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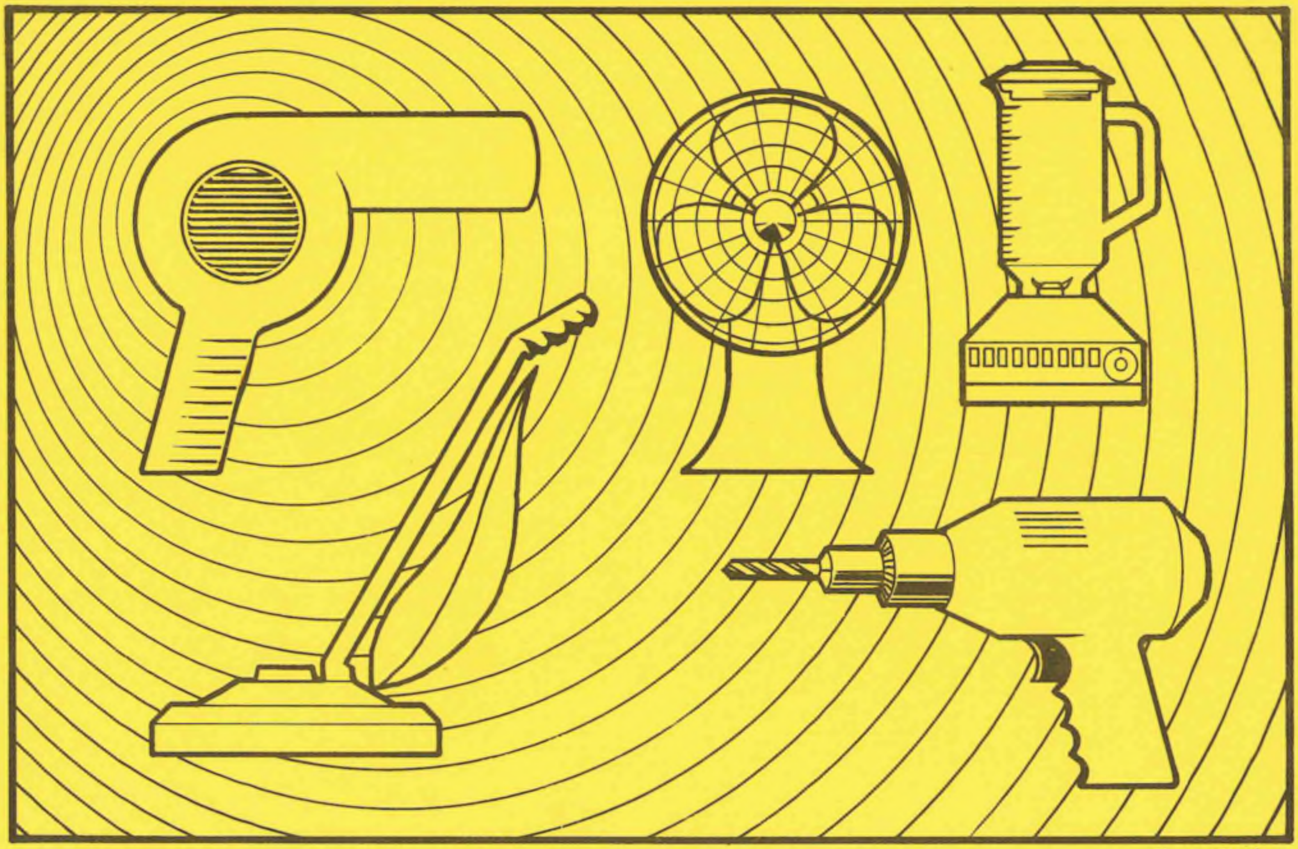

Simon Tuckett

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ACOUSTIQUE CANADIENNE publie des articles arbitrés et des informations sur tous les domaines du son et des vibrations. Les manuscrits seront inédits ou bien des aperçus, ainsi que des notes techniques, rédigés en françcais ou en anglais. Deux copies seront soumis au rédacteur en chef (articles en anglais), ou au rédacteur (articles en français). La forme et la préparation des manuscrits exigées pour reproduction se trouveront dans le premier numéro de chaque volume.

EDITORIAL

A new year and a new volume of your favourite acoustics journal brings changes to the layout. Over the years, the quality of CANADIAN ACOUSTICS has steadily improved. For a number of years now, papers have been reviewed by well-respected reviewers. For example, over the past year we published 12 refereed papers and refused 3; recently, there has been a considerable increase in the number of submissions. In spite of our efforts, some readers have not noticed how good we have become, and others have suggested that we take further steps to improve the quality of our journal.

We have thus chosen to make changes to better emphasize our true status and to better inform readers of the procedures for submitting papers. This will not decrease our news item content. The first change that you will notice is that our refereed papers appear first so that they are not missed. We have expanded the description of our publishing aims on the inside front cover. As before, we publish refereed articles and news items on all aspects of sound and vibration in English or in French. We welcome papers reporting new results, review and tutorial papers as well as shorter notes perhaps of a practical nature. Complete information to authors is now published in the first issue of each volume and appears at the end of this issue. Reprints are available prior to publication and order forms are sent to the authors of all submissions.

Finally, we have a second associate editor for advertising so that we are now also represented in the Montreal area. We welcome your comments and look forward to your submissions to future issues of CANADIAN ACOUSTICS.

EDITORIAL

La nouvelle année apporte un autre volume de l'ACOUSTIQUE CANADIENNE. Nous profitons de l'occasion pour faire le point. Nous avons remarqué que le nombre de soumissions a considérablement augmenté. Le dernier volume a vu paraître 12 articles sur un ~~total~~ de 15 soumissions. La sélection des articles est le résultat d'un arbitrage qui se montre de plus en plus rigoureux.

Afin de mettre en évidence l'évolution de l'ACOUSTIQUE CANADIENNE, nous proposons, dans ce premier numéro, une réorganisation du format. Ces changements viennent, en partie, de suggestions de la part de quelques membres. Dorénavant, les articles arbitrés occuperont la première moitier de chaque numéro. La section Informations suivra. Ceci ne veut pas dire que l'importance accordée aux informations est réduite. Au contraire, nous sommes concient de la place qui doit être réservée à cette section et soucieux de la maintenir. Afin de mieux définir les objectifs de l'ACOUSTIQUE CANADIENNE, nous avons élaboré la présentation à l'intérieur de la page couverture. Elle précise que nous publions des articles arbitrés et des informations sur tous les domaines du son et des vibrations. Les manuscrits seront inédits ou bien des aperçu, ainsi que des notes techniques redigés en français ou en anglais. De plus, la forme et la préparation des manuscrits seront reproduites dans le premier numéro de chaque volume. Des tirés à part sont disponibles s'ils sont commandés avant la publication. Chaques auteurs recevra un bon de commande suite à une soumission. Finalement, nous avons un deuxième rédacteur associé à la publicité dans la région de Montréal.

Il ne reste maintenant qu'a terminé en remerciant le comité organisateur du congrès de Québec et son équipe. Avec deux séminaires et quelques 60 communications il n'y a aucun doute dans l'esprit des participants du succès qu'a été ce congrès. Il ne faut pas oublier non plus les festins culinaires qui nous attendaient!

12th INTERNATIONAL CONGRESS ON ACOUSTICS AND INTERNATIONAL EXHIBITION

TORONTO, CANADA

JULY 1986

The 12th International Congress on Acoustics will be held in Toronto, Canada, from July 24 to August 1, 1986. In keeping with tradition, the Congress will provide an open scientific forum in all fields of acoustics. As part of the Congress, it is planned to hold Symposia on specific topics. The present status of these Symposia is:

July 14-16 —	Acoustical Imaging. Halifax, Nova Scotia, Canada
July 16-18 —	Underwater Acoustics. Halifax, Nova Scotia, Canada
July 21-22 —	Units and Their Representation in Speech Recognition. Montreal, Quebec, Canada
July 21-23 —	INTERNOISE-86 Cambridge, Mass. United States
July 24-31 —	12th Congress on Acoustics. Toronto, Ontario, Canada
July 28-31 —	Congress Exhibition. Toronto, Ontario, Canada
August 2-4 —	Acoustic and Theatre Planning for the Performing Arts. Vancouver, British Columbia, Canada

Congress participants may also be interested in EXPO '86, an international exposition, to be held in Vancouver, British Columbia, May-Oct., 1986.

ACTIVITIES

The Congress will include Special Lectures, Structured Sessions, Contributed Papers, Poster Sessions, Workshops and an Exhibition. The Special Lectures will be presented by internationally recognized scientists and will cover a wide variety of acoustical topics. The Technical Programme Committee solicits contributed papers from all areas of acoustics to be arranged into sessions of related topics.

PUBLICATIONS

The Congress Proceedings will include the Special Lectures, and authors' summaries of contributed papers accepted for the Programme. Authors may bring to the Congress more complete versions of their papers for dissemination there. The Congress Programme, the Exhibition Catalogue and the Proceedings will be provided to registered participants upon arrival in Toronto.

TECHNICAL VISITS AND SOCIAL ACTIVITIES

Technical visits will be organized in the Toronto area and elsewhere. Excursions of general interest will also be arranged particularly for persons accompanying the Congress participants.

EXHIBITION

The Exhibition will be held concurrently with the 12th Congress in Toronto from July 28 to July 31 for four days. The Exhibition and the Congress will be held in the new Metro Toronto Convention Centre located at the foot of the remarkable CN Tower, the tallest man-made structure in the world. International exhibitors, manufacturers, suppliers and organisations are invited to participate in this state-of-the-art display of instrumentation, equipment, materials, supplies, computers and software, architectural plans, drawings and photographs, and literature.

Information is available from the:

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Toronto, Canada, M4T 2L7
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12th Congress on Acoustics
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Toronto, Canada
July 1986

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Please send me information on the: Exhibition in Toronto ☐ Congress and technical meeting ☐

POSITION WANTED

I am an acoustic engineering technician, graduate from George Brown College, who is looking for an opportunity to put my education and related work experience to good use. I have worked as a noise surveyor, audio engineer and a room acoustical consultant. I am available immediately for full-time or part-time employment and am willing to relocate. Extensive references available.

Paul Gonsalves
66 Fordwich Crescent
Rexdale, Ontario
M9W 2T5
Tel.: (416) 749-0632

POSITION WANTED

Warren Kelly is seeking acoustics-related employment. He is a recent graduate, with honours, from the "Acoustics Engineering Technicians Program" at George Brown College in Toronto. Past experience includes employment with the Ontario Ministry of the Environment assessing: noise as occupational hazard, recorded data compiled from a small hand gun study and transportation and industrial noise on proposed land use projects.

Warren Kelly
590 Sandhurst Circle #2
Scarborough, Ontario
M1S 4J6
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AN EXPERIMENTAL ASSESSMENT OF THE CSA STANDARD ON 'MEASUREMENT AND RATING OF THE NOISE OUTPUT OF CONSUMER APPLIANCES'

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and

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Division of Building Research
Ottawa, Canada K1A 0R6

ABSTRACT

The noise output of five small sound sources has been measured using three different methods suggested by the CSA standard Z107.71-M1981. Results indicate they can produce consistent answers.

RÉSUMÉ

Le bruit produit par cinq sources sonores a été mesuré selon trois méthodes recommandées par la norme Z107.71-M1981 de l'Association canadienne de normalisation. Les données obtenues indiquent que ces méthodes fournissent des résultats sensiblement uniformes.

INTRODUCTION

This work was undertaken to provide additional experimental support to the CSA standard on 'Measurement and Rating of the Noise Output of Consumer Appliances.' Four small appliances and a standard ILG source were tested according to the three different methods suggested by the CSA standard. Although the noise output of some of the sources had been measured before,[1] they were retested here to form a complete set. No attempt has been made to compare the present results with those of Ref. 1 since the operating conditions of the appliances might not have been the same.

SOURCES

The sources and their operating conditions chosen for the present experiment are:

1) a standard ILG source;
2) a small blower operated at maximum speed;
3) a heat gun set in the 'cold' position with the air entry port set at maximum opening;
4) a fixed speed hand drill; and
5) a blender filled with 680 g (24 oz) of water and operated at three different speeds, No. 1 (slowest), No. 7 (medium), and No. 14 (maximum).

Although these sources represent only a small cross section of consumer appliances, it is hoped that their characteristics are different enough to provide a reasonably good test of the three methods of the standard. The one-third octave power spectra of these sources were measured in a reverberation room and are presented in Fig. 1.

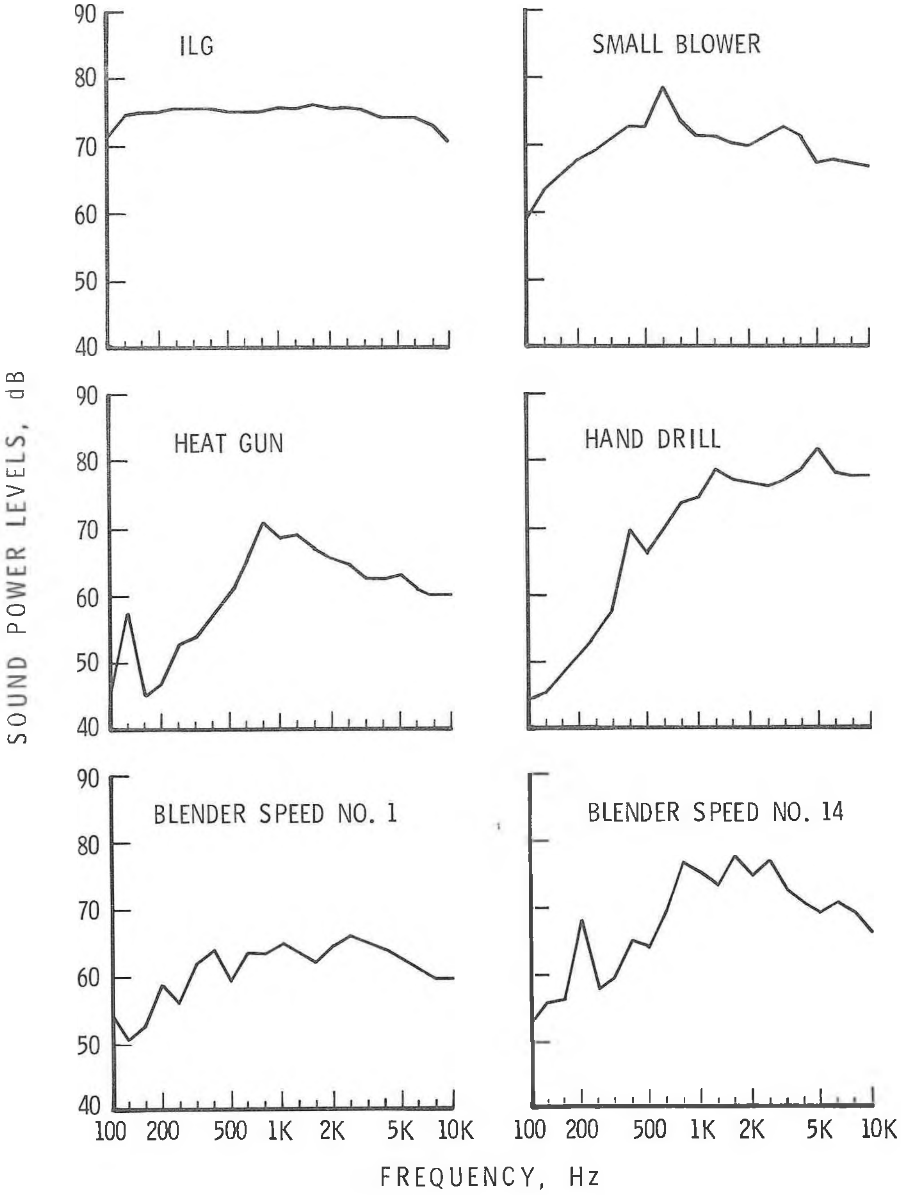

Figure 1. One-third octave band sound power levels of the different sources used in the experiment.

METHODS

The noise output for each of the sources listed above was measured with the source sitting on a hard surface using the following methods.

(1) Reverberation Room Method:

The measurements were conducted according to ANSI Standard S1.31-1980 in a reverberation chamber with a nominal volume of 255 m^3 and dimensions of 8.0 × 6.5 × 4.9 m. The room is equipped with fixed diffusers and a rotating vane. It has automatic environmental controls and is generally maintained at 21°C and 55% relative humidity.

The sound field was sampled by nine microphones located randomly in the room and the sources were tested at three different locations on the floor. The basic data obtained by this test were sound power levels for a series of one-third octave frequency bands from 100 to 10,000 Hz. These were then added with proper A-weighting corrections to produce the A-weighted sound power levels. A more detailed description of the instrumentation used can be found in Ref. 2.

(2) Free Field Method:

The measurements were made outdoors in an open field with the nearest building at least 100 m away. The reflecting floor was a painted 2.4 × 2.4 m wood panel with a 38 mm thickness. Two measuring radii of 0.75 and 1 m were used. Except for the ILG source and the heat gun, the four recommended measuring locations were found to be quite adequate. The A-weighted sound pressure levels were measured directly with a B&K Type 2218 integrating sound level meter equipped with a Type 4165 microphone and a windscreen; this combination offers a flat frequency response for free field measurement at 0° angle of incidence. The integration time used was 3.6 s. The instrument was calibrated with a B&K Type 4230 calibrator both before and after each test.

(3) Partially Absorptive Room Method:

For this case, a 122 m^3 reverberation room was converted into a partially absorptive room by adding absorption to meet the requirement that A/R^2 be greater than 20. R is the measurement radius and A is the sound absorption of the test room determined from reverberation time measurements. Two values of A, 19.1 and 27.8 metric sabins, were used. As in method (2), two measuring radii were used with the same positions around the sources. The A-weighted sound pressure levels were also taken with the B&K Type 2218 sound level meter.

RESULTS AND DISCUSSION

For comparison purposes, the results obtained by the three different methods have been converted to sound level ratings for indoor usage as specified in CSA Z107.71. These are presented in Table 1.

Although the reverberation room method tends to give higher values for most of the sources tested, the differences are not large and cast no serious doubts on the validity of the three methods used. It is hoped that this excercise will give manufacturers confidence in adopting any one of these methods for measuring the noise output and rating their products.

TABLE 1
Comparison of Sound Level Ratings (dBA) of Different Sources
Obtained by the Three Methods

Noise Sources	Reverberation Room	Free-Field Measurements		Partially Absorptive Room			
				A = 19.1		A = 27.8	
		R=.75	R=1.0	R=.75	R=1.0	R=.75	R=1.0
ILG	86.5	87.3	87.2	86.5	86.2	86.6	86.5
Small Blower	83.0	82.2	82.3	82.8	82.9	82.7	82.9
Heat Gun	77.0	77.5	77.3	76.6	76.5	77.0	77.4
Hand Drill	89.0	87.5	88.2	88.4	88.3	88.2	88.1
Blender Speed #1	75.5	73.5	73.4	73.0	73.6	74.5	74.0
Blender Speed #7	81.5	80.8	81.0	79.8	79.9	79.3	79.0
Blender Speed #14	85.5	84.9	84.9	84.3	84.7	84.8	84.3

REFERENCES

(1) T.D. Northwood and W.T. Chu, "Measurement of Sound Emission of Small Sources in Reverberant and Anechoic Environments," presented at the Canadian Acoustical Association Annual Meeting at Windsor, Ontario, 24-26 October 1979.

(2) W.T. Chu, "Reverberation Room Qualification Studies at the National Research Council of Canada," Building Research Note No. 203, Division of Building Research, National Research Council Canada, May 1983.

UTILISATION DE L'INTENSITE ET DE LA PUISSANCE ACOUSTIQUES POUR L'IDENTIFICATION DES SOURCES DE BRUIT

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SOMMAIRE

La mesure de l'intensité et de la puissance acoustiques livrent des informations précieuses pour l'identification des sources dominantes de bruit et pour l'élaboration d'une solution judicieuse et efficace au problème qu'elles causent. Cet article décrit une étude de cas où des solutions proposées, sans avoir recours à la puissance sonore, se sont avérées inefficaces. Il est démontré comment l'intensité et la puissance acoustiques peuvent prédire les résultats obtenus et identifier les sources qui doivent être traitées.

ABSTRACT

Sound intensity and sound power are useful informations to identify and rank noise sources, and to guide the noise control engineer toward an effective solution. This paper describes a case study where solutions proposed without the knowledge of sound power have proven to be ineffective. It is shown how this result could have been predicted by sound intensity and power measurements and how these lasts point out the sources that should have been treated.

INTRODUCTION

Les progrès récents de l'électronique permettent aujourd'hui de mesurer adéquatement et facilement l'intensité acoustique. Ce paramètre n'est pas nouveau puisqu'il est connu depuis les débuts de l'acoustique, tout comme la pression sonore et la puissance acoustique; cependant, sa mesure expérimentale a, jusqu'à ces dernières années, toujours été pour le moins problématique.

L'intensité acoustique est définie [1] comme étant le flux d'énergie sonore par unité de surface et est obtenue par le produit de la pression sonore par la vélocité des particules. La pression est une quantité scalaire; la vélocité par contre est une quantité vectorielle (une direction et un sens), ce qui fait que l'intensité l'est aussi. Cet aspect vectoriel confère à l'intensité deux applications fort utiles. Un, l'intensité acoustique permet de localiser une source de bruit: pour une direction donnée, l'intensité change de signe (i.e. sens) lorsque le capteur dépasse la source. Deux, lorsque, dans une salle quelconque, on intègre le produit de l'intensité par une surface élémentaire sur une surface fermée enveloppant en totalité une source de bruit, nous obtenons le flux net d'énergie produit par cette seule source, donc sa puissance acoustique, qu'il y ait ou pas d'autres sources à l'extérieur de cette surface.

Or la connaissance de la puissance acoustique irradiée par une source de bruit est fondamentale. C'est le paramètre qui caractérise le mieux une source parce qu'il est indépendant de l'environnement dans lequel se trouve la source, à l'instar de la pression sonore. Une même source de bruit produira un niveau de pression plus élevé dans un environnement réverbérant que dans un milieu anéchoïque; sa puissance demeure cependant la même. Par ailleurs, il est possible de dériver de la puissance de la source le niveau sonore qu'elle produit si le milieu est connu [1,2].

La puissance acoustique est donc le critère selon lequel les différentes sources de bruit en présence peuvent être classées par ordre d'importance; ce même classement indique l'ordre dans lequel les sources de bruit doivent être traitées en vue d'une réduction efficace du niveau sonore. L'intensité acoustique, quant à elle, permet la mesure sur place de la puissance acoustique et d'associer un son à sa source (localisation).

Nous présentons dans cet article un rappel sur la théorie de la mesure de l'intensité et de la puissance acoustiques, de même que les résultats et conclusions d'une étude que nous avons effectuée sur une machine à filer de l'industrie textile. Des solutions pour réduire le bruit, proposées par le manufacturier, ont été réalisées et se sont avérées inefficaces; nous verrons comment la puissance et l'intensité acoustiques peuvent expliquer ces résultats, comment elles pouvaient les prédire, et comment elles indiquent ce sur quoi doivent porter en priorité les efforts pour réduire le bruit.

MESURE DE L'INTENSITE ET DE LA PUISSANCE ACOUSTIQUES

Il est connu [1,3] que l'intensité acoustique I est obtenue par le produit de la pression sonore P par la vélocité $\vec{u}$ des particules d'air. La mesure de l'intensité requiert donc la mesure simultanée de la pression et de la vélocité. Cette dernière est difficilement mesurable. Cependant, l'utilisation d'une relation de la mécanique des fluides et d'une approximation par différence finie permet d'évaluer la vélocité u_r, composante de $\vec{u}$ dans une direction portée par r, selon l'équation suivante:

$$u_r(t) = \frac{-1}{\rho} \int \frac{\partial P(t)}{\partial r}\, dt \simeq \frac{-1}{\rho} \int \frac{P_2(t)-P_1(t)}{\Delta r}\, dt \qquad (1)$$

où ρ est la densité de l'air, $P_1(t)$ et $P_2(t)$ sont les pressions instantanées captées par les microphones 1 et 2 respectivement et où Δr est l'écart entre les microphones; cette approximation n'est valable que si Δr est petit devant la longueur d'onde. La mesure de u_r en un point M de l'espace requiert donc l'utilisation de deux microphones situés de part et d'autre du point M (voir Figure 1). Conséquemment, la pression P(t) au point M peut être approximée par la demi somme de $P_1(t)$ et $P_2(t)$, de sorte que l'intensité instantanée au point M dans la direction portée par r est:

$$I_r(t) = P(t)u_r(t) \simeq \frac{P_1(t)+P_2(t)}{2} \left(\frac{-1}{\rho}\right) \int \frac{P_2(t)-P_1(t)}{\Delta r}\, dt \qquad (2)$$

L'équation 2 est l'expression de l'intensité instantanée. Dans la pratique, il est préférable d'avoir recours à une valeur moyenne sur une période de temps suffisamment longue pour minimiser les erreurs statistiques. De plus, il existe deux techniques pour évaluer l'équation 2. L'une est son évaluation directe par des circuits électroniques sommateurs et intégrateurs; la composition fréquentielle de l'intensité peut alors être obtenue par un filtrage en bandes à pourcentage constant (e.g. 1/3 d'octave). La seconde technique consiste à exprimer l'équation 2 dans le domaine fréquentiel avant toute mesure. Il est démontré [3,4,5] que l'intensité acoustique peut alors être exprimée par:

$$I_r(f) = \frac{-1}{2\rho\omega\Delta r} \operatorname{Im} \{G_{12}(f)\} \qquad (3)$$

où f est la fréquence, ω est la fréquence angulaire, Im désigne la partie imaginaire et où $G_{12}(f)$ est le spectre croisé des pressions $P_1(f)$ et $P_2(f)$. Puisque la fonction $G_{12}(f)$ est usuellement disponible sur les analyseurs à transformée rapide de Fourier à deux voies, l'équation 3 est généralement évaluée à l'aide d'un tel appareil; la résolution fréquentielle est alors constante sur toute la plage de fréquences et est déterminée par les paramètres usuels de l'échantillonnage.

Quelque soit la technique utilisée, l'évaluation de l'équation 2 est sujette à des limitations dues aux approximations sur lesquelles elle repose. L'erreur introduite peut être évaluée dans le cas de situations simples [6]. Par exemple, si nous prenons le cas d'une source ponctuelle émettant des ondes sphériques et la géométrie de la Figure 1, il peut être démontré [7] que l'expression de cette erreur ε est donnée par:

$$\varepsilon=10 \log_{10} \left\{\frac{I_{\text{estimée}}}{I_{\text{exacte}}}\right\}=10 \log_{10} \left\{\frac{r^2}{r_1 r_2} \frac{1}{k\Delta r\cos\theta} \sin\left(\frac{2r}{r_1+r_2} k\Delta r\cos\theta+\Delta\phi\right)\right\} \qquad (4)$$

où k est le nombre d'ondes, θ est l'angle d'incidence et $\Delta\phi$ est l'erreur de phase introduite par l'instrumentation. Dans les conditions de champ éloigné et sous incidence de 0°, l'expression de ε se résume à:

$$\varepsilon = 10 \log_{10} \left\{\frac{1}{k\Delta r} \sin(k\Delta r + \Delta\phi)\right\} \quad \text{champs éloigné, incidence } 0° \qquad (5)$$

L'équation 5 indique bien qu'à basses fréquences ($k\Delta r$ faible) l'effet de $\Delta\phi$ est plus important qu'à hautes fréquences; par contre, en hautes fréquences ($k\Delta r$ grand), $\sin(k\Delta r)$ diffère considérablement de $k\Delta r$. La mesure de l'intensité acoustique est donc limitée en basses fréquences à cause de l'erreur de phase introduite par l'instrumentation et en hautes fréquences parce que les approximations par différence finie et moyenne numérique deviennent de plus en plus erronnées. La Figure 2 est la représentation de l'équation 5 en fonction de la fréquence pour un écart de 6 mm et des erreurs de phase de 0.3°, -0.3° et 1° respectivement. En basses fréquences nous constatons que l'intensité peut être surestimée ou sous-estimée dépendant du signe de l'erreur de phase $\Delta\phi$ et que le module de l'erreur est plus grand pour un $\Delta\phi$ plus grand. Aux hautes fréquences l'erreur de phase perd de son importance puisque les trois courbes convergent vers une seule. L'erreur y est principalement due aux approximations et est gouvernée par l'écart entre les microphones: plus Δr est grand plus l'erreur est grande. D'une part, l'instrumentation utilisée pour la mesure de l'intensité doit donc être des plus précises en phase pour permettre une mesure précise en basses fréquences, et d'autre part, l'écart entre les microphones doit être judicieusement choisi selon le contenu en fréquences du bruit pour assurer cette précision dans les hautes fréquences.

Différentes configurations concernant le capteur d'intensité peuvent être utilisées. Les plus répandues sont celles où les microphones sont soit face à face soit côte à côte. Chacune a ses avantages et ses inconvénients, et une certaine controverse à savoir laquelle est la meilleure persiste dans la littérature. Quelque soit la configuration utilisée, le capteur d'intensité est caractérisé par une même sensibilité théorique (excluant les effets d'obstacle et de diffraction). Cette sensibilité est définie par le rapport de l'intensité estimée sous l'incidence θ à l'intensité exacte sous indidence 0°; la sensibilité du capteur idéal serait donnée simplement par cos θ. Dans le cas d'un capteur quelconque, elle est donnée par:

$$q = \frac{r^2}{r_1 r_2} \frac{1}{k\Delta r} \sin \left(\frac{2r}{r_1+r_2} k\Delta r \cos\theta + \Delta\phi\right) \qquad (6)$$

Cette sensibilité ne tend vers l'idéal cos θ qu'en champ éloigné ($r \simeq r_1 \simeq r_2$), lorsque $\Delta\phi = 0°$ et que $k\Delta r$ est petit. Pour illustrer, la Figure 3 est le tracé polaire de $10 \log \{q\}$ dans le cas où $\Delta r = 12$ mm, $\Delta\phi = 0.5°$, f = 100 Hz en champ éloigné. Nous constatons le démarcage entre la sensibilité idéale (en pointillés) et celle du capteur. Par ailleurs le capteur n'a pas une sensibilité qui soit symétrique: les sensibilités aux angles θ et $\theta + 180°$ ne sont pas les mêmes. Ceci cause une erreur lorsqu'en un point donné nous voulons déterminer le flux net d'énergie comme c'est le cas lors de la mesure de la puissance acoustique; dans le cas de la Figure 3, la différence des sensibilités à 0° et 180° est de 3.7 dB. Une erreur faible sur la phase ($\Delta\phi$) permet de minimiser cette dissymétrie et d'assurer une évaluation précise du flux net. D'autre part, il est à remarquer que la sensibilité minimale du capteur n'apparaît pas aux angles $\theta = 90°$ et $\theta = 270°$. La position du capteur par rapport à la source où l'intensité est nulle est obtenue en posant q = 0, ce qui donne:

$$\theta \Big|_{I=0} = \text{arc cos} \left\{\frac{r_1+r_2}{2r} \left(\frac{-\Delta\phi}{k\Delta r}\right)\right\} \qquad (7)$$

Cet angle ne vaut donc 90° ou 270° que lorsque l'erreur de phase est nulle. En pratique cette erreur n'est pas nulle, ce qui explique pourquoi nous observons que l'intensité s'annule lorsque le capteur dépasse légèrement la source et non pas lorsqu'il est strictement en face de la source (θ=90°). Dans le cas de la Figure 3, la sensibilité est nulle aux angles θ = 113.5° et θ = 246.5°.

L'intensité acoustique est une quantité vectorielle. Sa direction est celle dans laquelle le gradient de pression a été approximée pour livrer la vélocité u_r; ceci signifie que cette direction est portée par l'axe qui joint les centres acoustiques des deux microphones. Le sens de l'intensité sur cette direction est fixé par le signe du gradient de pression [7]. Le sens de l'intensité dans une situation telle celle de la Figure 1 est positif, selon notre dérivation de l'expression de l'intensité. Si la source sur la Figure 1 était déplacée de façon à être à droite des microphones, le sens de l'intensité évaluée par l'équation 2 serait négatif, puisque le gradient de pression $[P_2(t)-P_1(t)]/\Delta r$ changerait de signe. Ceci explique le changement de signe de l'intensité observé lorsque le capteur d'intensité dépasse la source du bruit.

Cet aspect vectoriel est très utile pour localiser les sources de bruit et pour la mesure de la puissance acoustique W d'une source. Cette dernière est obtenue en intégrant le produit de la composante normale I_n de l'intensité par une surface élémentaire dA sur une surface S enfermant en totalité la source:

$$W = \int_s I_n dA \tag{8}$$

Cette méthode a plusieurs avantages: 1) l'intensité peut être mesurée dans le champ proche; 2) il n'y a pas de contrainte quant à la forme de la surface de mesure; 3) la mesure peut être effectuée en présence d'autres sources ou en milieu réverbérant, dans bien des cas. Cette dernière particularité vient du fait que la formulation de l'intensité acoustique (équation 2) donne en fait la valeur nette de l'intensité au point de mesure: l'intensité en provenance de l'extérieur de la surface de mesure (sens négatif) est soustraite de l'intensité issue de l'intérieur de la surface (sens positif). Globalement, toute l'énergie acoustique pénétrant à l'intérieur de cette surface en sort ultérieurement, s'il n'y a pas d'absorption à l'intérieur de la surface; il en résulte que les autres sources ou les réflexions n'ont aucune influence sur la mesure de la puissance et que celle-ci peut être faite dans les conditions réelles d'opération, sur place.

En pratique, l'intégrale de l'équation 8 est approximée par une sommation finie sur un certain nombre N de points auxquels sont rattachés des éléments A de la surface totale S. Le choix du nombre de points et de leur emplacement est important: le principe général est de diviser la surface S en autant d'éléments de façon que l'intensité mesurée en un point de chacun des éléments soit représentative de l'intensité en tous les points de cet élément. Ce principe peut conduire à un nombre important de points. Selon notre expérience de ce genre de mesures, des éléments d'environ 0.5 m^2 et de forme carrée mènent généralement à de bons résultats.

DESCRIPTION DE LA MACHINE A FILER

Le procédé de filage à anneaux dans l'industrie du textile primaire en est un qualifié d'assez bruyant. Le filage consiste à produire un fil fin et résistant à partir d'une mèche par torsion et traction. Les vitesses de rotation de certains éléments d'un métier à filer atteignent les 12 000 rpm ce qui a pour effet d'irradier du bruit des basses aux hautes fréquences.

Nous avons étudié de près les caractéristiques sonores d'un modèle particulier de métier à filer. La Figure 4 est une photographie du métier étudié. Les dimensions de cette machine sont approximativement de 14.8 m de long, 1.07 m de large et 2.1 m de haut incluant les supports de mèche. Cette machine peut être divisée en trois sections: la tête renferme les moteurs et mécanismes d'entraînement, de même qu'un puissant aspirateur pour les fibres en suspension; la queue renferme quelques mécanismes secondaires; le corps de la machine, qui s'étend sur 75% de la longueur totale, comporte deux rangées (une de chaque côté) de 126 broches où sont produits et embobinés autant de fils. La Figure 5 montre quelques unes de ces broches; les différentes constituantes y sont identifiées.

RECOMMANDATIONS DU MANUFACTURIER

La compagnie qui exploite plusieurs dizaines de ces machines a eu recours dans un premier temps à leur manufacturier. Celui-ci a recommandé trois modifications en vue d'une réduction du bruit : 1) installation d'un silencieux à la sortie de l'aspirateur; 2) installation de supports d'anneau en élastomère pour réduire les vibrations transmises au rail supportant les anneaux; 3) remplacement des poulies métalliques de tension des courroies d'entraînement des broches par d'autres faites de plastique, pour diminuer la radiation de bruit. Toutes ces modifications ont été effectuées successivement. Des mesures de la pression sonore ont été effectuées en cinq positions le long de la machine avant les modifications et après chacune des modifications de façon à pouvoir juger la réduction apportée par chacune. Les résultats de ces mesures sont résumés dans le Tableau 1.

Ces résultats démontrent que les supports d'anneau en élastomère ne s'avèrent pas d'une grande utilité et que les poulies de tension en plastique n'apportent qu'une réduction marginale. Ces deux modifications auraient dû avoir un effet beaucoup plus marqué selon le manufacturier. Le silencieux par contre apporte une réduction appréciable de 4 dBA au niveau de la tête de la machine.

MESURE DE LA PUISSANCE ACOUSTIQUE

Nous avons procédé à la mesure de la puissance acoustique de la machine à filer avant de procéder aux modifications décrites auparavant. Pour ce faire nous avons utilisé l'analyseur d'intensité acoustique BK3360 couplé à un calculateur, pour effectuer les calculs de la puissance; nous avons eu recours à des microphones de 6 mm distants de 6 mm ce qui nous assure une erreur maximale de 1.5 dB aux extrémités de la plage de fréquences de 160 Hz à 12.5 kHz (voir Figure 2). L'analyse a été effectuée en bandes tiers d'octave; la pondération A a été appliquée sur les valeurs numériques au niveau du calculateur pour éviter l'éventuelle erreur sur la phase introduite par l'utilisation des deux filtres de pondération A (un filtre pour chaque canal). Nous avons utilisé un total de 225 points de mesure répartis sur une surface parallélépipédique de dimensions 15 m de long, 1.27 m de large, 1.2 m de haut; l'aire moyenne associée à chaque point de mesure était de 0.258 m^2. La puissance totale W_k dans la bande tiers d'octave d'indice k a été obtenue par l'évaluation de l'équation suivante:

$$W_k = 10 \log_{10}\left[\sum_{i=1}^{225} I_{ki}A_i/1\text{pW}\right] - C_k \qquad (9)$$

où I_{ki} est la composante normale de l'intensité acoustique, dans la bande tiers d'octave d'indice k, au point i, ou A_i est l'aire associée à ce point i, et où C_k est le coefficient de la pondération A relatif à la bande tiers d'octave d'indice k. Le temps d'intégration à chaque point fut de huit secondes.

La puissance totale mesurée est de 103.6 dBA, référés à 1 pW. La Figure 6 présente la composition fréquentielle de cette puissance.

IDENTIFICATION DES SOURCES

L'intensité acoustique a été mise à profit pour identifier la ou les sources responsables des composantes dominantes du spectre de la puissance (voir Figure 5) alors que toute la machine fonctionnait normalement. Grâce à cette technique nous avons constaté que: 1) les composantes à 315 et 400 Hz sont dues principalement à l'aspirateur situé en tête de machine; 2) les composantes de 1 600 et 3 150 Hz sont reliées aux broches et aux bobines qu'elles supportent; 3) les composantes à 5 000 et 6 300 Hz sont reliées aux anneaux, à leurs curseurs et aux poulies de tension.

ANALYSE DES RESULTATS

L'association des composantes de la puissance et de leurs sources principales nous permet à ce stade-ci d'expliquer les résultats présentés au Tableau 1.

L'aspirateur est une source dominante de bruit sur cette machine. L'installation d'un silencieux a permis de réduire considérablement le bruit au voisinage de l'aspirateur ce qui confirme que la source touchée est la bonne. Cependant l'efficacité du silencieux installé n'est pas suffisante. Un calcul théorique simple justifie cette idée. Supposons que le silencieux permet de réduire la puissance à 315 et 400 Hz (97.8 et 89.1 dB) de 4 dB (à 93.8 et 85.1 dB), la puissance totale est réduite de 103.6 à 102.7 dB, donc une réduction de 0.9 dB. Cette diminution de la puissance totale injectée dans le local se traduit par une diminution de même grandeur du niveau moyen de la pression. Or la réduction moyenne mesurée dans le local (voir Tableau 1) suite à l'installation de ce silencieux est de 0.9 dB. Ce calcul indique donc que la performance du silencieux est une réduction de 4 dB de la puissance émise, ce qui est bien peu si l'on considère que la composante à 400 Hz surpasse ses voisines par environ 10 dB. Bien que la source touchée soit la bonne, la solution apportée est insuffisante. Des travaux entrepris à l'Université de Sherbrooke ont permis de réaliser un silencieux prototype offrant une réduction de 12 dB de la puissance émise à 400 Hz [8].

L'installation des supports d'anneau en élastomère n'a pas apportée à toute fin pratique une réduction du bruit global. La raison est que la puissance qui leur est associée, 91.8 dB, est négligeable devant la puissance totale de la machine, 103.6 dB. En fait si le bruit de ces anneaux était parfaitement annulé, la nouvelle puissance totale serait de 103.3 dB, soit une minime réduction de 0.3 dB. La réduction du bruit que ces supports apportent est, dans les circonstances, négligeable et il est inapproprié de s'attaquer à cette source, toujours dans les circonstances actuelles.

La réduction moyenne apportée par le changement des poulies de tension n'est guère plus marquée que celle due aux supports d'anneau. Les puissances qui leur sont associées étant voisines, le traitement des poulies de tension ne peut qu'être du même ordre de grandeur que celui des anneaux, et donc négligeable. Le traitement prioritaire de ces sources, c'est-à-dire avant de traiter les autres sources plus importantes, n'est pas justifiable.

Le spectre de la puissance (Figure 6) indique par ailleurs que les bobines et les broches sont une source importante de bruit. La somme des composantes de 1 600 à 3 150 Hz est égale à 98.9 dB, ce qui en fait une source légèrement plus importante que l'aspirateur. Il est étonnant que l'on n'ait pas tenté d'en réduire la puissance puisque cette source est dominante et qu'il existe de nouveaux types de broches qui sont plus silencieuses [9] que celles utilisées.

Par ailleurs, la connaissance de la puissance acoustique associée à chaque source permet de prédire la réduction moyenne du bruit apportée par une modification ou par un ensemble de modifications, donc permet d'orienter convenablement les efforts pour réduire le bruit. Le Tableau 2 résume les réductions prédites du niveau moyen obtenues par diverses modifications. Dans le cas qui nous préoccupe nous recherchons une réduction de l'ordre de 4 dB. Le Tableau 2 indique que la façon de l'obtenir est de traiter à la fois l'aspirateur (- 15 dB) et les bobines et broches (- 10 dB). Nous constatons que le traitement de l'aspirateur seul, des supports d'anneau seul ou des poulies seulement ne peuvent amener une réduction suffisante (- 1.5, - 0.3 ou - 0.3 dB); cette constatation aurait suffit à faire renoncer aux essais qui ont été réalisés dans cette étude et d'en éviter les coûts d'installation et de matériel.

La dernière modification envisagée au Tableau 2 est intéressante. Elle indique que le traitement des anneaux et poulies devient efficace (réduction additionnelle de 5.1 - 3.9 = 1.2 dB) une fois que les sources dominantes (aspirateur, broches et bobines) ont été traitées convenablement, parce que les anneaux et poulies deviennent alors les sources dominantes. Au besoin cette modification pourra être envisagée.

Cette analyse indique donc que les efforts doivent porter d'abord sur la réduction du bruit produit par le ventilateur, les bobines et les broches. Toute autre solution préalable est mathématiquement et techniquement injustifiable.

CONCLUSION

La connaissance de la puissance acoustique et la mesure de l'intensité acoustique peuvent être mises à profit pour éviter des dépenses de temps et d'argent dans la recherche d'une solution efficace pour réduire le bruit.

REMERCIEMENTS

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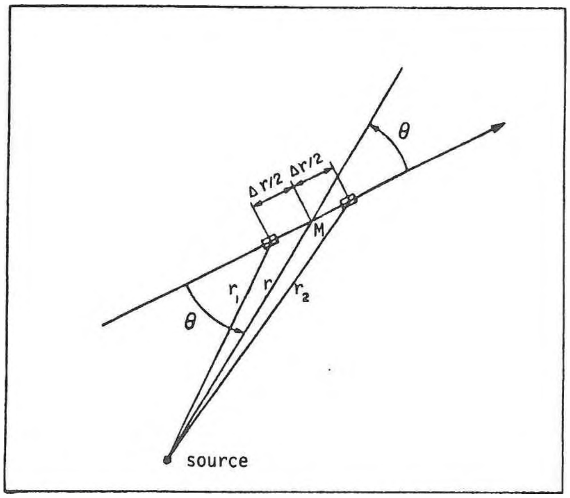


Figure 1. Géométrie et définitions

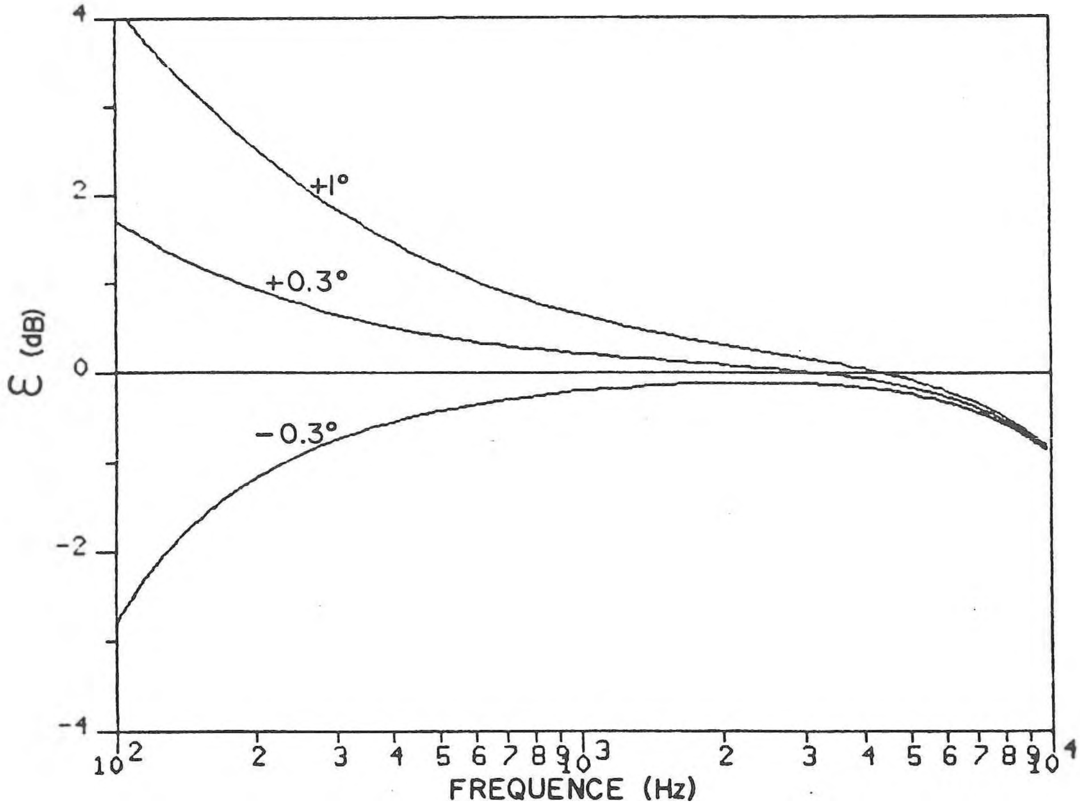


Figure 2. Erreur sur la mesure de l'intensité sous incidence de 0° en champ éloigné. Δr = 6 mm, $\Delta\phi$ = 0.3°, + 0.3°, + 1°.

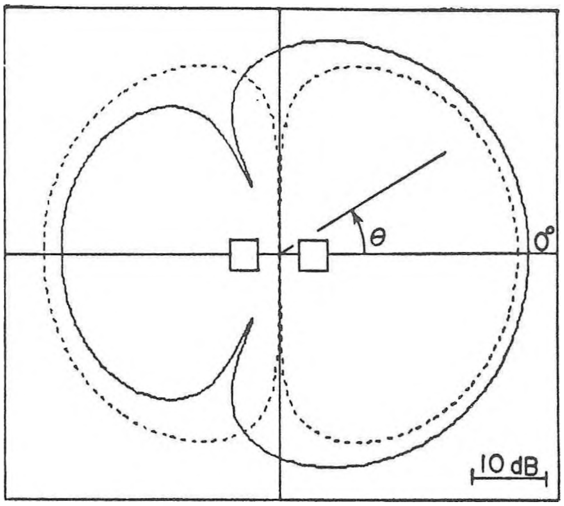


Figure 3. Tracé polaire du logarithme de la sensibilité en champ éloigné.
----- idéal; ——— Δr = 12 mm, Δφ = 0.5°, f = 100 Hz.

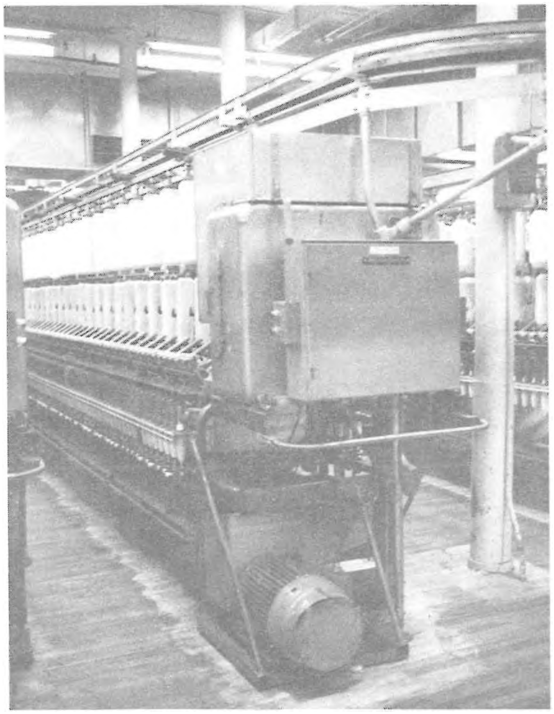


Figure 4. Vue d'ensemble du métier à filer.

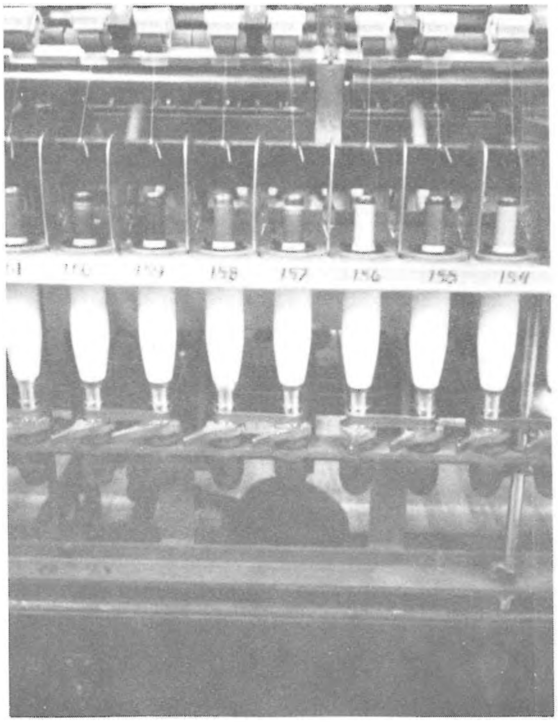
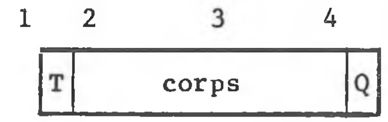


Figure 5. Vue d'une section du corps de la machine.
a) anneaux, b) rail supportant les anneaux, c) bobines,
d) broches (vue partielle),
e) courroies d'entraînement,
f) rail supportant les bobines.
Poulies de tension non visibles.

	NUMERO DU POINT DE MESURE					
	1	2	3	4	5	moyenne
silencieux	-4.0	-0.5	-0.2	-0.3	-0.5	-0.9
supports d'anneau	0.0	+0.1	-0.1	+0.1	+0.1	0.0
poulie de tension	-0.1	-0.1	-0.3	-0.2	-0.1	-0.2



T: tête
Q: queue

Tableau 1. Réduction (dBA) du bruit apportée par chacune des modifications (une valeur négative indique une réduction).

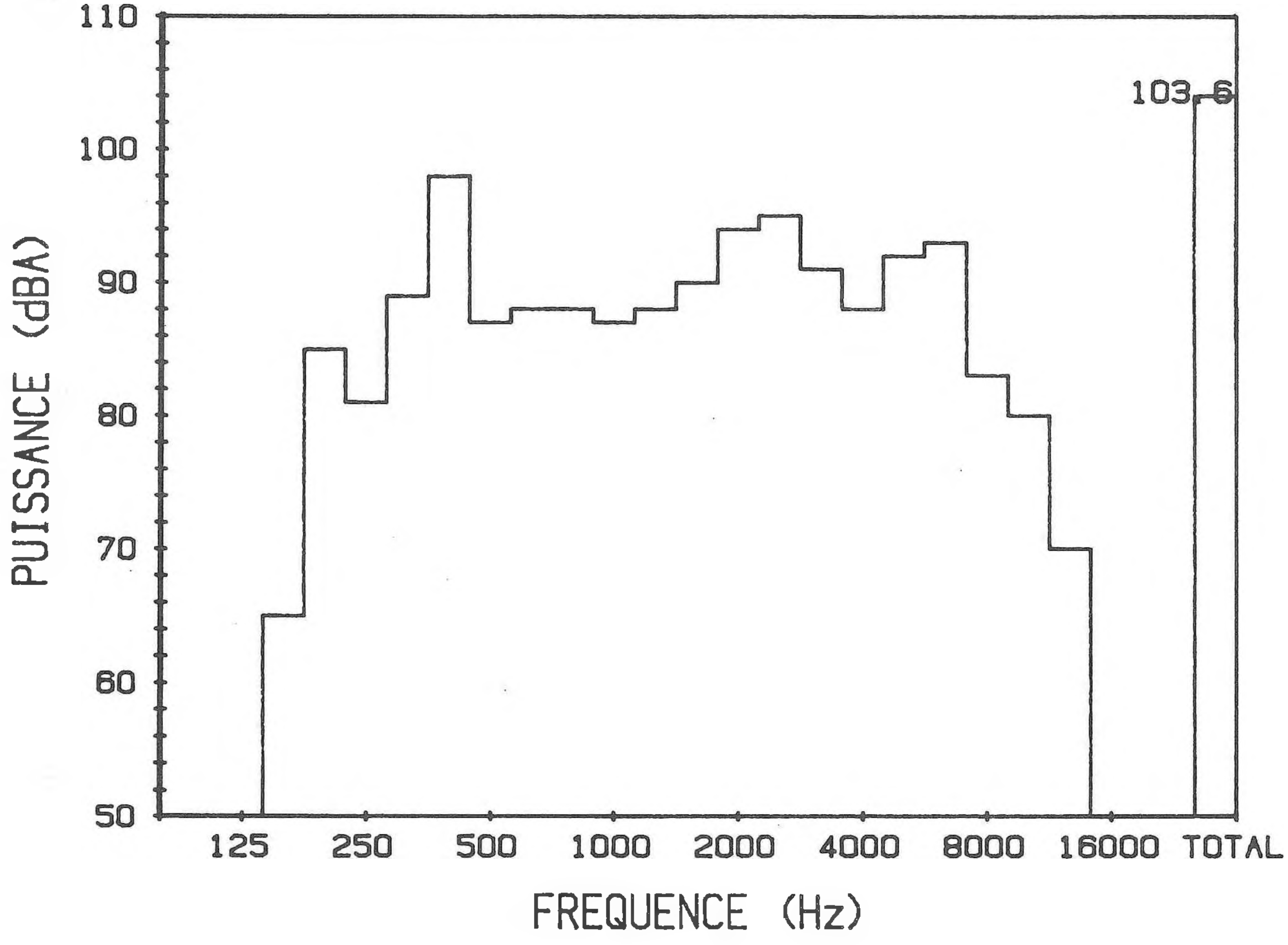


Figure 6. Composition fréquentielle (1/3 d'octave) de la puissance acoustique d'un métier à filer.

modification	réduction locale	réduction sur la puissance totale
aspirateur	-4 dBA à 315 et 400 Hz	-0.9 dBA
	-15 dBA à 315 et 400 Hz	-1.5 dBA
supports d'anneau	-5 dBA à 5 kHz	-0.2 dBA
	-10 dBA à 5 kHz	-0.3 dBA
poulies	-5 dBA à 6.3 kHz	-0.2 dBA
	-10 dBA à 6.3 kHz	-0.3 dBA
aspirateur plus supports d'anneau plus poulies	-15 dBA à 315 et 400 Hz -5 dBA à 5 k et 6.3 kHz	-2.1 dBA
	-15 dBA à 315 et 400 Hz -10 dBA à 5 k et 6.3 kHz	-2.4 dBA
aspirateur plus broches et bobines	-15 dBA à 315 et 400 Hz -5 dBA de 1.6 k à 3.15 kHz	-3.2 dBA
	-15 dBA à 315 et 400 Hz -10 dBA de 1.6 k à 3.15 kHz	-3.9 dBA
aspirateur plus broches et bobines plus supports d'anneau plus poulies	-15 dBA à 315 et 400 Hz -10 dBA de 1.6 k à 3.15 kHz -5 dBA à 5 kHz -5 dBA à 6.3 kHz	-5.1 dBA

Tableau 2. Réductions prévues du bruit pour différentes modifications de la machine à filer.

SIGNAL COHERENCE MODEL FOR WIDELY SPACED SENSORS IN SHALLOW WATER WITH ROUGH BOUNDARIES

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ABSTRACT

A model based on normal modes has been developed to predict signal coherence for a sound source in a shallow water waveguide with rough boundaries. Deterministic amplitudes and phases are calculated from a normal mode model and random phase or amplitude fluctuations are added. The model assumes that the mode phase fluctuates as a result of the water boundary roughness and that the fluctuations have a degree of independence that may be chosen arbitrarily. This independence is intended to account for the effect of large sensor separations. Receivers may be in any configuration but the source is restricted to the limiting cases of motions that either maintain the source-receiver range constant or change it by many wavelengths during the coherence estimation period. When the source-receiver range is changing rapidly and the receivers are closely spaced, it is found that the signal coherence depends only on receiver separation, mode shape and mode excitation. For closely spaced sensors broadside configurations give consistently high signal coherence. However, for widely spaced sensors and/or sources that maintain a constant source-receiver range the roughness parameters can have a profound effect on coherence. It is also found that certain configurations may be used to isolate the effect of the various model parameters, and hence may be used to measure these parameters experimentally.

SOMMAIRE

Un modèle, basé sur les modes normaux, a été développé pour prédire la cohérence d'une source sonore située en eau peu profonde limitée par des surfaces irrégulières. L'amplitude et la phase d'un signal certain sont calculées à partir du modèle a modes normaux; des variations aléatoires d'amplitude et de phase sont ensuite ajoutées. Le modèle assume que les fluctuations de phase du mode sont introduites par l'irrégularité des surfaces du guide d'onde, et qu'elles possèdent un degré d'indépendance arbitrairement choisi. Cette indépendance est prévue afin d'inclure le cas des récepteurs grandement espacés. La disposition des récepteurs ne comporte aucune restriction. La source, cependant, est contrainte aux déplacements pour lesquels la distance la séparant du récepteur est constante, ou pour lesquels la distance varie de plusieurs longueurs d'onde a l'intérieur de la période requise pour l'estimation de la cohérence. Lorsque la distance entre la source et le récepteur varie rapidement et que les récepteurs sont faiblement espacés, il est observé que la cohérence est fonction de la séparation entre les récepteurs, de la forme du mode et de son excitation. Pour des récepteurs peu distancés, une configuration dont la direction de la source est perpendiculaire aux récepteurs procure une très grande cohérence. Dans le cas où l'espacement est grand et/ou que la distance "source-récepteur" est maintenue constante, l'irrégularité des limites du guide d'onde a un effet considerable sur la cohérence. Il est également observé que certaines configurations peuvent être utilisées afin d'isoler l'effet de chaque paramètre et ainsi en déterminer expérimentalement leurs valeurs.

INTRODUCTION

This paper describes a numerical model for predicting signal properties for a sound source in a shallow layer of water that is bounded by rough surfaces. We also present samples of calculated signal coherence. Coherence is a measure of the similarity of signals at two separate sensors. When signal coherence is high at two separate locations, signals at those locations can usually be processed simply to improve signal-to-noise ratio. Our model can be used in developing more sophisticated array processing schemes that produce greater improvements in signal-to-noise ratio. Such arrays have possible applications in numerous areas, including underwater tracking of, and communication with, submerged survey vessels. Biological sound sources might also be tracked with such arrays. Any situation where the sound wavelength is comparable to the depth of the sound transmitting medium will be subject to similar effects.

During the past twenty years numerous measurements of signal coherence have been reported for underwater sound. Coherences or rates of phase change have been investigated for frequencies from 15 Hz to 13 kHz, at ranges from tens to thousands of miles and at a variety of water depths.[1,2,3,4] Models based on ray theory or normal mode theory, which have been used to predict or explain measured signal coherence, are equally numerous.[5,6,7]. These models are restricted to specific types of roughness or propagation conditions. Despite the wide range of measurements and the various theoretical models, signal coherence at low frequencies in shallow water has not yet received sufficient consideration.

Our interest in shallow water signal properties is derived from a desire to design, and to simulate the performance of, acoustic arrays operating at low frequencies in shallow water. These arrays are intended to detect and localize weak signals in background noise. It is therefore necessary to know the effect of the transmitting medium on such signals. At one shallow water Arctic location, it has been shown that the sound propagation fits a normal mode model at low frequencies and that only two modes propagate effectively.[8] However insufficient information is available to describe the fluctuations induced by the ice cover.

In a regime with only a few modes present, either a deterministic or a statistical approach, working directly from the bottom profiles and ice surface profiles, could be attempted. Instead, to make the problem more tractable, we assume that the roughness coupled with source motion has produced fluctuations of mode amplitude or of mode phase but not both. The statistical distribution of mode amplitude or mode phase is our starting point. We assume a family of such distributions, rather than a particular distribution, in an attempt to give the results more general significance. It should be emphasized that the model does not relate coherence directly to the roughness of the waveguide boundaries. Our model is a parametric model insofar as the fluctuations are concerned and thus enables testing of array processing schemes for a variety of possible fluctuation distributions when the roughness of the boundaries is unknown.

The model enables a calculation of coherence for arbitrary excitation of the normal modes, since source depth affects mode excitation, this allows any source depth to be treated. By introducing a degree of independence to the fluctuations, as measured at the receivers, coherences for sensor pairs in any orientation, and of arbitrarily large separation, can be modelled. Source motions modelled are such that during the coherence estimation period either the range to the receivers changes by very much less than one wavelength or by very many wavelengths. Many practical situations can be treated despite these restrictions on source motion. Nevertheless, by using an entirely numerical model, it would be possible to remove the restrictions on source motion but at the expense of greatly increased computation time. A more numerical approach is being used to investigate high resolution beamforming and has enabled cases with more modes to be modelled.[9]

In addition to aiding in array design and simulation of array performance, the model indicates what might be encountered in an experiment to measure signal coherence and so indicates how to go about the measurements. Furthermore, there is a rationale for explaining and categorizing the experimentally determined coherencies.

I. THEORY

The situation modelled, and the physical parameter values used to calculate the numerical values presented here, are shown in Figure 1. Sound from the monochromatic point source is received by a pair of hydrophones whose positions within the water column are completely arbitrary. The propagation of the sound is modelled as a

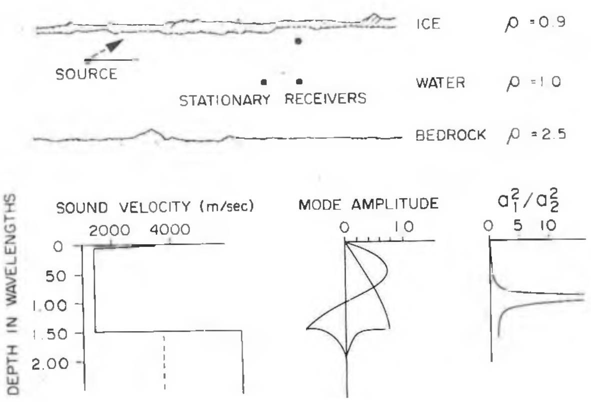

Figure 1. The geometry and geophysical parameters of the coherence model are shown. In the model the source is permitted to move either in the plane of the figure, perpendicular to it or along any intermediate path as long as the path is horizontal. a_1^2/a_2^2 is the ratio of the square of the mode amplitudes at 14.5 Hz.

deterministic part consisting of trapped normal modes with an added statistical com-components consisting of phase (or amplitude) fluctuations. These fluctuations are attributed to the rough ice surface on the water, the rough bottom, and local variations of sound speed in the water.

To describe sound propagation at a range of more than one wavelength in water, of about one wavelength depth, many rays would have to be included in a ray model. In contrast only a few modes are required to describe the propagation with consequent economies of computation. Thus modes represent the effect of summing over numerous rays. Modes can also be thought of as the interference between upgoing and downgoing acoustic waves as they zigzag between surface and bottom and propagate horizontally. This super-position of two waves traveling in different directions is analagous to a standing wave on a plucked string. Therefore, it is not surprising that the amplitude distribution for the normal modes shown in Figure 1 resembles that of a plucked string. However, the normal mode amplitudes for sound in water do not become zero at the bottom because the impedance contrast at the bottom is not large enough to prevent some motion in the bottom.

The amplitudes for the modes were calculated for a solid ice layer 2 m thick overlying water with a solid bottom. Velocities employed in the calculation were measured with a refraction survey. They represent a very hard bottom thought to consist of a layer of recrystalized dolomite. Only a thin layer (about 1 metre) of unconsolidated material overlies the bottom because of the high currents prevailing in the water. At low frequencies such a layer, be it ice on the surface or till on the bottom, has only a small effect on the deterministic portion of the modes if the layer is thin and smooth. If the layer is randomly rough it will produce mode phase fluctuations similar to those produced by rough ice. The precise nature of the effect of a periodic bottom roughness is a subject that is still under investigation but probably quite different from that of a randomly rough surface.

The wave equation was solved by finding the eigenvalues for a bounded uniform-depth waveguide. For the low frequency results presented, only two trapped slowly moving modes are present. In the modal analysis, energy travelling at higher speeds is carried in the bottom and for such means of transmission, little energy is found in the water column. It has been confirmed by experiment that the amount of energy propagated at these higher speeds is relatively insignificant compared to that propagated in the slowly moving modes.[8] For simplicity, the fast moving modes are ignored and only the slowly moving modes are included in the model.

A. Coherence Assuming Mode Phase Fluctuations

The fluctuation distribution to be described next allows control of the fluctuation distribution width and the dependence of fluctuations at sensors with spatial separation. To do this the mode phase fluctuations were formed as a linear combination of fluctuations from distributions of the form,[10]

$$P(x) = \exp(K\cos x)/(2\pi I_0(K)) \quad -\pi \leq x \leq \pi \qquad (1)$$

where $I_0(K)$ is the zeroth order modified Bessel Function of the first kind. This distribution ranges from a uniform distribution for K=0, to an infinitely narrow distribution, i.e. known phase, when $K=\infty$. Figure 2 illustrates the shape of the

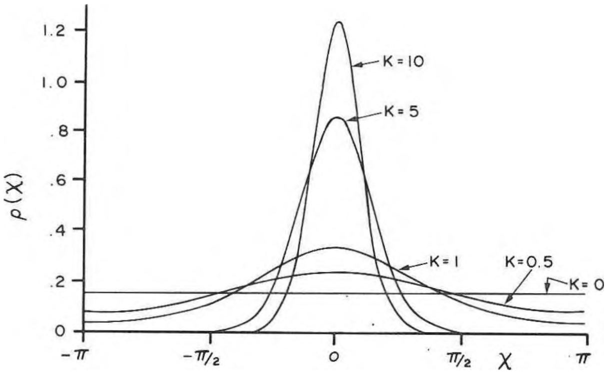

Figure 2. The distribution shown is the one from which the phase or amplitude fluctuations distributions are formed. The parameter K decreases with increasing roughness.

distribution for several values of K. It can be seen that for K=10 the effective width of the distribution has narrowed considerably from that for K=0. If theoretical fluctuation distributions are available for conditions similar to those encountered in a problem of interest, then these theoretical distributions are a guide to likely K values. When we evaluated K for one model corresponding to a sea swell on water,[9] and the physical conditions of Figure 1, values of K between 2 and 75 were obtained for RMS surface roughnesses between 1.0 and 0.1 m. Note that rough surfaces correspond to small values of K.

To simplify the analysis for the model described here K was purposely chosen to be identical for the two modes. Although the value of K for each mode is likely to be somewhat different in practice the conclusions that we draw here are not significantly changed by this simplification. However a more numerical approach can be taken in which K varies from mode to mode.[9]

θ_{ki} is used to represent the fluctuating component of the signal phase at the range of hydrophone k for the component of signal energy travelling as mode i. This phase fluctuation is defined for frequency ω. The fluctuation is written as a linear combination of two independently distributed phases u_i and v_i, where u_i and v_i are distributed as given by Equation (1). Thus

$$\theta_{1i} = 2(u_i + nv_i)/(1 + n)$$
$$\theta_{2i} = 2(v_i + nu_i)/(1 + n) \qquad (2)$$

When n = 1 the fluctuations at separated receivers are identical. While values of n near zero indicate fluctuations that are independent at the two receivers. Although it is generally recognized that signal coherence decreases with increasing sensor spacing there is insufficient data on the subject to determine suitable values for n.[11] Thus it is with a view to enabling an investigation of the effect of independence of the fluctuations at separated receivers that the parameter n is introduced. Whereas the parameter K depends on the roughness of the sea surface, and decreases with increasing roughness, n depends on the spatial correlation of the rough surface. At receiver 1 the output will be:

$$Z_1(\omega) = \exp(j\omega t) \sum_{i=1}^{N} \underline{A}_i \underline{B}_i \underline{X}_i(\omega) \exp(j\theta_{1i}) \tag{3}$$

Where, i = mode number with 1 used for the lowest order mode

$\underline{A_i}$ = $a_i\exp(j\phi_i)$, where a_i is the mode amplitude at the source depth and ϕ_i is the deterministic part of the mode phase at receiver 1 range, ϕ_i equals the product of the range and the horizontal mode wavenumber.

$\underline{B_i}$ = b_i the ith mode amplitude at receiver 1 depth

$\underline{X_i}(\omega)$ = source amplitude at frequency ω.

A_i, B_i, C_i and X_i are underlined to distinguish these quantities from those used in Equation (5).

The output at receiver 2 depends on θ_i where,

$\underline{C_i}$ = $c_i\exp(j\theta_i)$, where c_i is the mode amplitude at receiver 2 depth and θ_i is the mode phase shift between the receivers.

The signal coherence squared $\gamma^2(\omega)$ was calculated by evaluating the integrals required to find the expected values signified by E where:

$$\gamma^2(\omega) = \left| E(Z_1(\omega)\, Z_2{*}(\omega))\right|^2 / (E\left| Z_1(\omega)\right|^2 E\left| Z_2(\omega)\right|^2), \tag{4}$$

as described in Appendix A. Thus for two modes if we assume that the source-receiver range changes by very much less than one wavelength, i.e. the range remains essentially constant, then,

$$\gamma^2(\omega) = \frac{\begin{array}{c}\left| MG^2a_1^2b_1c_1\exp(-j\theta_1) + A^2B^2M^2(a_1b_1a_2c_2\exp j(\phi_1 - \phi_2 - \theta_2) + \right.\\ \left. a_2b_2a_1c_1\exp j(\phi_2 - \phi_1 - \theta_1)) + MG^2(a_2^2b_2c_2\exp(-j\theta_2))\right|^2\end{array}}{\begin{array}{c}\left[a_1^2b_1^2 + 2A^2B^2M^2a_1b_1a_2b_2\cos(\phi_1 - \phi_2) + a_2^2b_2^2\right] . \\ \left[a_1^2c_1^2 + 2A^2B^2M^2a_1c_1a_2c_2\cos(\phi_1 - \phi_2 + \theta_1 - \theta_2) + a_2^2c_2^2\right]\end{array}} \tag{5}$$

where A, B and G are functions of n and K as defined in Appendix A and $M=1/(4\pi^2 I_0{}^2(K))$.

In the event that source motion is such as to change the range to the receivers by very many wavelengths during the coherence estimation period, then a further integration is required over the variable $\phi_1 - \phi_2$ in the evaluation of the expected value of the signal coherence. For typical shallow water situations the source would have to traverse of the order of a kilometre during the estimation. When the integrations are carried out over a very large or integral number of periods, terms in Equation (5) that contain $\phi_1 - \phi_2$ will have dropped out, other terms in Equation (5) remain unchanged. For $n = 1$ in Equation (2), fluctuations are identical at the two receivers and $MG^2 = 1$, so that signal coherence does not depend on the value of K. This situation would arise with source motion towards closely spaced sensors.

B. Coherence Assuming Mode Amplitude Fluctuations

A version of the model for calculating signal coherence for a moving source was developed that assumed mode amplitude fluctuations caused by boundary roughness. To allow independence of these fluctuations at the two receivers the mode amplitude a_{ki} is written as a linear combination of two independently distributed amplitudes e and f, whose squares are distributed like x^2 in,

$$P(x^2) = \exp(K\cos(\pi(x^2-\alpha)/\alpha))/2\alpha I_0(K) \quad 0 \leq x^2 \leq 2\alpha \tag{6}$$

For receiver 1,

$$a_{1i} = (e + nf)$$

and for receiver 2,

$$a_{2i} = (f + ne)$$

where i indicates the mode number. Choosing the total energy radiated by the source into the two modes to be unity,

$$a_{12}{}^2 = 1 - a_{11}{}^2$$

and,

$$a_{22}{}^2 = 1 - a_{21}{}^2. \tag{8}$$

Now the signal at receiver 1 is,

$$Z_1(\omega) = \exp(j\omega t) \sum_{i=1}^{N} \underline{A}_{1i}\underline{B}_i\underline{X}_i(\omega) \tag{9}$$

where $\underline{A}_{1i} = a_{1i}\exp(j\phi_i)$ and otherwise the definitions for Equation (3) apply. Signal coherence squared, Equation (4), was evaluated by carrying out the necessary integrations as described in Appendix B.

Thus

$$\gamma^2(\omega) = \frac{\left| S_1 b_1 c_1 \exp(-j\theta_1) + S_2 b_1 c_2 \exp j(\phi_1 - \phi_2 - \theta_2) + S_2 b_2 c_1 \exp j(\phi_2 - \phi_1 - \theta_1) + S_3 b_2 c_2 \exp(-j\theta_2) \right|^2}{\left[S_4 b^2 + (1 - S_4) b_2^2 + 2S_5 b_1 b_2 \cos(\phi_1 - \phi_2)\right] \cdot \left[S_4 c_1^2 + (1 - S_4) c_2^2 + 2S_5 c_1 c_2 \cos(\phi_1 - \phi_2 + \theta_1 - \theta_2)\right]} \qquad (10)$$

where $S_i = S_i(n,K)$ as defined in Appendix B. For source motion such that source-receiver range is changing by very many wavelengths during the coherence estimation period, terms containing $(\phi_1 - \phi_2)$ in Equation (10) will have dropped out.

C. Calculation of coherences

The geophysical parameter values used to calculate the signal coherences in this paper are given in Figure 1. They represent a water layer 1.5 wavelengths deep capped by rough ice. The bottom is modelled as one layer characterized by high compressional wave velocities. The velocity used in this model is based on an unreversed refraction survey and a reflection survey carried out in a Canadian Arctic channel.

Three values of the ratio of the energy in the first mode to the energy in the second mode were used in the coherence calculations. The values were 0.1, 1.0 and 9.0, which occur for source depths near the surface, near the bottom and near the zero of the second mode respectively, as can be seen from Figure 1. The depths associated with the ratios assume no mode conversion or attenuation.

Although the evaluation of Equations (5) and (10) is well within the capabilities of modern computers some care must be taken in evaluating products such as $A^2B^2M^3G^2$ which are implicit in Equations (5) and (10) and defined in the appendices. For large K the order of calculation must be such that underflow or overflow are avoided. $I_n(K)$ was calculated by using coefficients taken from the Handbook of Mathematical Functions.[12] The integrals A, B, D and G were evaluated using Simpson's rule while the double integrals F, G , and H were evaluated by using Patterson's method. The mark 8 version of the Numerical Algorithm Group's D01DAF was used for the double integrals.[13,14]

II. DISCUSSION OF RESULTS

In Figures 3 to 6, coherences are presented for modes with fluctuating phase. Similar results are obtained for closely spaced sensors if the amplitude of the modes is assumed to fluctuate. In the case of n = 1, closely spaced sensors, the results for the amplitude case are either identical to or can be scaled from the phase case depending on the source motion.[15] When amplitude fluctuations are assumed and the source-receiver range is constant then scaling is required. Scaling is such that coherences assuming amplitude fluctuations are higher than coherences assuming phase fluctuations. The scaling also depends on the relative energy in the modes. However, scaling of the distribution parameters does not carry over to the case of widely spaced sensors. Suffice it to say that coherences for amplitude fluctuations are similar to those obtained assuming phase fluctuations.

A. Source Moving Towards Closely Spaced Sensors

If a sound source is moving towards closely spaced sensors with only horizontal separation in the direction of sound propagation, modelled coherence is a periodic function of sensor separation. Coherence decreases cosinusoidally from one, at zero horizontal separation, reaching a minimum at a separation of 4.2 wavelengths. This minimum coherence is that displayed on the diagonal in Figure 3. If separations of 4.2 wavelengths are well within the close spaced regime (n=1), coherence will recover at wider separations because of the cosinusoidal dependence of the coherence. The separation, 4.2 λ, at which the minimum occurs is determined by the difference between the mode propagation constants and will vary with frequency.

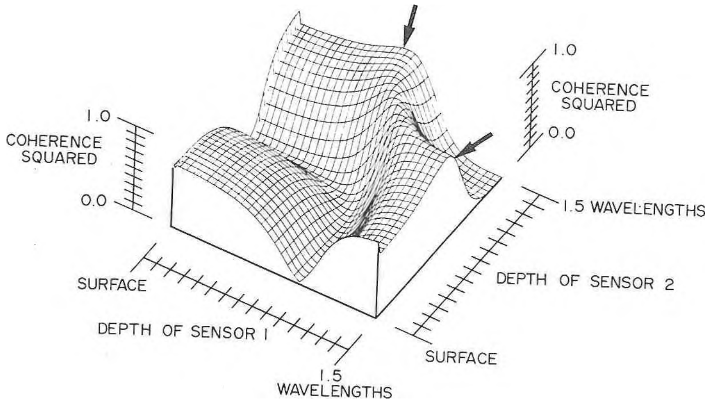

Figure 3. Coherence squared for a source moving towards closely spaced receivers with either mode amplitude or mode phase fluctuating. The sound source is near the bottom in water 1.5 wavelengths deep and the receivers are 4.2 wavelengths apart in the direction of sound propagation.

The coherences in Figure 3 are for closely spaced sensors, n=1, and represent results for a near-bottom source for sensors whose horizontal component of separation in the direction of sound propagation is 4.2 wavelengths. In the limiting case where the source-receiver range is changing rapidly, as modelled in Figure 3, the results shown apply without regard to whether the fluctuations are of phase or amplitude and there is no dependence on the parameter K that is used to account for roughness.[13] To completely determine signal coherence for this scenario, it is necessary only to specify source depth, receiver depths, mode shapes, and receiver separation in the direction of sound propagation. Coherences for this scenario are thus determined by modal properties for a smooth waveguide and by the source-receiver geometry.

On the diagonal in Figure 3, for which the depths of sensors one and two are equal, the coherence for a horizontal array of two hydrophones 4.2 wavelengths apart is displayed. These are the worst case coherences for a horizontal array, with sensor separation in the direction of sound propagation, provided that we can assume that the sensors lie in the close-spaced regime.

A special region of perfect coherence, where one receiver is displaced above the depth of the zero of the second mode (one wavelength depth) and the other an almost equal amount below the zero, is indicated by arrows in Figure 3. This includes the special case where both receivers are at the depth of the zero of the second mode, for which coherence is also perfect. The results in the figure indicate that a variation in the depth of one receiver of a very small fraction of a wavelength from the depth of the zero of the second mode will lead to a substantial loss of coherence.

As mentioned earlier coherences for three apparent source depths were calculated. These cases are similar in shape with different emphasis. If the source is near the zero of the second mode the rate of reduction of coherence as the sensors move away from the zero of the second mode will be reduced from that for the near-bottom source depicted in Figure 3. In contrast, for a source in the upper part of the water column the rate of reduction of coherence as the sensors move away from the zero of the second mode will be increased.

B. Source-Receiver Range Constant with Closely Spaced Sensors

To calculate coherence for source motion where the range to the receivers is constant, it is necessary to specify the type of fluctuation, the fluctuation distribution width and the source-receiver range. This is in addition to those parameters that determine modal properties and specify receiver geometry and which were the only parameters required when the source was moving rapidly towards closely spaced receivers. Thus coherences for this scenario reflect the effect of surface roughness on signal coherence.

Figure 4 illustrates how coherence depends on the parameter K that is used to account for roughness and the source-receiver separation in the direction of sound propagation. The source and receivers are near the bottom and the source-receiver range is such that the two modes are 180 degrees out of phase at the first receiver. Coherence is generally poor and decreases with increasing K, i.e. decreasing roughness. Very different results are obtained if the phase relationship of the modes at the first receiver is changed. Thus the effect of roughness on coherence can be modified dramatically by the range to the receivers. Nevertheless, measurements with closely spaced sensors with the source-receiver range constant could be used to indicate an appropriate value of K in an experiment to measure signal coherence.

One can see in Figure 4 that when the source is broadside to the receivers (zero receiver separation in the direction of sound propagation) coherence is good regardless of the value of the roughness parameter K. However, deviations of the receivers by 0.2 wavelengths from a broadside configuration will lead to a considerable loss of coherence at large values of the roughness parameter i.e. nearly smooth waveguide.

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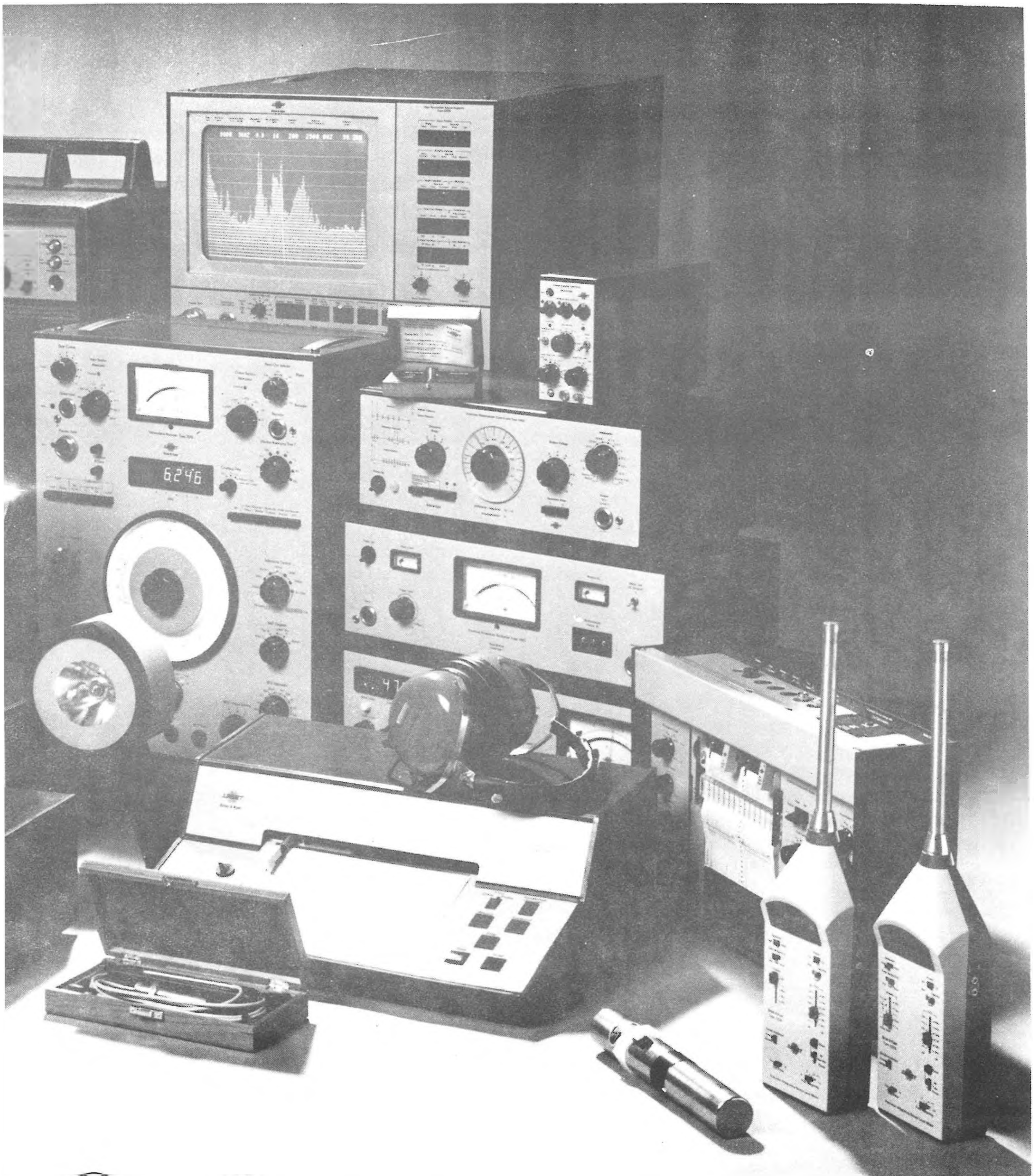

C. Source Moving Towards Widely Spaced Sensors

Figure 5 shows calculated coherences for a source moving towards a broadside array with K=0, corresponding to a very rough surface. It can be seen that coherence is high when n=1; this corresponds to the subset of closely spaced receivers. High coherence was also obtained for the closely spaced regime with a broadside array when the source-receiver range was constant, Figure 4. Both of these results hold true regardless of source depth.

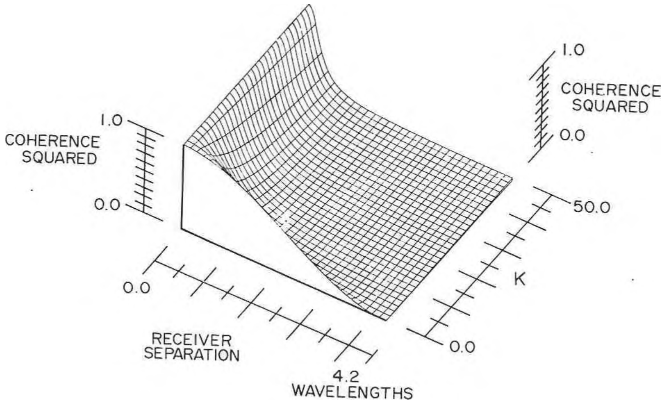

Figure 4. Coherence squared for phase fluctuations and a moving source that maintains constant source-receiver range as it moves horizontally near the bottom. The modes are 180^{0} out of phase at the first receiver, $a_1^2/a_2^2= 1$ and the closely spaced receivers are on the bottom in water 1.5 wavelengths deep. Larger values of K correspond to smaller values of roughness.

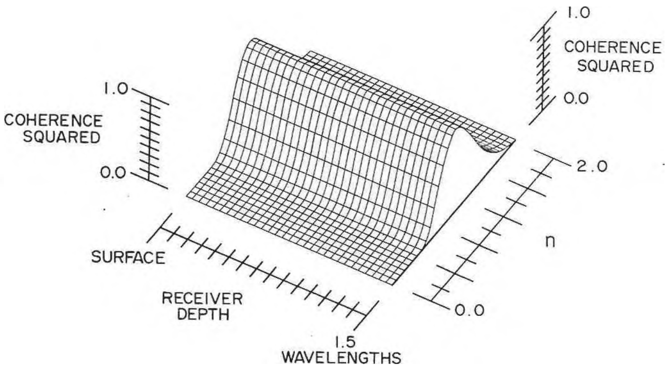

Figure 5. Signal coherence squared for a source moving towards the receivers assuming mode phase fluctuates. The source is broadside to the receivers and near the bottom (1.5 wavelength depth) in a rough waveguide (K=0). n=1 corresponds to small receiver spacings and $|n-1|$ increases with increasing receiver spacing.

The model accounts for more widely spaced sensors by introducing some independence to the fluctuations. As n increases or decreases from 1 the fluctuations become more independent at adjacent receivers. Figure 5 shows the rate at which coherence drops off with increasing independence of the fluctuations. Coherence plots for larger K values are similar to coherences shown in Figure 5 but have values that decrease less rapidly as n changes from unity.

A value for n is required to pursue the modelling of signal coherence for the scenario of a source approaching widely spaced sensors. This could be measured with a source approaching a broadside array containing receivers with a variety of separations. From such measurements the relationship between n and hydrophone separation could be obtained. By analogy with ray acoustics the demarkation between the widely spaced regime and the closely spaced regime would occur for hydrophone separations of the order of the dimensions of the first Fresnel zone at a sound reflection point. Still larger hydrophone separations could lie within the closely spaced regime if the rough surface were strongly correlated over regions larger than the Fresnel zones. These zones have dimensions of many wavelengths and depend on the geometry of the propagation path. However, it is unlikely that the ice surface roughness would be strongly correlated over regions exceeding the size of the Fresnel zones.

D. Source-Receiver Range Constant and Widely Spaced Sensors

When the receivers are widely spaced a constant range can only be approximated for a moving source by using a circular arc at very long ranges. A sample of calculated coherence for this scenario is presented in Figure 6. The sound source is near

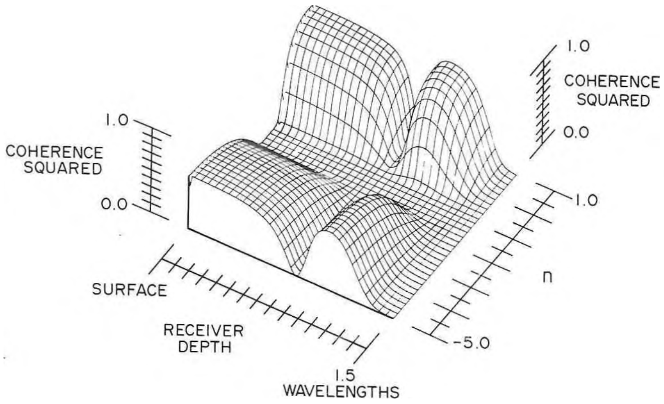

Figure 6. Signal coherence for a sound source moving such that the source-receiver range is constant. The source is near the bottom and the modes are in phase at the first receiver. A receiver separation of 4.2 wavelengths in the direction of sound propagation is assumed and the mode phase is fluctuating. This case corresponds to small roughness (K=50).

the bottom, the range is one for which the modes are in phase at the first receiver, and the receivers have a separation of 4.2 wavelengths in the direction of sound propagation. The results show clearly that coherence is dependent strongly on the depth and the independence of the fluctuations at the two receivers. When n=0 fluctuations are completely independent, but, because the roughness is small, (k=50 in Figure 6), the signals received are still coherent. Consequently, a measure of K might go a long way towards simplifying the range of possible signal coherences.

It is difficult to summarize the results for this particular regime since every parameter in the model has a bearing on the signal coherence. However, provided that the roughness is small enough that K is large, the independence of the fluctuation will have moderate effect on the coherence. Furthermore, if the source is broadside to the receivers and all other parameters remain the same higher coherences are generally obtained.

E. Discussion of Results

Coherences calculated with the model, fall into four major categories determined by whether the coherences are for closely or widely spaced sensors and whether source-receiver range is constant or varying. Table I indicates those parameters that we must specify to calculate coherence. In the limiting case, closely spaced sensors and source-receiver range changing rapidly, signal coherence is completely predictable without knowing the roughness. Only the modal properties for a smooth waveguide and the receiver geometry are required to determine signal coherence. In contrast, the number of parameters that must be specified and the variety of possible results is greatest for a widely spaced endfire array with a source moving so that the source-receiver range is constant.

TABLE I. Properties of Coherence Squared.

	SOURCE-RECEIVER RANGE CHANGING RAPIDLY	SOURCE-RECEIVER RANGE CONSTANT
CLOSELY SPACED SENSORS	INDEPENDENT OF FLUCTUATION DISTRIBUTION DEPENDS ON: - MODE SHAPES - SOURCE DEPTH - RECEIVER GEOMETRY	AMPLITUDE FLUCTUATION CASE SCALES FROM PHASE CASE DEPENDS ON: - MODE SHAPES - SOURCE DEPTH - RECEIVER GEOMETRY - DISTRIBUTION WIDTH - FLUCTUATION TYPE - SOURCE-RECEIVER RANGE
WIDELY SPACED SENSORS	DEPENDS ON: - MODE SHAPES - SOURCE DEPTH - RECEIVER GEOMETRY - DISTRIBUTION WIDTH - FLUCTUATION TYPE - DISTRIBUTION DEPENDENCE	DEPENDS ON: - MODE SHAPES - SOURCE DEPTH - RECEIVER GEOMETRY - DISTRIBUTION WIDTH - FLUCTUATION TYPE - SOURCE-RECEIVER RANGE - DISTRIBUTION DEPENDENCE

The model indicates how one may systematically go about measuring signal coherences at low frequencies. The simplest case of a closely spaced endfire array with the source moving towards the receivers would essentially indicate how the energy is distributed between the modes. Next a constant source-receiver range with a closely spaced endfire array would enable the roughness parameter K to be established. Lastly an array operating in the wide spaced regime would be used to evaluate the parameter n.

Without supporting measurements the model has indicated the effect of source motion and receiver geometry on signal coherence. It appears that a source in the broadside position is likely to produce coherent signals at receivers many wavelengths apart. Experimental measurements would indicate at just what receiver separation the value of n is reduced so that we have reached the wide spaced regime and therefore, if K is sufficiently small, the spacings at which coherence is poor.

Another approach to narrowing the range of possible predicted coherences is that of modelling the propagation in detail to evaluate K and n from the roughness. A theoretical investigation of the effect of roughness on modal properties is being carried out by G.H. Brooke of this establishment that should lead to the equivalent of a relationship between K and roughness. Evaluation of K for a given roughness for surfaces that are not near the small roughness limit is no small task and finding n for a rough surface is even more difficult. However, knowledge of the effect of roughness on signal properties is important for the prediction of array performance especially where the array is to be used to distinguish targets on the basis of depth, range or bearing.

CONCLUSIONS

A normal mode model for predicting signal coherence for a moving target in shallow water with rough boundaries has been described. The roughness was taken into consideration by introducing fluctuating mode phase or mode amplitude.

Coherences were calculated for two modes in water 1.5 wavelengths deep bounded by a hard single layer bottom. Calculated coherences for source motion towards closely spaced receivers were independent of the roughness or type of fluctuation assumed. Signal coherence was however strongly dependent upon roughness for widely spaced sensors and a source maintaining a constant range to the receivers. It turned out that a broadside source showed high coherence for closely spaced sensors regardless of the source motion.

The model also indicates how signal coherence might be measured in shallow water so that mode properties and the various effects of roughness can be isolated and measured. Such measurements would enable the appropriate values of the model parameters to be identified. A direct approach for predicting the effect of measured roughness on mode properties might also enable appropriate values of the model parameters to be identified.

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APPENDIX A

Signal Coherence for Phase Fluctuations

From Equation (3) and a similar equation for $Z_2(\omega)$ where $\underline{C}$ is substituted for $\underline{B}$ and we ignore source strength for simplicity,

$$\overline{Z_1Z_2^*} = \underline{A}_1\underline{B}_1\underline{A}_1^*\underline{C}_1^* \iint_{-\pi}^{\pi} \exp\{2j((1-n)u_1 + (n-1)v_1)/(1+n)\}.$$

$$\exp(K\cos u_1 + K\cos v_1)\,du_1dv_1/4\pi^2I_0^2(K)$$

$$+\ \underline{A}_1\underline{B}_1\underline{A}_2^*\underline{C}_2^* \iiiint_{-\pi}^{\pi} \exp\{2j(u_1 + nv_1 - v_2 - nu_2)/(1+n)\}\ .$$

$$\exp(K\cos u_1 + K\cos v_1 + K\cos v_2 + K\cos u_2)\,du_1du_2dv_1dv_2/16\pi^4I_0^4(K)$$

$$+\ \underline{A}_2\underline{B}_2\underline{A}_1^*\underline{C}_1^* \iiiint_{-\pi}^{\pi} \exp\{2j(u_2 + nv_2 - v_1 - nu_1)/(1+n)\}.$$

$$\exp(K\cos u_2 + K\cos v_2 + K\cos v_1 + K\cos u_1)\,du_1du_2dv_1dv_2/16\pi^4I_0^4(K)$$

$$+\ A_2B_2A_2^*C_2^* \iint_{-\pi}^{\pi} \exp\{2j((1-n)u_2 + (n-1)v_2)/(1+n)\}.$$

$$\exp(K\cos u_2 + K\cos v_2)\,du_2dv_2/4\pi^2I_0^2(K)$$

Now let

$$A(n,K) = \int_{-\pi}^{\pi} \exp(j(\pm 2x/(1+n)) + K\cos x)\,dx$$

$$B(n,K) = \int_{-\pi}^{\pi} \exp(j(\pm 2nx/(1+n)) + K\cos x)\,dx \qquad \text{(A2)}$$

$$G(n,K) = \int_{-\pi}^{\pi} \exp(\pm 2jx(1-n)/(1+n) + K\cos x)\,dx$$

$$M(K) = 1/(4\pi^2I_0^2(K))$$

Thus substituting A, B, G, and M in (A1) and similar expressions for $Z_1Z_1^*$ and $Z_2Z_2^*$ and substituting the result in (4) produces (5).

APPENDIX B

Signal Coherence for Amplitude Fluctuations

From Equation (9) and a similar equation for Z_2 except that $\underline{C}$ is substituted for $\underline{B}$.

$$\overline{Z_1Z_2^*} = b_1c_1\exp(-j\theta_1)\; n\int_0^{2\alpha} e^2P(e^2)de^2 + n\int_0^{2\alpha} f^2P(f^2)df^2$$

$$+ (1+n^2)\iint_0^{2\alpha} e\, f\, P(e^2)\, P(f^2)de^2\, df^2$$

$$+ b_1c_2\exp j(\phi_1 - \phi_2 - \theta_2)\iint_0^{2\alpha} (e+nf)\,\{1-(e+nf)^2\}^{1/2}\, P(e^2)P(f^2)de^2\, df^2$$

$$+ b_2c_1\exp j(\phi_2 - \phi_1 - \theta_1)\iint_0^{2\alpha} (f+ne)\,\{1-(f+ne)^2\}^{1/2}\, P(e^2)P(f^2)de^2\, df^2$$

$$+ b_2c_2\exp(-j\theta_2)\iint_0^{2\alpha} \{1-(e+nf)^2\}^{1/2}\,\{1-(f+ne)^2\}^{1/2}P(e^2)P(f^2)de^2\, df^2$$

let x or y = e^2 or f^2 as appropriate, and

$$D = \int_0^{2\alpha} x^{1/2}\, P(x)dx \tag{B2}$$

$$G = \iint_0^{2\alpha} (x^{1/2} + ny^{1/2})\{1-(y^{1/2}+nx^{1/2})^2\}^{1/2} \quad . \tag{B3}$$
$$\exp(-K\cos(\pi x/\alpha) - K\cos(\pi y/\alpha))dxdy$$

$$H = \iint_0^{2\alpha} \{(1-(x^{1/2}+ny^{1/2})^2)(1-(y^{1/2}+nx^{1/2})^2\}^{1/2} \quad . \tag{B4}$$
$$\exp(-K\cos(\pi x/\alpha - K\cos(\pi y/\alpha))dxdy$$

For the evaluation of $Z_1Z_1^*$ and $Z_2Z_2^*$ we need to define

$$F = \iint_0^{2\alpha}(x^{1/2} + ny^{1/2})\,\{1-(x^{1/2}+ny^{1/2})^2\}^{1/2}\, dxdy \tag{B5}$$

Now to further simplify the expression for signal coherence, Equation (10), let,

$$\begin{aligned}
S_1 &= 2n\alpha + \frac{(1 + n^2)\, D^2}{4\alpha^2 I_0{}^2(K)} \\
S_2 &= G/(4\alpha^2 I_0{}^2(K)) \\
S_3 &= H/(4\alpha^2 I_0{}^2(K)) \\
S_4 &= (1 + n^2)\alpha + 2nD^2/(4\alpha^2 I_0{}^2(K)) \\
S_5 &= F/(4\alpha^2 I_0{}^2(K))
\end{aligned} \qquad \text{(B6)}$$

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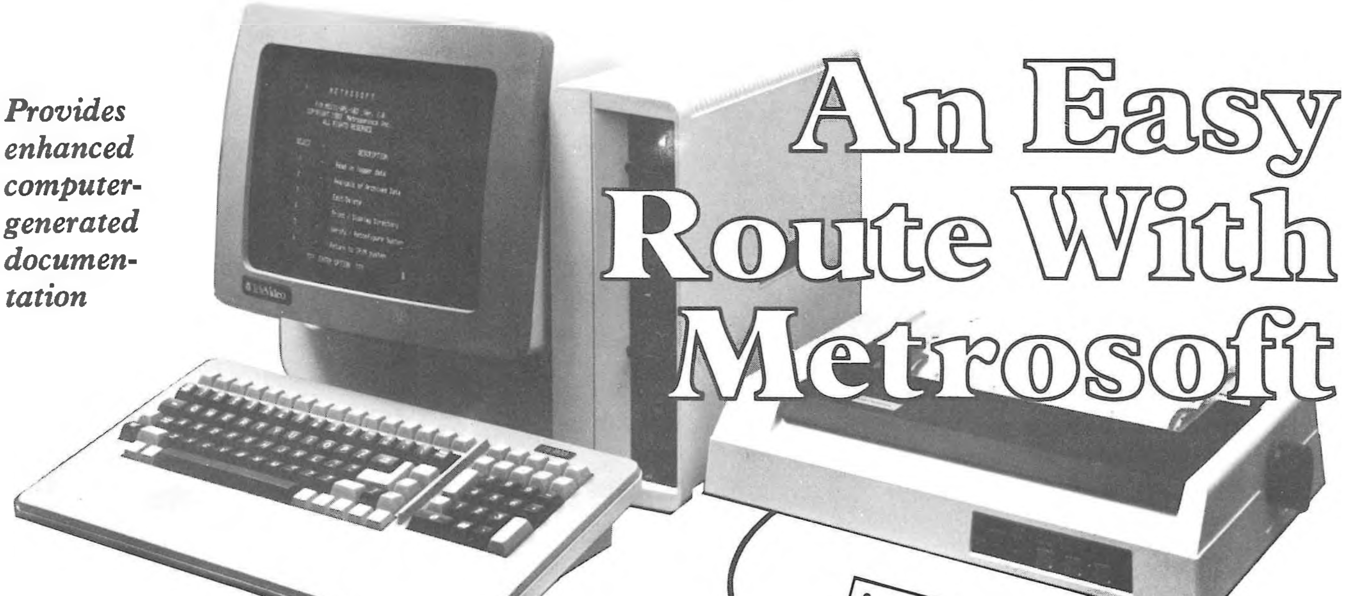

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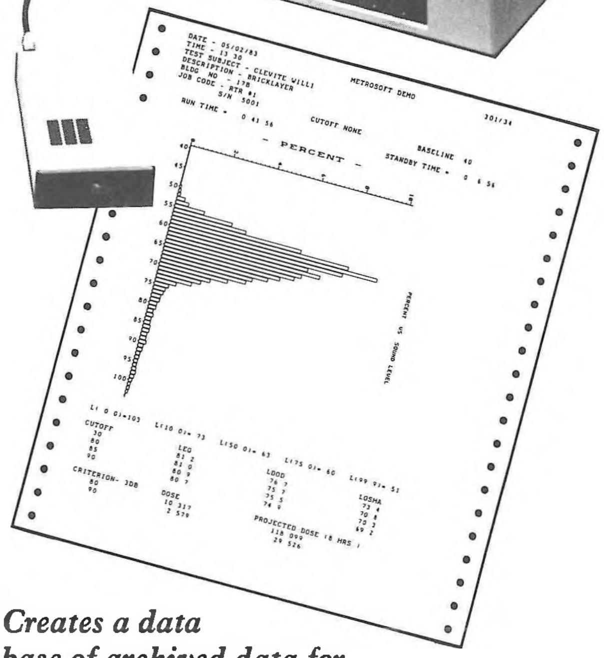
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DATE - 05/02/83
TIME - 13 30
TEST SUBJECT - CLEVITE WILLI
DESCRIPTION - BRICKLAYER                METROSOFT DEMO
BLDG  NO  - 178
JOB CODE - RTR #1
       S/N  5001                                        301/34
RUN TIME =    0 41 56          CUTOFF NONE
                                              BASELINE  40
                                           STANDBY TIME =   0 6 56

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CRITERION- 3DB                         75 7               73 4
 80              DOSE                  75 5               70 8
 90              10 317                74 9               70 3
                  2 579                                   69 2
                                  PROJECTED DOSE (8 HRS )
                                   118 099
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QUEBEC CITY MEETING, OCTOBER 1984

It was elegance! Set in a very elegant hotel in one of Canada's most elegant cities, the tone of the meeting was to some extent predetermined. But to finish it off with a very classy banquet to the accompaniment of a string quartet, put our most recent annual meeting into a class of its own. Over 100 people registered for the meeting and summaries of the 65 papers presented were printed in a conference proceedings. There were many praiseworthy comments concerning the technical quality of the meeting too. Several regular attendees at ASA meetings claimed that some sessions at Quebec City were better than sessions on similar topics at the previous ASA meeting. Certainly CAA meetings have come a long way and Jean-Gabriel Migneron is to be congratulated for taking us another positive step forward. We hope that complete versions of many of those 65 papers will appear in future issues of CANADIAN ACOUSTICS.

CHANGE OF ADDRESS

Mr. Dan Lyzun has recently joined Harford Kennedy Limited as a principal. The new company, Harford Kennedy Lyzun, is now located at:

103-3680 East Hastings Street
Vancouver, British Columbia
V5K 2A9

NEW ASA STANDARDS CATALOG AVAILABLE

A new catalog of acoustical standards, ASA Catalog 5-1984, has been published by the ASA Standards Secretariat. Copies are available from Dr. Avril Brenig, Standards Manager, 335 East 45th Street, New York, NY 10017, Tel.: (212) 661-9404.

CANADIAN ACOUSTICAL ASSOCIATION TORONTO CHAPTER AGENDA FOR 1985 SEASON

Tuesday, 29 January 1985:

Ontario Hydro Auditorium, 7:00 p.m.
Topic: Vibration: Perception and Criteria
Convenors: C. Krajewski and M. Barman

Tuesday, 19 March 1985:

Technical Visit: Location to be announced.
Convenors: A. Behar and A. McKee

Tuesday, 21 May 1985:

Ontario Hydro Auditorium, 7:00 p.m.
Topic: Industrial Noise
Convenors: W.V. Sydenborgh and M. Barman

TORONTO REGIONAL CHAPTER NEWS

The Toronto Chapter of the CAA held a meeting on Tuesday, 16 October in the Ontario Hydro Auditorium on the theme of Noise Dosimetry. Convenors for this meeting were A.C. McKee (B & K Canada) and W.V. Sydenborgh (Blackford Ltd.).

The first speaker, Andy McKee, presented basic ideas on measuring noise dose starting with how noise exposure used to be assessed using a SLM and timing device, up to the present use of exposure meters. He finished his presentation by discussing the accuracy of dosimeter measurements, emphasizing the importance of microphone location.

The second topic, "The New CSA Standard of Noise Exposure Assessment," was presented jointly by A. Behar (Ontario Hydro) and T. Kelsall (Hatch Associates Ltd.). They discussed several major issues in the draft. (This document has gone through its first reading in the CSA subcommittee Noise in Industry.) Special attention was paid to items such as instrumentation, sampling procedures, assessment of groups, etc.

After refreshments (courtesy of B & K and Ontario Hydro), an extensive period of questions and answers followed. The main topic was the new standard. Among the issues that were raised, the most controvertial were: microphone location, impulse noise hazard assessment, and cost. The authors invited written comments and critics to the draft.

UNDERWATER ACOUSTICS AND SIGNAL PROCESSING COURSE

A unique four-week program, comprised of five accredited graduate level courses in underwater acoustics and signal processing, will be offered 3-28 June 1985 by the Pennsylvania State University's Graduate Program in Acoustics in cooperation with the University's Applied Research Laboratory. Courses offered include: Fundamentals of Acoustics, Underwater Sound Propagation, Sonar Engineering, Digital Signal Processing, and Electroacoustic Transducers.

For further information, please contact:

Dr. Alan D. Stuart
Summer Program Coordinator
Pennsylvania State Graduate Program in Acoustics
P.O. Box 30
State College, PA 16804
Tel.: (814) 863-4128

or Mrs. Barbara Crocken, Administrative Assistant at (814) 865-6364.

NATO ADVANCED STUDY INSTITUTE

A NATO Advanced Study Institute on "Ultrasonic Methods in Evaluation of Inhomogeneous Materials" will be held at the Ettore Majorana Centre for Scientific Culture in Erice, Italy, 15-25 October 1985. Approximately 15 experts from Europe and North America will present invited state-of-the-art papers; in addition, a small number of advanced research papers by participants will be considered. Limited financial support for qualified post-doctoral fellows, post-graduates, and research workers is available. As participation is by invitation only by the ASI directors, inquiries should be sent to:

A. Alippi
Istituto di Acustica - C.N.R.
1216 Via Cassia
00189 Roma
Italy

or to:

W.G. Mayer
Physics Department
Georgetown University
Washington, DC 20057
U.S.A.

NEW JOURNAL

The new CHINESE JOURNAL OF ACOUSTICS, published by the Acoustical Society of China, is the first acoustics journal to publish original research from China. The English language version of the journal is available from STBS Ltd., 42 William W. Street, London WC2N 4DE, U.K.

NOISE-CON 85

"Computers for Noise Control" will be the theme of NOISE-CON 85, the 1985 National Conference on Noise Control Engineering. The Ohio State University in Columbus, Ohio will be the host for the 3-5 June 1985 national conference. The Ohio State Mechanical Engineering Department and the Institute of Noise Control Engineering are co-sponsoring the three-day meeting. Rajendra Singh is the General Chairman and Lynn L. Faulkner is the Technical Program Chairman.

ASTM NEWS

A new Task Group on Ceiling Insertion Loss Measurements was formed to examine ways to measure how an air conditioning unit above the ceiling can be isolated from the space below. The Task Group hopes to develop a method to measure or to calculate the insertion loss provided by ceiling products.

The Task Group on the Two-Room Method has prepared a draft method to measure the sound insulation between two rooms sharing a common ceiling and plenum. The group is organizing a round robin test series using three ceiling materials.

The Task Group on Fixed and Demountable Partitions is reviewing Recommended Practice E497 for "Installation of Fixed Partitions of Light Frame Type for the Purpose of Conserving Their Sound Insulation Efficiency" and Practice E557 for "Architectural Applications and Installation of Operable Partitions."

Revisions to Specification C635 for "Metal Suspension Systems for Acoustic Tile and Lay-In Panel Ceilings" and practice C636 for "Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels" are being made by the Task Group on Metal Suspension Systems.

The Task Group on Airflow Resistance is organizing a round robin test series to provide data on the precision of Test Method C522 for "Airflow Resistance of Acoustical Materials."

The Task Group on Open Office Recommended Practices is preparing recommended practices to aid designers, and the Task Group of Community Noise announced that Method E1014 for "Measurement of Outdoor A-Weighted Levels" has been approved.

For more information on ASTM activities, contact:

David Bradley
ASTM
1916 Race Street
Philadelphia, PA 19103
U.S.A.

NEW BOOKS

"Industrial Noise Control: Fundamentals and Applications"
Lewis H. Bell
Marcel Dekker Inc., New York, U.S.A.

"Noise and Society"
D.S. Gloss and M.G. Wardle
John Wiley, New York, U.S.A.

"Principles of Acoustic Devices"
Velimir M. Ristic
John Wiley, New York, U.S.A.

"Fast Transforms: Algorithms, Analyses, Applications"
D.F. Elliott and K.R. Rao
Academic, New York, U.S.A.

"Acoustical Measurements: Methods and Instrumentation"
(Benchmark Papers in Acoustics/16)
H.B. Miller, Ed.
Hutchinson Ross, Stroudsburg, PA, U.S.A.

"Time Series and System Analysis With Applications"
S.M. Doudit and S.M. Wu
John Wiley, New York, U.S.A.

"Sound and Sources of Sound"
A.P. Dowling and J.E. Ffowcs Williams
John Wiley, New York, U.S.A.

"Acoustic Transducers"
(Benchmark Papers in Acoustics/14)
I.D. Groves
Hutchinson Ross, Stroudsburg, PA, U.S.A.

"Noise and Noise Control"
Vol. I: M.J. Crocker and A.J. Price
Vol. II: M.J. Crocker and F.M. Kessler
CRC Press, Boca Raton, PA, U.S.A.

"Noise and Vibration"
R.G. White and J.G. Walker, Ed.
Ellis Howard, Chicester, U.K.

"Nonlinear Methods of Spectral Analysis"
S. Haykin, Ed.
Springer-Verlag, New York, U.S.A.

"Discrete Fourier Transformation and its Application to Power Spectra Estimation"
N.C. Geckinli and D. Yavuz
Elsevier, New York, U.S.A.

"Signal Theory and Random Processes"
H. Urkowitz
Artech House, Dedham, MA, U.S.A.

"Noise Assessment and Control"
K.A. Mulholland and K. Attenborough
Construction Press, Harlow, U.K.

"Engineering Principles of Acoustics: Noise and Vibration Control"
D.D. Reynolds
Allyn and Bacon, Boston, U.S.A.

"Number Theory in Science and Communication With Applications in Cryptography, Physics, Biology, Digital Information and Computing"
M.R. Schroeder
Springer-Verlag, New York, U.S.A.

CALENDAR 1985

28-31 January 1985
3rd Annual Modal Analysis Conference
Orlando, FL, U.S.A.

26-29 March 1985
IEEE International Conference on Acoustics, Speech and Signal Processing

6-10 April 1985
Man Under Vibration
Moscow, USSR

15-17 April 1985
Institute of Acoustics Spring Conference
York, England

22-26 April 1985
International Symposium on Acoustical Imaging
The Hague, The Netherlands

6-8 May 1985
International Symposium on Hand-Arm Vibrations
Helsinki, Finland

3-5 June 1985
NOISE CON 85
Ohio State University,
Columbus, OH, U.S.A.

2-4 July 1985
Ultrasonics International '85
Kings College, London, UK

3-5 July 1985
IUTAM Symposium on Aero and Hydroacoustics
Lyon, France

4-9 August 1985
International Congress on Education of the Deaf
Manchester, England

27-29 August 1985
5th FASE
Thessaloniki, Greece

18-20 September 1985
INTER-NOISE 85
Munich, West Germany

30 September-4 October 1985
Canadian Acoustical Association Symposium
Ottawa, Canada

1-4 October 1985
Architectural Acoustics
Strbske Pleso, Czechoslovakia

23-25 October 1985
International Conference on Speech Technology
Brighton, UK

4-8 November 1985
Fall Meeting of Acoustical Society of America
Nashville, TN, U.S.A.

28-30 November 1985
II Western Pacific Regional Acoustics Conference
Hong Kong

NEW RESEARCH CONTRACTS

To Ogmundson Marine Consultants, Chilliwach, B.C., $6,240, for "Hydro acoustic study of sockeye salmon stocks in Rivers Inlet." Awarded by the Department of Fisheries and Oceans.

To Nova Scotia Research Foundation Corporation, Dartmouth, N.S., $21,372, for "Study of the use of ultrasonic energy in the oxydesulphurization of coal." Awarded by the National Research Council.

To Netherlands Ship Model Basin, Wageningen, The Netherlands, $158,738, for "Performance, cavitation and noise testing of a new propeller design for DDH 265 and class." Awarded by the Department of National Defence.

To Mount Sinai Hospital, Toronto, Ontario, $32,888, for "Objective measures of speech discrimination in noise in hearing-impaired listeners" (Drs. S.M. Abel and H. Kunov, Department of Otolarynogology. Awarded by the Department of National Defence.

To Bell-Northern Research Limited, Ottawa, Ontario, $125,708, for "Study to evaluate the voice quality of candidate coding and modulation schemes for the Mobile Satellite Program." Awarded by the Department of Communications.

To Arctic Sciences Limited, Sidney, B.C., $33,439, for "Analysis of active sonar schemes for measuring wind direction." Awarded by the Department of Fisheries and Oceans.

To G. Crawford, Victoria, B.C., $3,500, for "Study of beam characteristics and sensitivity of hydrophones/transducers." Awarded by the Department of Fisheries and Oceans.

To Queen's University, Kingston, Ontario, $12,000, for "Design, develop and study the characteristics of transducers for the ultrasonic inspection of offshore structures" (Dr. D.A. Hutchins, Department of Physics). Awarded by the Department of Energy, Mines and Resources.

To McGill University, Montreal, Quebec, $60,720, for "Study of cylindrical acoustic waveguides for industrial applications. Awarded by the National Research Council.

To DuPont Canada Incorporated, Kingston, Ontario, $19,000, for "Evaluation of an ultrasonic technique for the measurement of density of polyolefin plastics in the solid state." Awarded by the National Research Council.

To Wycove Systems Limited, Darmouth, N.S., $29,204, for "Improvement of PROLOS/modes computer acoustic models - phase I, analysis." Awarded by the Department of National Defence.

To Barrodale Computing Limited, Victoria, B.C., $36,000, for "Investigation of stereo side-scan sonar imagery." Awarded by the Department of Fisheries and Oceans.

To University of Toronto, Toronto, Ontario, $168,554, for "Investigation of robust techniques for bearing determination of broadband underwater acoustic sources with a line array receiver" (S. Pasupathy, Department of Electrical Engineering). Awarded by the Department of National Defence.

To Barrodale Computing Services Limited, Victoria, B.C., $39,875, for "Investigation of algorithms for tracking an acoustic source in shallow water." Awarded by the Department of National Defence.

To Concordia University, Montreal, Quebec, $93,920, for "Ride vibration levels at the driver seat interface (Dr. R.B. Bhat, Department of Mechanical Engineering). Awarded by the Department of Transport.

To Seastar Instruments Limited, Sidney, N.S., $1,975, for "Develop technical specifications for bottom-mounted correlation sonar system to measure ice parameters." Awarded by the Department of Fisheries and Oceans.

To University of Calgary, Calgary, Alberta, $67,000, for "Acquisition and enhancement of high resolution digital seismic reflection profiles for improved interpretation (Drs. D.C. Lawton and A.R. Bays, Department of Geology and Geophysics). Awarded by the Department of Energy, Mines and Resources.

To Institute for Hydrogen Systems, Mississauga, Ontario, $224,963, for "Vibration testing of an on-board liquid hydrogen dewar." Awarded by the National Research Council.

To W.R.S. Sutherland and Associates Limited, Halifax, N.S., $5,960, for "Investigation of passive ASN acoustic localization techniques." Awarded by the Department of National Defence.

To Martec Limited, Halifax, N.S., $59,763, for "Computer codes for ship structural response to underwater shock." Awarded by the Department of National Defence.

SUSTAINING MEMBERS UPDATE

Due to the costs of typesetting the list of sustaining members on the rear covers, new sustaining members will only be added once each year in the July issue. Additional sustaining members are listed below.

Acoustec Inc.
Conseillers en Acoustique et Controle du Bruit
106 Chaudière
St. Nicolas, Québec GOS 2Z0
Tel.: (418) 839-0101

Canada Post Corporation

McCarthy Robinson Inc.
"Matrix Industrial Silencers"
321 Progress Avenue
Scarborough, Ontario M1P 2Z7
Tel.: (416) 298-1630

MINUTES OF CANADIAN ACOUSTICAL ASSOCIATION
ANNUAL GENERAL MEETING

1) Welcome

The meeting was called to order at 4:33 pm on October 25, 1984, at the Chateau Frontenac, Quebec City, Quebec. Forty people were present.

2) Minutes of 1983 Annual Meeting

The minutes of the 1983 Annual Meeting were circulated to the membership through publication in Volume 12(1) of Canadian Acoustics.

MOTION: That the minutes of the 1983 meeting be accepted as read.

CARRIED

3) Treasurer's Report for 1983-1984 Year (see Appendix 1)

This was presented by the Treasurer, Jean Nicolas. Bill Bradley stated that he had audited the books and all was correct.

MOTION: That the treasurers report be accepted as read.

CARRIED

The question of 1984 - 1985 audit was deferred to after Item 13.

4) Correspondence

a) Letter from H. Gordon Pollard

The President stated that he had just received a letter from Mr. H. Gordon Pollard which included a request for Tom Sidden, M.P., to be invited to the meeting. The letter had arrived too late for action but this would be considered for the next meeting.

b) Letter from Revenue Canada

The secretary stated that she had written to Revenue Canada requesting permission to hold funds for the 12 ICA meeting as directed by a motion at the last meeting. Revenue Canada had replied granting the request and detailing certain reporting requirements. This information had been passed onto the CAA Treasurer. The Secretary will send a copy to the new ICA Treasurer.

ACTION: Secretary

5. a) Editors Report for "83-84"

John Bradley, Editor, presented his report. The journal is now close to breaking even, costing each member only 10 cents an issue, largely due to increased revenue from reprints and advertising. A second person has been added to the team to help attract more advertising. The quality and number of papers is steadily increasing. The membership was asked for feedback and good papers.

ACTION: Membership

b) Membership Report for "83-84"

A written version of this report is attached as Appendix 2.

6. Report from Directors on the Winner of the Directors' Award

The president announced that the winner of the 1983 Directors' Award for the best paper published in the 1983 volume of CANADIAN ACOUSTICS by an author of 35 years or younger was David Chapman. David's paper entitled "Geo-Acoustic Models for Propagation Modelling in Shallow Water" appeared in Volume 11, Number 2 of CANADIAN ACOUSTICS. The presentation of the Award, a scroll, was made by the President at the Banquet held after the Annual Meeting.

7. Report from the 12 ICA Planning Committee

This report, attached as Appendix 3, was given by Edgar Shaw.

MOTION: That the CAA accept responsibility for the financial losses or profits of the 12 ICA Symposia on behalf of the local members organizing the Symposia, on condition that adequate safeguards be worked out between the organizers and the CAA Executive and Board of Directors.

CARRIED

8. Report on the Activities of the Directors and Executive

The President, Cameron Sherry, presented this report. He highlighted the following 3 activities:

1) The organization of the duties of the Treasurer and Secretary will be defined and approved by the Directors.

ACTION: Officers & Directors

2) Guidelines for convenors of meetings will be prepared.

ACTION: C. Sherry

3) The membership role will be defined.

ACTION: C. Sherry

9. Annual Meetings

a) 1984 Convenors Report

This was presented by the meeting convenor, Jean Migneron. He reported that there had been 50 and 15 registrants at the 2 seminars held prior to the annual meeting. The Annual Meeting had a total number of 105 registrants (some of these attending only a part of the meeting). A motion of thanks was given by Moustafa Osman as follows:

MOTION: De la part de l'ACA de sa direction j'aimerais remercier les professeurs J.G. Migneron et J. Nicolas et le group pour organiser une reunion annuelle bien reussie loi a Quebec.

On behalf of the CAA and its Board of Directors I would like to thank Professors J.G. Migneron and J. Nicolas and their group for organizing a very successful annual meeting here in Quebec City.

CARRIED BY APPLAUSE

b) Proceedings

The subject of meeting proceedings was extensively discussed with members speaking for and against the subject. Concern regarding problems publishing original data afterwards was expressed. The concensus was that this should not be a problem. Concern was also expressed that proceedings will reduce the number and quality of papers submitted to CANADIAN ACOUSTICS. This will be monitored closely. The decision of whether or not to publish proceedings is to be left with the meeting organizers at present.

c) 1985 Annual Meeting

Robin Halliwell presented a convenor proposal for the 1985 meeting (Appendix 4).

MOTION: That the 1985 meeting be held September 30 October 4, 1984 in Ottawa.

CARRIED

c) 1986 Annual Meeting

The President stated that the Directors and Executive had discussed this with respect to the large amount of work to be undertaken in July 1986, in connection with the 12 ICA.

MOTION: That a CAA Business meeting only be held before, during, or after 12 ICA in Toronto in 1986.

The question of whether this fulfilled By-law requirements was discussed. Bill Bradley stated that an Interim Report could be presented by the Treasurer and that this should not be a problem.

CARRIED

10. Fee Structure for 1984-1985

MOTION: That the membership fee for 1985 be:
$ 5.00 for students
$15.00 for members
$15.00 for subscriptions and organizations

CARRIED

11. Old Business

(a) Contact with the National Building Code Authorities

The secretary presented the letters written to these Authorities containing the 2 motions made at the last Annual Meeting, and the reply (Appendix 5). After some discussion it was agreed that the Executive and Directors would follow up on this.

ACTION: Directors

Edgar Shaw suggested a special session on Building Acoustics at the next Annual Meeting. Robin Halliwell stated that there will be a seminar on Building Acoustics presented by the Division of Building Research at NRC at the time of the next annual meeting.

b) Industrial Noise Manual

This was printed by the University of Calgary and is available at a cost of $20.00. Cheques should be sent c/o the Executive Secretary, CAA, P.O. Box.

c) Membership Directory

No action had taken place on this due to a lack of volunteers to undertake the project. Two people volunteered at the meeting, Winston Sydenborgh and Alberto Behar.

ACTION: W. Sydenborgh
A. Behar

d) Report from International INCE

Since International INCE has not met since the last annual meeting, no report was presented.

12. Report of the Nominating Committee

Tom Northwood, Past President, presented the following report previously published in CANADIAN ACOUSTICS 12(4) p.2:

The following nominations of officers are made:

President:	Cameron Sherry (continuing)
Executive Secretary:	Deirdre Benwell (continuing)
Editor:	John Bradley (continuing)
Treasurer:	Tom Ho

MOTION: That the nominations be closed.

CARRIED

The terms of 2 of the 8 Directors, Stuart Eaton and Moustafa Osman, expire this year. To replace them Lola Cuddy (Queen's University) and Jean Nicolas (Universite de Sherbrook) are nominated to serve for a 4 year term.

MOTION: That the nominations be closed

CARRIED

13. Appointment of Membership Chairman and Honorary Director

MOTION: That the position of Membership Chairman and Honorary Officer be continued for the next year and that Annabelle Cohen continue in this capacity.

CARRIED

A motion of thanks was made to outgoing Directors Stuart Eaton and Moustafa Osman and to Jean Nicolas for his work as Treasurer for the last 3 years.

CARRIED BY APPLAUSE

AUDITOR

MOTION: That Doug Whicker be accepted to be auditor for 1984 - 1985 if he agrees to the job.

CARRIED

ITEM 4 New Business

a) Exhibition Space at 12 ICA Meeting

The question of whether CAA should "fly the flag" at the 12 ICA was raised by the president. After some discussion Annabelle Cohen was directed to include this task in her responsibilities as Membership Chairman. It was suggested that she form a small task force with a couple of people from the Toronto area and coordinate activities with ICA organizers.

ACTION: Annabelle Cohen

b) Letter from Hugh Jones

The president read this letter, which was addressed to the secretary and contained the following motion (which was moved by the secretary).

MOTION: That the CAA set up, forwith, a committee of about 5 persons to prepare a policy for the fostering of research in all aspects of acoustics. Among its other activities, this committee to be charged with producing an annual document indicating areas of special interest for Canadian endeavors and implicit advice to funding agencies on the principles of evaluating research proposals.

Seconded.

The following amendment was then made:

AMENDMENT TO MOTION: That Hugh Jones be made chairman of this committee and charged to find 4 volunteers to do the job. In accordance with procedures the amendment was moved first.

CARRIED

The motion was then moved as written.

DEFEATED

c) Proceedings

Bill Bradley asked if copies of the 1984 meeting proceedings would be made available to the rest of the membership. It was indicated that if there were spare copies of this or the Seminar Proceedings they would be advertised in CANADIAN ACOUSTICS.

ACTION: John Bradley

d) CAN CAM 85

John Foreman announced that this meeting will be held at the University of Western Ontario in 1985. Those interested in submitting a 2 page abstract should contact the CAN CAM Secretary: Miss Carole Hamilton, Faculty of Engineering Science, University of Western Ontario, London, Ontario.

e) New members

The suggestion was made that each member try to get one new member in the next year. Good luck!

15. Adjournment

The meeting adjourned at 6:23 pm.

APPENDIX 1

Jean Nicolas, G.A.U.S., Génie Mécanique, Université de Sherbrooke

STATEMENT OF CAST RECEIPTS AND DISBURSEMENTS FOR PERIOD SEPT. 1, 1983, TO AUG. 31, 1984
ÉTAT DES REVENUS ET DÉPENSES POUR LA PÉRIODE DU 1er SEPT. 1983 au 31 AOÛT 1984.

Receipts - Revenus

Memberships, advertising, cotisation des membres, publicité	9 487.40 $
Reprints - tirés à part	1 324.98
Meeting - Vancouver 83 - Congrès	1 600.00
I.C.A. 86	1 154.00
Sustaining members - Contributions de soutien	1 710.00
	15 276.38 $

Disbursements - Dépenses

Printing of C.A. - Impressions de l'A.C. (3 numéros)	4 385.68
Postage - Poste	73.25
Reprints - tirés à part	1 324.98
I.C.A. 86	5 000.00
C.A.A. Québec 84	1 000.00
Internoise (2)	356.64
Photo for printings - Photos pour tirages	422.29
Miscellaneous - Divers (tél., frais bancaires, chèques sans fond)	139.07
	12 701.91

Excess receipts over disbursements Excédant revenus versus dépenses	2 574.47

BALANCE SHEET - ÉTATS FINANCIERS 31-08-84

Assets - Actif

Cash on hand - solde	18 947.07

Liabilities - Passif

(Balance - solde) 31-08-83	16 372.60
(Excess - Surplus) 30-08-84	2 574.47
	18 947.07

APPENDIX 2

Membership Report 1984

There were 336 paid members as of October, 1984 including 14 student members. This represents an increase of 17.5 per cent over the number of members recorded at the same time last year. This number does not include the 34 companies and 40 library subscribers.

Geographically, the largest per cent of members (including companies and libraries) is in Ontario (49), followed by Quebec (17), British Columbia (9), Alberta (6), Nova Scotia (3), Manitoba (2) and Saskatchewan (<1). There are no members in Prince Edward Island or Newfoundland. Canada represents 88 per cent, and the United States 6 per cent, with the remainder distributed among European countries, Australia, New Zealand, U.S.S.R., and Hong Kong.

During the last year, foundations for membership growth were developed and a number of innovations were carried out. A document on issues surrounding membership was drafted and circulated among representative members, directors, and officers of the CAA whose comments encouraged further actions.

Materials for publicity of the CAA were developed: a flyer, poster, information sheet, membership application forms. Letters were written to editors of newsletters, directors of companies and organizations, and to individuals involved in aspects of acoustics. A display was sent to the Canadian Speech and Hearing Association meeting in Regina along with sample copies of Canadian Acoustics. Addresses were made to the Piano Technicians' Guild and the Toronto Regional Chapter. An article on membership expansion appeared in Canadian Acoustics, calling for assistance from members in building membership through personal contact, active Regional Chapters, and liaison with other organizations. All of these activities resulted in a range of response and cooperation. In addition, the CAA executive officers conducted a number of activities that directly and indirectly benefitted membership.

A Membership Committee was formed consisting of Alberto Behar, Bannu Hurtig, Tim Kelsall, Chris Krajewski, Ron Newman, Mustafa Osman, Ramani Ramakrishnan, and Winston Sydenborg. A meeting was held in July which focussed on recommendations regarding membership expansion. These recommendations were briefly described at the Directors' Meeting October 25th. Approval of type-setting and printing of a flyer and sanction of a membership goal of an additional 100 - 200 members was obtained. The attainment of this goal will depend upon an appeal to each member to bring in one new member and an appeal to members of other related organizations. A list of some 30 national organizations has been produced along with strategies of approach and expected resultant membership increase.

Winston Sydenborg was selected as the recipient of the 1984 Membership Award for having contributed in recent years to the expansion of the CAA through personal contact. He has taken charge of membership for the Toronto Regional Chapter, and in his consulting work he has routinely introduced his clients to the benefits of the CAA and has provided them with membership application forms.

The support of membership recruitment by the executive, directors, membership committee and members is gratefully acknowledged.

Annabel J. Cohen
Membership

REPORT BY THE CHAIRMAN OF THE 12ICA EXECUTIVE COMMITTEE TO THE CANADIAN ACOUSTICAL ASSOCIATION FOR THE YEAR ENDING 25 OCTOBER 1984

During its second year the Executive Committee has again focussed its attention on strategic issues while the specialized committees have continued planning for the various Congress activities. Last month two members of the Executive Committee, Fred Hall and Werner Richarz, found it necessary to withdraw due to changes in personal circumstances and a third member, Aubrey Edwards, asked for lighter duties. It is a pleasure to report that Sharon Abel has accepted appointment as Chairman of the Local Planning Committee, Toronto, and James Ayres, C.A. as Treasurer and Chairman of the Finance Committee, while Aubrey Edwards will continue to serve as Advisor for Local Planning. An up-to-date listing of Committees is attached. Since October 1983, the Executive Committee has met formally on two occasions (28 February and 25 September 1984) and has taken the following specific actions:

(a) Invited Her Excellency the Governor General of Canada to open the Congress;

(b) Decided to hold the Congress in the new Metro Toronto Convention Centre which will provide excellent meeting rooms for the Technical Programme, a fine hall for the Exhibition and a spacious concourse for Registration and other services;

(c) Presented a progress report to the Commission on Acoustics at its meeting in Leuven in April and received further advice from the members of the Commission;

(d) Received and approved detailed plans for the Congress Technical Programme and prepared an updated timetable showing critical dates for the preparation and distribution of the second and third circulars, the registration of Congress participants and the handling of manuscripts;

(e) Maintained close contact with the organizors of Congress Symposia in Halifax, Montreal and Vancouver and prepared an organizational plan for the consideration of the CAA Board of Directors;

(f) Revised the procedures for financial planning and administration, received updated projections of receipts and expenditures through 1986 and approved a provisional budget for 1984-85;

(g) Given general approval to the plan presented by the Exhibition Committee and authorized the Committee to mail its brochure to potential exhibitors at an early date;

(h) Received proposed Terms of Reference from the various Committees which are to be reviewed to ensure that all facets of Congress planning are adequately covered without detrimental overlapping;

(i) Received a preliminary report from the Committee on Support identifying projects for consideration by potential Congress patrons;

(j) Discussed the possibility of providing special assistance to a few delegates from third world countries and selected Canadian students;

(k) Confirmed that the Congress in Toronto will open on Thursday morning July 24 and decided that it should close on Thursday afternoon July 31, 1986.

The first circular has now been distributed all over the world and the Secretariat already has a large file of preregistrations. When the second circular (call for papers) goes to press early in 1985, the Technical Programme Committee expects to be able to announce the names of the seven distinguished plenary session speakers and the titles and organizors of many of the specialized structured sessions. The deadline for titles and preliminary abstracts will be 31 July 1985. Special paper will be mailed to authors in October 1985 and camera ready text will be due on 31 January 1986. The authors of contributed papers will be allowed two full pages of text (four columns) in the Congress proceedings which will feature an enlarged page (285 mm x 210 mm). This will accomodate approximately the same amount of material as four of the smaller pages used at 11ICA and several earlier Congresses. The sorting of some 800 papers into technical sessions will be in the hands of a panel of subject coordinators most of whom have already been appointed.

In parallel with these essentially technical activities, the Committee in Toronto is now giving close attention to every facet of local planning: the accomodation of the delegates in appropriate hotels and university residences, the receptions and special events which will provide unique opportunities for delegates to meet one another and establish international communication, the development of a world class exhibition, the provision of registration and meeting room services and the skillful handling of information and publicity.

The unaudited statement from Fred Hall, chairman of the Finance Committee during the fiscal year ending 31 August 1984, shows that the Executive Committee received a forgivable loan of $5000 from the CAA during the year which was more than sufficient to cover the amount deposited at the Metro Toronto Convention Centre, the marginal costs associated with the distribtion of the first circular and a few minor items. The bank balance on August 31 was $3522.12. The provisional budget for 1984-85 shows estimated expenses of $21641 against anticipated receipts of $25000. The most recent projection through 1986 shows estimated net expenses of $310K balanced by estimated net income of $200K from registration fees, $50K from the Exhibition and $60K from grants, donations and forgivable loans. The proposed registration fee structure includes a discount rate for authors payable when the manuscripts are submitted, a similar discount for non-authors who register early, and a special rate for bona fide students.

22 October 1984

Edgar A.G. Shaw
Chairman, 12ICA Executive Committee

THE 12ICA ORGANIZATION

12ICA Executive Committee

E.A.G. Shaw	Chairman
T.F.W. Embleton	Vice-Chairman and Chairman, Technical Programme Committee
S.M. Abel	Chairman, Local Planning Committee, Toronto
J.A. Ayres	Treasurer and Chairman, Finance Committee
A.T. Edwards	Advisor for local Planning
R.B. Johnston	Chairman, Committee on Support
J. Manuel	Secretary-General
J. Nicolas	CAA Treasurer
J.E. Piercy	Chairman, Committee on Coordinated Meetings
C. Sherry	President, Canadian Acoustical Association
A.C. Warnock	Chairman, Congress Advisory Committee

Local Planning Committee, Toronto

S.M. Abel	Chairman
J.A. Ayres	Chairman, Finance Committee
A.T. Edwards	Adivisor for Local Planning sharing responsibilities for Facilities and Accomodation with S.M. Abel
J. Hemingway	Exhibition
J. Kowalewski	Secretary
J. Manuel	Secretary-General, 12ICA
M. Osman	Services
M. Sacks	Publicity
J. Swallow	Social Events

Finance Committee

J.A. Ayres	Chairman
S.M. Abel	
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J. Manuel	

Technical Programme Committee for 12 ICA

T.F.W. Embleton	Chairman
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M.R. Stinson	
A.C. Warnock	Congress Advisory Committee

Committee on Coordinated Meetings

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H.W. Jones	Halifax Meeting
P. Mermelstein	Montreal Meeting
J.P. Walsh	Vancouver Meeting
D. Whicker	Vancouver Meeting

Secretariat

J. Manuel	Secretary-General
H. Gidamy	
C. Krajewski	
V. Schroter	

22 October 1984

APPENDIX 4

CONVENOR'S REPORT

1985 Annual Meeting of Canadian Acoustical Association

It is proposed that the meeting be held at the Chimo Inn in Ottawa from 30 September to 4 October 1985. In addition to the CAA meeting and symposium, two lecture/workshop sessions have been planned. The Acoustics Section of the Division of Physics, National Research Council Canada (NRCC), will present a two-day series of lectures on loudspeaker acoustics and the measurement of sound. These lectures will be held at the Division of Physics, NRCC, and given by Dr. F. Toole and Dr. G. Wong. The Noise and Vibration Section of the Division of Building Research, NRCC, will present a one-day lecture/workshop on building acoustics to be held at the Chimo Inn. The speakers for this session will be Dr. A.C.C. Warnock, Dr. J.D. Quirt and Dr. J. Bradley. Participants at both these sessions will be encouraged to stay at the Chimo Inn where they will receive special conference rates.

AVADH BEHARI BHATIA, 1921-1984

After a long illness, A.B. Bhatia died at the age of 63 on 27 September 1984. Bhatia was born in India and obtained his education at the University of Allahabad where he received a B.Sc. (1940), M.Sc., and D.Phil. (1946) under K.S. Krishnan. In 1947 he received his Ph.D. under H. Frolich at the University of Liverpool and then worked with N.F. Mott and also Max Born. In 1953, Bhatia came to Canada and accepted a position at the University of Alberta where he remained for the rest of his career.

During his career, A.B. Bhatia made several significant contributions to acoustics. In the works of M. Born and E. Wolf, PRINCIPLES OF OPTICS, he wrote the chapter on the theory of diffraction of light by ultrasonic waves; a subject to which he had made substantial original contribution. His own book, ULTRASONIC ABSORPTION (Oxford University Press, 1967), is a complete and authoritative account of this theory. In other areas of physics, A.B. Bhatia has contributed to the theory of liquid alloys, work in theoretical nuclear physics and published many papers on mathematical physics.

Among many honours he received was his election as a Fellow of the Royal Society of Canada (1962), a Fellow of the American Physical Society (1966). He was appointed to the McCalla Research Professorship from the University of Alberta (1984).

H.W. Jones

INFORMATION FOR AUTHORS

General	Papers should be submitted in camera-ready, final format including placement of figures and final layout.
Type	Prestige Elite preferred.
Title	All caps, centred, large type if available.
Author	Name and full mailing address, centred.
Abstract	Short summary, indent left and right margins.
Sommaire	French translation of Abstract.
Text	Single spaced, leave one blank line between paragraphs.
Page Size	8 1/2" x 11"
Margins	Fill the page! Leave only small margins, typically 3/4".
References	Any consistent format, list at end of article.
Figures and Tables	Not too large, insert in text. Include title for each figure and table.
Page Numbers	In light pencil at bottom of each page.
Equations	Minimize. Number them.
Originals	Submit original or very good dark copy.
Photographs	Only if essential or if they add interest. Submit glossy black and white prints only.

INFORMATION AUX AUTEURS

Général	Le manuscrit doit inclure le collage des figures et être prêt à photographier.
Charactère	Prestige Elite préférée.
Titre	Entièrement en majuscule. Centrer.
Auteur	Nom et adresse postale. Centrer.
Sommaire	Elargir la marge de chaque côtè.
Abstract	Traduction anglaise du sommaire.
Texte	Simple interligne. Séparer chaque paragraph.
Pages	8 1/2" x 11".
Marge	Réduire à 3/4".
Références	A la fin de l'article dans un format uniforme.
Figures et Tables	Petites tailles. Insérer dans le texte et titrer.
Pagination	En crayon, en bas de chaque page.
Equations	Minimiser. Numéroter.
Original	A remettre ou une très bonne copie.
Photos	Seulement si essentiel ou d'un intérêt particulier. Remettre une photo glacé en blanc et noir.

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