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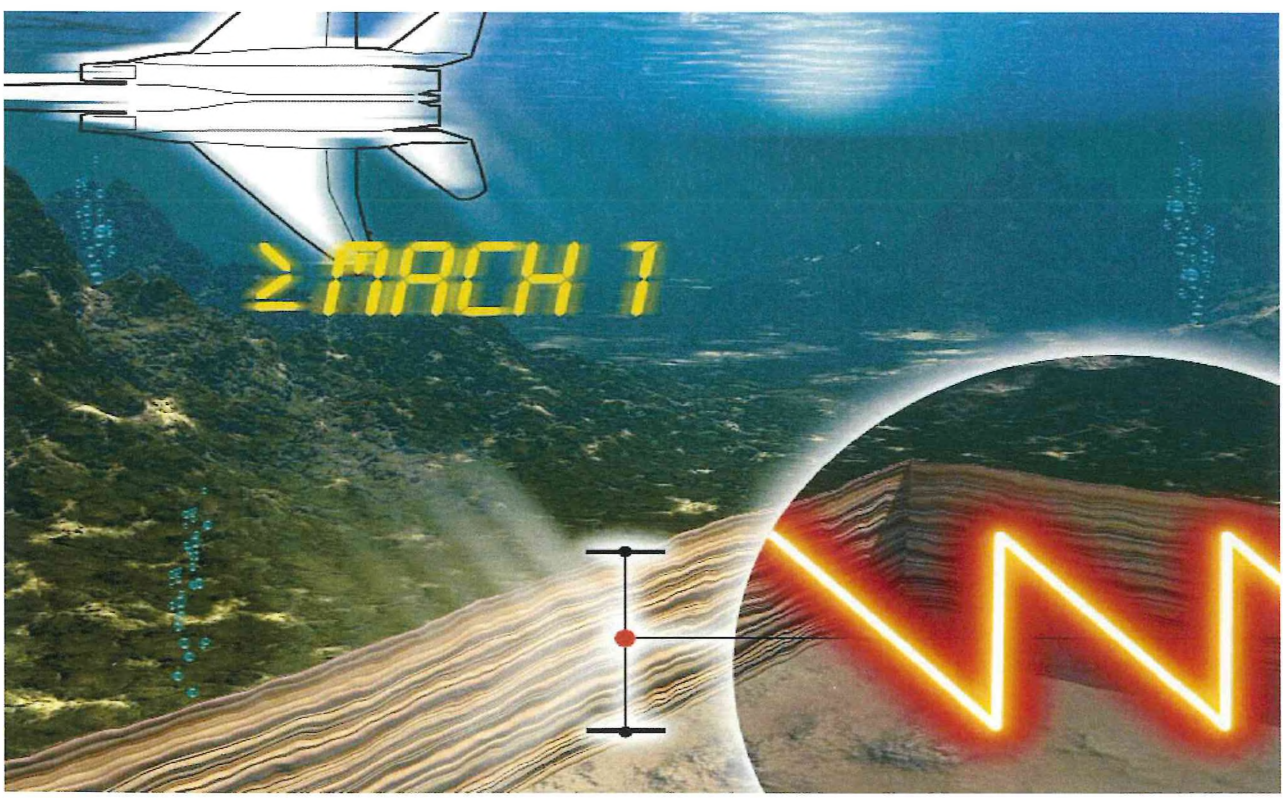

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CANADIAN ACOUSTICS publishes refereed articles and news items on all aspects of acoustics and vibration. Articles reporting new research or applications, as well as review or tutorial papers and shorter technical notes are welcomed, in English or in French. Submissions should be sent directly to the Editor-in-Chief. Complete instructions to authors concerning the required camera-ready copy are presented at the end of this issue.

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MESSAGE FROM THE PRESIDENT / MESSAGE DU PRÉSIDENT

As the incoming President of the CAA, I have been asked to provide (brief) editorial comments for this issue of Canadian Acoustics, and I am glad to do so.

First, I would like to take this opportunity to express my sincere appreciation, together, I'm sure, with the entire CAA Membership, Board and Executive, to John Bradley, who has served so capably as CAA President for the past six years. During this time, John's commitment, organizational skills and strong but calm leadership style have contributed enormously to a period of stability, productivity, and growth for the CAA. John now not only assumes the position of CAA Past President, but is also serving as the Convener for Acoustics Week in Canada 2004, which he and his committee will host in Ottawa. Hence, it is clear that John will continue his valuable contributes to the CAA.

Second, I thought it might be of interest to highlight what I see as three of the real strengths of the CAA: our annual meeting Acoustics Week in Canada (ACW), our journal Canadian Acoustics, and our Awards program.

ACW is a great opportunity to meet Canadian colleagues who work in the same area of acoustics, and also those who work in different areas. Our smaller size (compared to the ASA or international organizations) means a small number of parallel sessions, and the opportunity to hear a wide variety of Canadian acoustical work and personally meet the speakers. All of the ACW conferences in recent years have been a smashing success, and its a great opportunity to visit interesting regions of our country.

Étant le nouveau président de l'Association Canadienne d'Acoustique (ACA), il m'a été offert d'écrire un court éditorial pour cette édition de la revue l'Acoustique Canadienne.

Premièrement, je voudrais profiter de cette opportunité pour exprimer mon appréciation et j'en suis sûr avec l'appui des membres de l'ACA, des directeurs et administrateurs, à John Bradley qui a efficacement accompli son mandat de président du ACA, au cours des 6 dernières années.
Pendant son mandat, John a réussi a instaurer une période de stabilité, productivité et expansion du ACA, par son engagement, son sens de l'organisation et une gestion efficace. John assume actuellement le rôle d'organisateur pour la Semaine Canadienne de l'Acoustique 2004, qu'il présidera avec son comité, à Ottawa. Du fait même, il semble clair que John va continuer à apporter sa contribution à l'ACA.

Deuxièmement, j'ai cru qu'il serait approprié de mettre l'emphase sur les 3 principales forces du ACA : notre congrès annuel de la Semaine Canadienne de l'Acoustique (SCA), notre revue l'Acoustique Canadienne et notre programme de prix.

La SCA est une bonne opportunité de rencontrer des collègues canadiens qui travaillent également dans le domaine de l'acoustique. La taille de cette conférence (comparé à la ASA ou organisations internationales) permet une réduction des sessions parallèles, donne une grande variété de présentation sur des travaux acoustiques canadiens et facilite la rencontre des présentateurs. Toutes les conférences du SCA ont été un pur succès et sont une bonne occasion pour visiter différentes régions canadiennes.

contd. on Page 2. . .

EDITOR'S NOTE/NOTE DE L'ÉDITEUR

There is a change in the editorial board of the journal. Francine Desharnais of DREA, who has been managing the news items so ably in the past, has decided to withdraw from her duties. Steven Bilawchuk of ACI Acoustical Consulting of Edmonton, Alberta has kindly agreed to join the board as the News Editor. I'd like to express our thanks to Francine Desharnais and welcome Steven Bilawchuk to the board.

Il y a un changement dans l'équipe de rédaction de la revue. Francine Desharnais, du Centre de recherche pour la défense de l'Atlantique (DREA), a décidé de ne plus coordonner la section des informations. Steven Bilawchuck d'ACI Consulting à Edmonton prendra la relève. J'aimerais remercier Francine pour loyaux services au fil des ans et souhaiter la bienvenue à Steven au sein de l'équipe!

contd. from Page 1 . . .

The Canadian Acoustics journal seems to get better every year, and we owe a huge thanks to the Editor-in-Chief Ramani Ramakrishnan, Editor Chantal Laroche, and the Associate Editors and Editorial Board for a great job. (I'd like to know how Ramani comes up with a different interesting picture for the front cover of each issue!)

The CAA has the best Awards programs that I know of for any comparable organization, particularly student awards. There are awards for high-school students and undergraduate students, graduate-student awards for presentations and published papers, three graduate-student awards in specialized acoustics topics, postdoctoral awards, student travel subsidies, and paper awards for authors both under and over 30 years of age. As a professor of Ocean Acoustics at the University of Victoria, I have had a number of students win various CAA Awards, and seen the encouragement and motivation they provide. We need only publicize our Awards more widely, as some go unclaimed each year.

Finally, although I was only going to mention three highlights, I would also say the CAA website (www.caa-aca.ca) is wonderfully clear and informative and serves us very well indeed (thanks go to webmaster Dave Stredulinsky).

Stan Dosso

La revue l'Acoustique Canadienne semble s'améliorer d'une année a l'autre. Je tiens à remercier le rédacteur en chef Ramani Ramakrishnan, la rédactrice Chantal Laroche, ainsi que le comité éditorial pour leur bon travail. (Je me demande comment Ramani peut trouver un si grand nombre d'intéressantes photographies pour la page couverture de chaque édition!).

Le ACA a le meilleur programme de prix que je connaisse, particulièrement pour l'encouragement des étudiants. Il y a des prix pour les étudiants au niveau secondaire, au 1er cycle et aux 2e et 3e cycles d'université pour la présentation et publication d'articles. Il y a également des prix au niveau post-doctoral, des subventions pour frais de déplacement d'étudiants au congrès et des prix pour les auteurs, dans les catégories de moins de 30 ans et de plus de 30 ans. En tant que professeur en acoustique des océans à l'Université de Victoria, j'ai eu un certain nombre d'étudiants qui ont gagnés différents prix de l'ACA et j'ai pu réaliser que ces attributions de prix les a encouragé et a entraîné une augmentation de leur motivation. Nous devrions augmenter la publicité pour ces récompenses, puisque certain prix ne sont même jamais réclamés.

Finalement, je voudrais rajouter que le site internet de l'ACA (www.caa-aca.ca) est vraiment clair, informatif et il procure un bon service (merci au créateur de ce site Dave Stredulinsky).

Stan Dosso

WHAT'S NEW ??

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

Steven Bilawchuk, aci Acoustical Consultants Inc., Edmonton, Alberta, Email: **stevenb@aciacoustical.com**

Dr. Govinda Krishnappa

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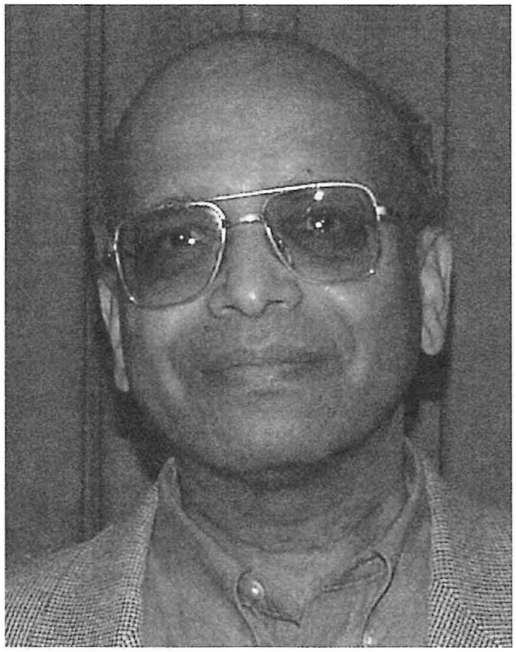

Dr. Govindappa Krishnappa passed away suddenly on September 18, 2003. He always asked us to call him Krish. Almost to the end, Krish seemed as vigorous and in as good spirits as always, yet somehow he succumbed to the ravages of an undiagnosed lymphoma. Krish is survived by his wife, Nimmi, his son Nini, and his daughter Chitty.

Krish established an international reputation for his fundamental contributions to acoustic and vibration analysis and for his ability to implant his developments into international standards. He was a good scientist who worked quietly, modestly and effectively, never putting himself first. He had an outstanding knowledge of acoustics that complemented his thorough understanding of aerodynamics, thermodynamics, physics, dynamics, signal processing and statistical methods. His publications in acoustics, vibration, sound intensity and machinery condition monitoring were well respected and frequently cited. Academics, industries, and governments around the world frequently sought his advice. Krish was a mentor and friend to scientists and students from many countries. Outside the office, his passions included philosophy, travel and walking. Krish also had a love of animals. He liked them so much he would not eat them.

Krish was born in India and studied Civil Engineering at the University of Mysore, receiving a B. Eng in 1958. He worked briefly on design and execution of civil engineering structures for the Mysore Public Works Department, but returned to school in 1960 at the Hydraulics and Hydraulic Machines Laboratory, Indian Institute Science, where he received a M.Sc. in Fluid Mechanics in 1963. Then Krish came to Canada to the Department of Mechanical Engineering at University of Waterloo, where he received his Ph.D. in 1967 for work on aerodynamic noise.

In 1967, Krish joined the National Research Council (NRC), Canada's Engine Laboratory, to work on VTOL propulsion noise and fan noise. By 1981, Krish was in charge of research activities on Machinery and Engine noise. He obtained international recognition for research programs he initiated in sound intensity measurements, machinery noise, wind turbine noise, gas turbine and diesel engine condition monitoring. He established extensive national and international collaboration with industry, universities, and other government departments. When the Engineering Research and Technology Sector was reorganized in 1993, Krish and his group transferred to the Institute for Machinery Research in Vancouver. He then faced almost the longest possible commute in Canada: 4611 km between his work in Vancouver and his wife and home in Ottawa. Krish juggled management of 80 workers, program changes, external collaborations, and research. In 1994 his hard work was rewarded with a promotion to Principal Research Officer. He finally retired from NRC in 1999, only to be invited to return to work as a guest worker and consultant with an office at the NRC Ottawa campus. In 2001 he was invited to return as principal research officer to help initiate a new project in the analysis of unsteady processes.

Krish made landmark advances in the fields of sound power and sound intensity measurement and analysis. His sound intensity work was incorporated in international standards for machinery noise measurements. His Sound Intensity Scanning Technique is the preferred method for the determination of the sound power of machinery for labelling and noise reduction purposes. He produced over 130 publications covering advances in acoustic and vibration. He was elected a fellow of the Acoustical Society of America, and a Fellow of the International Congress of Vibration and Acoustics. He received the rare distinction of being elected a Corresponding Member of the Institute of Noise Control Engineering (USA). He was a member of the Editorial Advisory Board of the Noise Control Engineering Journal (USA). He was one of the founding directors of the International Institute of Acoustics and Vibration (IIAV). He served as Chairman of the Awards, Honors and Membership Committee of the IIAV, and Secretary of the IIAV. He was Chair of the Canadian Advisory Committee on Acoustics, and represented Canada at meetings of the International Organization for Standardization for many years. He was also the Chair for American National Standards Institute (ANSI) instrument standard for sound intensity measurements.

We will all miss Krish's enthusiasm, knowledge and friendship.

Sonic Boom Excited Sediment Waves: A Model Study

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ABSTRACT

Sonic boom excited sediment waves are investigated with a model of interacting wave fields comprising water of finite depth and an elastic medium representing the sediment. The latter is assumed to be uniform, isotropic and semi-infinite in extent. The free modes are found to be dispersive, resulting in a finite (non-vanishing) resonance speed range. The study recognizes the difference in the far-field behavior between the excited resonance mode and the wave group of free modes: whereas the excited underwater wave of the resonance mode propagates at the same speed as the sonic-boom air load and remains in the form of a monochromatic wave train, the wave group of the free modes disperses into a wave packet and attenuate with increasing distance and time. Examples of a sediment model of fine sand with sonic boom waves at two flight Mach numbers are discussed. Differences and similarities between the present analysis and Desharnais and Chapman's study [1] are noted.

RÉSUMÉ

L'excitation d'ondes sédimentaires par le boom sonique est étudiée avec un modèle de champ d'ondes comprenant de l'eau de profondeur finie et un milieu élastique représentant le sédiment. Ce dernier est supposé uniforme, isotrope et d'étendu semi-infini. Les modes libres s'avèrent dispersifs, résultants une gamme finie de vitesse de résonance non atténuée. L'étude identifie la différence dans le comportement du champ lointain entre le mode de résonance excité et l'onde de groupe des modes libres: si l'onde sous-marine du mode de résonance se propage à la même vitesse que le boom sonique dans l'air et reste sous forme de train d'ondes monochromatiques, le groupe d'ondes des modes libres sont dispersés dans un paquet d'ondes et atténués avec l'augmentation de la distance et le temps. Des exemples d'un modèle de sédiment de sable fin avec des ondes de boomsonique à deux nombres de Mach de vol sont discutés. Des différences et les similitudes entre l'analyse actuelle et les travaux de Desharnais et de colporteur [1] sont aussi reportés.

1. INTRODUCTION

Many aspects of sound propagation in water can significantly affect the impact analyses of man-made noise underwater. [2,3]. This paper presents a model study of the transient, hydro-acoustic wave field in shallow water generated by a sonic boom over water and the resulting elastic-acoustic interaction that can excite sediment waves.

The problem of the underwater response to a sonic boom wave was modeled by Sawyers with a *flat* air-water interface [4] that has since been further elucidated [5], tested [6], and applied extensively.[7,8]. For convenience, Sawyers' model will be referred to as the "flat-ocean model". Tacitly assumed in Sawyers' analysis is an ocean of infinite depth not strictly applicable to the shallow coastal water. Aside from the effect of an impermeable bottom boundary, the interaction of a hydro-acoustic wave field with that of an elastic solid representing the sediment may excite seismic waves underwater [9-14] and could produce noticeable departures from Sawyers' prediction. Feasibility for sonic-boom-excited sediment waves was examined in the Desharnais and Chapman (D-C) paper [1] cited in the Abstract; the over-pressure signals received during the field test of a hydrophone array were identified to be disturbances originated from a Concorde airliner over-flight. Figure 1 reproduces from the D-C paper the over-pressure waveforms recorded at three depth levels and their comparison with the flat-ocean model prediction in this case. Except for the "ringing feature" on the downstream alluded to in Ref. [1], temporal averages of the over-pressure records tend to support Sawyers' prediction, as are made apparent from Fig. 1, even though the fluctuation/oscillation amplitudes are seen to be unexpectedly large. The analysis in the D-C study [1] employs a layered seismic model and indicates the existence of a resonance velocity not far from the reported Concorde

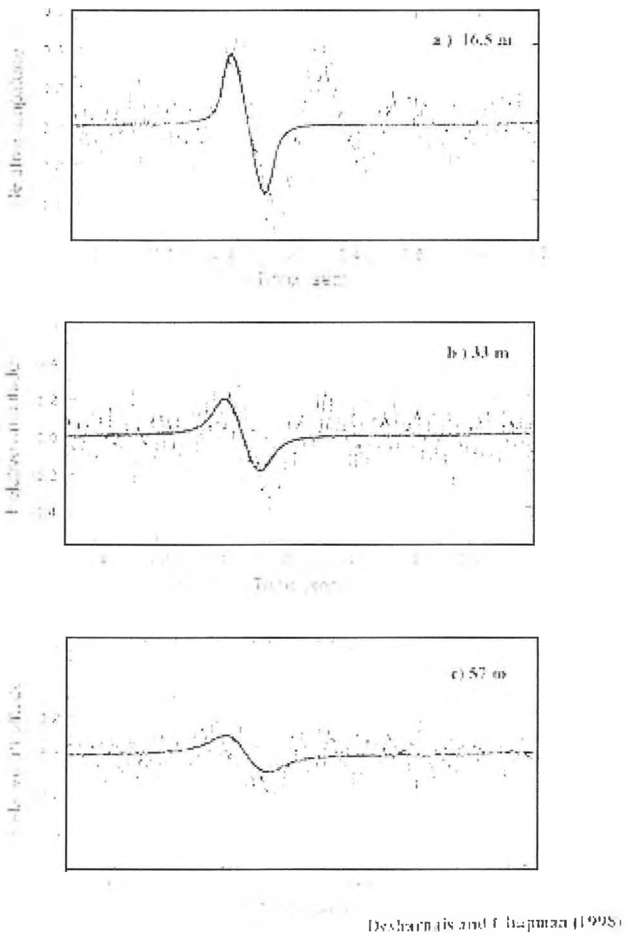

Figure 1. Overpressure waveforms recorded at three depth levels and their comparison with Sawyers' flat-ocean model predicted for a Concorde airliner over-flight, reproduced from Desharnais and Chapman's paper [1].

flight speed. The study furnishes also certain spectral properties which appear to support the "ringing feature" mentioned earlier, although an alternative model based on an interaction mechanism involving a *wavy* air-water interface [15-18] could explain the ringing and other features of Fig.1. The present study holds, nevertheless, that the seismic interaction mechanism considered in the D-C paper addresses a new aspect of sonic boom underwater impact, and should add valuable understanding to the broader problem of sea-floor influence on underwater sound and noise. In the present work, a simpler model is used to analytically delineate the key interaction mechanism and to ascertain certain unique features found in the D-C study.

Additional remarks on the present work and the related studies are made below in Section 2 along with a description of the model and assumptions used in the analysis. The problem formulation is given in Section 3, followed by analyses of the wave-train problems in Section 4, where certain distinctions from classical studies [9, 10, 11] are noted, and the forced wave-train mode under a periodic transient air load is delineated. The latter is to be used as a generating function in the analysis in Section 5 for the more general, compact, transient air load. Here, the excited resonance mode as well as the transient response beyond the resonance range are studied; the distinctly different far-field behavior of the excited mode and the corresponding behavior of the free-mode group are compared. In Section 6, examples illustrating excitation of resonance sediment waves by an incident sonic-boom wave in and beyond the critical Mach-number range are discussed. Concluding remarks with further discussions are given in Section 7.

2. REMARKS ON THE MODEL

It is quite well known that the strong variation in shear rigidity of the sediment material is an important elastic property controlling sediment wave propagations [12, 14]. This was recognized in the D-C study [1], in which computations based on a layered model were made to simulate an elastic sea bed, assuming a power-law variation of the shear-wave speed with depth; the work accounted also for the presence of a shallow water above the sediment, which was included as one of the many layers in their computational study. As a paper complementing the D-C study, we examine the effect of a *finite* water depth for a simpler sediment model represented by a *homogeneous, semi-infinite* elastic medium. The latter, as mentioned, is amendable to detailed, analytical enquiries on its seismo-acoustic behavior under a transient, supersonic air load. The following presentation will show that the simpler model can reproduce salient features similar to those in the D-C study which may, perhaps, be better understood. The analysis shares the same physical model used in the classical analysis of underwater sound transmission over an elastic solid bottom [12, 13]. Unlike the latter which concern mainly a wave train in "free mode", the present analysis addresses wave fields excited by an incident sonic boom as a compact air load, and recognizes the distinct difference between the free-modes in group and the excited mode found with the transient air load.

A model with two spatial dimensions will suffice for the present study, by virtue of the extremely high aspect ratio generally found with sea-level sonic boom impact zones [15-18]. Figure 2 depicts the two interfaces separating the air, the water, and the sediment media, the Cartesian coordinates used, and together with some features of the mathematical model. Here, the plane $z = 0$ is made to coincide with the liquid-solid interface, while the plane $z = -h$ is identified with the air-water interface. Subscripts "1" and "2" used in the sketch and in the following will refer to the hydro-acoustic and the elastic media, respectively, while the subscript "A" refers to the air above water.

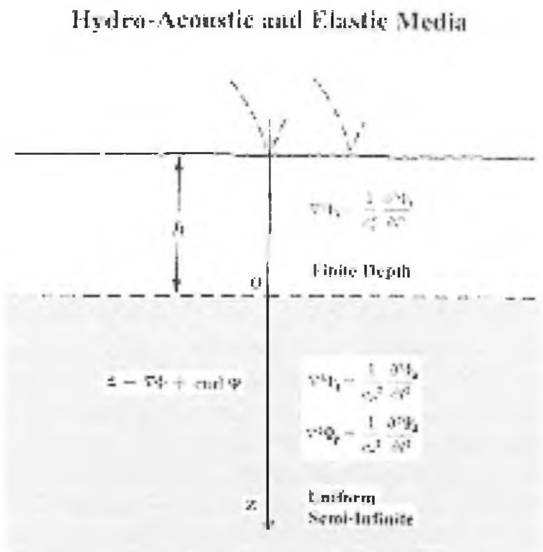

Figure 2. Schematic drawing depicting a planar hydro-acoustic medium of depth h and a semi-infinite elastic solid representing the sediment. In the coordinate system shown, the water-sediment interface and the air-water are identified at z = 0 and z = -h, respectively.

Implicitly assumed in Sawyers' theory as well as the present study are an extremely low air-to-water density ratio, $\rho_A / \rho_l << 1$, and an air-to-water sound speed ratio less than unity, i.e. $c_A / c_l < 1$. The first assumption makes the changes caused by the sonic boom in underwater fluid motion and in the air-water interface geometry negligibly small. The second assumption on sound speeds allows the underwater wave field to be treated as that in a *subsonic* flow, with the restriction that the Mach number M_A of the propagating sonic-boom wave field over water is less than c_l / c_A. The latter has the value 4.53 under standard conditions. This restriction, $1 < M_A < 4.53$, will be observed here, as in References 1, 4-8, 15-18.

For the uniform isotropic media, Rayleigh and Stoneley/Scholte waves [9-11] correspond respectively to vanishing and infinite water depths, and are known to be non-dispersive [14a,b] in that their propagation (phase) speed do not depend on frequency/wave-number; this would limit the free-mode excitation to one *single* speed for a given set of sediment properties. Unlike these limiting cases, however, the free mode in the finite-depth problem at hand is *dispersive,* and there exists a non-vanishing (finite) speed range in which hydro-acoustic waves and sediment wave trains can be excited by a compact, transient air load. A finite and perhaps wider, critical speed range may, nevertheless, be expected for sediments modeled with layered or heterogeneous structure without the additional assumption of a finite water depth, as in Reference 1's model.

3. GOVERNING EQUATIONS

The task of analyzing the interaction problem of two spatial dimensions can be reduced to solving for three unknown functions: the displacement potential Φ_1 of the hydro-acoustic field, the scalar potential Φ_2 associated with the compressive-wave field and the horizontal component of a vector potential Ψ_2 associated with the shear-wave field of the elastic medium [12-14]. For the uniform isotropic media considered, each of these functions are governed by its own acoustics-like equation

$$\nabla^2\Phi_1 = \frac{1}{c_1^2}\frac{\partial^2}{\partial t^2}\Phi_1, \qquad \nabla^2\Phi_2 = \frac{1}{c_p^2}\frac{\partial^2}{\partial t^2}\Phi_2,$$

$$\nabla^2\Psi_2 = \frac{1}{c_s^2}\frac{\partial^2}{\partial t^2}\Psi_2 \qquad (3.1\text{ a,b,c})$$

where c_1 is the sound speed in water defined earlier; c_p and c_s are the compressional (wave) speed and the shear (wave) speed related, respectively, to the (Lame') compressional and shear moduli λ and μ, and the medium density ρ

$$c_p = \sqrt{\frac{\lambda + 2\mu}{\rho}} \quad \text{and} \quad c_s = \sqrt{\frac{\mu}{\rho}} \qquad (3.2\text{a,b})$$

With the local displacement vector in the elastic medium represented by [13, 14]

$$\bar{d} = \nabla\Phi_2 + \nabla \times \bar{\Psi} \qquad (3.3)$$

the displacement continuity and the balance of the normal and tangential stresses across the (impermeable) horizontal, water-solid interface lead to three compatibility conditions at the interface z = 0:

$$\frac{\partial\Phi_1}{\partial z} = \frac{\partial\Phi_2}{\partial z} + \frac{\partial\Psi_2}{\partial x} \qquad (3.4)$$

$$-\rho_1\frac{\partial^2}{\partial t^2}\Phi_1 = \lambda_2\nabla^2\Phi_2 + 2\mu_2\left(\frac{\partial^2\Phi_2}{\partial z^2} - \frac{\partial^2\Psi_2}{\partial x\partial z}\right) \qquad (3.5)$$

$$0 = \frac{\mu_2}{\rho_2}\left[\left(\frac{\partial^2}{\partial x^2}-\frac{\partial^2}{\partial z^2}\right)\Psi_2 + 2\frac{\partial^2}{\partial x \partial z}\Phi_2\right] \quad (3.6)$$

where the left-hand member of (3.5) is the over-pressure on the water side, and Φ_1 is the displacement potential. The latter is an integral of the velocity potential with respect to time t.

At the air-water interface z = -h (refer to Figure 2), the over-pressure in water must balance that of the air load which can be assumed to be given by the known, incident and reflected sonic boom waves. For the present study, it suffices to consider three types of air loads at z = -h

$$-\rho_1 \frac{\partial^2}{\partial t^2}\Phi_1 = 0 \quad (3.7a)$$

$$-\rho_1 \frac{\partial^2}{\partial t^2}\Phi_1 = \rho_1 U^2 \alpha^2 \hat{P}_0\, e^{i(\alpha x - \omega t)} \quad (3.7b)$$

$$-\rho_1 \frac{\partial^2}{\partial t^2}\Phi_1 = F(x - Ut) \quad (3.7c)$$

pertaining to, respectively, the free mode, a transient sinusoidal air load, and a more general, non-sinusoidal, transient air load. The latter includes the over-pressure from a sonic boom. The propagation (phase) speed U of the air loads is assumed constant, and ω is αU. Results from the analysis for the air load of a sinusoidal wave train, (3.7b), will be used to generate solutions for the non-periodic, compact air load of interest. Since a semi-infinite elastic domain has been assumed, a vanishing Φ_2 and Ψ_2 at large z corresponding to the radiation condition will be required. With the use of the complex exponential functions in (3.7b) and in the following development, it is understood that these potentials and other quantities of physical interest are to be obtained from the *real parts* of the subsequent solutions.

The system of the three unknown functions Φ_1, Φ_2 and Ψ_2 are coupled through the interface compatibility conditions at z = 0, (3.4)-(3.6). The partial differential equations 3.1b and 3.1c for Φ_2 and Ψ_2 may also be coupled through additional terms in the equations, if the elastic moduli of the sediment were not uniform.

4. FREE AND FORCED WAVE TRAIN MODES

Solutions for the free mode and for the wave train mode forced by a sinusoidal air load of (3.7b) may be obtained in the wave train form

$$\begin{pmatrix}\Phi_1\\ \Phi_2\\ \Psi_2\end{pmatrix} = \begin{pmatrix}\hat{\phi}_1\\ \hat{\phi}_2\\ \hat{\psi}_2\end{pmatrix} \cdot e^{i\alpha(x-Ut)} \quad (4.1)$$

The resulting ordinary differential equation (ODE) system for the three unknowns $\hat{\phi}_1$, $\hat{\phi}_2$ and $\hat{\psi}_2$, with the aforementioned compatibility and boundary conditions, is no more or less than that in the classical analysis for the submarine wave guide modeled with an elastic sediment [13], also in common with mathematical models used in studies of submarine earthquakes, mud slides and underwater explosions [13, 14]. The solutions sought and developed for the present study differ however from those of Reference 13 for reasons to be brought out shortly. The product of the wave number and the water depth, αh, will be an important parameter in the analysis but was absent from analyses of Rayleigh and Stoneley/Scholte waves [9-11].

The equations up to this point have been written in the *rest* frame. The following analysis will be made in a *moving* frame at the uniform horizontal velocity U. In this frame, the foregoing equations are unchanged, except that $\partial^2/\partial t^2$ is replaced by

$$\frac{\partial^2}{\partial t^2} + 2U\frac{\partial^2}{\partial x \partial t} + U\frac{\partial^2}{\partial x^2}$$

while the exponential argument i(αx-ωt) in (4.1) is changed to i(αx-Ωt) with Ω=Uα+ω. The velocity of the reference frame U is chosen to coincide with the phase velocity $-\omega/\alpha$ so that the argument in (4.1) may become independent of time.

The underwater system admits solutions with "evanescent behavior"

$$\hat{\phi}_1 = A_1 e^{|\beta_1\alpha| z} + A_2 e^{-|\beta_1\alpha| z} \quad (4.2a)$$

$$\hat{\phi}_p = Be^{-|\beta_p\alpha| z}, \hat{\phi}_s = Ce^{-|\beta_s\alpha| z} \quad (4.2b, c)$$

for *real* values of

$$\beta_1 = \sqrt{1-M_1^2}, \beta_p = \sqrt{1-M_p^2}, \beta_s = \sqrt{1-M_s^2} \quad (4.2d)$$

i.e. for $M_1 \equiv U/c_1 < 1$, $M_p \equiv U/c_p < 1$, $M_s \equiv U/c_s < 1$.

It could admit "effervescent" (propagating-wave) behavior like $e^{\pm i|\beta|\alpha z}$ if any of the βs becomes imaginary, i.e., if any of the three Ms exceed one. From the interface boundary conditions at $z = 0$ and $z = -h$, linear relations among the four constants A_1, A_2, B, and C, can be obtained. After eliminating A_2 and C, one arrives at

$$\left|\frac{\beta_p}{\beta_1}\right|\left(1 - \frac{2}{2 - M_s^2}\right) \cdot B + D_{BW} \cdot A_1 = 0 \qquad (4.3a)$$

$$\left[1 + e^{-2|\beta_1\alpha|h} + D_{BW}\right] \cdot A_1 = \frac{\hat{P}_0}{\rho_1 U^2 \alpha^2} e^{-|\beta_1\alpha|h} \qquad (4.3b)$$

where

$$D_{BW} \equiv -\frac{2}{1 + \frac{\beta_1}{\beta_p}\frac{\rho_2}{\rho_1} M_s^{-4}\left[4\beta_s\beta_p - \left(2 - M_s^2\right)^2\right]} \qquad (4.3c)$$

Note that D_{BW} is a function of U through M_s and the β s. The above result includes both the free and forced wave-train modes; the constant $\hat{P}_0$ in (4.3b) is set equal to zero identically for the free modes.

Note that the surface air load (prescribed over-pressure) on the air-water interface has been assumed, up to this stage, to be a sinusoidal one

$$p'(x, -h; \alpha) = \rho_1 U^2 \alpha^2 \cdot \hat{P}_0 e^{i\alpha x} \qquad (4.4)$$

Free Mode: Sediment Wave Train in Shallow Water

Unlike the Rayleigh and Stoneley/Scholte waves, for which the phase and group velocities are independent of the frequency or wave number, the free mode determined by

$$1 + e^{-|\beta_1\alpha|h} + D_{BW} = 0 \qquad (4.5a)$$

is *dispersive* in that its phase speed so determined will vary with the wave number, or more precisely, the product of the wave number and the water depth, αh. This leads to a non-vanishing (finite) range of the free-mode propagation speed, and thus a wider speed range for its excitation by a transient air load (see below) than in the Rayleigh and Scholte waves.

On the other hand, the dispersive property may produce a far-field behavior of a group of free modes very different from those of the non-dispersive Rayleigh and Stoneley waves (to be explained below). Equation (4.5a) may be more explicitly written in terms of the density ratio, the three Mach numbers and the product αh as

$$-\left(2 - M_s^2\right)^2 + 4\sqrt{1 - M_s^2}\sqrt{1 - M_p^2} = \left(\frac{\rho_1}{\rho_2}\right) M_s^4 \frac{\sqrt{1 - M_p^2}}{\sqrt{1 - M_1^2}} \tanh\left(|\beta_1\alpha|h\right) \qquad (4.5b)$$

which is identical in form with that for the fundamental (first) free mode of the water-channel wave guide with a solid floor of uniform elastic properties [13]. It reduces to the Rayleigh limit as $\alpha h \to 0$ and to the Scholte/Stoneley limit as $\alpha h \to \infty$. With a finite, non-vanishing h, the phase speed of the free mode (through M_1, M_p and M_s) now becomes a function of the wave number α. However, to be a genuinely free mode of the wave-train form (4.1), the wave number α and the propagation speed U must both be *real*; this sets a limit on the range of U admissible to (4.5b).

Values of $U(\alpha)$ satisfying the free-mode condition, (4.5b), for real α will be called the *free-mode speed;* it will be denoted by $U_{FM}(\alpha)$, wherever such a distinction is necessary. The wave field excited by a traveling air load at the critical speed will be referred to as the *resonance mode.* To be sure, $U_{FM}(\alpha)$ is the *phase* speed of the free mode observed in the *rest* frame. More significant, physically, is $\frac{d}{d\alpha}\left[\alpha\, U_{FM}(\alpha)\right]$ which approximates the *group velocity* in the far field and controls the evolution of wave packet formed by a group of free modes, to be delineated more fully in Section 5.

For a given density ratio ρ_1/ρ_2, the critical speeds for various different combinations of c_1, c_p and c_s may be found from (4.5b) for three kinds of combination of M_1, M_p and M_s. The first kind is one with all three Mach numbers being less than unity; however, the Mach number M_A above the air-water interface must remain $M_A < 4.53$. The second M-combination requires all the three Mach numbers to exceed unity, which would require a M_A very much greater than 4.53 in most applications, since the compressional speed c_p of the sediment is normally not much lower than the water sound speed c_1. The third combination requires $M_1 > 1$, $M_p < 1$ and $M_s < 1$ (supersonic in water, and subsonic in solid). The second and third kinds are not of great relevance to the sonic boom impact study and will not be considered in the subsequent analysis. (The third kind is similar to the Love waves in an elastic solid and could be of relevance to impact study of an intense explosion over a shallow sea.)

The admissible range of U_{FM}, or $(M_A)_{FM}$, for the free mode is determined by the upper and lower limits of the hyperbolic tangent in (4.5b) and may therefore be inferred from (4.5a) through

$$-2 < D_{BW} < -1 \tag{4.6}$$

From the free-surface condition (3.7a) and the solution (4.2a), the underwater over-pressure field in the moving frame is given by

$$p' = A_1[e^{|\beta_1\alpha|z} - e^{-2|\beta_1\alpha|h} e^{-|\beta_1\alpha|z}]e^{i\alpha x} \tag{4.7}$$

There can occur, more often than not, free-mode wave trains made up of α from a continuum wave-number range allowed by (4.5b). Such a wave group from the free-mode continuum is expected to undergo *attenuation* as it progresses (in time and space); this will be substantiated at the end of Sec. 5.

Wave Train Forced By Traveling, Periodic Air Load

With (4.3b) for a non-vanishing P_0, the constant A_1 of the potential in (4.2a) is determined; Applying the pressure-continuity requirement at the air-water interface (z = -h) once again, the constant A_2 of the potential may also be obtained, yielding

$$p' = \hat{q}e^{i\alpha x} \tag{4.8a}$$

and

$$\hat{q}(z,\alpha) = e^{-|\beta_1\alpha|(h+z)} + \frac{e^{-|\beta_1\alpha|(h-z)} - e^{-2|\beta_1\alpha|h} \cdot e^{-|\beta_1\alpha|(h+z)}}{\left(1 + e^{-2|\beta_1\alpha|h} + D_{BW}\right)} \tag{4.8b}$$

where the constant $\hat{P}_0$ has been taken to be unity, so that $\hat{q}$ = 1 at the air-water interface z = -h, satisfying the prescribed boundary condition there. The solution is regular as long as the propagation speed U of the air load is not close to the critical speed U_{cr} at which the denominator in (4.8b) vanishes.

5. RESPONSE TO MORE GENERAL, MOVING AIR LOADS

Solution as Fourier Integral

The product $\hat{q}e^{i\alpha x}$ is an underwater solution to the system with $p' = e^{i\alpha x}$ at z=-h, as is its weighted integral with respect to the wave number α

$$\frac{1}{\sqrt{2\pi}}\int_{-\infty}^{\infty} e^{i\alpha x}\hat{q}(z,\alpha)F(\alpha)d\alpha \tag{5.1}$$

where $F(\alpha)$ is an arbitrary weighting function. The correct choice for $F(\alpha)$ is one that will allow the weighted integral with respect to α to represent the over-pressure field in water under a traveling load $p'(x,-h)$. Since $\hat{q}(z,\alpha)$ approaches unity as $z \to -h$, this boundary condition simply requires that $F(-\alpha)$ be the Fourier transform of the interface air load $p'(x,-h)$.

$$F(-\alpha) = \frac{1}{\sqrt{2\pi}}\int_{-\infty}^{\infty} e^{i\alpha x} p(x,-h)dx \equiv P(\alpha) \tag{5.2}$$

Thus, under the assumption that the Fourier integral of the air load and the inverse Fourier transform of the product $\hat{q}P$ both exist, the solution in question is, for $-h < z < 0$,

$$p'(x,z) = \frac{1}{\sqrt{2\pi}}\int_{-\infty}^{\infty} e^{-i\alpha x}\hat{q}(z,\alpha)P(\alpha)d\alpha \tag{5.3}$$

where $\hat{q}(z,-\alpha) = \hat{q}(z,|\alpha|)$ has been given earlier by (4.8b) for the wave-train air load.

Rigid Bottom Result as Special Limit

Outside of the free-mode speed range allowed by (4.6) for the parameter D_{BW}, the function $\hat{q}(z,-\alpha)$ in (4.8b) has no singularity and the p' integral is expected to attenuate with increasing distance from the forcing air load, as in the case of a rigid bottom. The latter case corresponds to the limit of infinite compressive and shear speeds, in which D_{BW} vanishes. Equation (5.3) is reduced in this limiting case to

$$p'(x,z) = \frac{1}{\sqrt{2\pi}}\int_{-\infty}^{\infty} e^{-i\alpha x}\frac{\cosh\beta_1|\alpha|z}{\cosh\beta_1|\alpha|h}P(\alpha)d\alpha \tag{5.4}$$

which represents an extension of Sawyers' [7] analysis to shallow water and provides an alternative solution form to the rigid sea-floor problem given earlier in References 17, and 18.

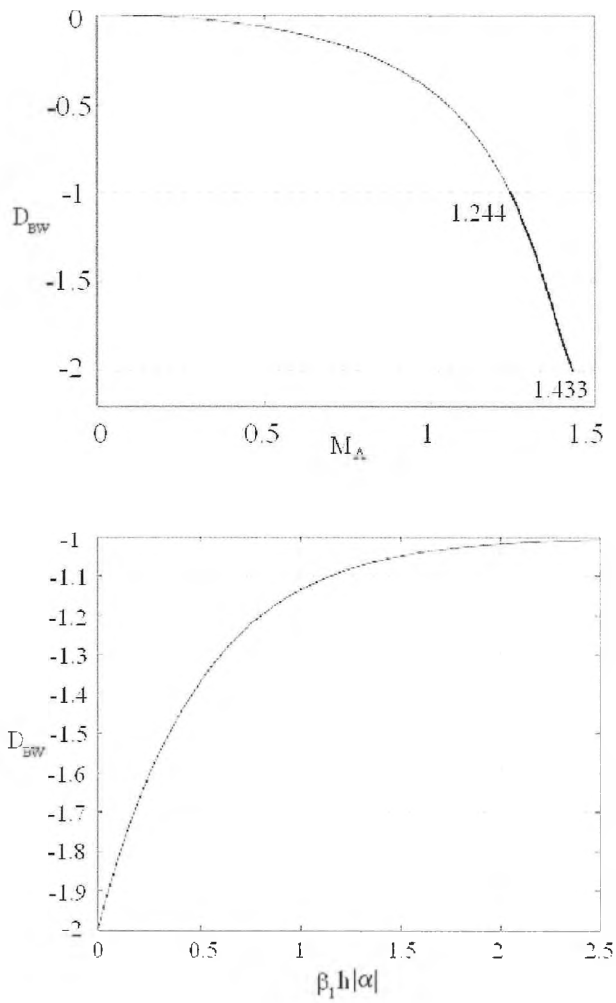

Figure 3. Illustration of diagrams used for determining of the air Mach number $M_A \equiv U/a_A$ corresponding to the free-mode phase velocity $U_{FM}(\alpha)$ for a wave number α through the function $D_{BW}(U)$, which can also be used to determine the specific wave number α_* in an excited resonance mode for a known air-load velocity U: (a) D_{BW} as function of M_A, (b) D_{BW} as function of $\beta_1 h|\alpha|$. The example shown was computed from $\rho_1/\rho_2 = 1.91$, $c_p = 1711\ \mathrm{m/s}$, and $c_s = 503\ \mathrm{m/s}$.

The Excited Resonance Modes

For a traveling air-load at speed U which falls inside the range allowed by (4.6), the integration path of (5.3) encounters the pole singularity of $q(z,\alpha)$ at the particular wave number α^* corresponding to U in the free-mode requirement (4.5b). This particular wave number α^* is therefore a function of the air-load velocity U, and will appear in solution pairs to the nonlinear algebraic equation (4.5b) for a given U. Examination of the relation between the exponential function in arguments β, α, h and the $D_{BW}(U)$ of (4.5a) indicates that only a single pair of real $\alpha^* = \alpha_{FM}(U)$ in the form of $\alpha^* = \pm|\alpha^*|$ is possible for a given U (cf. Fig. 3). This fact provides the basis for the following analysis. The analysis will also make use of the fact the the function $p'(x,-h)$ prescribed for the transient air load at the air-water interface is a *real* function of x.

Essential to the contributions from the poles is the behavior of the denominator of $q(z,\alpha)$ (cf. (4.8b))

$$\Delta \equiv 1 + D_{BW} + \exp(-2h\beta_1|\alpha^*|) \qquad (5.5)$$

whose behavior near α^* differs according to whether α^* is positive or negative. The function $\hat{q}(z,a)$ in the vicinity of the two poles $\alpha = \pm a$ may thus be represented by

$$\hat{q} \approx \frac{g_*(z,a)}{2\beta_1 h} \frac{1}{1+D_{BW}} \frac{1}{\alpha \mp a} \qquad (5.6a)$$

where $g(z,a)$ is the limit for $|\alpha| \to a$

$$g_*(z,a) = \lim_{|\alpha|\to a} g = 2e^{-2\beta_1 ha} \sinh(\beta_1 a(h+z)) \qquad (5.6b)$$

Recognizing that $P(-a)$ is the complex conjugate of $P(a)$, the excited overpressure field in water ($-h < z < 0$) may be re-expressed with the help of (5.6a,b) around the two poles, as[¥]

$$p'(x,z) = -\sqrt{\frac{\pi}{2}} \frac{g_*(z,a)}{\beta_1 h} \frac{sign(x)}{1+D_{FM}} * \mathbf{RP}\,[iP(a)e^{-iax}] + \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\infty} e^{-i\alpha x} Q(z,\alpha;a)\,d\alpha \qquad (5.7a)$$

where "**RP**" stands for the Real Part and

$$Q(z,\alpha;a) = \hat{q}(z,|\alpha|)P(\alpha) + \frac{g_*(z,a)}{2\beta_1 h} \frac{1}{1+D_{BW}} \left(\frac{P(a)}{\alpha - a} - \frac{\overline{P(a)}}{\alpha + a}\right) \qquad (5.7b)$$

¥ In deriving (5.7a), use was made of the identity

$$\frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\infty} \frac{e^{-i\alpha x}}{\alpha} d\alpha = -i\sqrt{\frac{\pi}{2}}\, sign\ x\,.$$

The existence of the inverse Fourier transform of Q requires regularity of $P(\alpha)$ along the real axis of α. The two poles in question are thus removed from the remaining integral. Note that the overpressure p' in (5.7a) is to be obtained from the *real part* of the equation's RHS. For large water depth p' of (5.7) may be seen to diminish as *1/h*. On the other hand, for small water depth, p' of (5.7) does not diminish with *h*, owing to the fact that both $\Delta\hat{q}$ and g_* vanish linearly with h (for $-h < z < 0$).

The above result represents the resonance mode in water excited by a traveling air load. Examples most befitting to this description are those found in sonic boom over flat (non-wavy) water, for which the air load is readily determined. A standard example of this kind will be examined in section 6.

Excited Far Field

At large distance (x>>1) from the air load, the integral in (5.7), which is the inverse Fourier transform of Q, *vanishes* for a wide class of Q which is *absolutely integrable* with respect to α.[20] The latter condition can be met by a $P(\alpha)$ which is *regular* along the real axis of α. Thus as $|x| \to \infty$, p' of (5.7) assumes the form of a free mode at a *specific* wave number pair $\alpha = \pm a$ corresponding to the air-load speed U. Rewriting (5.7) for coordinates in the rest frame, the overpressure in water *far* from the air load becomes

$$p'(x,z,U) \sim -\sqrt{\frac{\pi}{2}}\frac{g^*(z,a)}{\beta_1 h} * \\ sign(x-Ut)\mathbf{RP}\{\frac{iP(\alpha)e^{i\alpha(x-Ut)}}{1+D_{FM}}\} \qquad (5.8)$$

where a and D_{FM} are functions of U, and $g_*(z,a)$ is a function of both U and z (for the same set of sediment properties). The *monochromatic* character of this far-field resonance mode has a special significance for its *non-attenuating* nature. This behavior must be considered *distinct* from the shallow water free modes which are allowed to occur arbitrarily over a wide range of α. The combined effect of the free-mode wave *group* is expected to result in attenuation with distance and time, and warrants a closer examination to be made presently.

Free-Mode Group: Comparison

Physical realization of the free modes of (4.5)-(4.7) depends on the initial data or a prior production process (such as a finite-energy release) which normally involves a broad wave-number band. With the (rare) exception of a (very) narrow-band α-distribution, the wave group of the free modes, instead of (4.7) for a single mode, takes the form

$$p' = \frac{1}{\sqrt{2\pi}}\int_{-\infty}^{\infty}\frac{A(\alpha)\cdot e^{i\alpha[x-U_{FM}(\alpha)t]}e^{-\beta_1 h|\alpha|}}{\sinh[\beta_1 h(1+z/h)|\alpha|]}d\alpha \qquad (5.9)$$

for an arbitrary integrable $A(\alpha)$. The far field behavior of this integral along each ray of constant x/t is determined by the stationary phase, tantamount to the group velocity

$$\frac{d}{d\alpha}[\alpha U_{FM}(\alpha)] = x/t \equiv \eta \qquad (5.10)$$

and thereby attenuates as the inverse square root of $|x|$ or t [19-21]. More specifically, the non-coherent free-mode group (5.9) disperses and transforms itself into a packet of wavelets, each of which propagates along a "ray" of constant x/t with a fixed wave number/frequency at the group velocity, and attenuates according to the "cylindrical spreading rule" [19-21].

$$p'(x,z',t) \sim \frac{E_*}{\sqrt{2|\Omega_*'' t|}} exp\, i\alpha_* * \\ \left\{[x-U_{FM}(\alpha_*)t] + \frac{\pi}{4}(sgn\,\Omega_*'')\right\} \qquad (5.11a)$$

where the asterisk denotes the stationary value $\alpha = \alpha_*$ satisfying (5.10),

$$\Omega \equiv \alpha U_{FM}(\alpha),\ \Omega'' \equiv d^2\Omega/d\alpha^2 \qquad (5.11b,c)$$

and

$$E \equiv \frac{A(\alpha)e^{-\beta_1 h|\alpha|}}{\sinh[\beta_1 h(1+\frac{z}{h})|\alpha|]} * \qquad (5.11d)$$

Owing to their dispersive property, the free modes of (4.5)-(4.7) occurring in group differ significantly in the far-field behavior from the free mode of the Rayleigh wave or the Stoneley wave. To the latter, the far field of the excited resonance mode (5.8) is also similar, but differs in having a broad-band resonant U-range (4.6) that neither the Rayleigh nor the Stoneley wave enjoy.

6. EXAMPLES: SONIC BOOM EXCITED SEDIMENT WAVES

Sonic Boom N-wave as Air Load

A standard form of $p'(x,-h)$ in sonic boom prediction method is that of an N-shape. In terms of the normalized x-variable based on the sonic boom signature length (say, L'), it can be written as

$$p'(x,-h) = (1-2x)I(x)I(1-x) \qquad (6.1a)$$

where $I(\xi)$ denotes the unit-step function of ξ, and the overpressure p' is normalized by its maximum/peak value. The normalized x and p', together with the dimensionless z as well as the Fourier variable α are all be made dimensionless with L' in the example study below.

The Fourier transform of $p'(x,-h)$ in this case is

$$P(\alpha) = \frac{1}{\sqrt{2\pi}\,(i\alpha)} * \left[(e^{i\alpha}-1)(1+\frac{2}{i\alpha}) - 2e^{i\alpha}\right] \qquad (6.1b)$$

which is *finite* and *regular* (containing no pole) at the origin $\alpha = 0$, and vanishes as $1/\alpha$ for large α. These behaviors assure the existence of the integral solution (5.3).

Sediment Properties Selection

The range of U permitted by (4.5b) for resonance, and its existence, depends on the density ratio ρ_1/ρ_2 and the characteristic speeds c_1, c_p and c_s. More critical is the sediment shear speed c_s which is the lowest among the three characteristic speeds and controls the 4th power of M_s on the RHS of (4.5b). Resonance may be expected to occur when U and c_s are comparable. Three sediment samples are selected from measured and computed properties of mud and sand to show the variety in ρ_1/ρ_2, c_p and c_s (Cf. Table 8.2.1 Reference 22 and shown below). The sound speeds in air and water in the model study are taken to be c_A =331 m/sec and c_1 =1500 m/s, respectively. The range of U or the air Mach number M_A permitted by (4.5a,b) corresponding to (4.6) for resonance, can be determined from the listed density ratio and the characteristic speeds for sediment models I, II and III as

$$1.24 < M_A < 1.44,$$
$$0.52 < M_A < 0.56,$$
$$4.52 < M_A < 4.53 \qquad (6.2\text{ a, b, c})$$

respectively. The following discussion will focus on examples illustrating underwater responses of sediment Model I to sonic booms at speeds within and outside the above M_A range. Model II would support sediment wave trains for moving air load at subsonic speed as well. Interestingly, resonance may still be found even with shear speed as high as in the sediment model III, although the resonance-speed range is extremely narrow, as indicated by (6.2c). Examples with sediment models II and III will not be included for discussion below.

Supersonic Over-flights at M_A = 1.5 and M_A = 1.36

The case of M_A =1.5 outside the resonant range (6.2a) is first examined. To render the results more relevant, the reference length scale L' for x, z and h can be taken to be 100m, which is not far from the sonic boom signature of the Concorde airliner. With the set of constants assumed for data set I, we have ρ_2/ρ_1 =1.91, M_1=0.331, M_p =0.290, M_s=0.987, β_1=0.944, β_p=0.957, β_s=0.160, and D_{BW}=-15.41. In addition, the water-layer depth is taken to be *twice* the signature length, i.e. $h = 2$, a depth of 200 m.

The waveform at the sea level for an incident N-wave is shown in Figure 4a where the normalized maximum overpressure was set equal to 0.33. The underwater waveform at mid channel (i.e. z = -1) with the rescaled $p'(x)$ for the N-wave is shown in Figure 4b. Not shown for this case is the over-pressure on the sediment boundary (z =0), of which the magnitude is uniformly less than 10^{-3} of the surface value at x = -h. As expected, no evidence of interaction involving the sediment medium can be found in this case. In fact, the result differs little from that of a rigid, flat-bottom wall and appears to be very similar to results obtained for rigid bottom walls given in References 7, 8, and 16.

Next, we examine the results for M_A=1.36 which falls within the M_A-range of (6.2a) for which ρ_2/ρ_1 =1.91, M_1=0.300, M_p=0.263, M_s=0.895, β_1=0.954, β_p=0.965, β_s=0.445, D_{BW}=1.09, and h=2. The latter corresponds to a water depth of 200 m. The normalized overpressure waveforms at the water surface $z = -h = -2$, at mid channel $z = -h/2 = -1$, and on the bottom $z = 0$. are presented in Figures 5a, 5b, and 5c, respectively. Unlike the results shown earlier for M_A=1.5, undiminished sinusoidal oscillations at large distances in the form anticipated by

Table 1. Sediment Characteristics. (From Reference 22)

		ρ_2/ρ_1	c_p (m/s)	c_s (m/s)
I	Very fine sand (continental terrace)	1.91	1711	503
II	Clay (Abyssal hill)	1.42	1491	195
III	Uralite Basalt (Kolan rock)	3.06	6580	3660

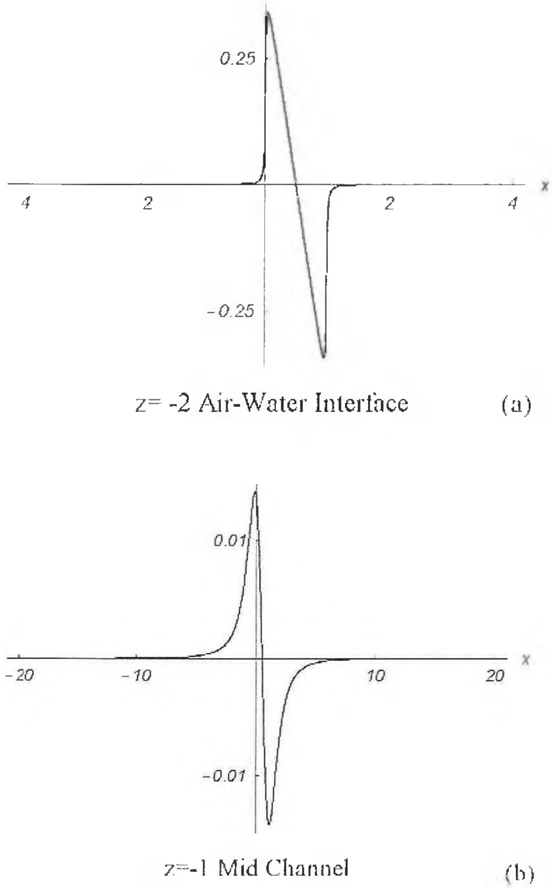

Figure 4. An example of hydro-acoustic response of the water-solid system to an incident sonic boom at $M_A = 1.50$ which is outside the resonance-speed range $1.24 < M_A < 1.44$ for a normalized water depth h=2, $\rho_1/\rho_2 = 1.91$, $c_p = 1711\ m/s$, and $c_s = 503\ m/s$; overpressure are shown at (a) sea level (z=-h=-2), (b) mid channel (z=-h/2=-1). Result at sediment boundary (z=0) not shown (Cf. text).

(5.8) appear at both the lower depth levels. The periodic oscillation in overpressure on the sea floor ($z = 0$) is seen to have *twice* the amplitude as that at mid-channel ($z = -h/2 = -1$), indicating clearly that the monochromatic, non-attenuating disturbances has been generated from the interaction at the lower boundary and radiate upward as if from a new acoustic source at the bottom. One may apply the results, for example, to the case with a maximum overpressure p' at the sea level equal exactly to 0.33 pounds per square foot (psf), the oscillatory p' amplitude at the mid channel and channel bottom would accordingly be close to 0.017 psf and 0.031 psf, respectively. These magnitudes correspond to sound levels close to, and slightly higher than,

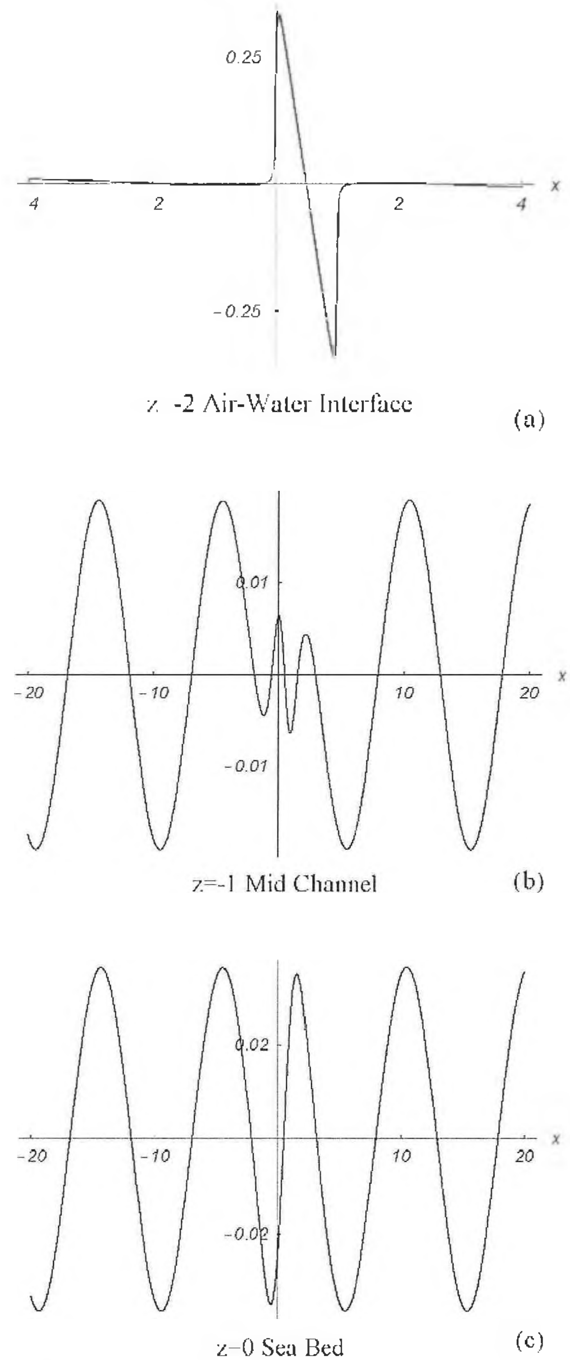

Figure 5. An example of sonic-boom excited sediment waves in a water-solid system same as in the proceeding figure, except $M_A = 1.36$ which falls within the resonance speed range ($1.24 < M_A < 1.44$): (a) sea level (z = -h = -2), (b) mid channel(z = -h/2 = -1), and (c) sediment boundary (z = 0).

120 dB (re 1 μPa), which may be compared with the levels of recorded whale calls in the infrasound range [2, 3].

Further Discussion

Two features of interest may be noted in Figures 5a, 5b, and 5c. The noticeably long wave length shown in Figures 5b, and 5c, which is $\lambda \equiv 2\pi / \alpha$, normalized by the sonic boom signature length, indicates that the excited wave length is nearly ten times the signature length. This should not be a surprise, however, after examining how $\alpha^*(U)$, or more precisely, how $2\beta_1 h\alpha^*$, is determined from a given U in the range $-2 < D_{BW} < -1$ (cf. Figure 3). A typical U well within the admissible range is seen to give an α^* pair corresponding to a $2\beta_1 h\alpha^*$ in the unit-order range, i.e. to a wavelength

$$\lambda^* \approx 4\pi\beta_1 h \tag{6.3}$$

This is numerically large, indeed, and suggests that the λ^* nearly ten (10) in length shown in Figures 5b, and 5c must have resulted from a $2\beta_1 h|\alpha^*|$ value comparable to 1/3. Therefore the apparently high numerical value comparable to that of (6.2) is not unexpected in the shallow water *far field* ($|x|>>1$). It is unclear if similarly long wavelengths were found in the corresponding results in the D-C study [1], since data were not furnished for far ($x>>1$) locations.

In the near field [$x=O(1)$] on the other hand, a characteristic wave length of unit order is expected.. This expectation finds support in the mid-channel result ($z=1$) of Figure 4b, where a relatively weak oscillation with a unit-order wavelength comparable to that of the sonic boom signature occurs in $x=O(1)$, while the solution is expected to approach the prescribed N-profile as z tends to the air-water interface $z= -h$. In the D-C study, it was reported that their spectral solution in the higher wave-number end appears to amplify with distance from the sediment boundary (z=0). The mid-channel result at $x=O(1)$ and related observation noted above could provide an explanation of the seemingly peculiar feature of the result in Reference 1 noted above, even through substantial differences exist between their model and the present one.

Unresolved among the reasons/cause for the differences between measurement records and model predictions are the absence of "ringing" on the upstream side and the presence of a large pressure over-shoot on the downstream side, which was revealed evidently in Figure1a (reproduced from Figure 5a of Reference 1).

7. CONCLUDING REMARKS

Sonic boom excited resonant interaction of the hydro-acoustic wave field and the elastic wave field of the ocean sediment is studied with a model of flat, uniform shallow sea over a homogeneous (uniform), semi-infinite, elastic solid. The finite depth h of the shallow water renders its free propagation mode dispersive when observed in a moving frame, allowing a family of free modes and a non-vanishing range of resonance speed for a traveling air load. For a rigid ocean bottom, the need for correcting Sawyers' theory [4] for applications to shallow coastal water is obvious, and this needed modification appears explicitly as a special limit in the present analysis [cf. (5.4)].

With suitable combination of sediment density, compress ional and shear speeds, the critical speed range of supersonic over-flight for the resonance interaction can be found. The hydro-acoustic field structure and the resonance condition (when the flight speed falls within the free-mode speed range) have been analytically studied for the far and near fields. Computed results for over-flight speeds within and outside the resonance-speed range were examined. Distinctions of the resonance mode analyzed from the Rayleigh and Stoneley waves and from the corresponding D-C study, have been noted. Significant differences between the shallow-water *free* modes and the *excited* resonance mode with regard to their far-field behavior have been recognized. The examples studied suggest not only that, with low enough shear-wave speed on the sediment, the excitation event in question is realizable, but also that the undersea sound level can be comparable to, or even higher than, that of the recorded infrasound from whale calls [2,3].

Similar behavior of the excited resonance mode can be expected of the D-C analysis; the layered sediment model assumed therein would introduce additional dispersive effects, as in most sediment wave studies involving heterogeneous media [14]. It is of interest to note that the values of $c_p = 1600\ \mathrm{m/s}$ and $\rho_2/\rho_1 = 1.8$ assumed in the D-C study were rather close to the corresponding values 1711 *m/s* and 1.91 of the sediment model (set I) used for the examples of Fig 4a,b. An important difference lies, of course, in the layer-approximation simulating the non-uniform shear-speed distribution assumed in Reference 1, namely, $c_s = 160(\bar{z})^{0.3}$, where $\bar{z}$ is in meters. If a typical shear speed value is to be taken from this power law at the representative location, say, $\bar{z} = 50\mathrm{m}$, one would obtain $c_s = 517\ m/\mathrm{sec}$, not far from the 503 *m/sec* in the present example. The Concorde airliner in question was estimated to cruise at Mach 1.75, corresponding to M_A at the air-water interface of M_A=1.5. The latter is not too far from the upper limit 1.44 for excitation for the present model (6.1a). As the discussion in Section 6 would suggest, several outstanding discrepancies between measurements and model predictions may not be resolved completely within the frame work of the flat-water model.

In conclusion, we consider the model of sonic-boom excited sediment waves proposed originally by Desharnais and Chapman [1] to have physical merit; the phenomenon is worthy of more critical studies for a wider class of sonic boom impact problems. Among the latters are the extension of a shallow-water analysis to account for the shear-speed non-uniformity, as well as a study of the evolution process of the steady-state free modes. New field measurements and laboratory studies will be necessary to resolve issues of the earlier and new measurements and to help in developing a viable prediction model. A fuller presentation of this work is given in a report entitled "A Model Study of Sonic Boom Excited Sediment Waves," available on the author's website [23].

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CANADIAN STANDARDS ASSOCIATION ACTIVITY IN ACOUSTICS

2003 UPDATE

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ABSTRACT

Many Canadian acousticians work on writing and reviewing acoustics standard, both in Canada and around the world. This article is an update for 2003 of Acoustics Standards activities in Canada, especially those of the Canadian Standards Association. CSA currently has 11 Acoustics Standards and two more with significant acoustics content. More than twice that number of acoustics standards from other organisations such as ANSI and ISO have been reviewed and either endorsed or adopted as suitable for use in Canada.

RÉSUMÉ

Plusieurs acousticiens canadiens travaillent à l'écriture et à la revue des normes acoustiques, autant au Canada que dans le monde entier. Cet article est une mise à jour des activités de normalisation en acoustique au Canada pour 2003, spécialement celles de l'Association canadienne de normalisation (ACNOR). L'ACNOR a présentement 11 normes acoustiques et 2 autres comportant un contenu acoustique important. Plus du double de ce nombre de normes provenant d'autres organisations telles que ANSI et ISO ont été revues et soit endossées ou adoptées comme étant acceptable pour une utilisation au Canada.

1. INTRODUCTION

Acoustics, like most technical activities, has procedures and terminology which has been standardised so that everyone involved will measure and calculate using the same tools and procedures. Without such standards, collaboration and comparing results between practitioners would scarcely be possible.

This standardisation does not come without effort. Many Canadian acousticians put in a hours of volunteer effort each year writing and reviewing acoustics standards. This article is intended to give an update for 2003 of acoustics standards activity in Canada. Most of the Canadian Acoustical Standards activity takes place within committees of the Canadian Standards Association. CSA has written Canadian Acoustics Standards for over 30 years and is one of the most respected standards writing organisations in the world.

Few acousticians could function successfully without the international effort to prepare and review acoustical standards on a wide variety of topics. Canada has been involved in this work for many years on both the national and international level. People using these standards are encouraged to contact the working group chairs listed below and join this effort.

2. COMMITTEE ACTIVITIES

There are two CSA Technical Committees in Acoustics: Z107 and Z94. The former oversees most of the acoustics standards work in Canada. The latter is responsible for a single standard. This reflects a trend in CSA away from Committees responsible for a single stanrdard and towards super-committees responsible for multiple standards in an area of expertise. Z107 was one of the first of such super-committees and helped pioneer this approach within CSA.

2.1 Z107 Acoustics and Noise Control

Z107, the Acoustics and Noise Control Technical Committee, is responsible for all CSA Acoustics standards other than Z94 and liaises with Canadian activities on ANSI, ASTM, IEC and ISO standards. Several members belong to these organisations' committees or Z94 and provide liaison to them.

The committee meets twice a year, once during the Canadian Acoustics Week and once in the spring. It reviews progress by each subcommittee and votes on any new work proposals. The main committee is the last technical hurdle for a standard before CSA editors put it into final form. The steering committee, to which the main committee reports, approves work and reviews completed standards, however they cannot make technical changes.

Z107 met most recently in Calgary and one item that was discussed was the possibility of adopting or endorsing the new ANSI standard on classroom acoustics. The Building Acoustics subcommittee headed by David Quirt is reviewing this standard. It is based on an intiative started by

ASA and fills a large existing gap.

Most of the work of the committee is carried out by its subcommittees who are responsible for the following standards:

Hearing Measurement, chaired by Tang Chow, is responsible for **CAN3-Z107.4-M86** Pure Tone Air Conduction Audiometers for Hearing Conservation and for Screening and **CAN/CSA-Z107.6-M90** Pure Tone Air Conduction Threshold Audiometry for Hearing Conservation

Vibration, chaired by Tony Brammer, provides liaison between Z107 and the Technical Advisory Committee of Standards Council on ISO standards on vibration. Tony is active on the ISO group for ISO 2631.

Powered Machines, no longer has standards of its own but recommends adopting or endorsing ANSI, SAE or ISO standards.

Industrial Noise, chaired by Tim Kelsall, is responsible for the following standards:

Z107.51-M1980 (R1994) Procedure for In-Situ Measurement of Noise from Industrial Equipment. A group is looking at replacing this standard with a series of ISO standards, within the framework of the new Z107.58 standard.

Z107.52-M1983 (R1994) Recommended Practice for the Prediction of Sound Pressure Levels in Large Rooms Containing Sound Sources. This standard is in need of major updating and a chair is being sought to do this work. The intent is to provide guidance to Canadian industry on how to design quiet plants. It is seen as building upon Z107.58 which provides advice on buying quiet equipment.

Z107.53-M1982 (R1994) Procedure for Performing a Survey of Sound Due to Industrial, Institutional, or Commercial Activities. This standard will be replaced with ISO1996. A working group chaired by Chris Krajewski and including several Ontario consultants is examining using 1996 as a way of updating the way tonal and impulse sounds are handled in community noise[1]. They have run several round robin tests of the procedures with sample sounds[2]. Stephen Keith of Health Canada is acting as liaison with the ISO committee. The Canadian version will include an informative annex relating the standard to the Canadian context.

CAN3-Z107.54-M85 (R1993) Procedure for Measurement of Sound and Vibration Due to Blasting Operations. A working group, chaired by Ramani Ramakrishnan, is revising this standard. This activity is just getting started.

CAN/CSA-Z107.55-M86 Recommended Practice for the Prediction of Sound Levels Received at a Distance from an Industrial Plant. A joint CSA/ANSI working group co-chaired by Rich Peppin and Tim Kelsall is looking at ISO9613 for adoption or endorsment. This standard was originally written by an ISO working group chaired by Joe Piercy of NRC. It may ultimately replace or become the basis for a revised version of Z107.55, however the group has identified a number of shortcomings which need to be addressed.

Z107.56-94 Procedures for the Measurement of Occupational Noise Exposure is referenced in Federal and some provincial regulations and has been updated by a working group chaired by Alberto Behar. At the subcommittee meeting in June it was decided to remove all reference to a 5 dB exchange rate although Ontario and Quebec still use it. The subcommittee felt that this exchange rate was no longer technically defensible and that only the 3 dB exchange rate should be used. Consultation with the provinces is ongoing, but a recent request by Ontario to revisit this issue was overwhelmingly turned down by the subcommittee members. This standard is currently being reviewed by the Editorial Subcommittee before the latest revision goes to ballot.

Z107.58-2002 Guidelines For Machinery Noise Emission Declarations Levels was written by a group chaired by Stephen Bly and was published[3] in 2003. It is a voluntary guide on noise emission declarations for machinery to be used in Canada and is compatible with European regulations to allow Canadian machinery to be sold into that market.

A Noise Emission Declaration is a statement of sound levels produced by equipment, which would usually be included with the instruction or maintenance manual. Measurements are made according to ISO standards and include estimates of the likely variability of the measurements. Canada recommends use of a declaration stating the level and uncertainty as two numbers, although in some cases they may be added together into a single number.

In addition, the Industrial Noise subcommittee undertakes reviews of proposed federal and provincial regulations,often at the request of the regulators, and other activities affecting industrial noise.

Transportation Noise, chaired by Soren Pedersen, is responsible for **CAN/CSA-Z107.9-00:** Standard for Certification of Noise Barriers. This standard is an adaptation of the Ontario MTO Highway Noise Barrier specification. It provides municipalities, developers, road and highway departments, railways and industry with a standard specification which can be used to define the construction of barriers intended for long term use in Canadian conditions.

Manufacturers' specific barrier designs are certified as complying with the standard in such areas as: materials used, weathering and corrosion resistance testing, STC, NRC, etc. In addition, each barrier installation is reviewed and certified for compliance with such items as footings design, material sample testing, welding, caulking, backfilling, etc.

The US Highway Barrier Design Manual is already harmonised with the CSA standard, as is the Ontario Provincial Standard, making this the de-facto standard for barriers across North America.

Editorial, chaired by Alberto Behar, (which reviews all proposed standards) is responsible for reviewing and endorsing ANSI S1.1-1994 Acoustical Terminology. They are currently reviewing the latest revision to Z107.56.

Building Acoustics, chaired by David Quirt, does not have its own standards, but endorses or adopts other standards, mostly from ASTM. The most recent under examination is the new ANSI classroom acoustics standard.

Instrumentation and Calibration, chaired by George Wong, liases with Canadian activities on ANSI, IEC and ISO instrumentation standards and endorses or adopts these standards. They have been actively involved in ongoing work to prevent changes to the A-weighting at the international level. This subcommittee is harmonised with the Standards Council of Canada Steering Committe for IEC Acoustical Instrumentation standards.

Liaison with the Canadian Steering Committee for ISO TC43 (Acoustics) and TC43(1) (Noise), chaired by Stephen Keith provides Canadian comments and votes on ISO standards and coordinates the work of Canadian representatives on several ISO working groups. This work was ably lead by Krish Krishnappa until his untimely death this year and Stephen Keith has agreed to take on the considerable work required to chair this active group. The Steering committee is run by the Standards Council of Canada and is harmonised with the Z107 committee to which Stephen reports regularly on progress. Draft international standards are provided on a private website to which members have access in order to review them and recommend Canada's position.

2.2 Z94 – Hearing Protection

The second CSA Acoustics Standards Committee, Z94 is responsible for a single standard, the Hearing Protection Standard Z94.2 which defines Type A, B, and C type hearing protectors and is widely referred to in Canadian occupational noise regulations. They have recently approved a major new version of this standard in light of changes to the ANSI hearing protector standards and procedures. This will mean the introduction of user-fit hearing protector measurements, similar to those used by ANSI and now recognized as being more representative of how hearing protectors are used in practice than the old technician-fitted testing methods. This standard also has extensive information for users on how to select and use hearing protection.

3. REVIEWING OTHER STANDARDS

A large part of the committee and subcommittee work is reviewing standards written by other standards-writing- bodies, such as ANSI or ISO, for adoption or endorsation by Canada. Whenever possible, as global harmonisation becomes more important, CSA adopts or endorses international standards rather than writing their own. In areas where standards apply to goods coming from or going to other countries, use of international standards makes considerable sense.

Adopting a standard, i.e. republishing it, with changes or additions if necessary, costs less than half the cost of writing a new standard. Endorsing, which means that the standard has been reviewed and found suitable for Canadian use as is is the least expensive option, but less useful because the standard is not so readily available.

4. CANADIAN ACOUSTICS STANDARDS

Table 1 shows all the Canadian Standards currently in force and also lists two standards whose Acoustics sections were written with the assistance of the Z107 committee. This table will also soon be found at the CAA website and will be kept up to date there. Meanwhile the list can be found at

http://www.csaintl.org/onlinestore/GetCatalogDrillDown.asp?Parent=430

There are also 24 acoustics standards from ANSI, ISO and ASTM endorsed by Canada. They are listed in Table 1 following the CSA standards.

Table 1- CSA Acoustics Standards

CAN3-Z107.4-M86 Pure Tone Air Conduction Audiometers for Hearing Conservation and for Screening / Audiomètres tonals à conduction aérienne pour la préservation de l'ouïe et pour le dépistage

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

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

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

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

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

Activities (soon to be replaced by ISO 1996).

CAN3-Z107.54-M85 (R1993) Procedure for Measurement of Sound and Vibration Due to Blasting Operations / Méthode de mesure du niveau sonore et des vibrations émanant des opérations de dynamitage

CAN/CSA-Z107.55-M86 Recommended Practice for the Prediction of Sound Levels Received at a Distance from an Industrial Plant / Pratique recommandée pour la prévision des niveaux sonores reçus à une distance donnée d'une usine

Z107.56-94 Procedures for the Measurement of Occupational Noise Exposure / Méthode de mesure de l'exposition au bruit en milieux de travail

Z107.58-2002 Guidelines For Machinery Noise Emission Declarations

Z94.2-02 • Hearing Protection Devices - Performance, Selection, Care, and Use / Protecteurs auditifs.

Standards with Acoustics Component:

Z62.1-95 Chain Saws

CAN/CSA-Z412-M00 Office Ergonomics / L'ergonomie au bureau

Endorsed Standards

ANSI S1.1-1994 Acoustical Terminology(R1999)

ANSI S1.4-1983 Specification for Sound Level Meters (R2001)

ANSI S1.11-1986 Specifications for Octave-band and Fractional (R1998) Octave-band Analog and Digital Filters

ANSI S1.13-1995 Measurement of Sound Pressure Levels in Air (R1999)

ANSI S12.31-1990 Precision Methods for the Determination of (R1996) Sound Power Levels of Broad-band Noise Sources in Reverberation Rooms

ANSI S12.32-1990 Precision Methods for the Determination of (R1996) Sound Power Levels of Discrete-frequency and Narrow-band Noise Sources in Reverberation Rooms

ANSI/ASTM Standard Test Method for Sound Absorption and C423:00 Sound Absorption Coefficients by the Reverberation Room Method

ANSI/ASTM Standard Test Method for Laboratory E492-90 (1996) E1 Measurement of Impact Sound Transmission Through Floor-ceiling Assemblies Using the Tapping Machine

ASTM C384-98 Standard Test Method for Impedance and Absorption of Acoustical Materials by the Impedance Tube Method

ASTM E90-99 Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements

ASTM E336-97 Standard Test Method for Measurement of Airborne Sound Insulation in Buildings

ASTM E596-96 Standard Test Method for Laboratory Measurement of the Noise Reduction of Sound-isolating Enclosures

ASTM E795-00 Standard Practices for Mounting Test Specimens During Sound Absorption Tests

ASTM E966-99 Standard Guide for Field Measurement of Airborne Sound Insulation of Building Facades and Facade Elements

ASTM E989-89 Standard Classification for Determination of (1999) Impact Insulation Class (IIC)

ASTM E1007-97 Standard Test Method Field Measurement of Tapping Machine Impact Sound Transmission Through Floor-ceiling Assemblies and Associated Support Structures

IEC 60651-2001 Sound Level Meters

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

ISO 6393:1998 Acoustics – Measurement of Exterior Noise Emitted by Earth-moving Machinery – Stationary Test Conditions

ISO 6394:1998 Acoustics – Measurement at the Operator's Position of Noise Emitted by Earth-moving Machinery –Stationary Test Conditions

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

ISO 6395:1998 Acoustics – Measurement of Exterior Noise Emitted by Earth-moving Machinery – Dynamic Test Conditions – Amendment 1

SAE J919-1995 Sound Measurement – Off-road Work Machines – Operator Singular Type

SAE J1096-2000 Measurement of Exterior Sound Levels for Heavy Trucks under Stationary Conditions

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Developing a New Measure for Assessing Architectural Speech Security

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Introduction

This paper describes the process and problems of developing a new measure of architectural speech security. Such a measure is required to more accurately rate the probability of a listener outside a room being able to overhear conversations from within the room. Previous work has considered various levels of speech privacy, where some speech is intelligible [1]. However, speech security usually implies that none of the overheard speech is intelligible, or in some cases it is not even audible.

One can describe 3 levels of speech security. The first level would be when only a very small percentage or none of the overheard words are intelligible. Even when no words are intelligible, it is often still possible to recognize the rhythm or cadence of the speech. Finally, the highest level of speech security would be when all speech sounds from the adjacent space are completely inaudible.

Speech privacy and speech security have been related to signal/noise (S/N) type measures (where the signal is the speech from the adjacent space). The simplest would be a difference of A-weighted speech and noise levels. More sophisticated measures such as the Articulation Index (AI), and its more recent replacement the Speech Intelligibility Index (SII) (ANSI S3.5), are known to be better related to speech intelligibility within rooms. They more correctly weight the importance of S/N ratios at different frequencies and more accurately combine the various frequencies. These frequency weightings may not be optimum for speech security situations, and these measures are not ideal at very low levels of speech intelligibility.

Experimental Procedure

In this work, subjects rated simulated speech security situations. The subjects sat in a sound-isolated room and heard speech sounds, modified to simulate transmission through various walls, and combined with typical ambient noises. The speech and noise sounds were spatially separated and were precisely measured at the listener's head position in an acoustically dead environment.

Many variables will influence the intelligibility of overheard speech, including: talker gender and voice characteristics, speech material, voice level, wall transmission loss characteristics, ambient noise spectrum shape and level, listener hearing sensitivity, and other listener characteristics. Many of these were determined to be of less importance in pilot tests. Only subjects with negligible hearing loss were included.

In the main intelligibility experiment, 30 subjects each listened to 340 test sentences. The phonetically balanced and low predictability Harvard sentences were used [2], and 5 different sentences were used for each physical condition. Each condition was one of 68 combinations of varied: ambient noise, wall transmission loss characteristics, and S/N ratio. The conditions were chosen so that intelligibility ranged from 0 to 100%. A second experiment was intended to determine the thresholds of: (a) audibility of any speech sounds, (b) audibility of the cadence of the speech, and (c) the intelligibility of the speech. In this experiment the 20 best listeners from the first experiment each listened to 160 sentences. Again there were 5 sentences for each condition, and a range of ambient noise and wall transmission loss values. However, in this experiment conditions had, on average, much lower S/N values so that they included situations where no speech sounds were audible to the listeners.

Evaluation of Measures of Intelligibility

Figure 1(a) plots intelligibility scores versus measured SII values in the test sound fields. To simplify the plot, the results were averaged over all subjects. Although intelligibility scores increase with SII as expected, at SII=0 intelligibility is not zero. Therefore, SII (and AI) cannot be used to describe conditions for high levels of speech security which would correspond to acoustical conditions below SII=0, where SII is not defined. Figure 1(b) shows that differences of A-weighted levels are not limited in this way but are much less accurately related to intelligibility scores.

An example of a more successful measure is shown in Figure 1(c), which plots the same intelligibility scores versus a S/N ratio measure that included the same frequency weightings as the SII measure.

Speech Security Threshold Measurements

The 6 graphs of Figure 2 show the results of evaluations of the 3 types of thresholds and the effects of different weightings of the importance of each frequency band. Each graph shows the percentage of subjects with responses indicating: at least one word is intelligible (a) & (d), the cadence of the speech is audible (b) & (e), and some speech sounds are audible (c) & (f). In graphs (a)-(c) results are plotted against SII-weighted S/N ratios and in graphs (d)-(f) against LF-weighted S/N ratios, having greater emphasis on the lower frequencies.

If one considers the threshold to be when 10% of the subjects respond, the threshold for intelligibility is reached at -18.5 dB, for detection of cadence at -24 dB, and for audibility at -27 dB on the SII-weighted S/N ratio measure. Thus, complete speech security (inaudibility) requires speech levels to be about 8.5 dB lower than for the threshold of intelligibility. This would correspond to a

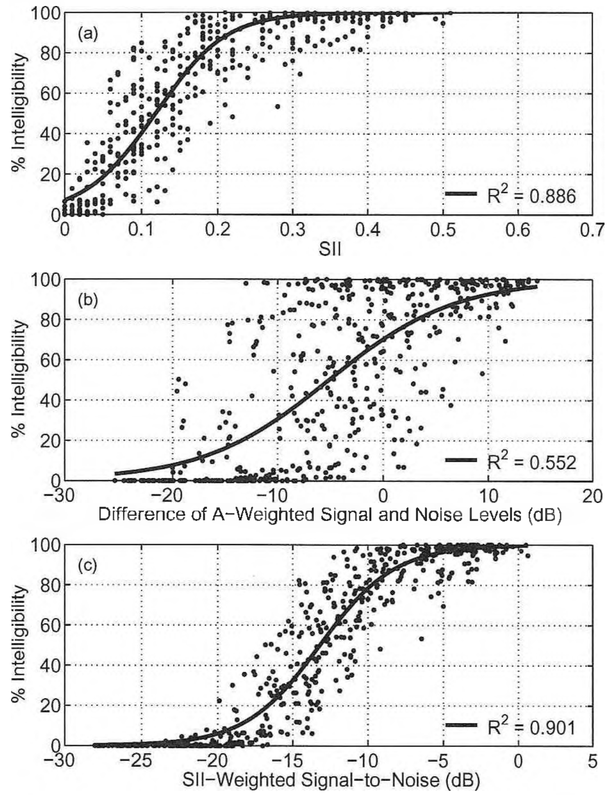

Fig 1. Speech intelligibility scores vs. (a) SII, (b) difference of A-weighted levels, and (c) SII-weighted S/N ratio.

substantially better wall transmission loss. Although the SII-weighted S/N ratios predict the intelligibility threshold reasonably well, the LF-weighting provides more accurate estimates of the thresholds of cadence and audibility.

Conclusions

Existing measures of speech intelligibility and speech privacy are not adequate for evaluating the speech security of closed offices and meeting rooms.

The optimum frequency weighting for predicting the onset or threshold of intelligibility is different from that for predicting the threshold of the audibility or the cadence of speech sounds.

Speech security must be statistically described in terms of the percentage of listeners able to hear or understand speech from adjacent spaces.

Complete speech security, where speech sounds are totally inaudible, would require substantially better sound isolation of meeting rooms than is required for eliminating word intelligibility in adjacent spaces.

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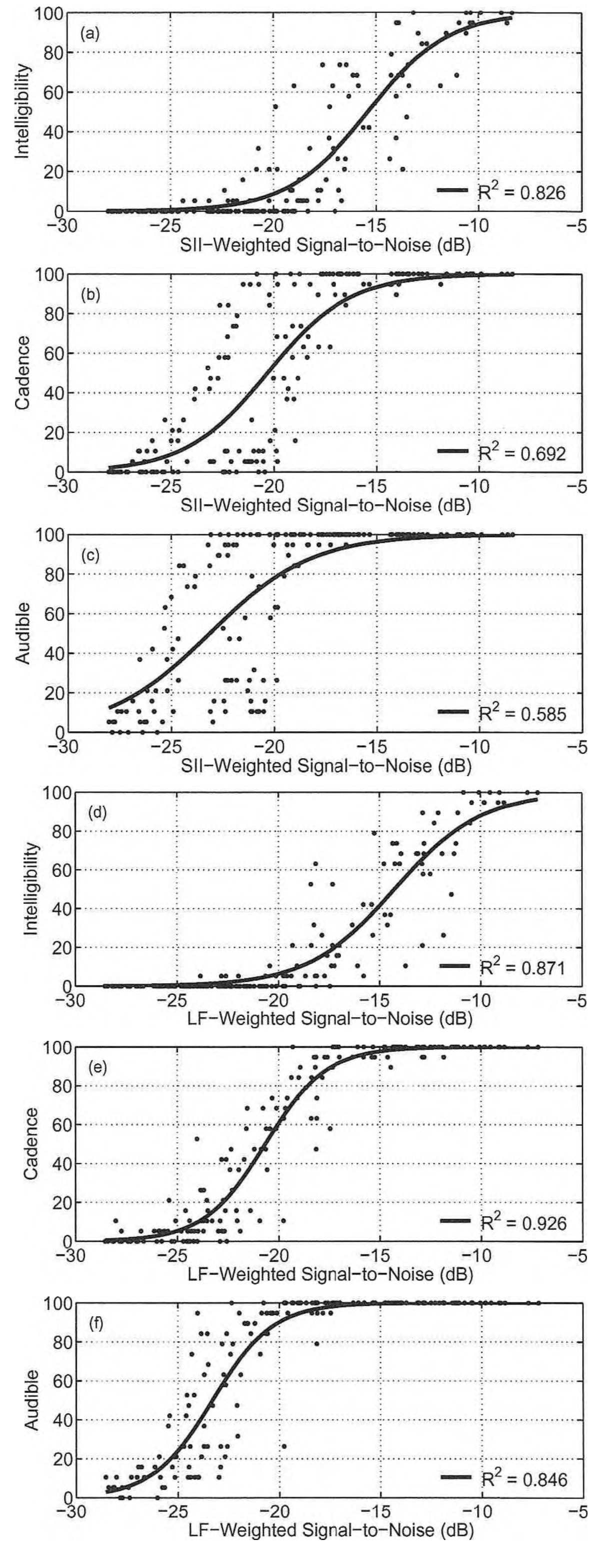

Fig 2. Percentage of subjects detecting some intelligibility (a) & (d), cadence (b) & (e), and audibility (c) & (f) vs. SII- weighted S/N (a)-(c), and LF-weighted S/N (d)-(f).

Editor's Note: This article by Neil Gross appeared originally in December 2002 issue of ***Acoustics Australia*** and is reproduced here with the permission of the author and the journal.

ROAD TRAFFIC NOISE - THE SELECTION OF A PREFERRED ROUTE

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1. INTRODUCTION

For new road projects the route selection process is an essential part of determining the preferred route. This includes many selection parameters of which noise is just one. Technical information which includes some form of noise assessment needs to be provided at the Value Management Workshop which would occur early in the road design and is a requirement of the EIS process. However, normally little or no data is available regarding the different options with the exception of several coloured lines on a map. The required input to the VM workshop is that these route options need to somehow be ranked. Time frame is 1 week and the budget may only be a few thousand dollars.

This article should not be considered as a research paper but rather as a technical note which may prove beneficial to those assessing road traffic noise in order to satisfy RTA requirements.

Wilkinson Murray's involvement in road traffic noise projects which have required a route selection process has led to the development of a simple assessment procedure. The procedure is described in this article

When faced with 6 different coloured lines on a map which represent 6 route options to be assessed, how can you decide which is the best overall from a noise perspective? Are 10 residences set back 50m from a new road better or worse than a combination of 5 residences set back 25m with a further 5 residences set back 100m. What happens if some of these residences are already affected by road traffic noise. Imagine how much harder the selection becomes when there are possibly 400 to 500 residences at varying distances up to 300m and beyond.

Without a site visit or the option of doing detailed calculations (the route selection assessment is normally restricted to a desktop study with limited budget and without a road design) the assessment has to be based on professional judgement and intuition.

An assessment procedure has been developed, which probably supports the intuition, which uses a simple numbers approach to break the overall selection process into a number of smaller packages that allow comparison and can be handled with greater ease.

To assess the future likely impact of road traffic noise, three basic parameters have been chosen.

- Number of residential properties potentially affected.
- Future absolute noise level at each residence.
- Change in noise level (both increase and decrease) from existing situation at each residence.

In other words, the more residences affected the worse the route, the higher the noise level, the worse the route and the bigger the increase the worse the route.

2. WHAT DO YOU NEED?

- Aerial photography and perhaps the opportunity to speak on the phone with someone (Project Manager) who is reasonably familiar with the area;
- a scale rule;
- a simple spreadsheet; and
- the ability to count.

3. WHAT IS THE BASIS OF CALCULATING EXISTING AND FUTURE NOISE LEVELS?

In the absence of information at the early stage of any project it is likely that the number of vehicles, vehicle distribution, traffic speed and road surface will all remain the same for each route. The parameters which will vary are, distance to each residence, natural shielding and road gradient. Since the road design (ie cut, fill and gradient) is not fixed at this early stage then it is impossible to account for these factors. Realistically, distance from the centre line of the proposed road alignment to each residence is the only readily available parameter to assess future noise levels. In a similar fashion, distance from the centre line of the existing road alignment is the only readily available parameter to assess existing noise level.

4. WHAT TO DO?

Previous assessments conducted by Wilkinson Murray have considered a region 300m either side of the route centre line. This has been based on the area over which information has been readily available. The recent change in EPA guidelines may indicate that 500m or even further is a more appropriate distance within which to include residences.

The procedure requires counting residences along each route option and compiling a spreadsheet for each route option (including the do nothing). A sample spreadsheet is attached.

The first step involves getting a decent size map and enough space on the office floor to spread it out. It is then necessary to split the areas either side of the existing and new routes into the following different distance categories from each route: 0-50m, 50-100m, 100-200m, 200-300m. Just use a scale rule and draw lines parallel to each of the route options. The first distance category realistically deals with residences within 25-50m from the edge of a road. The move from one distance category to the next therefore typically represents equal changes in traffic noise level when allowing for geometric spreading and ground effects.

The second stage involves dividing the route options into different sections along their length (chainages) which simply makes residences easier to count and recount. This should typically be about 10 sections and preferably based on obvious features such as intersections with existing roads.

Thirdly, for any one of the 6 options for each residence it is necessary work out how far the residence is from the existing road and how far it would be from the route option being assessed. For example, if a residence will end up being 50-100m from the new alignment, this residence must be added to one of the columns within the 50-100m category depending on its distance from the existing alignment.

The fourth stage involves repeating this process for all the other options.

The fifth stage involves applying the various weightings shown at the top of each column. The weightings have been selected by using a paired comparison procedure in conjunction with experience in the likely effects of absolute traffic noise level and of changes in traffic noise level on potential annoyance. This is explained in more detail below.

The weightings range from 0.4 to 6.4 and have been selected starting with a weighting of 1. This represents the situation where there is no change in noise level at a residence set back 200-300m from the existing road. If noise levels are higher (residences are closer) or increases are bigger, a weighting greater than 1 needs to be applied since it would represent a greater impact. Similarly if noise levels were to reduce a weighting less than 1 needs to be applied.

However for the same change in noise level either up or down the procedure recognises that the increase is perceived to be worse than the decrease. For example a route which improves noise at 50 residences but makes it worse at 50 is not considered to be as as good as a route, for the same changes in noise level, which increases noise at 10 and reduces noise at 10.

Since a 10dBA increase in noise level is widely accepted to be a subjective doubling in noise, this has been used to loosely set the weightings by comparing the different distance categories. The weightings have then been refined by comparing different situations and deciding which would be better or worse.

Finally, it is necessary to total the number of residences affected and calculate the total weighting for each route option. Basically the lowest total is the route which affects the least number of residences and the lowest "weighted" total is the route with the least impact.

Impress the client by issuing a report with a clear ranking and be satisfied with the quality of your work. Don't be disappointed when you realise there were at least 25 other route selection assessment parameters and the quietest route didn't win. At least the fees for future noise control may make up for the disappointment that noise was not the most important selection parameter.

5. SUCCESS AND IMPROVEMENTS

The success of the procedure is hard to define since noise is only one of many selection parameters and of course all 6 route options are never built or even assessed in more detail. However the procedure has certainly helped the author prepare a quantitative assessment which appears to match the intuition.

This procedure is far from perfect in many ways but does meet its objective. Minor adjustments have already been made to this procedure when dealing with specific projects. Two examples are given below.

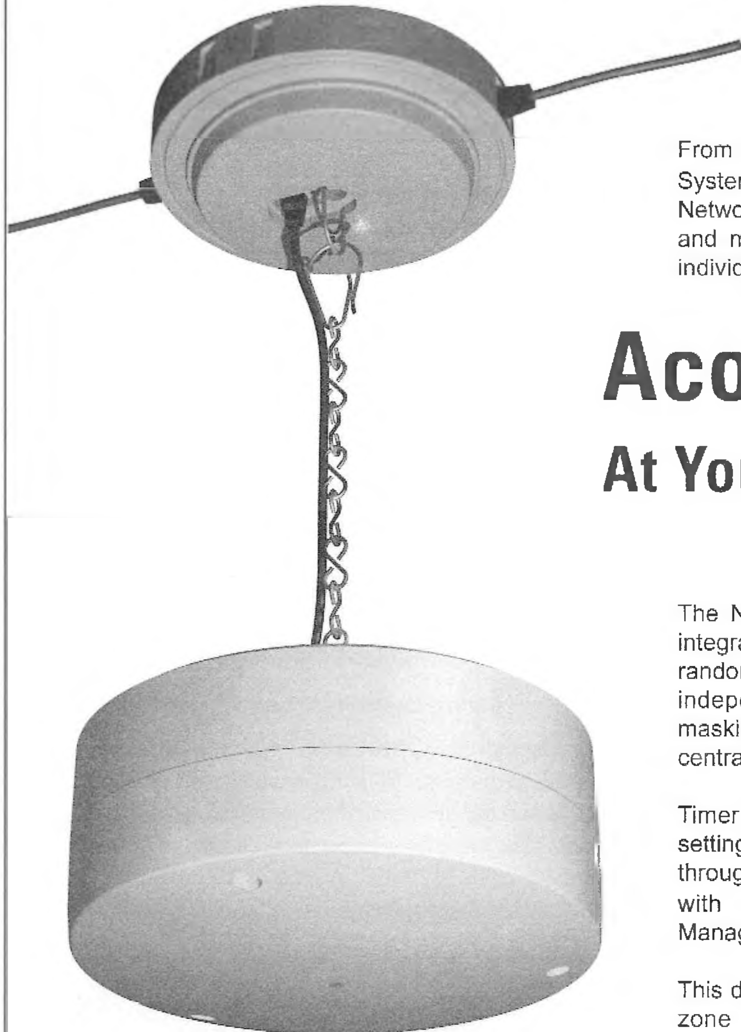
Some projects have had one route option, which involves an upgrade of an existing alignment with the other options in virgin areas. This means the existing route would remain open to traffic but with a lower flow. In these instances it has been necessary to adjust the weighting for any residence. This has been done by moving it into a different distance category depending on the difference in traffic numbers between the existing and future flow.

Some projects have had route options in undulating terrain and it has been quite obvious where cut and fill will be required. Again adjustments can be made by moving the number of residences from one distance category to another to account for more shielding or reduced ground effects. These adjustments require professional judgement but in shallow cut where shielding of approximately 5dBA would be achieved would be similar to approximately a change of one distance category. For a deeper cut this may equate to a change of 2 distance categories.

In using this technique I have been able to criticise it and feel that it could be improved. However this would require more detailed input information and time to assess these details, both of which are not available at the early stage. In addition the improvement in accuracy that they may bring is not considered warranted at this early stage of a project when noise is just one of many selection parameters.

The author would welcome any feedback.

Option	Distance from Proposed Alignment																			
	0 - 50					50 - 100					100 - 200					200 - 300				
Distance from existing alignment	>300	200-300	100-200	50-100	0-50	>300	200-300	100-200	50-100	0-50	>300	200-300	100-200	50-100	0-50	>300	200-300	100-200	50-100	0-50
Weighting	6.4	5	3.7	3	2.2	4	3	2.3	1.7	0.9	2.2	1.7	1.3	.85	.7	1.5	1	.8	.6	.4
Chainage Wilkinson Rd to Murray St	5	0	0	5	0	0	5	0	0	5	0	0	5	0	0	5	0	0	5	0
Murray St to Heggie Ave	10	5	0	10	5	0	10	5	0	10	5	0	10	5	0	10	5	0	10	5
Heggie Ave to Athol Ln	0	0	10	0	0	10	0	0	10	0	0	10	0	0	10	0	0	10	0	0
Athol Ln to Benbow Pde	5	10	0	5	10	0	5	10	0	5	10	0	5	10	0	5	10	0	5	10
PROPERTIES	20	15	10	20	15	10	20	15	10	20	15	10	20	15	10	20	15	10	20	15
PROPERTIES x WEIGHTING	128	75	37	60	33	40	60	35	17	18	33	17	23	13	7	30	15	8	12	6
WEIGHTED TOTAL			333					170					93					71		
										PROPERTY TOTAL			305							
										WEIGHTED GRAND TOTAL			667							



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Good, Good, Good Vibrations!!!

Caroline Hulbert
Winner of the CAA Youth Science Foundation Award, 2003

Background

Have you ever had a car pull up beside yours with the base booming so loud that your car vibrates? When that happened, did you ever think about the effects that those vibrations must be having on you as well as the person in the booming car, or just on matter in general? Normally when we think of vibrations, we think of sound and particularly music. But in truth, vibrations are a much greater part of our lives and through my investigations, I hope to show you that.

Vibrations come from many sources, from the smallest units of light and matter to the largest even including stars. The range of vibrations makes up the electromagnetic spectrum. Although there are many sources, from boats to planes and cell phones to stars, I am most interested in radio sound vibrations, the longest waves in the electromagnetic spectrum. My interest is that under certain conditions, the waves can interact to form interference patterns as illustrated in Figure 1.

Interference occurs when the phases of two interacting waves are not aligned. This happens when there is intermediate phase alignment. When the waves are phase aligned, they add and when they are phase opposed, they cancel each other out. The significance of interference patterns is they influence all kinds of matter in many different ways [4, 5].

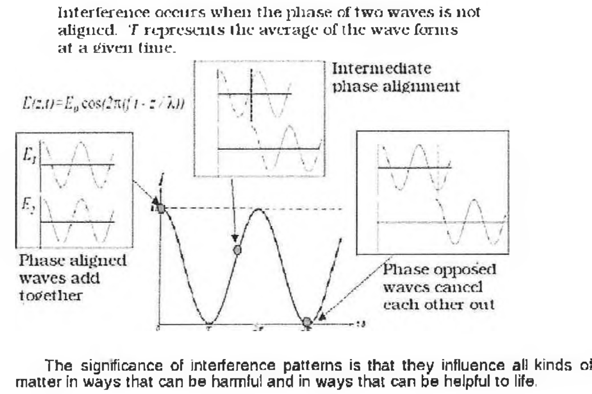


Figure 1. Interference Concept.

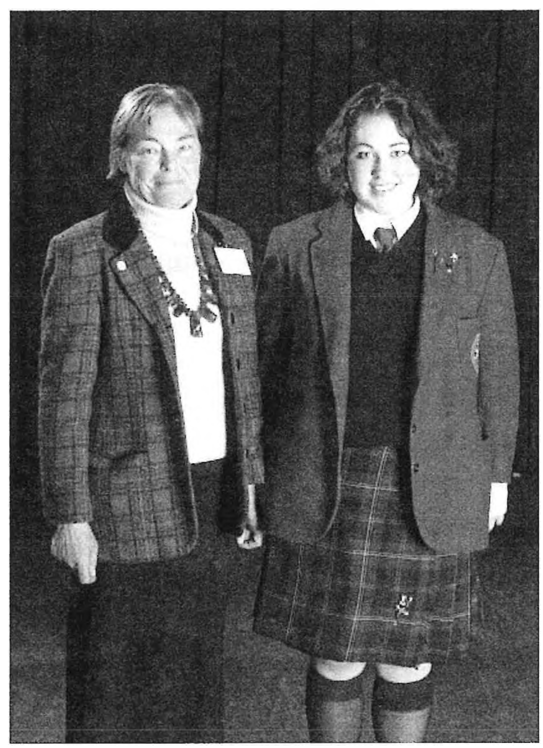
Back in 1787, physicist Earnst Chladni founded the sci-

Canada Wide Science Fair

From File Reports

Caroline Hulbert, a Grade 10 student at St. Margaret's School in Victoria, BC, won this year's acoustics prize at the Canada Wide Science Fair. Hulbert is currently in Grade 11 at Mount Douglas Secondary. She is the Year book Editor for the Fine Arts. She is also in the School Concert choir and has been surrounded by music through out her life. Because these vibrations always played such a major role in her life, Hulbert started to ask questions, such as: what are the effects of constantly bombarding oneself with all these different vibrations? With her father as her mentor Hulbert set out to find the answer. Along the way she came across the above experiment that could further her knowledge about these vibrations and validate the research that she had done.

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



Caroline Hulbert (r) with CAA's Elzbieta Slawinski (l)

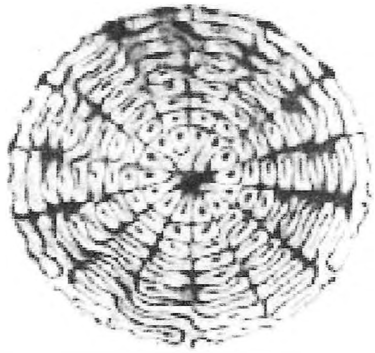


Figure 2. Plant Cell Patterns in Sand.

ence of Cymatics which is the study of how sound affects matter. His work was extended by Dr. Hans Jenny, a Swiss physician [2, 6]. He suspended a metal plate on crystal oscillators connected to a frequency generator. Then he put various media on the plate and observed the patterns formed when he changed the frequencies. He demonstrated that the shapes of various plants, animals and insects could be reproduced in sand patterns in his laboratory just by selecting various frequencies. One example of his findings is shown in Figure 2. This pattern is very similar to the organization of cells in the stem of a plant. So, neat sand patterns are formed because of interference patterns. Now then, what is the relationship between the sand patterns and the interference patterns? Dr. Jenny found that the area in the sand pattern that had no sand was the area of high energy, where the waveforms had added together. Where the waveforms had canceled each other out, there was an area of low energy and that was where the sand had deposited. He showed that sand patterns are negatives of interference patterns.

Purpose

To explore the relationship between frequencies and waveforms that produce defined interference patterns in sand and their effects on biological matter - bacteria growth and plant seed germination and growth.

Hypotheses

1) different waveforms at a given frequency will produce different interference patterns, and
2) sounds that cause different interference patterns in sand to form will affect the rate of *E. coli* bacteria colony growth and the rates of Alfalfa seed germination and growth.

Procedure

I. Frequency Generator Setup Holes (1/8" diameter) were drilled into the bottom of a 1 Kilo size coffee can and a speaker was mounted over the holes. A rubber sheet was

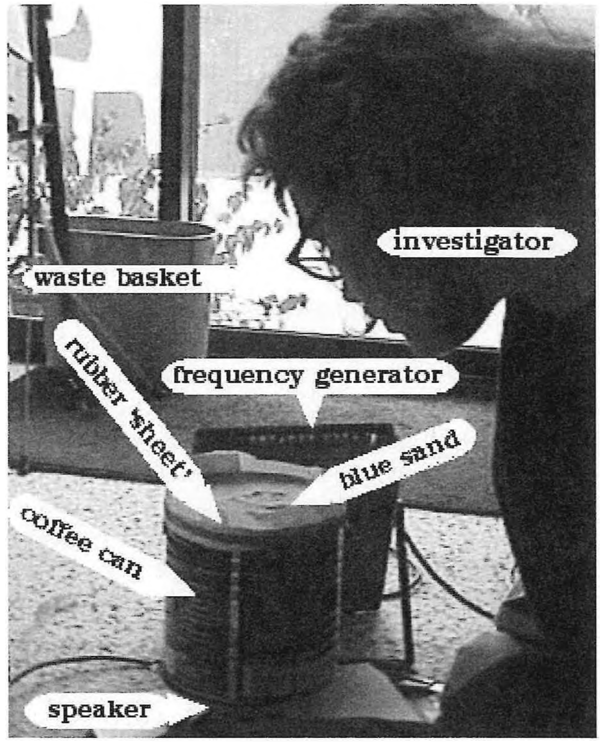


Figure 3. Experimental Set-Up.

carefully stretched across the top of the coffee can and secured with an elastic band. A paper retainer was placed around the rim of the can to contain the sand on top of the rubber sheet. Leads were connected from the Circuitmate frequency generator to the speaker. The maximum amplitude was used for all frequencies tested. The experimental set-up is shown in Figure 3.

II. Sand Procedure

a) Multi-waveform patterns Three frequencies, 200 Hz, 3000 Hz, and 8500 Hz were selected for testing. The waveform output of the frequency generator was swiitched from sine wave to square wave to triangular wave and the patterns generated were recorded with a digital camera.

b) Experimental waveforms for Bacteria Two square waves at 1000 Hz and 790 Hz were selecetd because the interference patterns generated were so significantly different from one another.

c) Experimental waveforms for Plants Two frequencies, 200 Hz and 8500 Hz were selecetd for experimentation on seed germination and growth. 200 Hz represents the base booming heard in cars and 8500 Hz represents the frequencies for bird chirps. These frequencies were also selected because with the test apparatus, they produced distinctly different interference patterns in sand which was one of the test criteria.

III. Bacteria Procedure Petri dishes were inoculated with *E. coli* on nutrient medium. Three petri dishes were placed on top of the rubber sheet and then exposed to either 790 Hz or 1000 Hz for 1.5 hrs. Following treatment, the plates were placed into a home made incubator at a temperature of 30^0 C. The plates were removed at intervals of 7 hrs, 23.5 hrs and 33.5 hrs and photographed to record colony size for measurement.

IV. Seed and Plant Procedure

a) General Twenty Alfalfa seeds for each of the 12 experimental sound treatments for both the 'wet exposed' and 'dry exposed' conditions (24 groups in total) were placed between folded strips of paper towel, approximately 3cm wide, into 2 - 23 X 28cm plastic lids (one for dry and one for wet exposures). They were moistened with water, covered with plastic wrap to prevent dehydration, and then put into a cardboard box incubator with a heat lamp to germinate and grow.

b) Sound Exposure Alfalfa seeds were exposed to 200 Hz or 8500 Hz sine, square, and sawtooth waves by placing the seeds in the folded paper towel into a petri dish that was placed directly on the rubber sheet on the coffee can. The Alfalfa seeds were either exposed to the two frequencies and 3 waveforms for 1/2 hr 'dry', or 'wet' with water. Exposures were done in one room of my house and the plants not being exposed were in another part of the house.

Results

I Bacteria

a) Interference Patterns in Sand The effects of sound is shown in Figure 4 for two square waves. Figure 4 (1) - for 790Hz -shows an interference pattern characterized by a central peak with some marginal accumulation as well. Figure 4 (2) - for 1,000Hz - shows an interference pattern characterized by a ring of sand with the center clear. There is some marginal accumulation and patterning as well.

b) Effects on the Size of Bacterial Colonies The different wavelengths affect the size of the bacterial colonies differently, as shwon in Figure 5. At all time intervals examined, bacteria exposed to 1000Hz exhibited significantly larger colonies ($p < 0.05$) than the control. By contrast, bacteria exposed to 790 Hz had significantly smaller colonies ($p < 0.05$) at 23.5 hrs after exposure, but, that reversed by 33.5 hrs where colony size was significantly greater than control ($p < 0.05$). See Table 1 for statistical details [1].

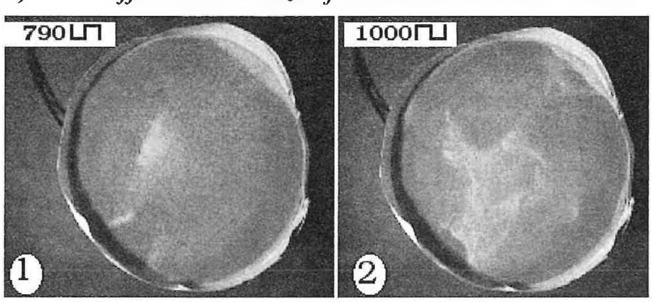


Figure 4. Interference Patterns in Sand.
1 - 790 Hz square wave; 2 - 1000 Hz sqaure wave.

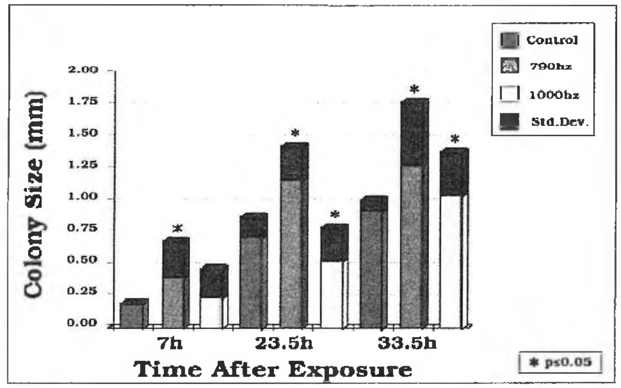


Figure 5. Size of E-Coli Colonies after expsoure to square waves for 1.5 hours.

Control vs 790 Hz			
p value	0.0393	0.0001	0.0001
Control vs 1000 Hz			
p value	0.5101	0.0001	0.0001
790 Hz vs 1000 Hz			
p value	0.0025	0.0001	0.0001

Table 1. Statistical details for Figure 5 [1].

II Sand The different wave forms (sine, square, saw-

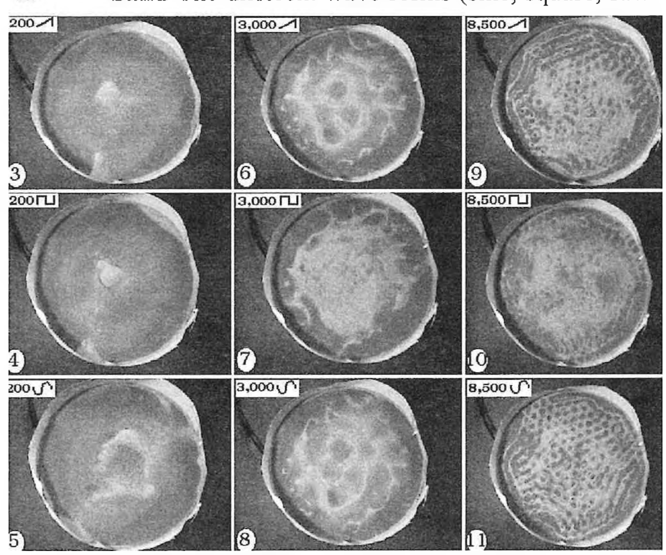


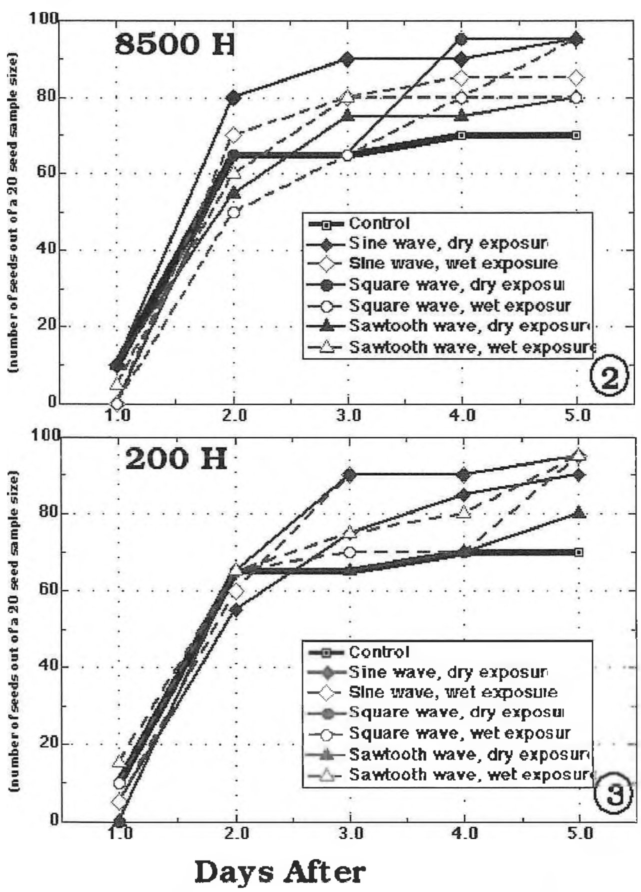
Figure 6. Interference Patterns in Sand.
a) 200 Hz Plates 3- sawtooth; 4 -square and 5 - Sine;
b) 3000 Hz Plates 6- sawtooth; 7 -square and 8 - Sine;
c) 8500 Hz Plates 9- sawtooth; 10 -square and 11 - Sine;

tooth) yielded different interference sand patterns as did the frequencies (200 Hz, 3000 Hz, 8500 Hz); moreover, as the frequencies increased, the interference patterns increased in complexity, as shown in Figure 6. The frequency of 200 Hz yielded the simplest sand pattern with the sawtooth (Plate 3) and square wave (Plate 4) forms resulting in a central dome while the sine wave (Plate 5) resulted in the negative of a dome, a central open circle. At the higher frequencies, the square wave resulted in a poorly defined interference pattern compared to the sawtooth and sine waves. Note the intricate patterning in the sand exposed to 8500 Hz compared to that of 3000 Hz (Plates 9-11 & 6-8) and 200 Hz (Plates 3-5).

III Alfalfa Seed Germination and Growth

i) Germination The effects of sine, square and sawtooth waveforms at 200 Hz and 8500 Hz on Alfalfa seed germination are shown in Figures 7 and 8. Three consistent observations are 1) that the exposure to the frequencies caused more seeds to germinate, and, 2) there does not seem to be any difference in the number of seeds germinated if the seeds are dry or wet, and 3) there was no special effect of the frequencies or waveforms tested on seed germination.

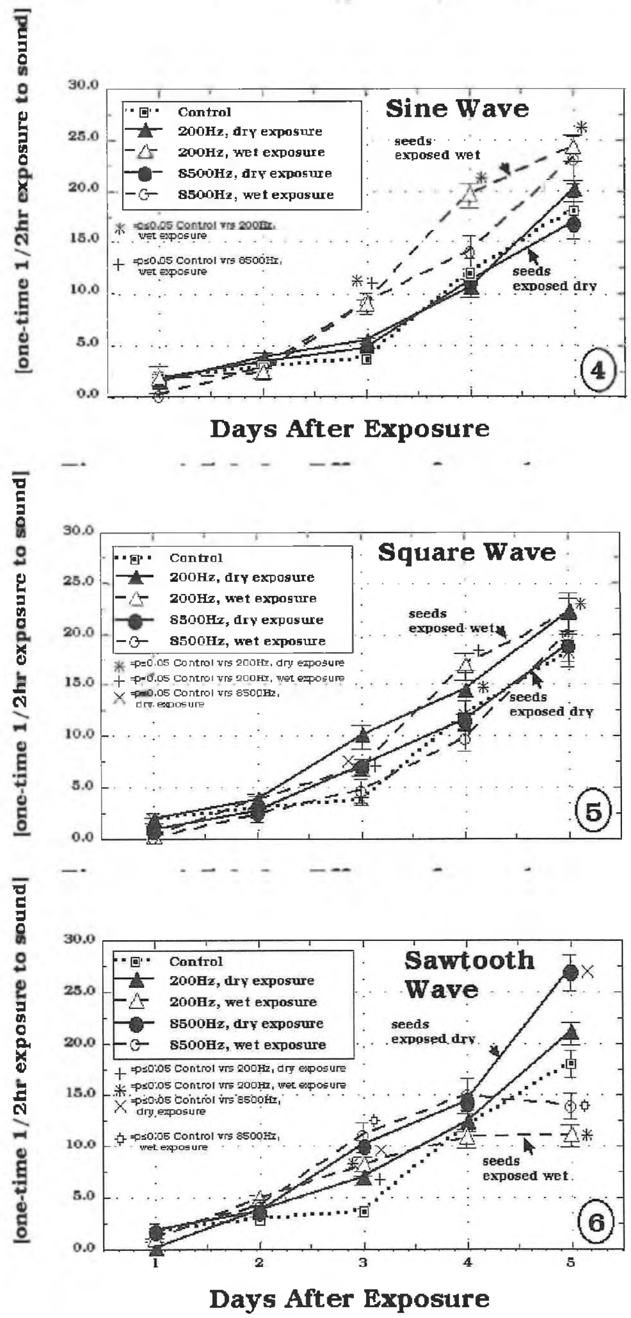
ii) Growth There was no consistent effect of frequency on Alfalfa seeds exposed dry or wet (Figures 9,10 and 11) over a 5 day assessment period, but, seeds exposed wet to sine waves at both 200 Hz and 8500 Hz grew significantly more than controls and seeds exposed dry (Figure 9); and seeds exposed wet or dry to sawtooth wave at both 200 Hz and 8500 Hz had reduced growth at 5 days compared to controls and seeds exposed dry.



Figures 7 and 8. Effect on Alfalfa Seed Germination.

Discussion

This research presents concrete evidence that links sound directly to an alteration in the structural organization of abiotic matter and subsequent effects in living tissue. The



Figures 9, 10 and11. Effect on Alfalfa Seed Shoot and Growth.

bacteria study showed an enhancement in the colony size that was different for the different frequencies and interference patterns. The sand pattern study showed a direct correlation between frequency and complexity of interference patterns. The Alfalfa seed germination and growth study showed that sound can enhance seed germination and that some waveforms at specific frequencies can have significantly different effects on plant growth. The plant literature study [3] reported showed how living organisms will either grow towards a set of vibrations and flourish, or away from vibrations and actually die. The animal literature studies [3] showed behavioral and neurological pathologies that resulted from short exposures to specific sounds that were irreversible!

One of the questions that I asked in this study was whether there was a direct link between an interference pattern and an effect on biotic matter. My results on bacteria seem to indicate this is the case because the sand interference patterns at 790 Hz and 1000 Hz were different, and, the sizes of the *E. coli* colonies were also different. The mechanism for this could be several things. It is possible that there was a stimulation of nutrient uptake by an alteration of the media itself, or by activation of enzymes responsible for growth in the bacteria. Also, changes in the bacteria genome are possible as vibrations can directly affect the expression of DNA as Drs. Bird and Schrekenberg have shown [3]. Clearly, more research is needed to understand how the colony sizes of the bacteria *E. coli* increased so much.

Because of the role of plant hormones in seed germination and growth, it is tempting to speculate that the sounds somehow affected hormone production, gibberellin and auxin. However, it is also possible that nutrient uptake from the seed, or water uptake into the seed and the root system was affected and this could alter germination and growth rates.

Conclusion

1) There is a direct correlation between increasing frequency and increasing complexity of interference patterns in sand , independent of waveform.
2) Frequencies and waveforms that produce different interference patterns in sand cause different rates of growth in *E. coli* bacteria and in Alfalfa seed germination and growth.

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Acknowledgment

I thank my family for supporting me through this study because they had to listen to the nauseating sounds too. I also thank Dr. Girard for donating the rubber sheet, Mr. Kerfoot, University of Victoria, for loaning me the frequency generator, and Mrs. Nobel at Royal Roads University for preparing the E. coli bacteria plates.

Array Signal Processing: Concepts and Techniques **by Don H. Johnson and Dan E. Dudgeon, Pages 512 Prentice Hall Inc., 1993 - ISBN 0-13-048513-6.**

The book under review is a paperback re-print of a 1993 text. In their Preface, the authors state that the book was written "primarily to serve as a text for a graduate course in advanced digital signal processing, but practicing engineers should also find it useful as a reference for array processing." As might be expected for a graduate-level text, the book assumes a high level of mathematical maturity on the part of the reader, who is expected to be conversant with multi-dimensional Fourier transforms, the Dirac delta function, etc. (There are several mathematical Appendices for refreshing the reader's memory on particular topics.) Each chapter ends with a set of problems.

One distinguishing feature of the book is its coverage of virtually all topics associated with the processing of sensor arrays. The book opens with a description of space-time signals, starting with the wave equation and the nature of its solutions. The treatment is based on the frequency-wavenumber representation of space-time signals, a representation that serves as a unifying thread throughout the book. The following chapter on apertures and arrays is quite thorough, with more details on multi-dimensional arrays than one finds in many books. Sparse and random arrays are briefly covered. In the next chapter, the conventional beamformer is treated in some detail, both from the viewpoint of theory and that of implementation. There follow two chapters on detection and estimation theory, the latter containing a discussion on the connection between spectral estimation and conventional beamforming. The topic of the next chapter is adaptive array processing, including constrained optimization methods (e.g., leading to the minimum-variance beamformer) and eigenanalysis methods. The treatment here is not encyclopedic, which in my opinion is not a drawback: there are innumerable slight variants of these methods, and new algorithms continue to appear. The main body of the book wraps up with a chapter on target tracking, based mainly on the Kalman filter.

The authors have clearly attempted to squeeze a lot of topics into one book. As many of these topics have each furnished sufficient material for book-length treatments elsewhere, it is to be expected that the authors are often terse. They themselves admit to "the brevity of the coverage given detection theory and estimation theory ...". To take one example, I was unable to locate any mention of the detection of narrowband signals with unknown phase, although the theory of the non-coherent (envelope) detector is important for radar and sonar applications. For this reason, I consider the value of this book to lie mainly in its treatment of concepts which relate more directly to array processing, such as the frequency-wavenumber view of space-time processing, and which cannot be found elsewhere in a unified exposition.

The text has more of an academic than an engineering slant, and for this reason it would be necessary to supplement it with specialized literature for many practical applications. (I am speaking as someone involved mainly with the processing of underwater acoustic signals.) Sometimes common engineering terminology is not mentioned. For example, when discussing the mainlobe width of an array pattern the authors introduce the acronym FWHM for "full-width half-maximum". Only by comparing their stated FWHM values with those in another text did I conclude that the width was measured between points where the response was down by 6 dB and not 3 dB (i.e., halfway down in amplitude and not power). There is no mention of this common way of talking about lobe width. Also, it should be borne in mind that this is not an *acoustics* book, and so there is no discussion of the physical units used in acoustic processing.

The book is cleanly typeset, and the typographical errors are few (the only typos I noticed were in equations). The figures are rudimentary, as in so many books today, but they are usually clear and understandable. One pleasing feature of the book is the extensive cross-referencing by page number. For example, when the authors cite an equation number, they also provide the page number. More usefully, in the list of mathematical symbols located at the back of the book, the authors provide not only a short definition of each symbol but the page number where the symbol is first used. (However, the symbol , used throughout the book to denote the tail of the Gaussian distribution, was somehow omitted from the list.) Even in the bibliography, each reference is followed by a list of the page numbers where the authors cite the reference.

In summary, the strength of this book lies in its presentation of the fundamental concepts in array signal processing, and it is well suited for giving a mathematically mature researcher the background required for understanding the current literature. Although the book is now a decade old, its emphasis on fundamental concepts means that it has aged well. However, most researchers in acoustics will find it necessary to supplement this work with a text dealing specifically with the processing of acoustic signals.

Brian H. Maranda

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Inter Noise 2003

Inter Noise was held this year at the International Conference Center, Seogwipi, Jeju Island, South Korea. Although the organizers faced many severe challenges in encouraging participants to travel to Korea, they were very successful. In spite of SARS and tensions with North Korea, there were 658 presentations from authors representing 39 countries. The proceedings are available in CD format. For more information contact the Inter Noise 2003 website http://www.internoise2003.com/.

I-INCE General Assembly

The General Assembly of I-INCE (International Institute of Noise Control Engineering) consisting of representatives of the various member organizations, such as CAA, also met in conjunction with Inter Noise. The assembly approved two new member organizations, and a modest increase in member organisation fees to 225 Euros per year. Inter Noise 2004 will be in Prague, 2005 in Rio de Janerio, and 2006 in Hawaii.

Noise News International

I-INCE publishes Noise News International on a quarterly basis. CAA receives copies of this publication. We would like to establish a more effective distribution of this publication to CAA members interested in receiving it. Although CAA is not charged for the copies we receive, we would have to cover the costs of mailing copies to members. It is proposed to allow CAA members to opt to have copies of Noise News International mailed to them. The CAA Board of Directors has approved an optional additional charge to members of $5 to cover mailing costs to those in Canada wishing to receive Noise News International. This option will be included with our next membership renewal form.

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

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 stevenb@aciacoustical.com

2003

10-12 December: 3rd International Workshop on Models and Analysis of Vocal Emissions for Biomedical Applications, Firenze, Italy. Fax: +39 55 479 6767; Web: www.maveba.org

2004

17-19 March: Spring Meeting of the Acoustical Society of Japan, Atsugi, Japan. Fax: +81 3 5256 1022;
Web: wwwsoc.nii.ca.jp/asj/index-e.html

22-25 March: Joint Congress of the French and German Acoustical Societies (SFA-DEGA), Strasbourg, France. Fax: +33 1 48 88 90 60; Web: www.sfa.asso.fr/cfa-daga2004

23-26 March: International Conference: Speech Prosody 2004, Nara Japan (K. Hirose, School of Frontier Sciences, University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-0033, Japan; Fax +81 3 5841 6648; Web: www.gavo.t.u-tokyo.ac.jp/sp2004)

31 March – 3 April: International Symposium on Musical Acoustics (ISMA2004), Nara, Japan. Fax: +81 774 95 2647; Web: www2.crl.go.jp/jt/al32/isma2004

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

11-13 April: International Symposium on Room Acoustics (ICA2004 Satellite Meeting), Hyogo, Japan. Fax: +81 78 803 6043; Web: rad04.iis.u-tokyo.ac.jp

8-10 May: 116th AES Convention, Berlin, Germany. (Web: aes.org/events/116)

17-21 May: International Conference on Acoustics, Speech, and Signal Processing (ICASSP 2004), Montreal, Canada. Web: www.icassp2004.com

24-28 May: 75th Anniversary Meeting (147th Meeting) of the Acoustical Society of America, New York, NY. Contact: Acoustical Society of America, Suite 1NO1, 2 Huntington Quadrangle, Melville, NY 11747-4502; Tel: 516-576-2360; Fax: 516-576-2377; E-mail: asa@aip.org; Web: asa.aip.org

8-10 June: Joint Baltic-Nordic Acoustical Meeting, Mariehamm, Åland, Finland. Contact: Acoustical Society of Finland, Helsinki University of Technology, Laboratory of Acoustics and Signal Processing, P.O. Box 3000, 0215 TKK, Finland; Fax: +358 09 460 224; e-mail: asf@acoustics.hut.fi

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 courriel à stevenb@aciacoustical.com

2003

10-12 décembre: 3e Atelier international sur les modèles et analyse d'émissions vocales avec applications bio-médicales, Florence, Italie. Fax: +39 55 479 6767; Web: www.maveba.org

2004

17-19 mars: Rencontre de printemps de la Société japonaise d'acoustique, Atsugi, Japon. Fax: +81 3 5256 1022;
Web: wwwsoc.nii.ca.jp/asj/index-e.html

22-25 mars: Congrès combiné des Sociétés française et allemande d'acoustique (SFA-DEGA), Strasbourg, France. Fax: +33 1 48 88 90 60; Web: www.sfa.asso.fr/cfa-daga2004

23-26 mars: Conférence internationale : la parole prosodie 2004, Nara Japan (K. Hirose, School of Frontier Sciences, University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-0033, Japan; Fax +81 3 5841 6648; Web: www.gavo.t.u-tokyo.ac.jp/sp2004)

31 mars – 3 avril: Symposium international sur l'acoustique musicale (ISMA2004), Nara, Japon. Fax: +81 774 95 2647; Web: www2.crl.go.jp/jt/al32/isma2004

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

11-13 avril: Symposium international sur l'acoustique des salles (Rencontre satellite de ICA2004), Hyogo, Japon. Fax: +81 78 803 6043; Web: rad04.iis.u-tokyo.ac.jp

8-10 mai: 116e Convention sur AES, Berlin, Germany. (Web: aes.org/events/116)

17-21 mai: Conférence internationale sur l'acoustique, la parole, et le traitement de signal (ICASSP 2004), Montréal, Canada. Web: www.icassp2004.com

24-28 mai: 75e rencontre anniversaire (147e rencontre) de l'Acoustical Society of America, New York, NY. 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

8-10 juin: Rencontre acoustique jointe Baltique-Nordique, Mariehamm, Åland, Finlande. Info: Acoustical Society of Finland, Helsinki University of Technology, Laboratory of Acoustics and Signal Processing, P.O. Box 3000, 0215 TKK, Finland; Fax: +358 09 460 224; courriel: asf@acoustics.hut.fi

5-8 July: 7th European Conference on Underwater Acoustics ECUA 2004, Delft, The Netherlands. Contact: Debbie Middendorp, Secretariat of the 7th European Conference on Underwater Acoustics ECUA 2004, D'Launch Communications, Forellendaal 141, 2553 JE The Hague, The Netherlands; Tel.: +31 70 3229900; Fax: +31 70 3229901; E-mail: middendorp@dlaunch.nl

11-16 July: 12th International Symposium on Acoustic Remote Sensing (ISARS), Cambridge, UK. Contact: S. Bradley, School of Acoustics and Electronic Engineering, Brindley Building, Room 301, University of Salford, Salford M5 4WT, UK; Fax: +44 161 295 3815; Web: www.isars.org.uk

3-7 August: 8th International Conference of Music Perception and Cognition, Evanston, IL. Contact: School of Music, Northwestern Univ., Evanston, IL 60201; Web: www.icmpc.org/conferences.html

22-25 August: Inter-noise 2004, Prague, Czech Republic. Web: www.internoise2004.cz

23-27 August: 2004 IEEE International Ultrasonics, Ferroelectrics, and Frequency Control 50th Anniversary Conference, Montreal, Canada. Contact: R. Garvey, Datum, 34 Tozer Road, Beverly, MA 01915-5510; Fax: +1 978 927 4099; Web: www.ieee-uffc.org/index2-asp

13-17 September: 4th Iberoamerican Congress on Acoustics, 4th Iberian Congress on Acoustics, 35th Spanish Congress on Acoustics, Guimarães, Portugal. Contact: Sociedade Portuguesa de Acústica, Laboratório Nacional de Engenharia Civil, Avenida do Brasil 101, 1700-066 Lisboa, Portugal; Fax: +351 21 844 3028; E-mail: dsilva@lnec.pt

4-5 November: Autumn Meeting of the Swiss Acoustical Society, Rapperswil, Switzerland. Contact: SGA-SSA, c/o Akustik, Suva, P.O. Box 4358, 6002 Luzern, Switzerland; Fax: +41 419 62 13; Web: www.sga-ssa.ch

15-19 November: 148th Meeting of the Acoustical Society of America, San Diego, CA. Contact: Acoustical Society of America, Suite 1NO1, 2 Huntington Quadrangle, Melville, NY 11747-4502; Tel: 516-576-2360; Fax: 516-576-2377; E-mail: asa@aip.org; Web: asa.aip.org

2005

7-10 August: Inter-Noise, Rio de Janeiro, Brazil. Details to be announced later.

28 August – 2 September: Forum Acusticum Budapest 2005, Budapest, Hungary. Fax: +36 1 202 0452; Web: www.fa2005.org; E-mail: sea@fresno.csic.es

5-8 juillet: 7e Conférence européenne sur l'acoustique sous-marine ECUA 2004, Delft, Pays-Bas. Info: Debbie Middendorp, Secretariat of the 7th European Conference on Underwater Acoustics ECUA 2004, D'Launch Communications, Forellendaal 141, 2553 JE The Hague, The Netherlands; Tél.: +31 70 3229900; Fax: +31 70 3229901; Courriel: middendorp@dlaunch.nl

11-16 juillet: 12e Symposium international sur la télédetection acoustique (ISARS), Cambridge, Royaume-Uni. Info: S. Bradley, School of Acoustics and Electronic Engineering, Brindley Building, Room 301, University of Salford, Salford M5 4WT, UK; Fax: +44 161 295 3815; Web: www.isars.org.uk

3-7 août: 8e Conférence internationale sur la perception et la cognition de la musique, Evanston, IL. Info: School of Music, Northwestern Univ., Evanston, IL 60201; Web: www.icmpc.org/conferences.html

22-25 août: Inter-noise 2004, Prague, République tchèque. Web: www.internoise2004.cz

23-27 août: 50e Conférence anniversaire internationale IEEE 2004 sur les ultra-sons, la ferroélectricité et la régulation par la fréquence, Montréal, Canada. Info: R. Garvey, Datum, 34 Tozer Road, Beverly, MA 01915-5510; Fax: +1 978 927 4099; Web: www.ieee-uffc.org/index2-asp

13-17 septembre: 4e Congrès ibéro-américain d'acoustique, 4e Congrès ibérien d'acoustique, 35e Congrès espagnol d'acoustique, Guimarães, Portugal. Info: Sociedade Portuguesa de Acústica, Laboratório Nacional de Engenharia Civil, Avenida do Brasil 101, 1700-066 Lisboa, Portugal; Fax: +351 21 844 3028; Courriel: dsilva@lnec.pt

4-5 novembre: Rencontre d'automne de la Société suisse d'acoustique, Rapperswil, Suisse. Info: SGA-SSA, c/o Akustik, Suva, P.O. Box 4358, 6002 Luzern, Switzerland; Fax: +41 419 62 13; Web: www.sga-ssa.ch

15-19 novembre: 148e rencontre de l'Acoustical Society of America, San Diego, CA. 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

2005

7-10 août: Inter-Noise, Rio de Janeiro, Brésil. Information à suivre.

28 août – 2 septembre: Forum Acusticum Budapest 2005, Budapest, Hongrie. Fax: +36 1 202 0452; Web: www.fa2005.org; E-mail: sea@fresno.csic.es

The Canadian Acoustical Association/L'Association Canadienne d'Acoustique

PRIZE ANNOUNCEMENT • ANNONCE DE PRIX

A number of prizes and subsidies are offered annually by The Canadian Acoustical Association. Preference will be given to citizens and permanent residents of Canada. Applicants can obtain full eligibility conditions, deadlines, application forms, past recipients, and the names of the individual prize coordinators on the CAA Website (http://www.caa-aca.ca). · Plusieurs prix et subventions sont décernés à chaque année par l'Association Canadienne d'Acoustique. La préférence sera accordée aux citoyens et aux résidents permanents du Canada. Les candidats peuvent se procurer de plus amples renseignements sur les conditions d'éligibilités complètes, les dates limites, les formulaires de demande, les récipiendaires des années passées, ainsi que le nom des coordonnateurs des prix en consultant le site Web de l'ACA (http://www.caa-aca.ca).

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

$3,000 for full-time postdoctoral research training in an established setting other than the one in which the Ph.D. was earned. The research topic must be related to some area of acoustics, psychoacoustics, speech communication or noise. • $3,000 pour une formation recherche à temps complet au niveau postdoctoral dans un établissement reconnu autre que celui où le candidat a reçu son doctorat. Le thème de recherche doit être relié à un domaine de l'acoustique, de la psycho-acoustique, de la communication verbale ou du bruit.

Alexander Graham Bell Graduate Student Prize in Speech Communication and Behavioural Acoustics • Prix Étudiant Alexandre Graham Bell en Communication verbale et Acoustique comportementale

$800 for a graduate student enrolled at a Canadian academic institution and conducting research in the field of speech communication or behavioural acoustics. • $800 à un(e) étudiant(e) inscrit(e) au 2e ou 3e cycle dans une institution académique canadienne et menant un projet de recherche en communication verbale ou acoustique comportementale.

Fessenden Graduate Student Prize in Underwater Acoustics • Prix Étudiant Fessenden en Acoustique sous-marine

$500 for a graduate student enrolled at a Canadian academic institution and conducting research in underwater acoustics or in a branch of science closely connected to underwater acoustics. • $500 à un(e) étudiant(e) inscrit(e) au 2e ou 3e cycle dans une institution académique canadienne et menant un projet de recherche en acoustique sous-marine ou dans une discipline reliée à l'acoustique sous-marine.

Eckel Graduate Student Prize in Noise Control • Prix Étudiant Eckel en Contrôle du bruit

$500 for a graduate student enrolled at a Canadian academic institution and conducting research related to the advancement of the practice of noise control. • $500 à un(e) étudiant(e) inscrit(e) au 2e ou 3e cycle dans une institution académique canadienne et menant un projet de recherche relié à l'avancement de la pratique du contrôle du bruit.

Raymond Hétu Undergraduate Prize in Acoustics • Prix Étudiant Raymond Hétu en Acoustique

One book in acoustics of a maximum value of $100 and a one-year subscription to *Canadian Acoustics* for an undergraduate student enrolled at a Canadian academic institution and having completed, during the year of application, a project in any field of acoustics or vibration. · Un livre sur l'acoustique et un abonnement d'un an à la revue *Acoustique Canadienne* à un(e) étudiant(e) inscrit(e) dans un programme de 1er cycle dans une institution académique canadienne et qui a réalisé, durant l'année de la demande, un projet dans le domaine de l'acoustique ou des vibrations.

Canada-Wide Science Fair Award • Prix Expo-sciences pancanadienne

$400 and a one-year subscription to *Canadian Acoustics* for the best project related to acoustics at the Fair by a high-school student · $400 et un abonnement d'un an à la revue *Acoustique Canadienne* pour le meilleur projet relié à l'acoustique à l'Expo-sciences par un(e) étudiant(e) du secondaire.

Directors' Awards • Prix des Directeurs

$500 for the best refereed research, review or tutorial paper published in *Canadian Acoustics* by a student member - $500 for the best paper by an individual member · $500 pour le meilleur article de recherche, de recensement des travaux ou d'exposé didactique arbitré et publié dans l'*Acoustique Canadienne* par un(e) étudiant(e) - $500 pour le meilleur article par un membre individuel.

Student Presentation Awards • Prix pour communications étudiantes

Three $500 awards for the best student oral presentations at the Annual Symposium of The Canadian Acoustical Association. · Trois prix de $500 pour les meilleures communications orales étudiant(e)s au Symposium Annuel de l'Association Canadienne d'Acoustique.

Student Travel Subsidies • Subventions pour frais de déplacement pour étudiants

Travel subsidies are available to assist student members who are presenting a paper during the Annual Symposium of The Canadian Acoustical Association, if they live at least 150 km from the conference venue. · Des subventions pour frais de déplacement sont disponibles pour aider les membres étudiants à venir présenter leurs travaux lors du Symposium Annuel de l'Association Canadienne d'Acoustique, s'ils demeurent à au moins 150 km du lieu du congrès.

Underwater Acoustics and Signal Processing Student Travel Subsidies • Subventions pour frais de déplacement pour étudiants en Acoustique sous-marine et Traitement du signal

One $500 or two $250 awards to assist students traveling to national or international conferences to give oral or poster presentations on underwater acoustics and/or signal processing. · Une bourse de $500 ou deux de $250 pour aider les ètudiant(e)s à se rendre à un congrès national ou international pour y présenter une communication orale ou une affiche dans le domaine de l'acoustique sous-marine ou du traitement du signal.

Canadian Acoustical Association
Association canadienne d'acoustique

2003 PRIZE WINNERS / RÉCIPIENDAIRES 2003

FESSENDEN GRADUATE STUDENT PRIZE IN UNDERWATER ACOUSTICS / PRIX ÉTUDIANT FESSENDEN EN ACOUSTIQUE SOUS-MARINE

Victor Young, Dalhousie University
"Discrimination of underwater targets using auralization"

ECKEL GRADUATE STUDENT PRIZE IN NOISE CONTROL / PRIX ÉTUDIANT ECKEL EN CONTRÔLE DU BRUIT

Dominic Pilon, Université de Sherbrooke
"Développement de mousses métalliques hautes performances pour l'absorption acoustique en basses fréquences (50-500 Hz)"

RAYMOND HÉTU UNDERGRADUATE PRIZE IN ACOUSTICS / PRIX ÉTUDIANT RAYMOND HÉTU EN ACOUSTIQUE

Carlos De Segovia, Université d'Ottawa
"Logiciels de présentation de signaux acoustiques pour recherche en audiologie"

CANADA-WIDE SCIENCE FAIR AWARD / PRIX EXPO-SCIENCES PANCANADIENNE

Caroline Hulbert, Victoria, British Columbia
"Good, good, good vibrations"

DIRECTORS' AWARDS / PRIX DES DIRECTEURS

Professional ³ 30 years / Professionnel ³ 30 ans :

Stuart Eaton, Workers Compensation Board of B.C.
"Review of Orchestra Musicians' Hearing loss risks"

Student / Étudiant(e) :

Matthew Barlee, University of Victoria

"Array element localization of the bottom moored hydrophone array"

STUDENT PRESENTATION AWARDS / PRIX POUR COMMUNICATIONS ÉTUDIANTES

Carrie Gotzke, University of Alberta

"Comparison of intelligibility measures on single word and spontaneous speech tasks for children with and without cleft palate"

Ann Nakashima, University of British Columbia

"Effect of the ground surface and meteorological conditions on the active control of a monopole noise source"

Benjamin Zendel, University of Calgary

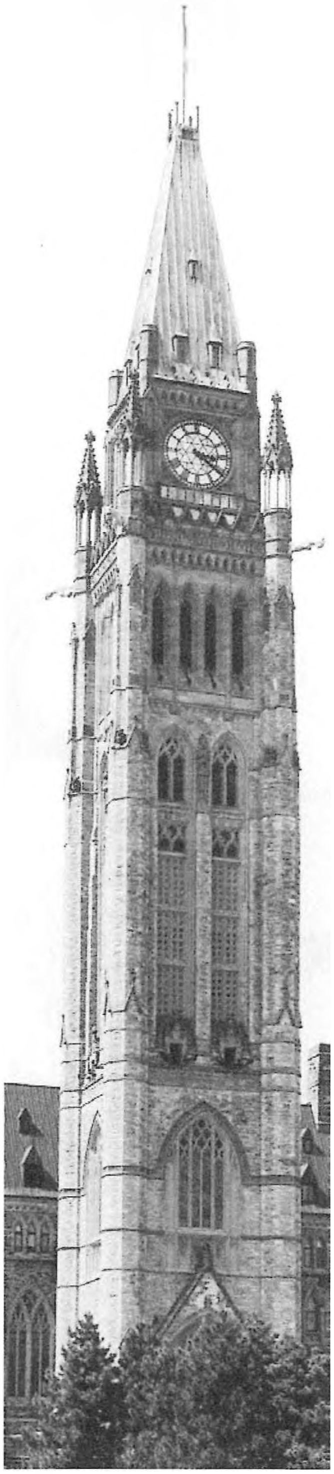
"How music of different rhythmicities and intensities affects driver performance"

CONGRATULATIONS / FÉLICITATIONS

CAA Annual Conference in Ottawa

October 6-8,2004

www.caa-aca.ca/ottawa-2004.html



First Announcement

The 2004 annual conference of the Canadian Acoustical Association will be held in Ottawa October 6-8, 2004. With a location in Ottawa, and the theme 'Acoustics: A National Issue', we hope to make it one of our more significant conferences. There will be three days of three parallel sessions of papers on all areas of acoustics. In addition to various associated meetings, there will be tours of local acoustical laboratories. Mark your calendars and plan now to participate!

Special Sessions

We intend to have a number of special sessions including both invited and contributed papers. If you would like to suggest a topic for a special session or if you would like to organise one, please contact the Conference Convenor or Papers Chair.

Venue and Accommodation

The conference will be held at the newly renovated and enlarged Lord Elgin hotel, centrally located in Ottawa a few blocks from parliament hill. Participants registering with the hotel by September 5, 2004 will receive a room rate of $128/night (single or double). (1-800-267-4298). Please stay at this hotel to be with your friends and to support CAA.

Exhibits

There will be an exhibit of measurement equipment and other acoustical products. As usual the exhibit area will also be the central coffee break area. Please contact our exhibit coordinator for early information on the planned exhibit and sponsorship of various aspects of this meeting.

Student Participation

CAA has a very strong emphasis on encouraging students. Student members who make presentations can apply for travel support and can win one of a number of student presentation awards. See our website for details.

Submissions

The deadlines for the submission of abstracts and the subsequent two-page summary papers will be announced in the March issue of Canadian Acoustics. All submissions will be required to be made electronically.

Hospitality

CAA conferences are always an opportunity to meet old friends and to make new ones over a coffee during the conference, or over a drink after the sessions are over. There are many nearby bars and restaurants and of course there will be a banquet as part of the conference. Why not make it a holiday too, and stay on to see the Fall colours in Ottawa and Gatineau?

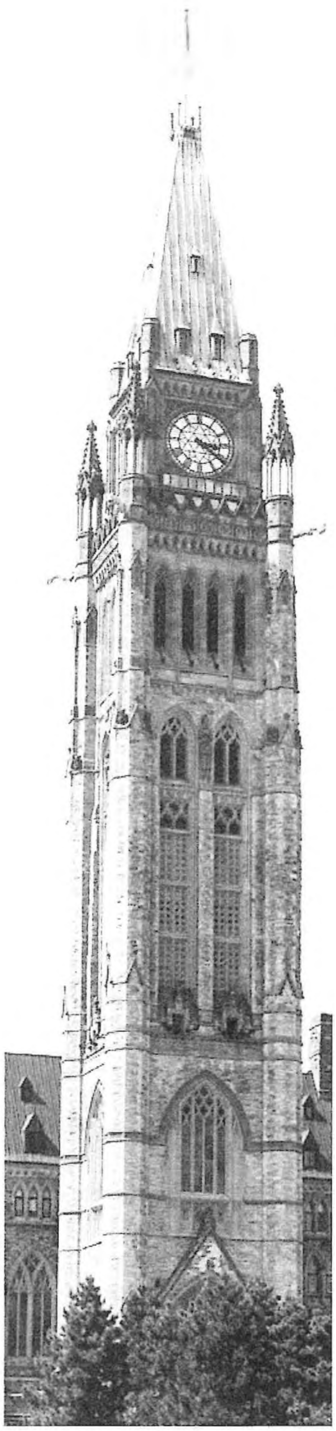
Contacts

Convenor	John Bradley	(john.bradley@nrc.ca)
Papers Chair	Brad Gover	(brad.gover@nrc.ca)
Publicity	Christian Gigu re	(cgiguere@uottawa.ca)
Exhibits	Hugh Williamson	(hughwilliamson@sympatico.ca)
Webmaster	Alf Warnock	(alf.warnock@nrc.ca)
Audio-Visual	Frances King	(frances.king@nrc.ca)
Web site		www.caa-aca.ca/ottawa-2004.html

Congrès annuel de l'ACA à Ottawa

6 au 8 octobre 2004

www.caa-aca.ca/ottawa-2004.html



Premier avis

Le congrès annuel de l'Association canadienne d'acoustique se tiendra à Ottawa du 6 au 8 octobre 2004. Avec comme site Ottawa et comme thème « L'Acoustique : Une question nationale », nous espérons en faire l'un de nos congrès les plus mémorables. Trois jours de communications scientifiques comprenant trois sessions parallèles sont prévus touchant tous les domaines relevant de l'acoustique. En plus des réunions habituelles, des visites de laboratoires en acoustique seront également au programme. Veuillez planifier dès maintenant de participer à cet événement !

Sessions spéciales

Des sessions spéciales seront structurées autour de conférenciers invités et des communications soumises par les délégués. Si vous désirez suggérer un sujet de session spéciale ou organiser une de ces sessions, veuillez communiquer avec le Président du congrès ou le Directeur scientifique.

Lieu du congrès et hébergement

Le congrès se tiendra à l'hôtel Lord Elgin, tout récemment agrandi et rénové, situé au cœur d'Ottawa à proximité de la colline parlementaire. Les délégués qui réserveront leur chambre à cet l'hôtel (1-800-267-4298) avant le 5 septembre 2004 bénéficieront d'un tarif préférentiel de $128/nuit (occupation simple ou double). Choisissez cet hôtel pour participer pleinement au congrès et encourager l'ACA.

Exposition technique

Il y aura une exposition d'instruments et d'autres produits en acoustique. La salle d'exposition agira aussi comme lieu central lors des pauses. Veuillez communiquer dès maintenant avec le coordonnateur de l'exposition pour de plus amples renseignements et pour la commandite d'événements particuliers lors du congrès.

Participation étudiante

L'ACA accorde beaucoup d'importance à la participation des étudiants. Les membres étudiants qui présenteront une communication pourront soumettre une demande de subvention pour frais de déplacement au congrès et pourront se voir mériter l'un des prix pour communications étudiantes. Veuillez consulter notre site Internet.

Appel de communications

Les échéances pour soumettre vos résumés et l'article de deux pages seront annoncées dans le numéro du mois de mars de l'*Acoustique Canadienne*. Toutes les soumissions devront se faire par courriel.

Votre séjour à Ottawa

Le congrès de l'ACA demeure toujours une excellente occasion de renouer avec vos collègues acousticiens et de faire de nouvelles connaissances. Il y a plusieurs bistros et restaurants à proximité de l'hôtel et il y aura aussi le banquet du congrès. Pourquoi aussi ne pas en profiter et demeurer un peu plus longtemps pour découvrir les couleurs d'automne de la région d'Ottawa-Gatineau ?

Personnes contacts

Président	John Bradley	(john.bradley@nrc.ca)
Directeur scientifique	Brad Gover	(brad.gover@nrc.ca)
Publicité	Christian Giguère	(cgiguere@uottawa.ca)
Exposition	Hugh Williamson	(hughwilliamson@sympatico.ca)
Webmaster	Alf Warnock	(alf.warnock@nrc.ca)
Audio-Visuel	Frances King	(frances.king@nrc.ca)
Site internet		www.caa-aca.ca/ottawa-2004.html

Canadian Acoustical Association

Minutes of Annual General Meeting

16 October 2003
Edmonton, Alberta

Call to Order

President John Bradley called the meeting to order at 5:05 p.m. with 24 voting members of the Association present. Minutes of the previous Annual General Meeting on 10 October 2002 in Charlottetown PEI were approved as printed in the December 2002 issue of Canadian Acoustics. (Moved by Ramani Ramakrishnan, seconded by Cameron Sherry, carried unanimously.)

President's Report

John Bradley summarized the results of the executive meeting. First, he announced his decision not to seek re-election. He emphasized that the society is in good condition, and he thanked all those who have made major contributions to our activities, both in the annual conferences and in ongoing activities such as the website and the journal.

(In response, Ramani Ramakrishnan proposed a motion of thanks for John Bradley's five years as President, which triggered loud applause from all present.)

Secretary's Report

David Quirt presented a brief report: the membership of the Association has remained quite steady, with 333 members as of 31 August. Details are in the report from Board of Directors meeting on October 14. The administrative budget of $1414 covered website, database, and membership correspondence expenses in the last fiscal year. An itemized account was presented to the Board of Directors, and reduction to $1000 is proposed for the next year.

In response to a question from Harold Forrester, about errors in the technical interest codes in the membership directory published each December, the Secretary detailed the steps underway this year to correct this problem, and also to update other database fields such as e-mail addresses.

The report was accepted. (Moved by Alberto Behar, seconded Murray Hodgson, carried.)

Treasurer's Report

Dalila Giusti reported on the Association finances.

We are in good shape, with $244,534 in our accounts and a variety of securities (as detailed in the Board of Directors report).

Interest on our capital fund is providing nearly $8000 in annual interest, which is enough to cover most of the awards. Successful meetings plus increased income from advertising and subscriptions have also generated funds. There has been no need to dip into fixed assets for several years.

We budget each year's expenses and track costs and revenues; this allows us to plan. That process has identified a tightening budget situation, and the Board is therefore proposing a small increase in annual fees to maintain an adequate financial cushion. Discussion of this proposal clarified the current status of the capital and operating funds. It was explained that increases in advertising rates and fees for Sustaining Subscribers are not recommended because these were increased since the last increase in membership dues.

An increase in the dues for Members (to $60) and for Students (to $20) was approved. (Moved by Dalila Giusti, seconded Cameron Sherry, carried.)

Editor's Report

Ramani Ramakrishnan gave the Editor's report. *Canadian Acoustics* highlights were:

For the first time, the September 2003 issue used fully digital printing, and colour is readily included.

Articles will be very welcome and will generally be published within 2-3 months. Historically about 25% of papers get rejected. This will be published to substantiate that the articles are refereed.

A move to 6 issues per year will be delayed until the supply of submissions increases enough to ensure a reasonable number of articles available for each issue.

A special issue, presenting refereed conference papers on underwater sound, is planned for June 2004. The conference will cover part of the expenses for the issue, so this should both provide good content that is of interest to our audience, and help with the publication budget.

Karen Fraser has been very effectively soliciting ads and following up advertising invoices.

Award Coordinator's Report

Christian Giguère reported the awards to be presented this year. CAA is awarding the Fessenden Prize, Eckel Prize, Hétu Prize, and Award for the Canada-Wide Science Fair. In addition, there are 2 Directors' awards, plus the student paper awards. (See separate announcement in this issue for names of recipients.)

The Board of Directors has decided to change the Directors' Awards for coming years: the two prizes for best paper in

Canadian Acoustics written by a professional will be merged (with no criterion for author's age) with a prize value of $500.

Christian acknowledged the hard work of the awards committees, and the contributions of David Stredulinsky in updating the web pages for awards. For 2004 there will be a major effort to promote the prizes.

Past/Future Meetings

Brief reports were presented on meeting status:

Charlottetown (2002): Annabel Cohen provided a final report. The technical program was very well received, with over 100 papers and 85 full registrations plus 12 exhibitors and many 1-day participants. The final financial status was a surplus of $1412. There were many compliments on all aspects of the meeting, and the President repeated the thanks from the Board for a great success.

Edmonton (2003): Corjan Buma gave a preliminary report on the meeting. Advance registration was less than expected, but the total registration may be sufficient to balance the budget. The number of papers submitted is lower than usual (55) but this has been supplemented by excellent plenary talks, a great site visit to the Winspear concert hall, and an exhibition with very good representation of acoustical product manufacturers. An effective website based on the PEI model was developed by Steve Bilawchuk, who also handled loading of PowerPoint presentations for the session; those present expressed their appreciation with a round of applause. Corjan continued with thanks for the significant efforts by the whole Edmonton team; the visitors responded with a final vote of thanks.

Ottawa (2004): The conference will be at the recently renovated Lord Elgin Hotel in downtown Ottawa, on 6-8 October. John Bradley will lead a very-experienced team to organize this meeting. See the preliminary advertisement in this issue.

London (2005): There will be an ASA meeting in May 2005 in Vancouver but we will have a CAA meeting as usual in October. A team from London Ontario has offered to organize the meeting, and the Board has given approval to proceed. A detailed plan will be presented at the next Board meeting in spring 2004.

International Liaison

Murray Hodgson spoke about the meeting of Acoustical Society of America planned in Vancouver on 16-20 May 2005. Murray will be the Chair, and Stan Dosso is Technical Program Chair. Murray asked for suggestions on how to highlight Canadian activities at the meeting.

John Bradley reported that the Board has decided to improve the circulation of Noise News International to interested CAA members, by adding this as an option on the annual renewal form, with a charge of $5/year to cover mailing costs. NNI is published by International Institute of Noise Control Engineering and distributed in bulk to member societies, including CAA.

CAA Website

David Stredulinsky reported that our website has current forms and information on most aspects of CAA operations and membership. It is clearly becoming the main conduit for members needing information, and traffic has doubled over the last year. A job wanted page is now available, and the student awards page is substantially revised. A complete index of Canadian Acoustics is also available on the website, and it has become a key part of advertising and managing the annual conference. David was thanked for all his hard work.

Nominations

Cameron Sherry nominated Stan Dosso as President. Alberto Behar seconded. There were no other nominations, so the candidate was acclaimed.

Cameron Sherry nominated David Quirt as Secretary, Dalila Giusti as Treasurer and Ramani Ramakrishnan as Editor. Harold Forrester seconded. There were no other nominations, so these candidates were acclaimed.

Cameron Sherry nominated Raymond Panneton (from Sherbrooke, Quebec) and Vijay Parsa (from London, Ontario) as Directors. Murray Hodgson seconded. There were no other nominations, so these Directors were acclaimed.

Karen Fraser and Meg Cheesman were thanked for their efforts as Directors for the last 5 years.

Adjournment

Alberto Behar moved and Ramani Ramakrishnan seconded that the meeting be adjourned. Carried. Meeting adjourned at 5:50 p.m.

Canadian Acoustical Association
Minutes of the Board of Directors Meeting
14 October 2003

Edmonton, Alberta

Present: J. Bradley, D. Giusti, D. Quirt, C. Buma, A. Behar, K. Fraser, M. Hodge, R. Ramakrishnan, D. Stredulinsky, C. Giguère, M. Cheng
Regrets: M. Cheesman
The meeting was called to order at 4:07 p.m. Minutes of Board of Directors meeting on 10 May 2003 were approved as published in Canadian Acoustics (June 2003 issue). *(Approval moved by C. Buma, seconded by A. Behar, carried).*

President's Report

John Bradley reported that there have been no major changes or problems in the affairs of the Association. John announced that he does not plan to continue for another term. Having completed an unprecedented five consecutive terms, he suggested it is time for fresh leadership with new priorities. He paid tribute to the strong support provided during his tenure by other Board members, with special mention for the contributions by the Editor of Canadian Acoustics (Ramani Ramakrishnan), the Treasurer (Dalila Giusti), and the Webmaster (David Stredulinsky) who have significantly enhanced key operational aspects of the Association.

Secretary's Report

David Quirt reported that in FY2002/03 the membership is steady at essentially the same level observed last year and through the '90's. As of the end of August, the total paid membership stood at 333 (an increase of 6). About 80% of the members are located in Canada, with the remaining 20% divided between the USA and overseas. The number of Sustaining Subscribers has risen, but there is a reduction in subscriptions via agents, presumably due to major disruptions in that business sector.

	FY 2000/01	FY 2001/02	FY 2002/03
Member	278	220	212
Emeritus	-	-	2
Student Member	46	44	51
Subscriber	34	29	31
Sustaining Subscriber	33	32	37
Total	391	325	333

Member: A professional who is named on the application form.
Student Member: A person in full-time attendance at an academic institution.
Subscriber: A company that receives the journal (non-voting)
Sustaining Subscriber: A company or individual who promotes activities of CAA by paying an increased subscription fee. (non-voting)
All categories receive a copy of the journal.

To ease membership renewal, the Secretary and Treasurer have implemented a process to permit payments by VISA; 29% of the renewals have used VISA. Each year, about 15% of members fail to renew until we send a reminder, and ~5% of long-term members fail to pay; most rejoin a year or two later when they notice Canadian Acoustics is not arriving. To address this, the Secretary proposes to add a stamped return envelope to Canadian renewal notices, hoping to avert some of the memory lapses. Use of e-mail for reminders is also proposed. To improve use of e-mail for CAA communication, and to reduce errors in mailing Canadian Acoustics, it is proposed to add systematic updating of all membership address data to the renewal process.

Secretarial operating costs for FY2002/03 were $1414, which included mailing costs and maintaining the address database including the annual membership renewal process. This also included fees for the website that will be handled separately by the Webmaster in future years. A budget for the next fiscal year of $1000 was requested.

(D.Giusti moved acceptance of report and budget approval, seconded K. Fraser, carried)

Treasurer's Report

The Treasurer, Dalila Giusti, submitted a report and a financial statement prepared by our auditor, Paul A. Busch, for the fiscal year ending August 31, 2003. It was a good year financially. Interest on our capital fund exceeded the requirements for prizes this year, because the Bell and Fessenden Prizes were not awarded. Most major expenses were under budget, the conference made a profit, and outstanding invoices for advertising were all collected. Overall, revenues of $65194 exceeded the expenses of $55668, and total assets at year-end have risen to $244,534.

The Treasurer reported that a VISA card account has been established for paying CAA expenses, as authorized at the June 2002 meeting, and that normal financial activities have proceeded smoothly.

A draft budget for FY2003/04 was presented and discussed. Given the constant membership, and small increases forecast in most expenses, the margin of revenue over expenses would be only $500 if fees were held constant. After extensive discussion, it was decided that an increase of $5 in all membership/subscription fees would be appropriate, except for Sustaining Subscribers (which were recently increased) and those subscriptions for which invoices have already been issued. (Moved by D. Giusti, seconded A. Behar that this increase in fees be proposed to the AGM; carried)

(R. Ramakrishnan moved acceptance of Treasurer's report, D. Stredulinsky seconded, carried)

Editor's Report

The Editor, Ramani Ramakrishnan, presented a brief report. A number of specific issues related to content, appearance, and publication process for *Canadian Acoustics* were discussed. There are continuing problems requiring editing of the nominally publication-ready pdf files submitted by authors for the September issue, and it was agreed that a template document should be included with the instructions to authors, to minimize the need to edit the submissions.

The September 2003 issue is the first with full digital printing, and all agreed that appearance is excellent. The Editor was congratulated on the continuing quality of the publication, and his record for on-time publication. Recognition was also given to the success of Karen Fraser in handling advertising for *Canadian Acoustics* – invoices are up to date, and the backlog from delayed billing for advertising has been collected.

The News Editor, Francine Desharnais, has resigned. The Board passed a motion of thanks to Francine for her substantial contribution to the Association in this role.

Ramani announced his decision to delay publishing six issues of the journal each year until there is a continuing backlog of publishable papers. Although there are good papers coming in, there is occasionally less material than desired. A decision has been made to publish at least one paper in French each year, and the Editors are confident this can be maintained. Overall, the publication is proceeding fairly smoothly, and the Board expressed their thanks for the huge effort by all involved.

(A. Behar moved acceptance of Editor's report, D.Giusti seconded, carried.)

Past and Future Conferences

2002 Charlottetown: Annabel Cohen (conference chair) submitted her final report. The website was used extensively to support the organizing process, and this major contribution by David Stredulinsky was specially commended. The budget surplus was $1412. It was agreed that the organizers for the 2002 Charlottetown meeting should be congratulated, as the conference had excellent technical sessions with about 100 papers, the exhibition was good, the food and meeting rooms were excellent, and the budget target was met – satisfying all our objectives for the annual event.

2003 Edmonton: Corjan Buma provided a preliminary status report on the 2003 meeting. An effective website based on the PEI model was developed by Steve Bilawchuk, and has worked well. Corjan noted the support he had received from Christian Giguère and Annie Ross who translated the conference announcements, and the strong contributions by all of the Edmonton team. The number of papers submitted is lower than usual (55) but this has been supplemented by excellent plenary talks, a site visit to the Winspear concert hall, and an exhibition. Advance registration was less than expected; although the total registration may be sufficient to balance the budget, this will not be clear until the last day. The Board congratulated the Edmonton team on their efforts to date.

2004 Ottawa: John Bradley reported that preliminary arrangements have been made in Ottawa, with the Lord Elgin Hotel as the proposed site for a conference on 6,7,8 October 2004. John will be conference Chair, and many members in Ottawa have agreed to participate in the organizing team. The Board agreed that this team should proceed and approved the plan as presented. (Moved by D. Quirt, seconded by D. Giusti, carried).

2005, (London): A team from London Ontario, led by M. Cheesman, has proposed that the 2005 conference be held in London. The Board agreed that this would be a good choice, and that they should be encouraged to proceed with preliminary arrangements.

International Liaison:

Two current issues were discussed.

Distribution of Noise News International: This newsletter is published by International Institute of Noise Control Engineering and distributed in bulk to member societies, including CAA. To improve the circulation to interested CAA members, it was decided to add this as an option on the annual renewal form, with a charge of $5/year to cover mailing costs.

Meetings of International Standards Committees: ISO committee TC43 "Acoustics" and its subcommittees and IEC committee TC29 "Electroacoustics" have been invited to meet in Toronto in spring of 2005. It is not clear yet whether the Canadian invitation will be accepted.

J. Bradley advised that the CAA had received a letter from the Canadian Advisory Committee asking if the CAA would support, via a letter of support and/or monetary contribution, the bid to host international standards meetings in Canada. A copy of this letter was sent to each CAA Board member in August for review. All Board members felt it was important to support the Canadian bid and felt it appropriate that a contribution be made. Mark Cheng requested that any financial contribution by the CAA should be coupled with a request for a member of the Canadian delegation to write a paper for the CAA journal or present at the next annual conference to communicate the workings of these international standard committees to help share and distribute knowledge to the general CAA membership.

(Moved by R. Ramakrishnan that CAA formally support the invitation for the ISO and IEC meetings, and pledge financial support of $500 for each of the two consecutive standards meetings accompanied with a request for a paper or article summarizing the meetings, second M. Cheng, approved)

Awards

Christian Giguère presented a report, based on submissions from the Awards Coordinators. Specific progress for various awards was reported:

Shaw Prize not awarded

Bell Prize not awarded

Successful applicant for the Fessenden Prize.

Successful applicant for the Eckel Prize.

Successful applicant for the Hétu Prize.

Award for the Canada-Wide Science Fair.

Directors' Awards given for both the student and professional over 30.

Student travel subsidies will again have $2500 allocation (in proposed budget).

Concern was expressed about the infrequent applicants for some prizes. One response to correct this is more advertising of their availability (as discussed below). In the case of the Directors' Awards, it was decided a change in the prizes is also desirable, so the two awards for best paper by a professional will be replaced by a single award of $500 with no age criterion (moved by C. Giguère, seconded D. Giusti, approved)

Requirements for all prizes are now presented correctly on the CAA web site, and most include French translations. Revisions to the Directors' Awards and Student Subsidy pages, plus a downloadable version of the prize application form will be added soon. Once correct information is available, reminders will be sent to the membership and academic institutions to encourage applications.

CAA Website

David Stredulinsky submitted a report on the CAA website. Site traffic has approximately doubled in the last 12 months. Content is steadily expanding, and now includes the index for Canadian Acoustics, updated information on CAA awards, job advertisement and job-wanted sections, a sustaining subscribers' page, and downloadable pages for membership/subscription applications. For the "job-wanted" page, it was agreed a disclaimer to clarify that CAA is not endorsing those posting ads should be included. Overall, there was enthusiastic support for the content, especially the pages used for the annual conference.

Investigation of establishing a secure website to permit membership payments by VISA did not establish a cost-effective solution for an association of our size, so no action on this was pursued. Ongoing improvement of French pages and continuing updating of the index for Canadian Acoustics are the next priorities.

Change of Directors

Two Directors come to the end of their terms this month. The President recognized the contributions by Meg Cheesman and Karen Fraser, and expressed the thanks of the Board for their efforts on behalf of the Association. The President announced a slate of nominees for the positions as Director has been established for presentation at the AGM, with due regard for provincial distribution.

Adjournment

D. Giusti moved to adjourn the meeting, seconded by A. Behar, carried. Meeting adjourned at 7:55 p.m.

Special Action Items (Continuing or Arising from the Meeting)

J. Bradley

Deal with transfer of leadership to new President, after election at the AGM.

Establish bank account and proceed with organizing the 2004 Conference in Ottawa.

D. Quirt

Implement new process for distribution of Noise News International

Update database information as part of annual membership renewal process and develop address list for e-mail communication the CAA membership.

D. Giusti

Transfer funds to secretarial account for administrative expenses, and transfer advance funds for Ottawa conference.

C. Giguère and D. Stredulinsky

Continue to update Awards pages on the CAA website.

C. Giguère and M. Hodge

Prepare and distribute notice re CAA prizes to Canadian university departments.

The Canadian Acoustical Association
l'Association Canadienne d'Acoustique

MEMBERSHIP DIRECTORY 2003 / ANNUAIRE DES MEMBRES 2003

The number that follows each entry refers to the areas of interest as coded below.
Le nombre juxtaposé à chaque inscription réfère aux champs d'intérêt tels que condifés ci-dessous

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

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