. A conventional beamformer employing array shape correction was used in all the processing. For both data sets the integration period for each update was 15 seconds.

In the analysis given here, the noise distribution and threshold levels, obtained from the noise sections were static. The static threshold condition was required because of the fact that our source was stationary. One of the bases for using CFAR is that a target will create dynamic features (changing beams with time), with time scales short (minutes to 10 s of minutes), compared to changing noise time scales that are much longer. In practice, thresholds would be set on a slowly varying time scale, and therefore would adapt to changes in ambient conditions.

Figure 4 shows beam noise intensity (linear scale) from the Octopus array integrated over the band 200-400 Hz for the first 2 hours. The graph shows that the general background level is relatively low and steady with a 2-3 dB higher level

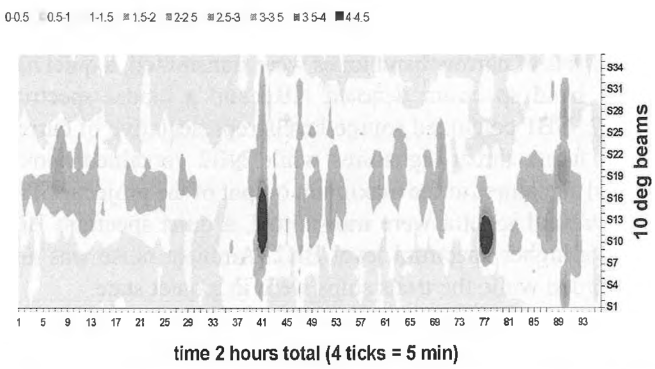

Figure 4 Beam noise intensity from Octopus array in the band 200-400 Hz from 01:00CST 6/11/1998

to the North (Beam 14) and East (Beam 23) directions. The time history (horizontal axis) contains some short duration 'outbursts' of noise that are believed to be due to biologics.

Figure 5 shows the beam noise pressure from the ULRICA array (HLA05) in the band 200-400 Hz from 00:00 CST on 6/11/1998. The beam noise response is displayed as the mean intensity in a 1 Hz band between 200 and 400 Hz as opposed to the integrated power in this bandwidth. The array response was calculated from only 16 of the 32 channels in the ULRICA array (channels 16-31) for two reasons. Firstly, for comparison purposes, only 16 channels were considered since the Octopus array comprised 16 channels and secondly the selected channels from the ULRICA array were approximately linear (figure 3). The graph shows that the variation (from lowest to highest) in noise levels with bearing is typically 5 dB. Lower noise levels are obtained near the endfire directions (to the east and west). The array response is almost symmetrical about the endfire directions because the array is approximately linear. High noise levels are obtained in all directions in a single update 590 s from the start. This transient event was found to be due to vibration of the sensors resulting from current flow over the array. Many more transient events were recorded in the band 100-200 Hz (not shown).

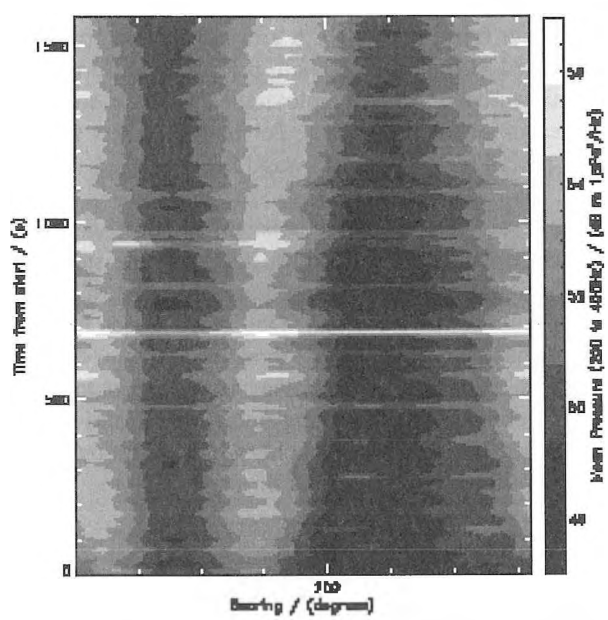

Figure 5 Beam noise pressure from channels 16-31 in ULRICA HLA05 in the band 200-400 Hz from 00:00 CST 6/11/1998

The results show that there are significant differences in the beam response of the Octopus and ULRICA arrays to the noise. This is likely to be due to the different beam-patterns of the arrays. A planar array such as the Octopus array can resolve beams in azimuth without ambiguity and have some discrimination in the vertical plane, although the beams will be wider than a corresponding line array. A horizontal line array that is deployed in a straight line is symmetric and has an ambiguity in the beampattern. In addition, energy is admitted from a wide range of elevation angles, except in the endfire direction.

Figure 6 shows pressure spectra from a single channel in the ULRICA array on two different days, 6/11/1998 at 00:00 CST and 8/11/1998 at 14:07 CST. At the first of these times, the array was deployed 35 km from the trials site. The trials ships were therefore at some distance from the array. The spectrum level is relatively low. Higher levels are obtained between 550 and 700 Hz and around 800 Hz due to energy arriving from the NE. At the second of these times, the trials ships were much closer to the array but were in a quiet state prior to an acoustic transmission from the projector (PD5). Higher noise levels were obtained at this time above 350 Hz due to biological activity. In particular croaker fish were identified. Similar results were obtained from the Octopus

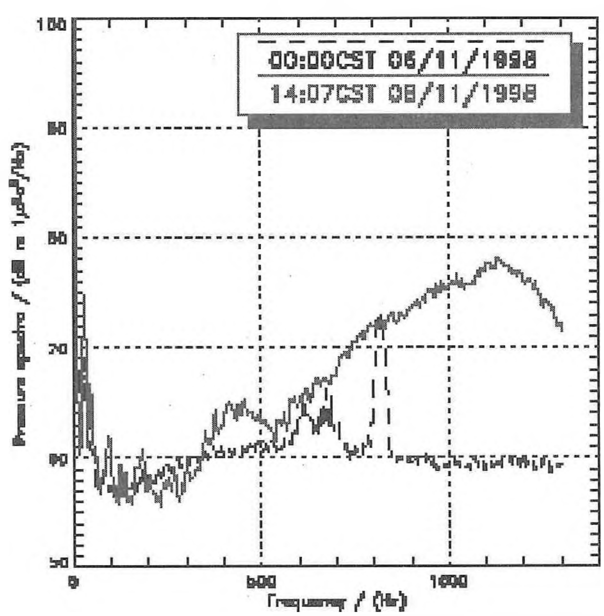

Figure 6 Pressure spectra from single channel in ULRICA during ambient noise recordings on two different days

array, but are not included.

CFAR THRESHOLDS

Noise data from the Octopus array (a sample of which is shown in figure 4) were used to calculate the noise distribution. The noise distribution was formed from 160 updates (15 s segments) in each beam. Threshold levels were then set for each beam based on a specified Probability of False Alarm (PFA). The threshold levels (in intensity units, right vertical axis) for the Octopus array data in the band 200-400 Hz are shown in figure 7 as a function of beam number. The probability that a 15 s time (update) would have an intensity greater than that level is indicated by the gray-scale. The large area in the upper portion of the graph shows the probability of exceeding the threshold is from 0.0-0.05. Following the lower edge of this region for each beam yields the threshold level (right axis) for that beam for a PFA of 0.05. As the threshold levels decrease, there is a corresponding increase in the PFA. Specifying the PFA specifies the threshold in an autonomous fashion.

The noise distribution in the ULRICA array was formed from the 108 updates shown in figure 5. Figure 8 shows the threshold levels in 16 channels of the ULRICA array in the band 200-400 Hz as a function of bearing and PFA. The threshold levels are given as the mean power in a 1 Hz band between 200 and 400 Hz. The threshold levels vary by 5 dB

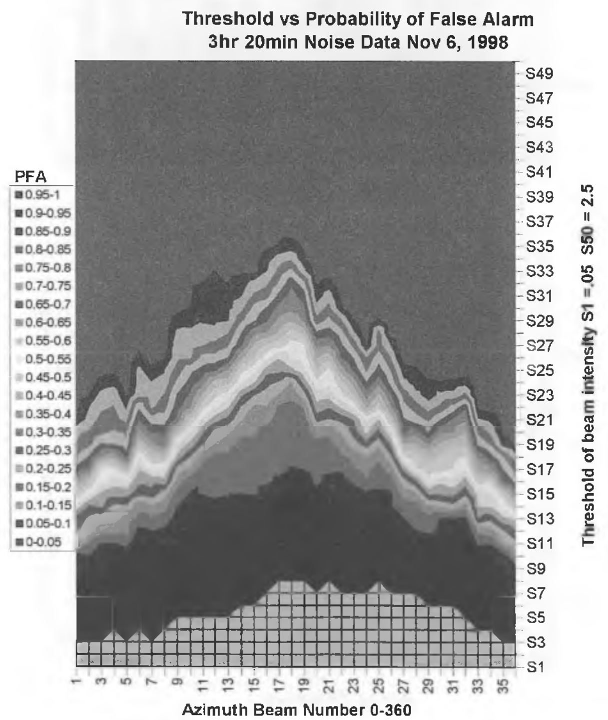

Figure 7 Octopus beam thresholds in the band 200-400 Hz for different probabilities of false alarm

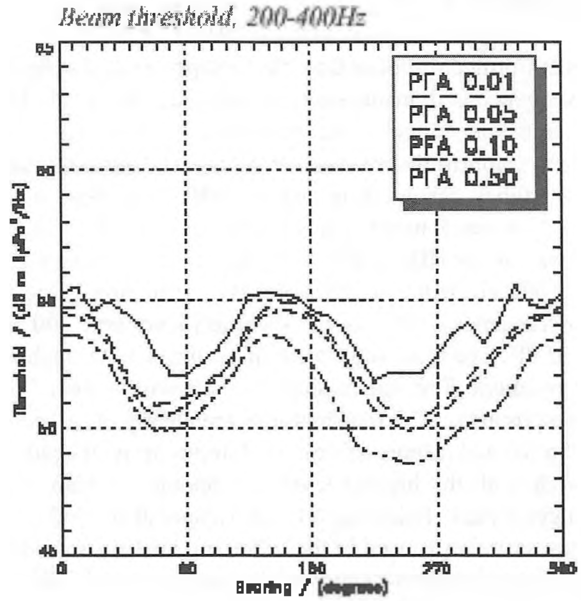

Figure 8 Beam thresholds in 16 channels of ULRICA in the band 200-400 Hz

with bearing. The highest thresholds are approximately in the north and south directions, broadside to the array. The lowest thresholds are in the east and west directions at end-fire.

The difference in the form of the threshold levels with bearing between the two arrays (figures 7 and 8) is due to the different beampattern of the arrays. It should also be noted that the noise distributions were obtained at slightly different times. Similar results are obtained in the band 100-200 Hz (figure 9), although the threshold levels are slightly higher for low PFA. This is due to the higher levels of transient noise in the 100-200 Hz band.

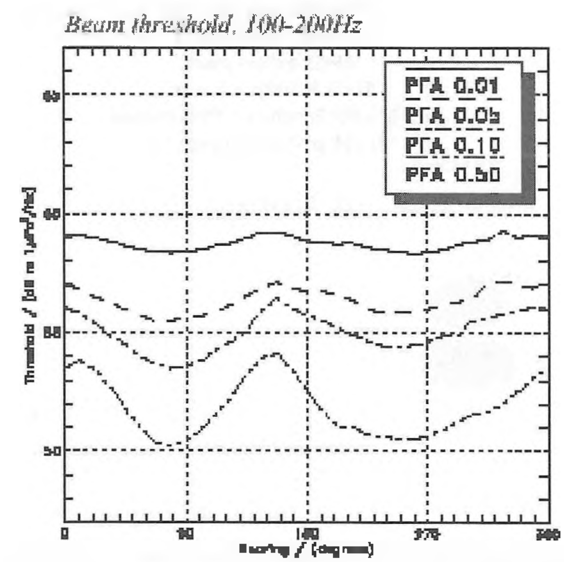

Figure 9 Beam thresholds in 16 channels of ULRICA in the band 100-200 Hz

THE SIGNAL

The beamformed response from the Octopus array during the PD5 sequence of transmissions is shown in figure 10. The range from the source to the array was 4.27 km. The PD5 sequence comprised continuous transmissions for 5 minutes of low signal narrow band tones (NB1), ambient noise (AN1), high signal narrow band tones (NB2) and high signal broadband noise (BB2). BB2 transmissions were from 100 Hz to 1000 Hz with a 6 dB per octave reduction going to higher frequencies. The source spectrum level near 300 Hz was 122 dB. The trials ships were in a quiet state throughout the experiment. The source ship was in beam number 7 of the Octopus array. The transmissions are clearly observed in the beamformed response from the Octopus array in beam 7. The peak with the highest level corresponds to NB2. The next highest peak, following NB2, corresponds to BB2. The BB2 transmission is used in the following analysis to calculate the detection performance of the Octopus and ULRICA arrays.

Figure 11 shows beam spectra from the Octopus array during the BB2 transmission. Beams were formed which were directed towards and away from the source. The spectra have been smoothed in frequency with a 20 Hz running mean. The structure in the signal spectra between 100 and 400 Hz is believed to be due to multi-path interference. Over the range 100 to 400 Hz, the response in the signal beam is typically 10 dB higher than the response in the noise beam. Above 500 Hz, ambient noise dominates over the signal. High levels of biological noise were present during the PD5 sequence and this accounts for the large increase in both the beams above 500 Hz.

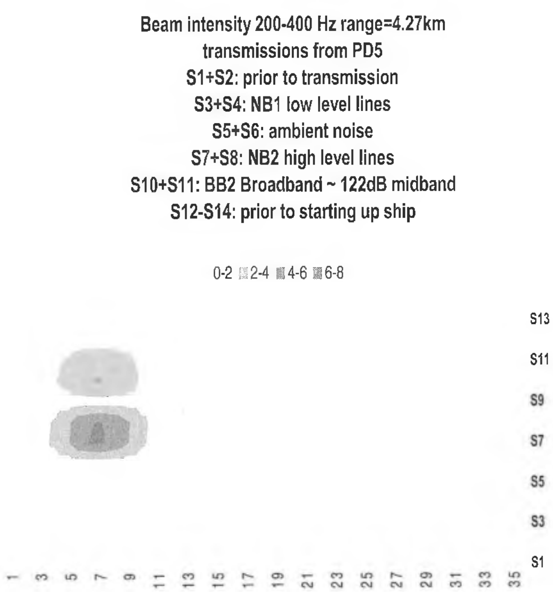

Figure 10 Beamformed response from Octopus array during PD5 sequence in the band 200-400 Hz

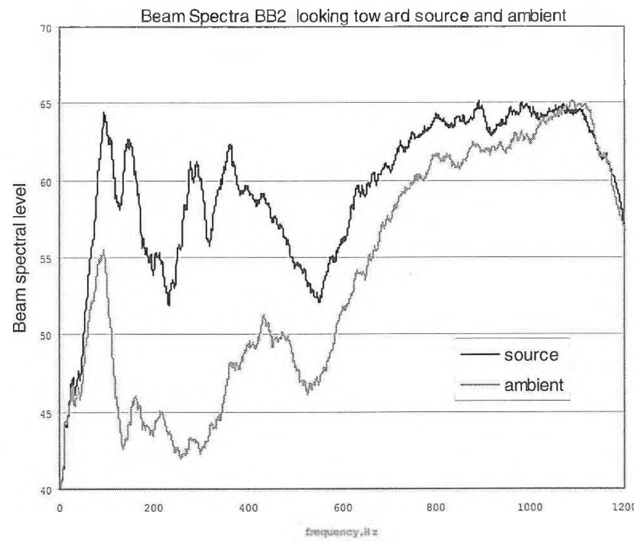

Figure 11 Octopus beamformed response directed towards and away from source during BB2 transmissions

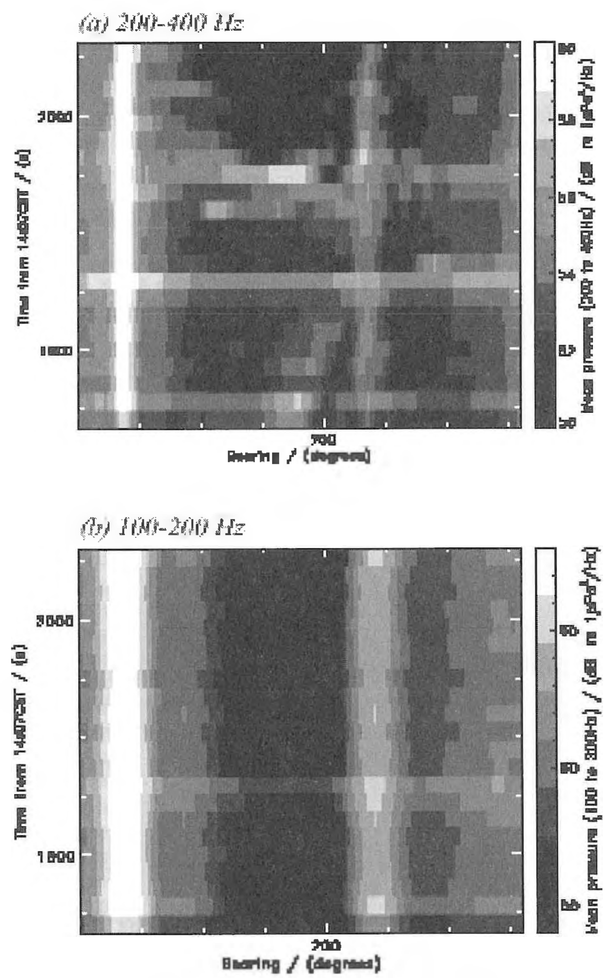

Figure 12 Beamformed response from ULRICA array during BB2 transmission in the bands (a) 200-400 Hz and (b) 100-200 Hz

Figure 12 shows the beamformed response from the ULRICA array during the BB2 transmission in the bands 200-400Hz and 100-200 Hz. The array response was calculated from all the sensors in the array. Data from the sensors were not shaded prior to beamforming. The integration period was 15 s and a total of 22 updates are shown. The signal is clearly identified in the band 200-400 Hz at a bearing of 35 deg. The signal level varies by typically less than 1dB during the transmission. The array is not straight and high side lobes result in energy leakage from the source. This is observed as a second peak, 6 dB lower than the main response, at a bearing of 235 deg. A number of 'bursts' of energy are present in the 200-400 Hz band at different bearings and times. These transient events are thought to be due to biological noise from croaker fish. Lower noise levels from biological sources are present in the band 100-200 Hz.

DETECTION

So far we have examined the noise distribution from which we have set our thresholds. We now determine the detection performance by adding the signal and noise distributions. Threshold levels were set for a false alarm rate (FAR) of 5%. The received signal from the BB2 transmission was injected into the noise data in a specified beam for a variety of source levels.

Figure 13 shows the probability of detection in the band 200-400 Hz for a source injected in beam 18 of the Octopus array. Signal data were obtained by subtracting an estimate of the noise during the BB2 transmission from the BB2 data. This reduced the apparent signal level by approximately 1 dB. The source spectral level during the BB2 transmission was assumed to be 122 dB at mid-band and the signal data were adjusted to simulate the specified source levels. To reduce false detections resulting from transient events, such as the biological noise outbursts already observed in the data, each sample in the signal-plus-noise data was examined. A detection was said to be obtained if 3 samples out of 4 consecutive samples exceeded the threshold level. The results indicate that a probability of detection of 0.5 is obtained for a source level between 112 and 113 dB at range of 4.27 km. The width of the peak is due to the beam width of the array at 200-400 Hz. The false alarm rate is about 5% for beams that do not contain the signal. This is to be expected since a false alarm rate of 5% was specified in setting the threshold levels.

Figure 14 shows the relation between source level, probability of detection, and beam number in the Octopus array at a range of 4.27 km. The signal has been injected in a number of different beams and the probability of detection in that beam calculated for different source levels. The graph shows that there is significant variation in detection with beam number due to the different ambient beam levels.

At a range of 9.0 km, the source levels required to give the same probability of detection are 10 to 11 dB higher than at a range of 4.27 km (results not shown). Theoretical predictions of propagation loss were obtained for the site using the model RANDI2 [2]. This is an ambient noise model which originated in SACLANTCEN and incorporates the mode-based propagation model SUPERSNAP. Although not presented here, theoretical predictions of transmission loss between the ranges of 4.27 and 9.0 km indicate a value of 9 dB at the site [2]. The predicted transmission loss is in quantitative agreement with the results.

Data from the Octopus and ULRICA arrays were processed independently (personnel, processing programs, assumptions, etc.). In the ULRICA array analysis it was assumed that the source level during the BB2 transmission was 123 dB. This is 1 dB higher than assumed in the Octopus array analysis. In addition, an estimate of the noise level during the

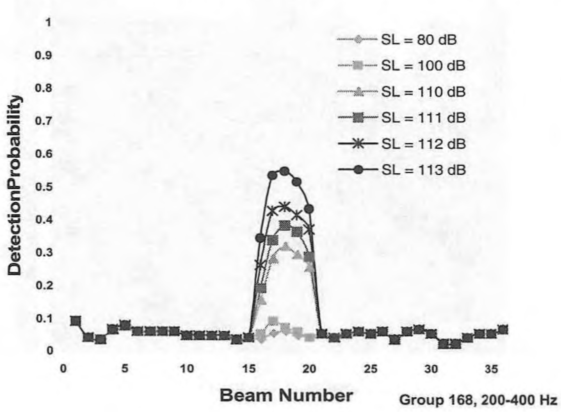

Figure13 Probability of detection in the band 200-400 Hz for source at range 4.27 km in beam 18 of Octopus array, FAR 5%

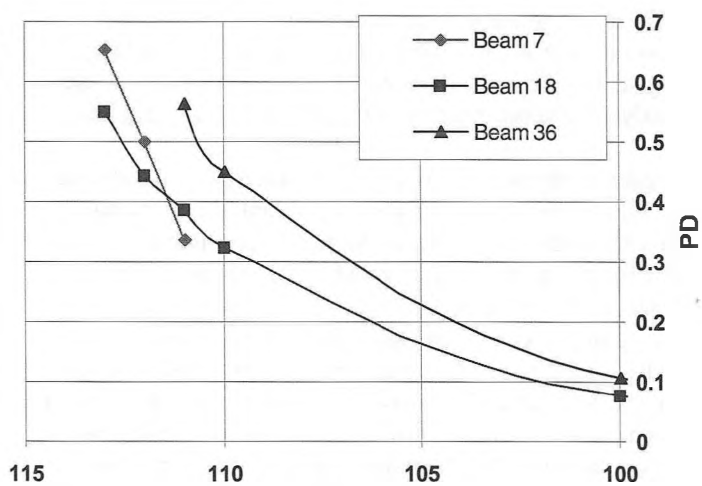

Figure 14 Probability of detection in the band 200-400 Hz versus source level and beam number in Octopus array at 4.27 km range

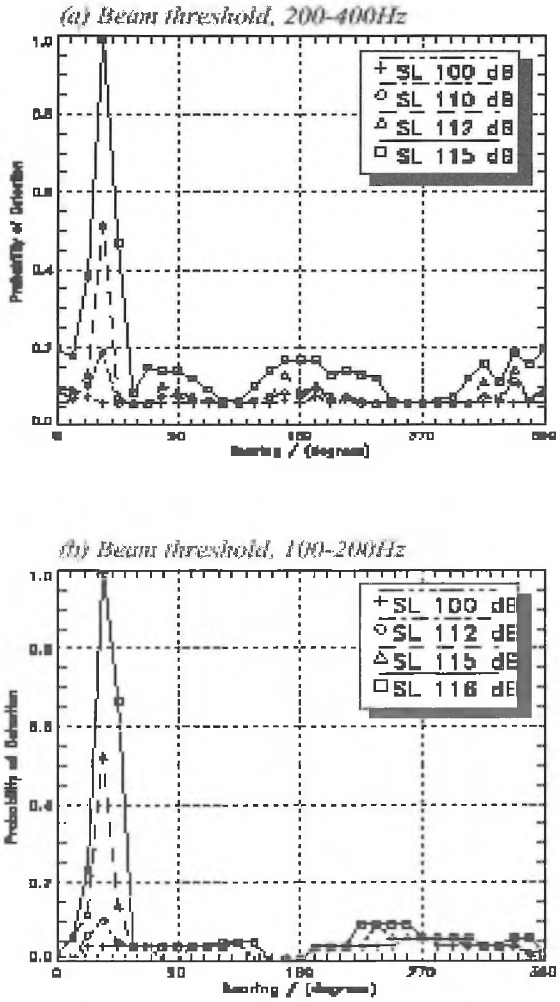

Figure 15 Probability of detection in 16 channels of the ULRICA array in the bands (a) 200-400 Hz and (b) 100-200Hz for source at bearing of 35^0, range 4.27 km, FAR 5%

BB2 transmission was not subtracted from the signal data, as was the case in the Octopus array analysis. This reduced the signal level by approximately 1 dB in the Octopus array analysis. The net effect of these differences is negligible.

Figure 15 shows the probability of detection in 16 channels of the ULRICA array for a source at range 4.27 km injected at a bearing of 35 degrees. The false alarm rate was 5%. In the band 200-400 Hz, a probability of detection of 0.5 is obtained for a source level of 112 dB. This is very close to the results from the Octopus array, where a source level of between 112 and 113 dB gave the same probability of detection at this range. However, the probability of detection in beams that do not contain the signal is between 0.05 and 0.2. This is because data from the ULRICA array contained biological noise in the band 200-400 Hz (figure 12). Note that in the ULRICA array analysis, an estimate of the noise during the BB2 transmission was not subtracted from the signal data. Consequently, the probability of detection is observed to increase as the source level increases in beams that do not contain the signal. Lower levels of biological noise were present in the band 100-200 Hz. The probability of detection is close to 5% in beams that do not contain the signal in the band 100-200 Hz. Higher source levels are required to achieve the same probability of detection in the band 100-20 0Hz than in the band 200-400 Hz.

The signal was then injected into each beam in turn and the probability of detection calculated as a function of source level. Figure 16 shows the probability of detection at a range of 4.27 km in 16 channels of the ULRICA array versus bearing and source level. The false alarm rate was 5%. The probability of detection is dependent on bearing and source level. A probability of detection of 0.5 is obtained for source levels in the range 111 to 114 dB. A probability of detection of 0.95 is obtained for source levels in the range 112 to 116 dB. The variation in source level with bearing required to achieve a given probability of detection is typically 3 to 4 dB for PD greater than 0.2. As might be expected, this is similar to the variation in threshold level with bearing. Higher source levels are required to achieve the same probability of detection in directions that have higher noise levels. For probabilities of detection lower than 0.2, the variation in source level with bearing is greater. This is due to false detections resulting from biological noise in the signal data.

Figure 17 shows the detection performance of 16 channels in the ULRICA array at the same range of 4.27 km but for threshold levels that are independent of bearing. In this case

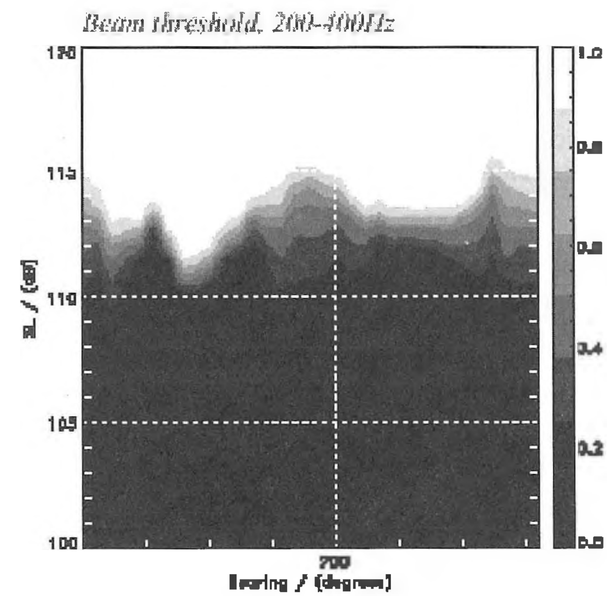

Figure 16 Probability of detection for different source levels at range 4.27 km in 16 channels of ULRICA array in the band 200-400 Hz using beam threshold levels

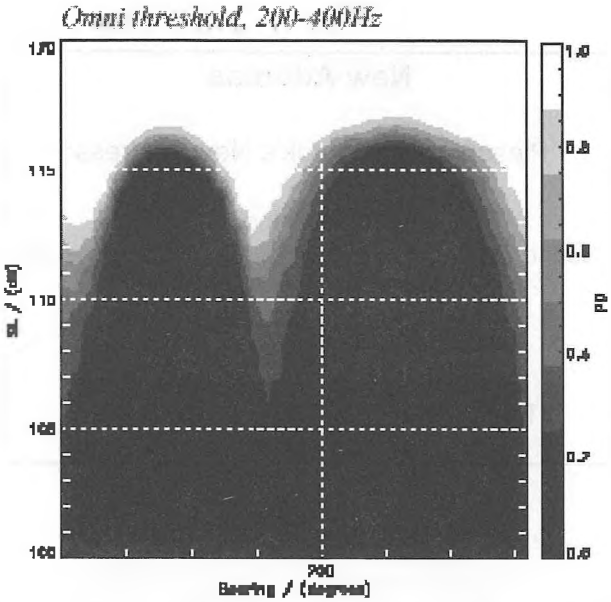

Figure 17 Probability of detection for different source levels at range 4.27 km in 16 channels of ULRICA array in the band 200-400 Hz using omni threshold levels

the distribution of the noise data was obtained using data from all the beams. A single threshold level was applied to all the beams corresponding to a probability of false alarm of 5%. The source level now varies with bearing in an opposite sense to the noise response of the array. The graph suggests that to achieve the same probability of detection, lower source levels are required in directions that contain higher noise levels (for example at bearings of 0 and 160 deg). This is clearly not the case and is because the threshold level was calculated from data from all the beams. Consequently, beams with high noise levels result in false detections when the noise levels exceed the threshold level. Conversely, beams with low noise apparently require higher source levels to achieve the same probability of detection.

When the entire aperture of the ULRICA array is employed, comprising 32 hydrophone elements, the source levels are reduced by 3 dB (results not shown).

CONCLUSIONS

This paper has compared the broadband detection performance of 2 different bottomed array geometries: that of the Octopus (compact planar) and ULRICA (line) arrays at the RDS-2 site. A section of noise data was used to set individual threshold levels in each beam. An experiment employing a submerged sound source provided signal data, which were injected into noise data from different beams at a range of source levels. The detection performance of the arrays was evaluated in the band 200 to 400 Hz.

The responses of both the Octopus and ULRICA arrays to the noise were dependent on bearing. The variation in array response to noise with azimuth was up to 5 dB in the band 200-400 Hz. Much higher variations in ambient noise directionality are expected in littoral or shallow water sites close to shipping lanes or to ports. If a single threshold is set for all the beams based on the total noise distribution, beams that contain high noise levels result in false detections when the noise exceeds the threshold. Increasing the threshold so that an acceptable false alarm rate is obtained in all the beams then results in lower probabilities of detection in beams that contain lower noise levels. The results have demonstrated the importance of setting thresholds in each beam for anisotropic noise distributions.

The dependence of threshold on bearing was significantly different in the Octopus and ULRICA arrays. This is principally due to a difference in beampattern between arrays. The beampattern of the Octopus array is almost independent of steer direction because the array is planar. However, the beampattern of the ULRICA array is dependent on steer direction due to its linear configuration.

The results indicate that the detection performance of 16 element ULRICA and Octopus arrays is very similar. Experimental data were examined in the band 200 to 400 Hz at the RDS-2 site for a false alarm rate of 5%. At a range of 4.27 km a source level of typically between 112 and 113 dB is required to achieve a probability of detection of 0.5 in both systems.

Increasing the aperture (and number of elements) of the array reduces the source level required to achieve a given probability of detection. For a 32-element ULRICA array, the source levels are reduced by 3 dB compared to a 16-element array. Similarly, it is expected that a larger Octopus array than that tested during RDS-2, comprising 32 elements, would obtain a similar increase in performance.

The results have shown that to achieve the same probability of detection as the range increases from 4.27 to 9.0 km requires an increase of 10 to 11dB in the source level. This is thought to be due to the high transmission loss at the RDS-2 site.

REFERENCES

F Desharnais and G Heard, TTCP Trial RDS-2: Rapidly Deployable Systems Non-acoustic data, DREA TM 1999/069 (May 1999).

N. Goddard et al., UK report on TTCP collaborative trial RDS-2 in the Timor Sea, DERA/S&P/UWS/TR990046 (Feb 1999).

ACKNOWLEDGEMENTS

The United States work was sponsored by ONR, Dr. Don Davison, code 321. The United Kingdom work was supported by the Defense Evaluation and Research Agency and is published with the permission of the Controller of Her Britannic Majesty's Stationery Office. We are deeply indebted to the Australian government for the hosting of the experiments and their many contributions including the planning and the coordinating of the execution, the contribution of the *Southern Surveyer* and the dedicated work of the chief scientist Mr. Ian Cox. We acknowledge the contribution from the New Zealand government for the *Manawanui* and their crew. Finally, the captain and crew of the *Pacific Conquest* were extremely helpful, and put effort into the execution well beyond what could possibly have been expected. That vessel and her crew proved to be near ideal for the operations required.

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A LOOK AT THROAT SINGING

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1. INTRODUCTION

Throat singing is a peculiar vocal art that allows a singer to sing simultaneously with two, three and even four voices. It is also known as overtone singing, biphonal singing and harmonic singing.

The source of speech or singing are the vocal cords (or vocal folds) located in the trachea. They are set to vibration by periodically closing the passage of the air exhaled from the lungs. The frequency of this interruption, which gives the fundamental frequency of the sound, can be as low as 70 Hz. Its energy is relatively low, reason for not being perceived in normal speech or singing. Another characteristic of the sound so generated is that it is far from being sinusoidal and contains many harmonics.

Once generated, the sound waves travel through the vocal tract. There, the different harmonics contained in the original sound, are amplified by the resonant activity of the various cavities found along the tract. Those harmonics, known as formants, are the result of the transformation of the buzz emitted by the vocal folds into something much closer to speech or singing. The transformation of the sound does not end with the action of the vocal tract. Once the sound waves exit the tract, there is the external filtering, due to the radiation characteristic of the head as well as to the impedance mismatch between the acoustical fields inside and outside the mouth cavity.

In normal speech and singing the false vocal cords (false folds) are not used at all for generating sound waves. In throat singing, unlike in normal singing, the vocal cords are still the main sound generator. However, there are many other flexible structures inside the tract that can be set to vibration. They are: the false cords (paired tissues located directly above the true cords), the arytenoids cartilages (which sit in the rear of the throat and help control phonation), the aryepiglottic folds (tissues between the arytenoids and the epiglottis) and the epiglottic root (the lower part of the epiglottis). All of them can be set into vibration, resulting in the various types of throat singing.

There are three basic styles of throat singing:

a) Khoomei
b) Kargyraa, and
c) Sygyt

Each style is also divided into various sub-styles.

Throat singing is practiced by nomadic tribes of South Siberia, located basically in the tiny republic of Tuva (that now is a part of the Russian Federation), Western Mongolia, Tibet, Sardinia and Bahrain. Tibetian monks throat sing as expression of faith. However, in Tuva, people sing about their everyday life and special times in their past. Some popular topics are horses, the countryside and their families.

The York University Overtone Throat Singing choir, called "Sound Shatter" is probably the only throat singing institution in Canada. Besides replicating Tuvian Throat singing, they sing "normal" vocal music. Also, they try to develop extended vocal range and unique and idiosyncratic timbers.

Many studies have dealt with the subject of throat singing (see references). In our case, one of the authors (MK) is a throat singer. That gave us the opportunity to perform a limited study, using "real" samples of this particular style of singing.

Our original intention was to perform a multidisciplinary study, involving acoustical as well as laryngoscope analysis. The acoustical part of the study was performed at the IBBME and reported here, while Dr Annie Ramos Pizarro was to perform the laryngoscopy at the St Michael's Hospital, Toronto. Unfortunately, because of Dr Ramos moving to the USA, the laryngoscope aspect of the study was initiated, but not finished at this time.

2. MATERIAL

Samples of singing were taken from:

a) Two "normal" singing male subjects, D (age 31) and A (age 69). Each sample consisted of a steady sound of some 15 or so seconds duration, keeping constant the loudness and the pitch. Those samples were used for comparison with samples from throat singing. Only one sample was collected from each of the "normal singing" subjects.

b) One male subject, (age 30) performing three types of throat singing: Kargyraa - Mountain, Kargyraa - Steppe ("Mountain" and "Steppe" in this paper) and Sygyt. Three samples were taken from each type of singing, to examine variations among the same type of singing. For this purpose, the singer was instructed to try to repeat each sample exactly in the same way.

Subjects were requested to emit the sound signal and to keep it steady for some 15 seconds. This duration is necessary for the processing of the signal by the analyzer.

3. INSTRUMENTATION

Signals were collected using an ATF - Artificial Test Fixture (1), one of whose auditory canals was equipped with a Zwislocki type DB100 coupler and a B&K type 4134 microphone thus simulating the acoustic impedance of a human ear. The singers and the ATF were located in a double (two rooms), double walled audiometric room type IAC No 109277. The output from the ATF was analyzed in 1/3 octaves bands, using a B&K Dual Channel Real Time Frequency Analyzer Type 2144.

The measuring system was not calibrated, since we were only interested in the relative values of the sound levels at the different frequencies. Because all measurements were conducted within a period of a couple of hours, it was assumed that the characteristics of the system did not change.. Therefore, differences between samples are accepted as intrinsic and not due to variations in the components of the measuring system.

4. MEASUREMENT RESULTS AND OBSERVATIONS

4.1 Two "normal "singing males.

Figure 1 shows the spectra of the two "normal" singing subjects A and D. With the exception of the interval 100 - 200 Hz, it can be seen that the general shape of both spectra is similar. It follows a pattern typical for male voices, with most of the energy contained in the interval 400 – 2000 Hz.

It should be noted that the first important harmonic of the singer A has a frequency of 125Hz, while that of singer D is one octave higher, at 250 Hz. The fundamental frequency of both singers, that is close to 63 Hz is not noticeable in any of the two spectra.

4.2 Throat singing

Figure 2, shows the spectra obtained from the three samples of the Mountain style. It can be observed that the peaks and valleys in the three spectra are located at the same frequencies. Some large differences between sound levels at the same frequency can also be observed. This can be expected, since no specific precautions were taken to keep the loudness and the pitch constant during the session.

The spectra in Figure 2 show three distinct peaks at 63.5, 125 and 200 Hz. The first corresponds to the fundamental frequency, resulting from the vibration of the vocal cords. As mentioned above, in general it does not contain much energy and is not detected in normal singing. While the second peak is a harmonic of the first, the third peak is not, suggesting that it is due to independent vibrations of structures other than the vocal cords.

The spectra of the Mountain samples show a pattern that resembles the most to the "normal" singing pattern as opposed to the other throat singing types. This is better illustrated by comparing the spectra in Figure 3A and Figure 3B where the averages of the two male samples and this of the three Mountain samples are shown. It can be seen that in both averages most of the energy is concentrated in the 500 – 1600 Hz region. However, on the "normal" singing side, there are

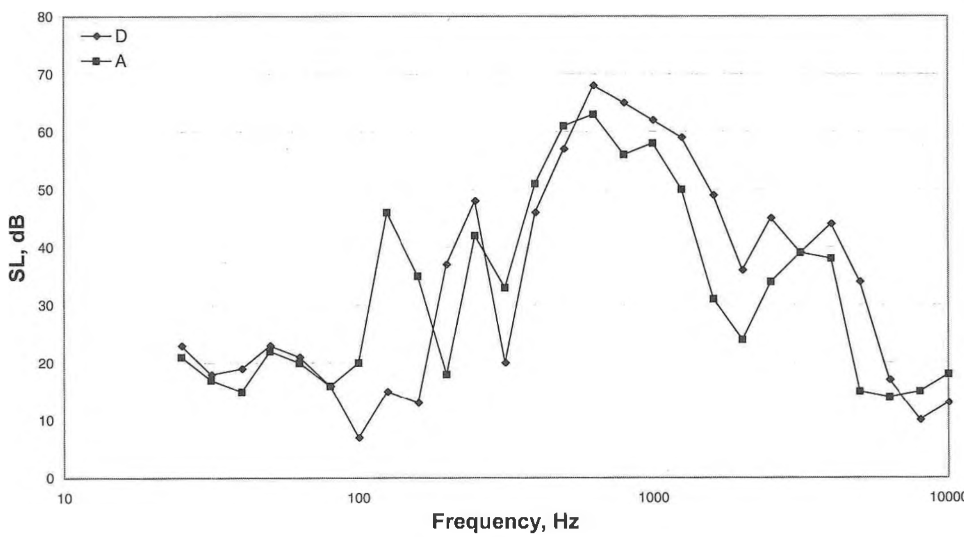

Figure 1. Samples 'A' and 'D'.

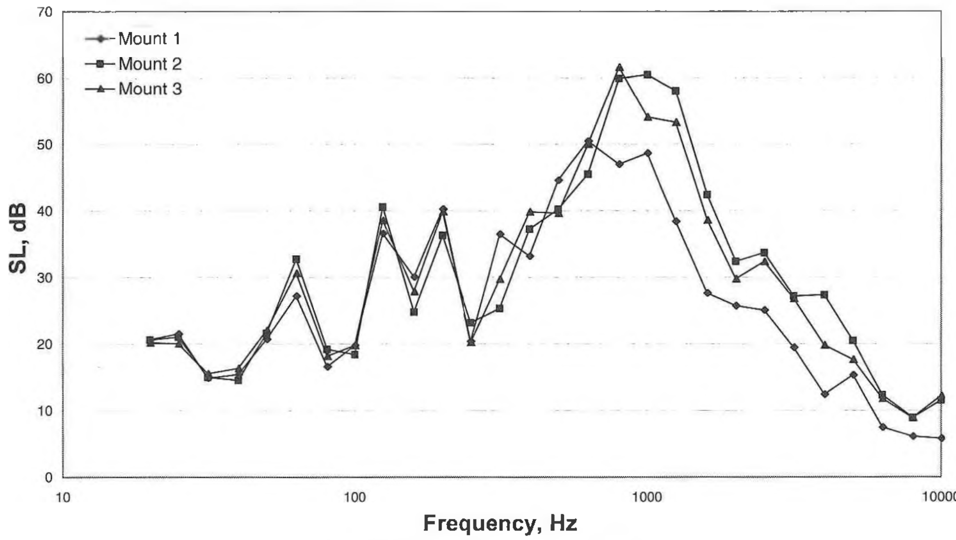

Figure 2. Three MOUNTAIN Samples.

only two peaks that are harmonically related: at 125 and 250 Hz.

The three Steppe style samples are shown in Figure 4. Again, it can be observed that individual peaks are located at the same frequencies, thus allowing for the use of their average, shown in Figure 5. The pattern here is quite distinct: there are peaks at 63.5, 125, 200, 315 and 400 (those two not clearly distinguished), and 1250 Hz. It is interesting to observe that, except for the 63.5 Hz peak, the other four peaks have similar sound levels. There is no significant energy contribution at frequencies higher than 2 kHz.

The three Sygyt type samples, shown in Figure 6, exhibit similar locations of their peaks and valleys. Figure 7 shows the average of the three samples. Here the pecks are located at 250, 500 and 2000 Hz, with most of the energy located between 200 and 3150 Hz, with no significant contributions outside those frequencies. It is interesting to observe a valley at 100 Hz, showing a resonant absorption.

All nine (9) throat-singing samples were obtained from the same subject. Therefore, any conclusion should be taken with caution.

BIBLIOGRAPHY

Kunov, H. and Giguere, C. An acoustic head simulator for hearing protector evaluation. J.Acoust. Soc. Am. 85 (3), March 1989

Levin TC. and Edgerton ME. The Throat Singers of Tuva. Sci. Am. 1999 Sep; 281(3): 80-7. PMID: 10467751; UI: 99397082.

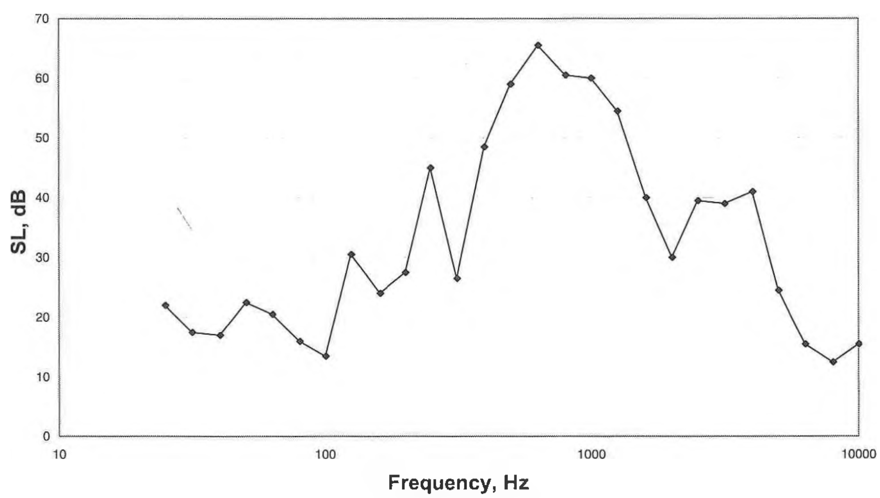

Figure 3A. Average of MALE Samples.

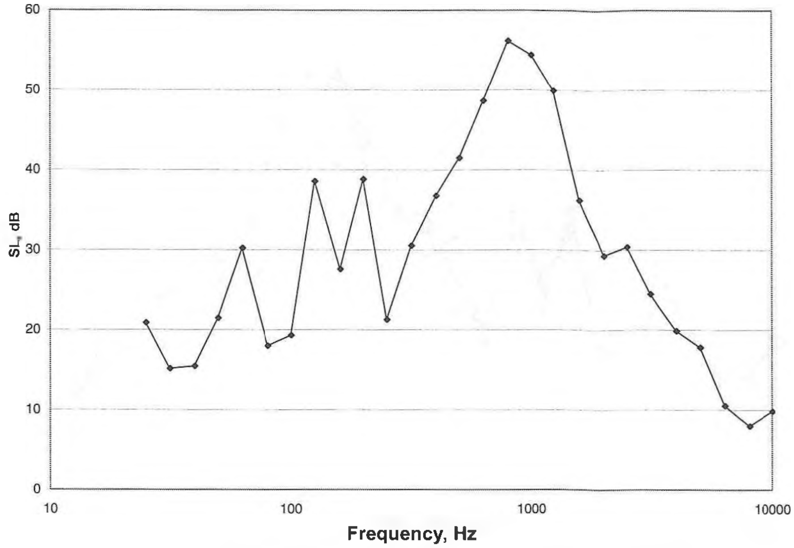

Figure 3B. Average of MOUNTAIN Samples.

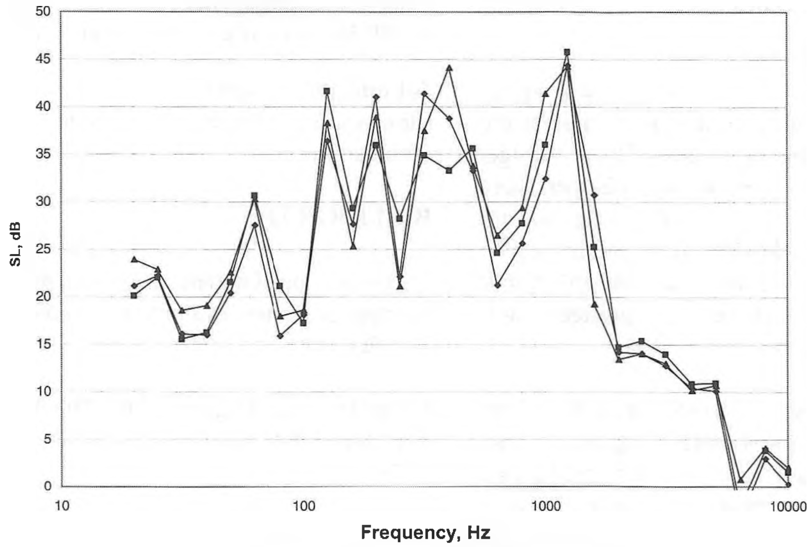

Figure 4. Three STEPPE Samples.

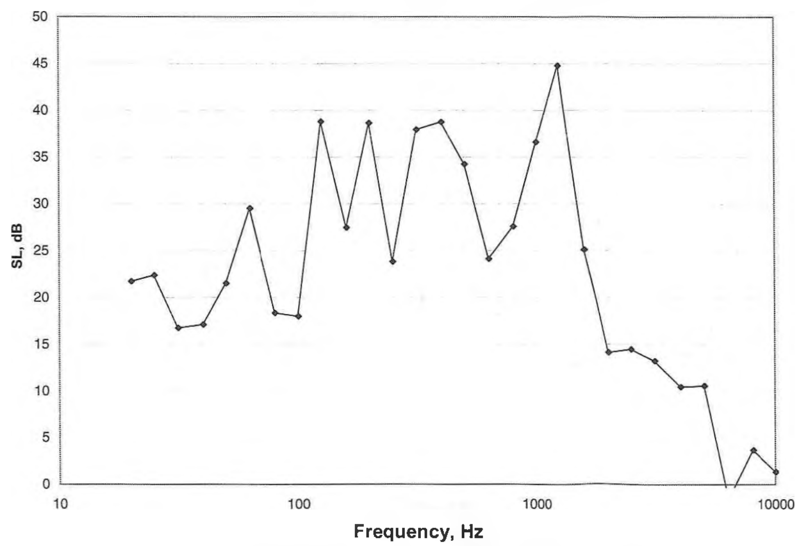

Figure 5. Average of STEPPE Samples.

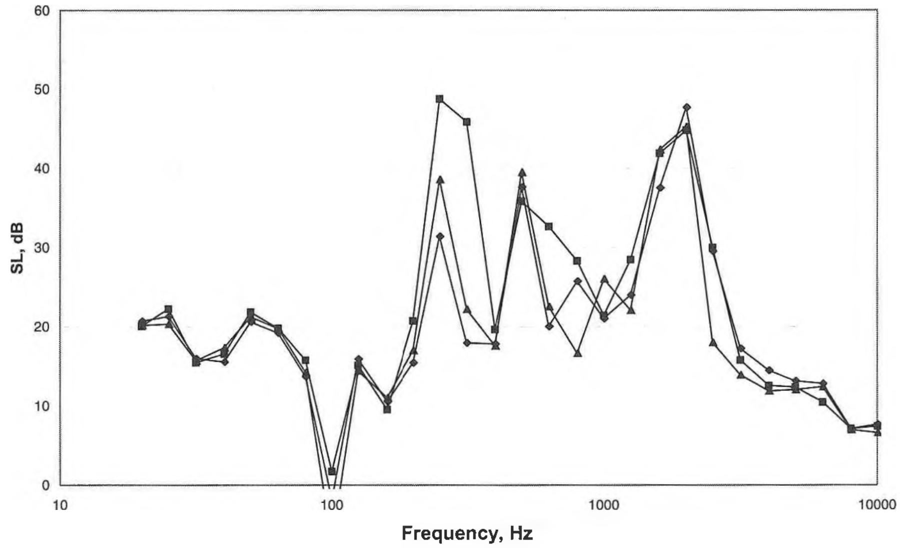

Figure 6. Three SYGYT Samples.

REFERENCES

a) On the Internet:

Levin TC. and Edgerton ME. The Throat Singers of Tuva: www.sciam.com/1999/0999issue/0999 levinbox1.html

Sami Jansson. A miraculous method of singing. http://www.jyu.fi/~sjansson/throat.htm

The Throat Singing Society. What is throat singing: http://www.mmjp.or.jp/booxbox/nodo/what/towa.html

b) Publications

Klingholtz F. Overtone singing: productive mechanism and acoustic data. J Voice.1993 Jun; 7(2): 118-22. PMID: 8353624; UI: 93358080

Bloothoof G., Bringmann E, van Cappellen M. van Liupen J.B., Thomassen K.P. Acoustics and perception of overtone singing. J Acoust Soc Am. 1992 Oct; 92 (4 Pt 1): 1827-36. . PMID: 1401528; UI: 93017421.

Dmitriev L.B., Chernov.B.P., Maslov V.T. Functioning of the voice mechanism in double-voice Touvinian singing. Folia Phoniatr (Basel) 1983: 193-7. PMID: 6654270; UI: 84086218.

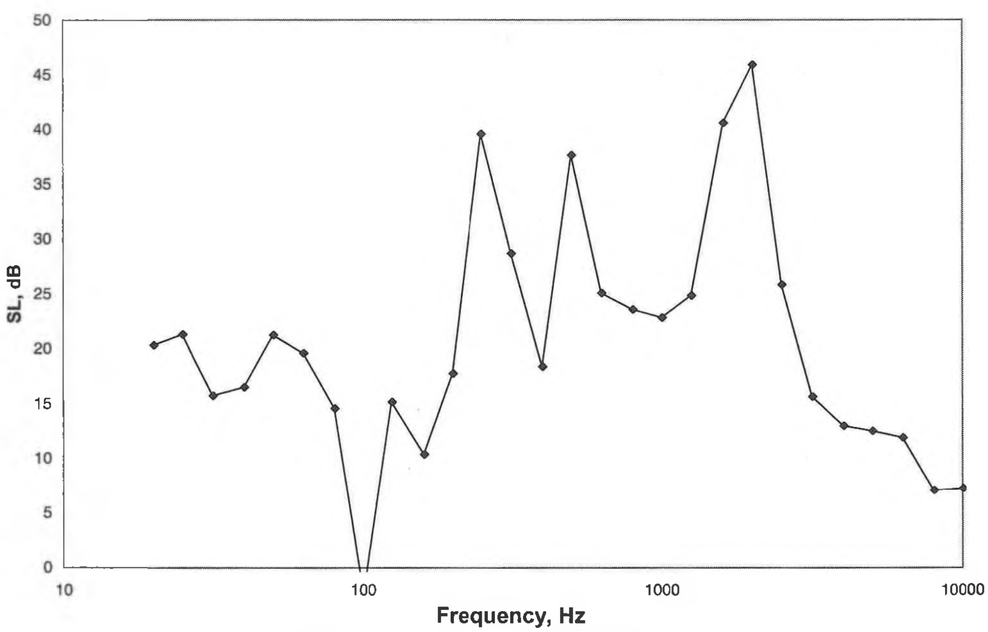

Figure 7. Average of SYGYT Samples.

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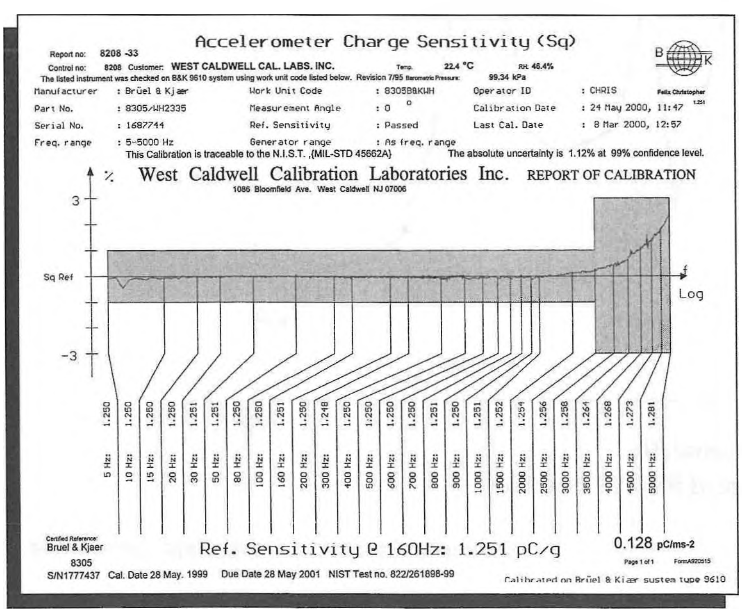
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Control no: 8208 Customer: WEST CALDWELL CAL. LABS. INC. Temp. 22.4 °C RH 46.4%
The listed instrument was checked on B&K 9610 system using work unit code listed below. Revision 7/95 Barometric Pressure: 99.34 kPa

Manufacturer	: Brüel & Kjær	Work Unit Code	: 8305BBKWH	Operator ID	: CHRIS
Part No.	: 8305/WH2335	Measurement Angle	: 0 °	Calibration Date	: 24 May 2000, 11:47
Serial No.	: 1687744	Ref. Sensitivity	: Passed	Last Cal. Date	: 8 Mar 2000, 12:57
Freq. range	: 5-5000 Hz	Generator range	: As freq. range		

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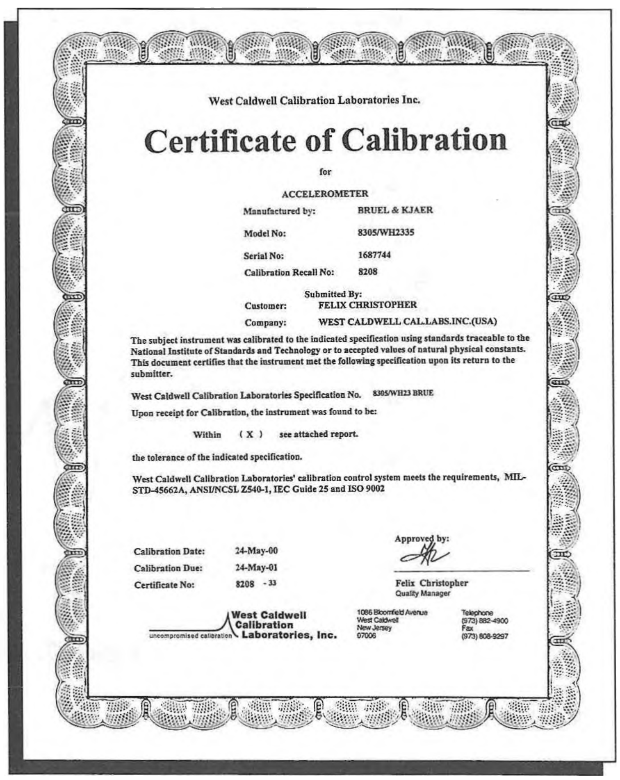
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The Noise Manual. Fifth Edition. Editors: E.H.Berger, L.H.Royster, J.D.Royster, D.P.Driscoll and M.Layne. AIHA Press, Fairfax, VA; 2000 xxii+796pp. ISBN:0-932628-02-9 USD 59.00 (members) and 74.00 (non-members).

The first impression one gets from looking at this book is its thickness: the 800+ pages make for a full 5 cm (2") is more appropriate for an encyclopaedia instead of a manual. This is the fifth edition of the Industrial Noise Manual that appeared in 1958. The second edition came out in 1966, then there was a third edition in 1975 and a fourth edition in 1988, each one thicker than the previous one, containing more information. The last edition (under the title of Noise & Hearing Conservation Manual) had 592 pages, divided into 13 chapters. There were four editors and 12 authors.

The present book (A sample of one chapter can be seen by visiting the following URL: www.aiha.org/pubs/noise.pdf) has changed the name to the more ambitious "Noise Manual". The reason for the change of the title as well its objectives and the intended readers are stated in the Preface. It explains that the new book includes new material and expands existing topics so that the result can be used as a reference handbook. However, when examined, this reviewer did not find the content to be more oriented toward "noise" than the previous editions. Even though there is more information and some new, not previously included issues are dealt with now, its main thrust is still (as it should be if intended for Occupational Hygienists) in the area of hearing conservation. In that respect, the reader can find the title misleading.

The book is a massive work done by 16 authors, and five editors, many of them well known by the hearing conservation community because of their publications and professional activities. Their experience is drawn from the academia as well as from consulting, manufacturing and governmental institutions.

The book starts with a comprehensive section of Symbols and Abbreviations that helps the reader when faced with an unknown symbol or wanting to know a unit. Four appendices at the end of the book, complement the information given within the book.

The Manual is divided into four Sections. The first section (150 pages), Fundamentals of Sound, Vibration and Hearing, comprises five chapters. The first of them, Objectives of Noise Control and Hearing Conservation, could have very well been used as the introduction or overview of the whole book, since it deals with this capital issue and goes well beyond the title of the chapter. The next two chapters deal with physics of noise and vibration and with sound measurements. Following are two chapters, originally written by the late D.Ward and now edited and slightly enlarged by J.D.Royster and L.H.Royster that deal with hearing and effects of noise on hearing.

The second section deals with Elements of a Hearing Conservation Program. It is the longest (400 pages) and probably the most important part of the book.

The first chapter, Program Overview and Administration, explains how a program should be prepared and implemented. The second, Noise Survey and Data Analysis, explains thoroughly all issues involved in a noise survey, starting from the political considerations in dealing with management and labour, down to how to write the final report. It even examines the way a group noise exposure survey has to be conducted, including the statistical calculations involved. At times a little too technical, this chapter is worth studying in depth. The next chapter deals with education and motivation, an issue essential for any hearing conservation program.

It is always difficult to deal with Noise control engineering (forth chapter) in 90 or so pages, without previous knowledge of some math and physics. In the present case, the author has provided a mix of basic noise control principles, plus some practical calculations and examples, that are relatively easy to follow. Hearing conservation practitioners wisely avoid getting into this type of control by themselves and look for help from noise control experts. Therefore, there was no need for more details for the readers of this Manual.

Hearing protector devices, the subject of the next chapter, are by now the most used control of occupational noise. Although we all agree that engineering noise control is the most effective one, there are many reasons for the HPDs to be as important as they are. Therefore, the 80 or so pages dealing with them are all well spent. In a quite comprehensive manner, the author reviews the existing hearing protection devices, before getting into the more practical issues of fitting and issuing them. Next are a couple of sections on measuring the attenuation and what to do with the results. A section examines the new types of protectors, including the active (or electronic) devices. The chapter ends with a section dealing with standards and recommendations.

Audiometric monitoring, the next chapter, provides a wealth of information useful to the practitioner. It contains details on implementing an audiometric program, including information regarding personnel and instrumentation. Then it examines the issue of the audiogram itself and its validity, to end up with the phases of follow-up and record keeping. A bonus in the chapter is the use of the audiometry as a tool for evaluating the effectiveness of a hearing conservation program.

Section III, "Noise Interference and Annoyance," deals, in a tangential way, with aspects that may be of interest for the occupational hygiene professional. The first chapter examines room noise criteria, something more in line with office noise, while the second, Speech Communication and Signal Detection in Noise, deals with speech interference and masking. The final chapter, Community Noise, examines basic concepts, measurements (including choice of instruments) and use of the results for a proper assessment.

The final section, Regulations, Standards and Laws, is divided into three chapters. The first of the three deals precisely with those issues, including damage-risk criteria, US federal regulations and international (ISO) standards. It also includes information regarding enforcement and compliance and the Americans with Disabilities Act (ADA). The second chapter deals with the ANSI S3.44 standard that is a tool for the prediction of the hearing threshold level resulting from age and exposure to noise (equivalent to the ISO 1999 standard).

The final chapter of the book, entitled "Workers' Compensation" explains the basis for a claim as well as the procedure for handling a claim.

In summary, this is an excellent reference book, that is a real bargain for its price. It contains much more than the hearing conservation professional needs to know and therefore may not be easy to be used as a manual. However, it does contains a wealth of valuable information for whoever is interested in getting beyond the mere solving of problems. This reviewer is confident that The Noise Manual will find an important place on the bookshelf of anyone dealing with occupational hearing conservation.

Alberto Behar
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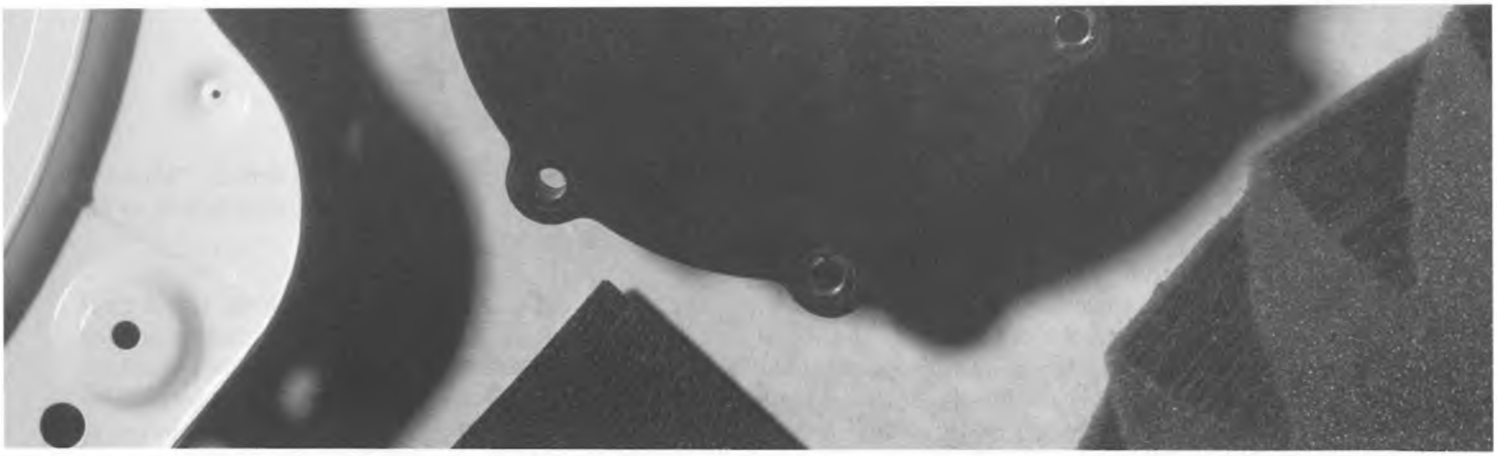
e-mail: albehar@orbonline.net



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It is well known that noise is emitted from vibrating structures or substrates. The amount of noise can be drastically reduced by the application of a layer of a vibration damping compound to the surface. The damping compound causes the vibrational energy to be converted into heat energy. Blachford's superior damping material is called ANTIVIBE and is available in either a liquid or a sheet form.

Antivibe® DL is a liquid damping material that can be applied with conventional spray equipment or troweled for smaller or thicker applications.

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Antivibe DS is an effective form of damping material provided in sheet form with a pressure sensitive adhesive for direct application to your product.

Sound Barriers

Sound barriers are uniquely designed for insulating and blocking airborne noise. The reduction in the transmission of sound (transmission loss or "TL") is accomplished by the use of a material possessing such characteristics as high mass, limpness, and impermeability to air flow. Sound barrier can be a very effective and economical method of noise reduction.

Barymat® is a sound barrier that is limp, has high specific gravity, and comes in plastic sheets or die cut parts. It can be layered with other materials such as acoustical foam, protective and decorative facings or pressure sensitive adhesives to achieve the desired TL for individual applications.

Sound Absorbers

Blachford's **Conasorb®** materials provide a maximum reduction of airborne noise through absorption in the frequency ranges associated with most products that produce objectionable noise. Examples: Engine compartments, computer and printer casings, construction, forestry and agriculture equipment, buses and locomotives.

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Working with data supplied by you, H.L. Blachford Ltd. will recommend treatment methods which may include specific material proposals, design ideas, or modifications to components.

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NEWS / INFORMATIONS

CONFERENCES

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

2001

22-25 March: "New Frontiers in the Amelioration of Hearing Loss," St. Louis, MO. Contact: Sarah Uffman, CID Department of Research, 4560 Clayton Ave., St. Louis, MO 63110; Tel.: 314-977-0278; Fax: 314-977-0030; E-mail: suffman@cid.wustl.edu

26-29 March: German Acoustical Society Meeting (DAGA 2001), Hamburg-Harburg, Germany. E-mail: dega@aku.physik.uni-oldenburg.de

9-11 April: Acoustical Oceanography, Southampton, UK. Fax: +44 1727 850553; Web: www.ioa.org.uk

23-25 April: 1st International Workshop on Thermoacoustics, s'Hertogenbosch, The Netherlands. Contact: C. Schmid, Acoustical Society of America, Suite 1NO1, 2 Huntington Quadrangle, Melville, NY 11747-4502, USA; Web: www.phys.tue.nl/index.html

30 April-3 May: 2001 Society of Automotive Engineers (SAE) Noise & Vibration Conference and Exposition, Traverse City, MI. Contact: Patti Kreh, SAE Int'l., 755 W. Big Beaver Rd., Suite 1600, Troy, MI 48084; Tel.: 248-273-2474; Fax: 248-273-2494; Email: pkreh@sae.org

21-25 May: 5th International Conference on Theoretical and Computational Acoustics (ICTCA2001), Beijing, China. Contact: E. C. Shang, CIRES, University of Colorado, NOAA/ETL, Boulder, Colorado, USA; Fax: +1 303 497 3577; Web: www.etl.noaa.gov/ictca01

28-31 May: 3rd EAA International Symposium on Hydroacoustics, Jurata, Poland. Contact: G. Grelowska, Polish Naval Academy, Smidowkcza 69, 81-103 Gdynia, Poland; Fax: +48 58 625 4846; Web: www.amw.gdynia.pl/pta/sha2001.html

4-8 June: 141st Meeting of the Acoustical Society of America, Chicago, IL. Contact: Acoustical Society of America, Suite 1NO1, 2 Huntington Quadrangle, Melville, NY 11747-4502; Tel: 516-576-2360; Fax: 516-576-2377; Email: asa@aip.org; Web: asa.aip.org

2-5 July: Ultrasonics International Conference (UI01), Delft, The Netherlands. Contact: W. Sachse, T&AM, 212 Kimball Hall, Cornell University, Ithaca, NY 14853-1503, USA; Fax: +1 607 255 9179; Web: www.ccmr.cornell.edu/~ui01/

2-6 July: 8th International Congress on Sound and Vibration, Kowloon, Hong Kong. Fax: +852 2365 4703; Web: www.iiav.org

CONFÉRENCES

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

2001

22-25 mars: "Nouvelles frontières dans l'amélioration de la perte d'audition," St. Louis, MO. Info: Sarah Uffman, CID Department of Research, 4560 Clayton Ave., St. Louis, MO 63110; Tél.: 314-977-0278; Fax: 314-977-0030; Courriel: suffman@cid.wustl.edu

26-29 mars: Rencontre de la Société allemande d'acoustique (DAGA 2001), Hamburg-Harburg, Allemagne. Courriel: dega@aku.physik.uni-oldenburg.de

9-11 avril: Océanographie acoustique, Southampton, Royaume-Uni. Fax: +44 1727 850553; Web: www.ioa.org.uk

23-25 avril: 1er atelier international sur la thermo-acoustique, s'Hertogenbosch, Pays-Bas. Info: C. Schmid, Acoustical Society of America, Suite 1NO1, 2 Huntington Quadrangle, Melville, NY 11747-4502, USA; Web: www.phys.tue.nl/index.html

30 avril-3 mai: Conférence et exposition 2001 de la Société des Ingénieurs d'autos (SAE) sur le bruit et les vibrations, Traverse City, MI. Info: Patti Kreh, SAE Int'l., 755 W. Big Beaver Rd., Suite 1600, Troy, MI 48084; Tél.: 248-273-2474; Fax: 248-273-2494; Courriel: pkreh@sae.org

21-25 mai: 5e Conférence internationale sur l'acoustique théorique et de calcul (ICTCA2001), Beijing, Chine. Info: E. C. Shang, CIRES, University of Colorado, NOAA/ETL, Boulder, Colorado, USA; Fax: +1 303 497 3577; Web: www.etl.noaa.gov/ictca01

28-31 mai: 3e Symposium international EAA sur l'hydro-acoustique, Jurata, Pologne. Info: G. Grelowska, Polish Naval Academy, Smidowkcza 69, 81-103 Gdynia, Poland; Fax: +48 58 625 4846; Web: www.amw.gdynia.pl/pta/sha2001.html

4-8 juin: 141e rencontre de l'Acoustical Society of America, Chicago, IL. Info: Acoustical Society of America, Suite 1NO1, 2 Huntington Quadrangle, Melville, NY 11747-4502; Tel: 516-576-2360; Fax: 516-576-2377; Courriel: asa@aip.org; Web: asa.aip.org

2-5 juillet: Conférence internationale sur les ultrasons (UI01), Delft, Pays-Bas. Info: W. Sachse, T&AM, 212 Kimball Hall, Cornell University, Ithaca, NY 14853-1503, USA; Fax: +1 607 255 9179; Web: www.ccmr.cornell.edu/~ui01/

2-6 juillet: 8e Congrès international sur le son et les vibrations, Kowloon, Hong Kong. Fax: +852 2365 4703; Web: www.iiav.org

9-13 July: 2001 SIAM Annual Meeting, San Diego, CA. Contact: Society for Industrial and Applied Mathematics (SIAM), Tel.: 215-382-9800; Fax: 215-386-7999; Email: meetings@siam.org; Web: www.siam.org/meetings/an01/

15-19 August: ClarinetFest 2001, New Orleans, LA. Contact: Dr. Keith Koons, ICA Research Presentation Committee Chair, Music Dept., Univ. of Central Florida, P.O. Box 161354, Orlando, FL 32816-1354; Tel.: 407-823-5116; E-mail: kkoons@pegasus.cc.ucf.edu

28-30 August: Inter-Noise 2001, The Hague, The Netherlands. Email: secretary@internoise2001.tudelft.nl; Web: internoise2001.tudelft.nl

2-7 September: 17th International Congress on Acoustics (ICA), Rome, Italy. Fax: +39 6 4976 6932; Web: www.ica2001.it

10-13 September: International Symposium on Musical Acoustics (ISMA 2001), Perugia, Italy. Contact: Perugia Classico, Comune di Perugia, Via Eburnea 9, 06100 Perugia, Italy; Fax: +39 75 577 2255; Email: perugia@classico.it

7-10 October: 2001 IEEE International Ultrasonics Symposium Joint with World Congress on Ultrasonics, Atlanta, GA. Contact: W. O'Brien, Electrical and Computer Engineering, Univ. of Illinois, 405 N. Mathews, Urbana, IL 61801; Fax: 217-244-0105; WWW: www.ieee-uffc.org/2001

17-19 October: 32nd Meeting of the Spanish Acoustical Society, La Rioja, Spain. Contact: Serrano 144, Madrid 28006, Spain; Fax: +34 91 411 76 51; Web: www.ia.csic.es/sea/index.html

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

2002

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

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

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

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

9-13 juillet: Rencontre annuelle SIAM 2001, San Diego, CA. Info: Society for Industrial and Applied Mathematics (SIAM), Tél.: 215-382-9800; Fax: 215-386-7999; Courriel: meetings@siam.org; Web: www.siam.org/meetings/an01/

15-19 août: ClarinetFest 2001, Nouvelle Orléans, LA. Info: Dr. Keith Koons, ICA Research Presentation Committee Chair, Music Dept., Univ. of Central Florida, P.O. Box 161354, Orlando, FL 32816-1354; Tél.: 407-823-5116; Courriel: kkoons@pegasus.cc.ucf.edu

28-30 août: Inter-Noise 2001, La Haye, Pays-Bas. Courriel: secretary@internoise2001.tudelft.nl; Web: internoise2001 .tudelft.nl

2-7 septembre: 17e Congrès international sur l'acoustique (ICA), Rome, Italie. Fax: +39 6 4976 6932; Web: www.ica2001.it

10-13 septembre: Symposium international sur l'acoustique musicale (ISMA 2001), Perugia, Italie. Info: Perugia Classico, Comune di Perugia, Via Eburnea 9, 06100 Perugia, Italy; Fax: +39 75 577 2255; Courriel: perugia@classico.it

7-10 octobre: Symposium international IEEE 2001 sur les ultrasons, combiné au Congrès mondial sur les ultrasons, Atlanta, GA. Info: W. O'Brien, Electrical and Computer Engineering, Univ. of Illinois, 405 N. Mathews, Urbana, IL 61801; Fax: 217-244-0105; WWW: www.ieee-uffc.org/2001

17-19 octobre: 32e rencontre de la Société espagnole d'acoustique, La Rioja, Espagne. Info: Serrano 144, Madrid 28006, Spain; Fax: +34 91 411 76 51; Web: www.ia.csic.es/sea/index.html

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

2002

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

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

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

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

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

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

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

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

INCE/USA PUBLISHES NOISE-CON 2000 CD-ROM WITH FIVE PROCEEDINGS VOLUMES

The Institute of Noise Control Engineering of the USA (INCE/USA) and the Acoustical Society of America (ASA) jointly sponsored NOISE-CON 2000, the 2000 National Conference on Noise Control Engineering, which was held in Newport Beach, California on December 3-5, 2000. The conference was held in conjunction with the 140th meeting of the ASA. NOISE-CON 2000 was the seventeenth in a series of national conferences on noise control engineering that began in the USA in 1973.

The proceedings of NOISE-CON 2000 were prepared in CD-ROM format in cooperation with the American Institute of Physics. As a benefit to users, four additional conference proceedings have been included on the CD-ROM for a total of more than 500 technical papers on all aspects of noise control engineering. The CD-ROM is searchable by keywords, by paper title, and by author. All files are in Portable Document Format (PDF), and can be read with the Adobe Acrobat® reader (included in the CD-ROM) using Windows®, MAC or UNIX platforms.

The additional proceedings included on the CD-ROM are the proceedings of NOISE-CON 96, NOISE-CON 97, NOISE-CON 98, and the proceedings of the 1998 Sound Quality Symposium (SQS 98). In addition, the tables of content of all previous NOISE-CON proceedings have been included – together with ordering information. There was no NOISE-CON conference in 1999; instead, INCE/USA organized INTER-NOISE 99, the 1999 International Congress and Exposition on Noise Control Engineering and ACTIVE 99, the 1999 International Symposium on Active Control of Sound and Vibration. The proceedings of these meetings are available on a second CD-ROM.

The CD-ROMs may be ordered from Bookmasters International, Distribution Services Division, 30 Amberwood Parkway, Ashland, OH 44805, USA. Telephone (USA and Canada only): 1 800 247 6553. The fax number is 1 419 281 6883, and the e-mail address is *order@bookmaster.com*. Major credit cards are accepted.

The stock number for the CD is CD-NC00; the price is 75 U.S. dollars. Shipped postpaid by first class mail in the USA and by air mail overseas. The CD-ROM of the INTER-NOISE 99 and ACTIVE 99 proceedings is also available for the same price and the same terms. The stock number is CD-AI99. For information on the printed proceedings of these two meetings, contact INCE/USA at the following address:

George Maling, Managing Director
Institute of Noise Control Engineering of the USA, Inc.
P.O. Box 3206 Arlington Branch
Poughkeepsie, NY 12603, USA
Telephone: +1 845 462 4006; FAX: +1 845 463 0201
E-mail: hq@ince.org

WHAT'S NEW ??

Promotions
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Moves
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Degrees awarded
Distinctions
Other news

Do you have any news that you would like to share with Canadian Acoustics readers? If so, send it to:

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Autres nouvelles

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

Francine Desharnais, DREA Ocean Acoustics, P.O. Box 1012, Dartmouth NS, Email: desharnais@drea.dnd.ca

Call for Papers
Acoustics Conference in Canada 2001
Nottawasaga Inn, Alliston, Ontario
October 1, 2 and 3, 2001

Organizing Committee

The Acoustics Conference in Canada 2001 will be held at the Nottawasaga Inn located in Alliston, Ontario, which is approximately 45 minutes to an hour from the Toronto Airport. The conference will commence on Monday October 1, 2001 and end on Wednesday October 3, 2001. Members of the CAA located in the Greater Toronto Area will organize the conference sponsored by the Canadian Acoustical Association. The conference chair is Dalila Giusti of Jade Acoustics Inc. The technical chairs are Tim Kelsall of Hatch Associates and Alberto Behar.

Conference e-mail: caa2001@jadeacoustics.com
Web site: http://www.caa2001.com

Scientific and Technical Papers

The emphasis for the 2001 Conference will be to ensure that all areas of acoustics are represented. The sessions will include opening plenary lectures, invited and contributed papers, panel discussions and exhibits. In order to ensure that all areas of acoustics are represented the technical chairs are putting together a group of highly skilled and motivated individuals to act as session chairs. They can only be successful if the membership, including students, attend the conference and present papers.

The following technical areas are proposed to be included:

Industrial Noise	Building Acoustics	Vibration
Outdoor sound Propagation	Speech Perception	Occupational Hearing Loss
Hearing Protection	Acoustic Materials	Underwater Acoustics
Physiological Acoustics	Sound Quality	Legislation/Environmental Noise
Computer Applications	Canadian Standards	Instrumentation
Transportation Noise	Community Noise	Musical Acoustics

Abstracts

Abstracts of a maximum of 250 words must be submitted by June 1, 2001. The abstract should be prepared and sent in accordance with the instructions appearing in this issue of *Canadian Acoustics*. Submission by e-mail is strongly encouraged; files can be prepared in any word processing software. For those without access to e-mail, digital files on diskette or paper copy should be mailed to the address given below. Notification of acceptance of abstracts will be sent to the authors by June 20, 2001 along with a registration form. Summary papers are due by July 31, 2001. This deadline will be strictly enforced in order to meet the publication schedule of the proceedings issue of *Canadian Acoustics*.

For specific information regarding the technical topics contact:

Tim Kelsall
Hatch Associates Ltd.
2800 Speakman Dr.
Mississauga, Ontario L5K 2R7
e-mail: Tkelsall@Hatch.ca
Telephone: (905) 403-3932
Fax: (905) 855-8270

Alberto Behar, Noise Control
45 Meadowcliffe Dr.
Scarborough, Ontario
M1M 2X8
e-mail: albehar@trigger.net
Telephone/fax: (416) 265-1816

Students

Student participation at the CAA 2001 Conference is strongly encouraged. Awards are available to students whose presentations at the Conference are judged to be particularly noteworthy. To qualify students must apply by enclosing an *Annual Student Presentation Award* form with their abstract. Students presenting papers may also apply for a travel subsidy to attend the Conference if they live at least 150 km from Alliston, Ontario. To apply for this subsidy, students must submit an *Application for Student Travel Subsidy* included in this issue.

Accommodations

Accommodations and meeting space for the delegates of the 2001 Conference will be at the Nottawasaga Inn (www.NottawasagaResort.com) located just north of Toronto, Ontario. The Conference rate will be $110.00 per night. To reserve your accommodation, please contact the Inn directly at (416) 364-5068.

It is important to note that the rooms are only guaranteed for the CAA Conference up to **July 1, 2001.** After that date the rooms are subject to availability. This is extremely important because there are not many alternative accommodations in the area.

Exhibits

A permanent exhibition showcasing the latest technology in acoustics and vibration equipment, instrumentation, materials and software will be open continuously during the Conference.
Space will be available for exhibits by companies and organizations in the field of acoustics. Sponsorship of the breaks and/or lunches is also welcome. If you are interested in either of these opportunities please contact Dalila Giusti.

Important Dates

June 1, 2001 Deadline for submission of abstracts June 20, 2001 Notification of acceptance of abstracts July 1, 2001 Deadline for guaranteed rooms July 31, 2001 Deadline for receipt of summary papers & early registration October 1 to 3, 2001 Acoustics Conference in Canada 2001.

For more information contact:

Dalila Giusti, Jade Acoustics Inc.
545 North Rivermede Rd. Ste 203
Concord, Ontario L4K 4H1
e-mail: dalila@jadeacoustics.com
Telephone: (905) 660-2444; Fax: (905) 660-4110

Appel de Communications
Semaine Canadienne d'acoustique 2001
Nottawasaga Inn, Alliston, Ontario
1, 2 et 3 Octobre 2001

Comité Organisateur

La semaine canadienne d'acoustique 2001 aura lieu à l'auberge Nottawasaga à Alliston, en Ontario. Alliston se situe à une distance approximative de 45 à 60 minutes de l'aéroport de Toronto. La conférence débutera le lundi 1er octobre 2001, pour conclure le mercredi 3 octobre 2001. Les membres de l'ACA de la région de Toronto organiseront la conférence commanditée par l'Association Canadienne d'Acoustique. La présidente du congrès est Dalila Giusti de la compagnie Jade Acoustics Inc. Les conseilliers techniques sont Tim Kelsall de Hatch Associates et Alberto Behar.

Courriel pour la conférence : caa2001@jadeacoustics.com
Site internet : http://www.caa2001.com

Articles Scientifiques et Techniques

L'emphase de la conférence sera mise sur la représentation de tous les domaines en acoustique. Les séances inclueront des exposés plénières, des communications invitées et proposées, des panels de discussion ainsi qu'une exposition. De façon à assurer que tous les domaines d'acoustique soient représentés au sein de cette conférence, les conseillers techniques ont approché un groupe d'individus motivés et très expérimentés qui agiront en tant que responsables de sessions. Cependant, le succès de ce congrès dépend fortement de la participation de tous les membres, incluant les étudiants.

Les domaines techniques suivants sont proposés:

Le bruit industriel	L'acoustique des bâtiments	Vibration
La propagation du son à l'extérieur	La perception de la parole	La protection de l'ouïe
Les matériaux acoustiques	Les normes canadiennes	L'instrumentation
L'acoustique sous-marine	L'acoustique physiologique	La qualité de son
Les applications informatiques	Le bruit communautaire	L'acoustique musicale
Le bruit relié aux moyens de transport	Les pertes auditives en milieu de travail	
La législation relié au bruit environnemental		

Résumés

La date limite de soumission des résumés (maximum de 250 mots) est le 1er juin 2001. Ces abrégés doivent être préparés et soumis selon les instructions retrouvées dans l'édition courante de la revue Acoustique canadienne. Les soumissions par courriel sont fortement encouragées; les fichiers peuvent être préparés à l'aide de tout logiciel de traitement de texte. Pour les gens n'ayant pas accès au courriel, les fichiers électroniques sur disquette ou les copies sur papier peuvent être envoyés par la poste à l'adresse publiée ci-dessous. Un avis, accompagnée d'un formulaire d'inscription, sera envoyée d'ici le 20 juin 2001 aux auteurs des résumés qui auront été approuvés. Les articles de résumés devront être reçus avant le 31 juillet 2001. Afin de respecter l'horaire de publication de l'édition "compte-rendu" de la revue Acoustique canadienne,cette date limite devra être respectée.

Pour obtenir de plus amples informations au sujet des thèmes techniques,veuillez vous adresser à:

Tim Kelsall, Hatch Associates Ltd
Courriel: Tkelsall@Hatch.ca
Téléphone: (905) 403-3932
Télécopieur: (905) 855-8270

Alberto Behar, Noise Control
courriel: albehar@trigger.net
téléphone/télécopieur: (416) 265-1816

Étudiants

La participation des étudiants à la conférence de l'ACA 2001 est fortement encouragée. Des prix seront accordés aux étudiants dont la présentation à la conférence aura été jugée particulièrement emarquable. Afin d'être éligibles à ces prix, les étudiants doivent remplir le formulaire du Prix Annuel de Présentation Étudiante. Ce formulaire devrait être envoyé avec le résumé. Les étudiants qui habitent dans une région suffisamment éloignée d'Alliston (plus de 150km), et qui désirent présenter leur article à la conférence, devraient également faire application pour une subvention de voyage, afin de défrayer leurs coûts de déplacement.

Logement

Les délégués de la conférence seront logés à l'Auberge Nottawasaga (www.NottawasagaResort.com), située au nord de Toronto. Le tarif pour la conférence est de 110.00$ par nuit. Veuillez s'il-vous-plait communiquer avec l'auberge au (416) 364-5068 pour les réservations.

Il est important de noter que les chambres seront garanties aux membres de l'ACA participant à la conférence jusqu'au 1er juillet 2001. Après cette date, la disponibilité des chambres n'est pas garantie. Puisque les autres options de logement dans la région sont limitées, il est extrêmement important de faire les réservations avant cette date.

Exposants

Lors de la conférence, une exposition permanente portant sur les dernières technologies entourant l'équipement, l'instrumentation, les matériaux et les logiciels reliés aux domaines de l'acoustique et des vibrations, sera ouverte à tous. Un espace sera disponible pour les exposants provenant d'organismes et de compagnies spécialisés dans le domaine de l'acoustique. La commandite de période de pauses et/ou de collations serait également appréciée. Si l'une ou l'autre de ces suggestions vous intéresse, veuillez vous adresser à Dalila Giusti.

Dates À Retenir

Le 1er juin 2001 Date limite pour la soumission des résumés Le 20 juin Avis pour les résumés approuvés Le 1er juillet 2001 Date limite pour la réservation de chambres garanties Le 31 juillet 2001 Date limite pour la soumission des papiers résumés et l'inscription à l'avance Du 1er au 3 octobre 2001 Semaine canadienne d'Acoustique 2001

Pour de plus amples informations, veuillez communiquer avec:

Dalila Giusti,
Jade Acoustics Inc.
545 North Rivermede Rd. Ste 203, Concord, Ontario L4K 4H1
Courriel: dalila@jadeacoustics.com
Téléphone: (905) 660-2444; Télécopieur: (905) 660-4110

Acoustics Conference in Canada 2001 / Semaine Canadienne d'acoustique 2001
Nottawasaga inn, Alliston, Ontario
October 1, 2 and 3, 2001 / 1, 2 et 3 Octobre 2001

Message from the Technical Committee

The organization of the technical portion of the Conference is in full swing. Following is the list of sessions already set up and the names of the session chairmen:

SESSION	CHAIRMAN
Industrial Noise	Cameron Sherry cwsherry@aol.com
Hearing Protection in Industry	Sharon Abel Abel.Sharon@torontorehab.on.ca
Vibrations	Tony Brammer tony.brammer@nrc.ca
Architectural Acoustics	John Swallow John.swallow@attglobal.net
Speech Perception	Luc de Nil luc.denil@utoronto.ca
Hearing loss and Hearing Aids	Marshall Chasin mchasin@chass.utoronto.ca
Legislation/Environmental Noise	Chris Krajewsky KRAJEWCH@ENE.GOV.ON.CA
Transportation Noise	Soren Pederson sorenp@home.com
Product noise	Steven Bly S_Bly@hc-sc.gc.ca
Computer Applications	Noureddine Atalla noureddine.atalla@gme.usherb.ca
Perception	Robert Arabito robbie.arrabito@dciem.dnd.ca

If you are interested in organizing a session (and chairing it), we will be happy to hear from you. Please contact Alberto Behar (albehar@trigger.net) or Tim Kelsall (tkelsall@hatch.ca)

Offre d'emploi en recherche / Research Position Available

Le GAUS (Groupe d'Acoustique de l'Université de Sherbrooke), groupe de recherche internationalement reconnu en contrôle du bruit et des vibrations, est à la recherche d'un ingénieur de recherche pour participer à des projets fondamentaux ou appliqués. Exigences: diplôme d'ingénieur récent ou équivalent, avec spécialisation en acoustique et vibration. La maîtrise de l'anglais est un atout. Rémunération: selon l'expérience.

Envoyez une lettre d'application, un curriculum vitae et les coordonnées de 3 références à:
Pr. Alain Berry, Département de génie mécanique, Université de Sherbrooke, Sherbrooke (Qc) J1K 2R1 Canada. Tél: (819) 821-8000 poste 2148; Fax: (819) 821-7163; courriel: alain.berry@gme.usherb.ca: Info WWW : http://www.gaus.gme.usherb.ca.

GAUS (Groupe d'Acoustique de l'Université de Sherbrooke), an internationally recognized research center in noise and vibration control is seeking a research engineer to participate in fundamental or applied projects. Qualifications: recent engineering degree or equivalent, with a specialization in acoustics and vibration. Knowledge of French is required.
Salary: based on experience.

Send a letter of application, a resume and contact information of 3 references to:
Prof. Alain Berry, Département de génie mécanique, Université de Sherbrooke, Sherbrooke (Qc) J1K 2R1 Canada. Tél: (819) 821-8000 poste 2148; Fax: (819) 821-7163; courriel: alain.berry@gme.usherb.ca: Info WWW : http://www.gaus.gme.usherb.ca.

ECKEL

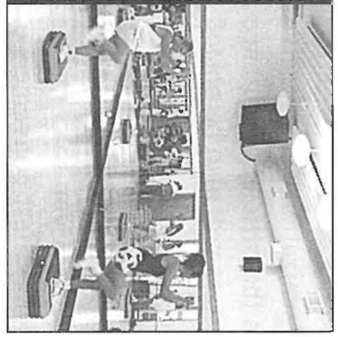
NOISE CONTROL TECHNOLOGIES

CANADIAN OFFICE

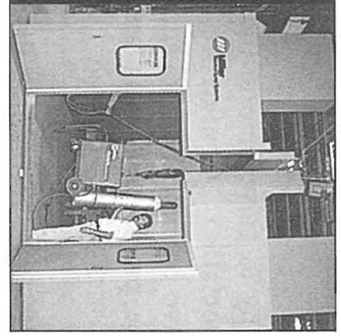
Box 776 100 Allison Avenue Morrisburg ON K0C 1X0
Tel: 613-543-2967 800-563-3574 Fax: 613-543-4173
Web site: www.eckel.ca/eckel e-mail: eckel@eckel.ca

AUTOMOTIVE TEST CHAMBER

ARCHITECTURAL ACOUSTICS

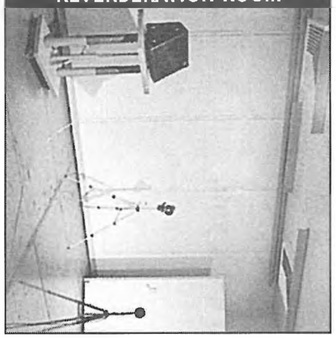


O.E.M. ENCLOSURE

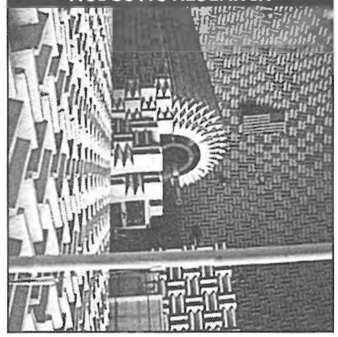


ENGINE TEST FACILITY

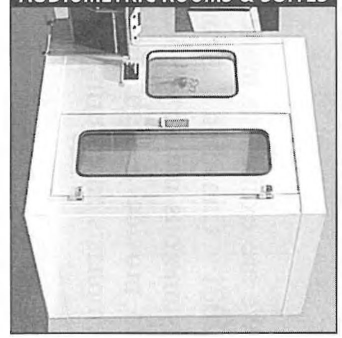
REVERBERATION ROOM



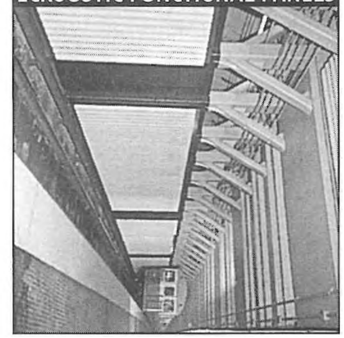
ACOUSTIC RESEARCH



AUDIOMETRIC ROOMS & SUITES



ECKOUSTIC FUNCTIONAL PANELS



SOUND SOLUTIONS FOR THE FUTURE

ECKEL

NOISE CONTROL TECHNOLOGIES

CANADIAN ACOUSTICAL ASSOCIATION
2001 Annual Conference

The CAA:
- fosters communication among people working in all areas of acoustics in Canada
- promotes the growth and practical application of knowledge in acoustics
- encourages education, research, protection of the environment, and employment in acoustics

The Conference:

Web:
- www.caa2001.com

Location:
- Nottawasaga Inn, Alliston, Ontario

Dates:
- October 1-3, 2001

Features:
- Panel discussions
- Permanent exhibition showcasing latest technologies
- Technical presentations

For more information on sponsorship opportunities and exhibits, contact David Hunt at HGC Engineering:

Phone (905) 826 4044
Fax (905) 826 4940
dhunt@hgcengineering.com

Dear Industry Colleague:

We are excited to invite your company to participate in the 2001 Canadian Acoustical Association Conference. Numerous industry representatives have organized this event to provide a high quality conference programme, with an emphasis on ensuring all areas of acoustics are represented.

With the conference this year just outside of Toronto, at the Nottawasaga Inn, we expect to have an unprecedented level of participation and interest in sponsorship opportunities.

As a sponsor of the event, your organization will receive enhanced recognition and exposure on the official conference website. A listing of conference exhibitors will also be posted on the site.

Opportunities for sponsorship are limited. Information can be found on the following pages, which we ask you to complete and return to HGC Engineering at your earliest convenience. We look forward to seeing you there!

Thank you,

Bill Gastmeier, MASc, PEng
2001 CAA Conference Committee

David Hunt
Sponsor / Exhibit Co-ordinator

The Canadian Acoustical Association

l'Association Canadienne d'Acoustique

Proposed Topics:

- Industrial Noise
- Outdoor Sound Propagation
- Hearing Protection
- Physiological Acoustics
- Computer Applications
- Transportation Noise
- Building Acoustics
- Speech Perception
- Acoustic Materials
- Sound Quality
- Canadian Standards
- Community Noise
- Vibration
- Occupational Hearing Loss
- Underwater Acoustics
- Environmental Noise & Legislation
- Instrumentation
- Musical Acoustics

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CAA Annual Conference in Canada 2001
Nottawasaga Inn, Alliston, Ontario
October 1, 2 & 3, 2001

SPONSORSHIP OPPORTUNITIES

The Conference organizing committee is offering opportunities for corporate or personal recognition by sponsoring the event and supporting the CAA.

For increased exposure, a **limited** number of sponsorship opportunities exist during conference break sessions. You will be given priority appearance on conference boards as a sponsor of the break, as well as acknowledgement on the conference website.

General event sponsors will also be listed on the conference website and receive exposure at the event.

BREAK SPONSORSHIPS (limited availability)

The 2001 Acoustics Conference offers **5** opportunities for premium break sponsorships. Sponsored coffee breaks will be held Monday and Tuesday in the morning and afternoon, and finally, on Wednesday morning.

Two options are available for sponsors:

"Classic" Break	@	**$450**
"Upscale" Break	@	**$700**

The upscale break option includes a superior selection of food and refreshments, such as danishes and pastries. These prices do not include applicable taxes. Companies interested in break sponsorships are encouraged to contact us without delay, as these are limited. (first come, first served basis)

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Fax (905) 826 4940
dhunt@hgcengineering.com

CAA 2001 CONFERENCE SPONSORS

Companies and individuals can support the CAA and gain recognition as event sponsors.

You will receive a listing on conference sponsor boards as well as acknowledgement on the official conference website.

Indicate your interest on the attached sponsor form to show your support of the national event that will attract key players in the Canadian acoustical industry.

EXHIBITOR INFORMATION*

With a large number of CAA members located near the greater Toronto Area, we expect to receive a great deal of interest from companies wishing to exhibit at the Conference.

A permanent exhibition showcasing the latest technology in acoustics and vibration equipment, instrumentation, materials and software will continuously run during the Conference.

Exhibitors will reach all attendees of the conference over the three day period, and will be listed on the Conference website. Cost for an exhibition booth is only $400, plus any power requirements and applicable taxes. Exhibit space will be allocated on a first-come / first-served basis.

Interested exhibitors will have the option to set-up on September 30th, the day before the Conference. All exhibitors should contact David Hunt of HGC Engineering for information about nominal electrical requirement fees and information.

* Actual booth set-ups, if required, are exhibitors responsibility for move-in, move-out and set-up and tear-down. Draping can be rented from an outside company if required. Please advise Nottawasaga Inn of your set-up requirements to ensure that there are no misunderstandings. Any electrical hook-up that is required for the exhibits will be subject to an additional electrical charge per booth. Please contact David Hunt for power requirements and cost. Should damage occur or cleanup of the room be required a compensating fee will be charged. Procedures regarding move-in and move-out dates for exhibitors will follow and they will include the set-up and tear-down of all exhibits with scheduled dates and times.

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2001 Annual CAA Conference

Sponsorship & Exhibitor Response Sheet

We hope to include your organization as part of this exciting event, bringing together people from across Canada who have an interest in acoustics.

Please fully complete this form and return with payment.
Confirmation and acknowledgement of sponsors and exhibitors upon receipt of payment. **Payments due by July 31, 2001.**
Sponsorship is on a first come, first served basis.
Payments are by cheque only. Make payable to the Canadian Acoustical Association. Mail CAA Conference payments c/o HGC Engineering, 2000 Argentia Rd, Plaza 1 Suite 203, Mississauga, ON L5N 1P7

Name of Company: ______________________________

Contact Person: ______________________________

Mailing Address: ______________________________

Mailing Address: ______________________________

Phone: ________________ Fax: ________________

Email: ________________ Website: ________________

Exhibition Booth ....$400 ____________

Booth Power Requirements (contact David Hunt of HGC Engineering)

Break Sponsorship (5 available):

"Classic" Break ....$450 ____________

"Upscale" Break ....$700 ____________

CAA Conference Sponsor (enter contribution amount) ____________

Subtotal: $__________

GST (7%) $__________

TOTAL $__________

ASSOCIATION CANADIENNE D'ACOUSTIQUE
Conférence annuelle, 2001

L'ACA:

- favorise la communication entre les gens qui travaillent, au Canada, dans tous les domaines de l'acoustique
- assure la promotion de la croissance et de l'application pratique des connaissances en acoustique
- encourage l'éducation, la recherche, la protection de l'environnement, ainsi que l'embauche dans le domaine de l'acoustique

La conférence:

Site internet:
- www.caa2001.com

Lieu:
- Auberge Nottawasaga à Alliston, en Ontario

Dates:
- 1er au 3 octobre, 2001

Rubriques:
- Panels de discussions
- Exposition permanente au sujet des dernières technologies
- Présentations techniques

Pour obtenir de plus amples informations au sujet des expositions, ainsi que des opportunités de commandites, veuillez contacter David Hunt à l'HGC Engineering:
Téléphone: (905) 826 4044
Télécopieur:(905) 826 4940
Courriel:
dhunt@hgcengineering.com

Chers collègues:

Ils nous fait plaisir d'inviter votre entreprise à participer à la conférence de l'Association Canadienne d'Acoustique qui aura lieu au cours de l'année 2001. Plusieurs représentants au sein de l'industrie ont organisé cet événement dans le but d'offrir un programme de haute qualité dont l'emphase porte sur la représentation de tous les domaines de l'acoustique.

La conférence ayant lieu près de Toronto, à l'auberge Nottawasaga, nous prévoyons un niveau élevé, sans précédent, de participation et d'intérêt à l'égard des opportunités de commandites.

En tant que commanditaires de cet événement, votre organisation bénéficiera d'une forte reconnaissance et visibilité sur le site internet de la conférence. Une liste des participants aux expositions y sera également publiée.

Les opportunités de commandites sont limitées. Des informations supplémentaires sont présentées dans les prochaines pages, que nous vous demandons de remplir et de retourner le plus tôt possible à l'HGC Engineering. Au plaisir de vous y voir!

Merci,

Bill Gastmeier, MASc, PEng
Comité de la conférence de l'ACA 2001

David Hunt
Commanditaire / Coordonnateur des expositions

The Canadian Acoustical Association

l'Association Canadienne d'Acoustique

Thèmes proposés:

- Le bruit industriel
- La propagation du son à l'extérieur
- La protection de l'ouïe
- L'acoustique physiologique
- Les applications informatiques
- Le bruit relié aux moyens de transport
- L'acoustique des bâtiments
- La perception de la parole
- Les matériaux acoustiques
- La qualité du son
- Les normes canadiennes
- Le bruit communautaire
- Les vibrations
- Les pertes auditives au travail
- L'acoustique sous-marine
- La législation du bruit environnemental
- L'instrumentation
- L'acoustique musicale

La conférence:

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dhunt@hgcengineering.com

Conférence annuelle de l'ACA au Canada en 2001
Auberge Nottawasaga à Alliston, en Ontario
1,2&3 octobre, 2001

OPPORTUNITES DE COMMANDITES

En parrainant cet événement et en offrant un support à l'ACA, le comité de la Conférence offre des opportunités de reconnaissance personnelle ou de corporation.

- Afin d'augmenter la qualité de reconnaissance, un nombre limité d'opportunités de commandites existe pour les pauses de la conférence. En tant que commanditaire de la pause, la priorité d'apparition sur le conseil de la conférence, ainsi qu'une reconnaissance sur le site internet vous seront accordées.

- Une liste des commanditaires d'événements généraux sera également publiée sur le site internet. Ces commanditaires seront aussi reconnus lors de la conférence.

COMMANDITAIRES DES PAUSES (disponibilité limitée)

La conférence d'Acoustiques qui aura lieu au cours de l'année 2001 offre 5 opportunités de commandites des pauses. Les pauses-café auront lieu au cours de la matinée et dans l'après-midi lundi et mardi, avec une dernière pause mercredi matin.

Deux options sont disponibles aux commanditaires:

Pause "classique"	@	**$450**
Pause "première classe"	@	**$700**

L'option "première classe" comprend une sélection supérieure de nourriture et de rafraîchissements, tels que des pâtisseries variées. Les taxes applicables ne sont pas incluses dans les prix ci-haut. Les entreprises intéressées au parrainage d'une pause sont encouragées à nous contacter dans les plus brefs délais en raison du nombre limité des pauses (les possibilités de parrainage seront accordées sur la base "premier-arrivé/premier-servi")

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l'Association Canadienne d'Acoustique

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COMMANDITAIRES DE LA CONFERENCE DE L'ACA, 2001

Les entreprises et particuliers peuvent offrir un soutien à l'ACA et être ainsi reconnus en tant que commanditaires d'événements.

Votre nom sera inscrit dans la liste des conseils de parrainage de la conférence et votre générosité sera également reconnue sur le site internet officiel de la conférence.

Veuillez nous faire part de votre intérêt sur le formulaire de parrainage ci-joint afin de démontrer votre soutien de cet événement national qui attire des personnes clé au sein de l'industrie canadienne d'acoustique.

INFORMATION CONCERNANT LES EXPOSITIONS*

Étant donné le grand nombre de membres de l'ACA oeuvrant près de la région de Toronto, nous envisageons recevoir un niveau élevé d'intérêt de la part d'entreprises désireuses de participer aux expositions de la conférence.

Une exposition permanente se déroulera tout au cours de la conférence et portera sur les dernières technologies dans le domaine de l'acoustique, ainsi que sur les vibrations, l'instrumentation, les matériaux et les logiciels.

Au cours d'une période de trois jours, les exposants auront la chance de rejoindre tous les participants de la conférence. Leurs noms seront également publiés sur la liste des exposants du site internet de la conférence. Le prix d'un espace d'exposition est de seulement $400. Ce prix n'inclut ni les taxes applicables, ni les besoins de courant électrique. Les espaces disponibles pour les expositions seront alloués sur la base du concept "premier-arrivé/premier-servi".

Les exposants intéressés auront l'option d'organiser leur espace le 30 septembre, journée précédent la conférence. Tous les exposants devraient contacter David Hunt de l'HGC Engineering pour obtenir des informations concernant les coûts associés aux besoins de courant électrique.

---

* Les exposants sont la responsables d'organiser leur propre espace d'exposition, ainsi que l'aménagement et le déménagement. Si nécessaire, des rideaux peuvent être loués auprès d'une entreprise externe. Veuillez, s'il-vous-plait, informer l'auberge Nottawasaga de vos besoins particuliers afin d'éviter les malentendus. Une charge additionnelle pour chaque espace sera facturée pour tout besoin d'arrangement électrique. Veuillez contacter David Hunt pour discuter de vos besoins de courant électrique et des prix associés. Des frais supplémentaires seront chargés afin de compenser pour tout dommage et pour défrayer les coûts associés au nettoyage, si jugé nécessaire. Des informations portant sur les procédures d'aménagement et de déménagement, ainsi que sur les dates importantes suivront.

La conférence:

Site internet:
- www.caa2001.com

Lieu:
- Auberge Nottawasaga à Alliston, en Ontario

Dates:
- 1er au 3 octobre, 2001

Rubriques:
- Panels de discussions
- Exposition permanente au sujet des dernières technologies
- Présentations techniques

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dhunt@hgcengineering.com

Conférence annuelle de l'ACA, 2001

Feuille de réponse pour les commanditaires et exposants

Nous espérons compter sur la présence de votre organisation lors de cet événement excitant qui réunit des gens de tous les coins du Canada qui démontrent un intérêt dans les domaines variés de l'acoustique.

- Veuillez compléter ce formulaire et le retourner avec le versement.
- La confirmation et reconnaissance des commanditaires et exposants s'effectueront au moment de la réception du versement. **Les versements doivent nous parvenir avant le 31 juillet 2001.**
- Les opportunités de parrainage seront allouées sur une base "premier-arrivé/premier-servi".
- **Versements par chèques seulement.** Payez à l'ordre de l'Association Canadienne d'Acoustique. Postez les versements de la conférence de l'ACA c/o HGC Engineering, 2000 Argentia Rd, Plaza 1 Suite 203, Mississauga, ON L5N 1P7

Nom de l'entreprise: ____________________________________

Personne contact:____________________________________

Adresse postale: ____________________________________

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Courriel: ______________ Site internet: ______________

Espace d'exposition .... $400 __________

Besoins de courant électrique (contacter David Hunt de l'HGC Engineering)

Parrainage de pauses (5 pauses sont disponibles):

Pause "classique: .... $450 __________

Pause "première classe" .... $700 __________

Commanditaires de la conférence (montant de la contribution) __________

Sous-total: $__________

GST (7%) $__________

TOTAL $__________

CAA Student Travel Subsidy and Student Presentation Award
Application Form
DEADLINE FOR RECEIPT 1, August, 2001

Procedure

- Complete and submit this application at the same time as the abstract to the Technical Chair of the Conference. Both must be received on or before deadline listed above.
- By 31 August 1999, the CAA Secretary will notify you of the Travel Subsidy funding that you can expect to receive.
- Subsidy cheques will be mailed directly to you within 30 days of the end of the Conference

Eligibility Requirements

In order to be eligible for the Travel Subsidy you must meet the following requirements:
1. Full-time student at a Canadian University;
2. Student Member in good standing of the Association;
3. Distance traveled to the Conference must exceed 150 km (one way);
4. Submit a summary paper for publication in the Proceedings Issue of Canadian Acoustics with the applicant as the first author;
5. Present an oral paper at the Conference. Due to limited funding, a travel subsidy can only be given to the presenter of the paper even though there may be more than one student authors.

Section A: All applicants must complete this section

Name of Student:______________________________

Address:______________________________
(where the cheque is to be sent)

Title of the proposed paper:______________________________

Is the paper to be judged in the Student Presentation Award(s) [Yes/No]:______________________________

Name and Location of the University: ______________________________, ______________________________

Faculty and Degree Being Sought: ______________________________, ______________________________

Section B: Complete this section only if you are applying for the CAA Student Travel Subsidy

I hereby apply for a travel subsidy from the CAA

Proposed Method of Transport to conference:______________________________
Brief description of the route and method of transportation (e.g., bus, train, air, etc.)

Estimated Cost of Transportation:______________________________
Provide least expensive transportation cost.

Date of Departure to, and Return from the Conference: ______________________________, ______________________________

Other Sources of Travel Funding:______________________________
List other sources of travel funding and the amount

Signature of Applicant

____
I certify that the Information provided above is correct

____
Print Name

Signature of University Supervisor

____
I certify that the applicant is a full time student

____
Print Name

Subvention de l'ACA pour les Frais de Déplacement des Etudiants et Prix Récompensant les Présentations d'Etudiants - Formulaire d'Inscription
DATE LIMITE DE RÉCPTION, 1 AOUT 2001

Procédure

- Compléter le formulaire et le soumettre en même temps que le sommaire au Président Technique de la Conférence. Tous deux doivent être reçus avant la date limite indiquée ci-dessus.
- Le Secrétariat de l'ACA vous enverra une note avant le 31 Août 1999 indiquant la Subvention que vous êtes susceptible de recevoir.
- Les chèques de Subvention vous seront directement envoyés dans les 30 jours suivant la fin de la Conférence.

Conditions d'Eligibilité

1. Pour avoir droit à la Subvention pour les Frais de Déplacement, vous devez remplir les conditions uivantes:
2. Etre étudiant à temps plein dans une Université Canadienne;
3. Etre Membre de l'ACA;
4. La distance parcourue jusqu'à la Conférence doit être supérieure à 150km (aller simple);
5. Soumettre un sommaire en vue de sa publication dans les actes d'Acoustique Canadienne, l'étudiant doit être le premier auteur du som maire;
6. Présenter une communication orale pendant la conférence. En raison du financement limité, une Subvention pour les Frais de Déplacement ne peut être attribuée qu'à l'étudiant présentant la communication même si plusieurs étudiants sont auteurs du sommaire.

Section A: Tous les candidats doivent remplir cette section

Nom de l'étudiant:________________________________

Adresse: ________________________________
(où le chèque doit être envoyé)

Titre de la communication proposée: ________________________________

La communication est elle inscrite au concours pour le Prix Récompensant les Communications d'Etudiants [Oui/Non]: __________

Nom et adresse de l'université: ________________________________

Faculté et niveau d'étude en cours: ________________________________

Section B: Compléter cette section si vous postulez pour une Subvention des Frais de Déplacement
Je postule par le présent document à une Subvention de l'ACA pour des Frais de Déplacement

Moyen de Transport proposé pour se rendre a la conférence: ________________________________
Brève description du trajet et du moyen de transport (i.e bus,train,avion etc.)

Coût estimé du Transport: ________________________________
Fournir le coût de transport le moins élevé
Date de Départ pour la Conférence et de Retour: ________________________________

Autres sources de financement pour le transport:________________________________
donner la liste des sources de financement et leur montant

Signature du candidat	**Signature du superviseur**
____________________	____________________
Je certifie que les informations fournies ci dessus sont correctes	Je certifie que le signataire est un étudiant à temps plein
____________________	____________________
Nom	**Nom**

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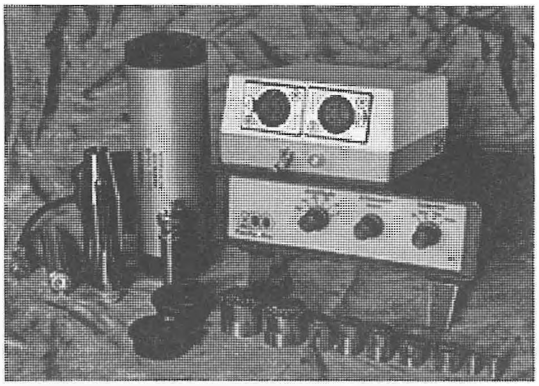

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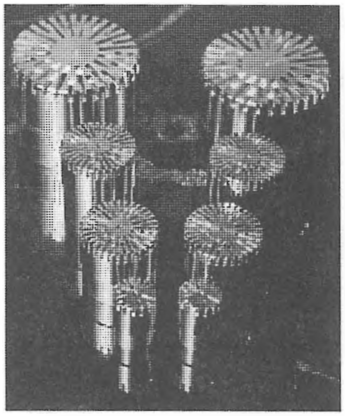

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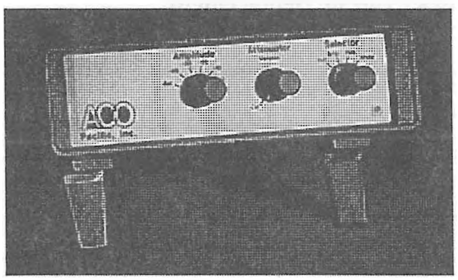

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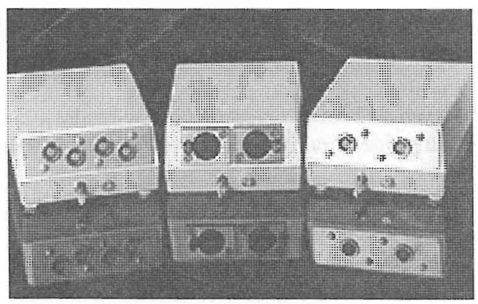

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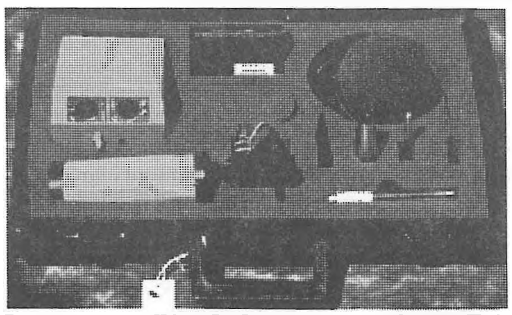

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INSTRUCTIONS TO AUTHORS FOR THE PREPARATION OF MANUSCRIPTS

Submissions: The original manuscript and two copies should be sent to the Editor-in-Chief.

General Presentation: Papers should be submitted in camera-ready format. Paper size 8.5" x 11". If you have access to a word processor, copy as closely as possible the format of the articles in Canadian Acoustics 18(4) 1990. All text in Times-Roman 10 pt font, with single (12 pt) spacing. Main body of text in two columns separated by 0.25". One line space between paragraphs.

Margins: Top - title page: 1.25"; other pages, 0.75"; bottom, 1" minimum; sides, 0.75".

Title: Bold, 14 pt with 14 pt spacing, upper case, centered.

Authors/addresses: Names and full mailing addresses, 10 pt with single (12 pt) spacing, upper and lower case, centered. Names in bold text.

Abstracts: English and French versions. Headings, 12 pt bold, upper case, centered. Indent text 0.5" on both sides.

Headings: Headings to be in 12 pt bold, Times-Roman font. Number at the left margin and indent text 0.5". Main headings, numbered as 1, 2, 3, ... to be in upper case. Sub-headings numbered as 1.1, 1.2, 1.3, ... in upper and lower case. Sub-sub-headings not numbered, in upper and lower case, underlined.

Equations: Minimize. Place in text if short. Numbered.

Figures/Tables: Keep small. Insert in text at top or bottom of page. Name as "Figure 1, 2, ..." Caption in 9 pt with single (12 pt) spacing. Leave 0.5" between text.

Line Widths: Line widths in techincal drawings, figures and tables should be a minimum of 0.5 pt.

Photographs: Submit original glossy, black and white photograph.

Scans: Should be between 225 dpi and 300 dpi. Scan: Line art as bitmap tiffs; Black and white as grayscale tiffs and colour as CMYK tiffs;

References: Cite in text and list at end in any consistent format, 9 pt with single (12 pt) spacing.

Page numbers: In light pencil at the bottom of each page.

Reprints: Can be ordered at time of acceptance of paper.

DIRECTIVES A L'INTENTION DES AUTEURS PREPARATION DES MANUSCRITS

Soumissions: Le manuscrit original ainsi que deux copies doivent être soumis au rédacteur-en-chef.

Présentation générale: Le manuscript doit comprendre le collage. Dimensions des pages, 8.5" x 11". Si vous avez accès à un système de traitement de texte, dans la mesure du possible, suivre le format des articles dans l'Acoustique Canadienne 18(4) 1990. Tout le texte doit être en caractères Times-Roman, 10 pt et à simple (12 pt) interligne. Le texte principal doit être en deux colonnes séparées d'un espace de 0.25". Les paragraphes sont séparés d'un espace d'une ligne.

Marges: Dans le haut - page titre, 1.25"; autres pages, 0.75"; dans le bas, 1" minimum; latérales, 0.75".

Titre du manuscrit: 14 pt à 14 pt interligne, lettres majuscules, caractères gras. Centré.

Auteurs/adresses: Noms et adresses postales. Lettres majuscules et minuscules, 10 pt à simple (12 pt) interligne. Centré. Les noms doivent être en caractères gras.

Sommaire: En versions anglaise et française. Titre en 12 pt, lettres majuscules, caractères gras, centré. Paragraphe 0.5" en alinéa de la marge, des 2 cotés.

Titres des sections: Tous en caractères gras, 12 pt, Times-Roman. Premiers titres: numéroter 1, 2, 3, ..., en lettres majuscules; sous-titres: numéroter 1.1, 1.2, 1.3, ..., en lettres majuscules et minuscules; sous-sous-titres: ne pas numéroter, en lettres majuscules et minuscules et soulignés.

Equations: Les minimiser. Les insérer dans le texte si elles sont courtes. Les numéroter.

Figures/Tableaux: De petites tailles. Les insérer dans le texte dans le haut ou dans le bas de la page. Les nommer "Figure 1, 2, 3,..." Légende en 9 pt à simple (12 pt) interligne. Laisser un espace de 0.5" entre le texte.

Largeur Des Traits: La largeur des traits sur les schémas technique doivent être au minimum de 0.5 pt pour permettre une bonne reproduction.

Photographies: Soumettre la photographie originale sur papier glacé, noir et blanc.

Figures Scanées: Doivent être au minimum de 225 dpi et au maximum de 300 dpi. Les schémas doivent être scannés en bitmaps tif format. Les photos noir et blanc doivent être scannées en échelle de gris tifs et toutes les phoots couleurs doivent être scannées en CMYK tifs.

Références: Les citer dans le texte et en faire la liste à la fin du document, en format uniforme, 9 pt à simple (12 pt) interligne.

Pagination: Au crayon pâle, au bas de chaque page.

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The Canadian Acoustical Association — l'Association Canadienne d'Acoustique

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FACTURE D'ABONNEMENT

L'abonnement pour la présente année est dû le 31 janvier. Les nouveaux abonnements reçus avant le 1 juillet s'appliquent à l'année courante et incluent les anciens numéros (non-épuisés) de l'Acoustique Canadienne de cette année. Les abonnements reçus après le 1 juillet s'appliquent à l'année suivante.

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The Canadian Acoustical Association
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