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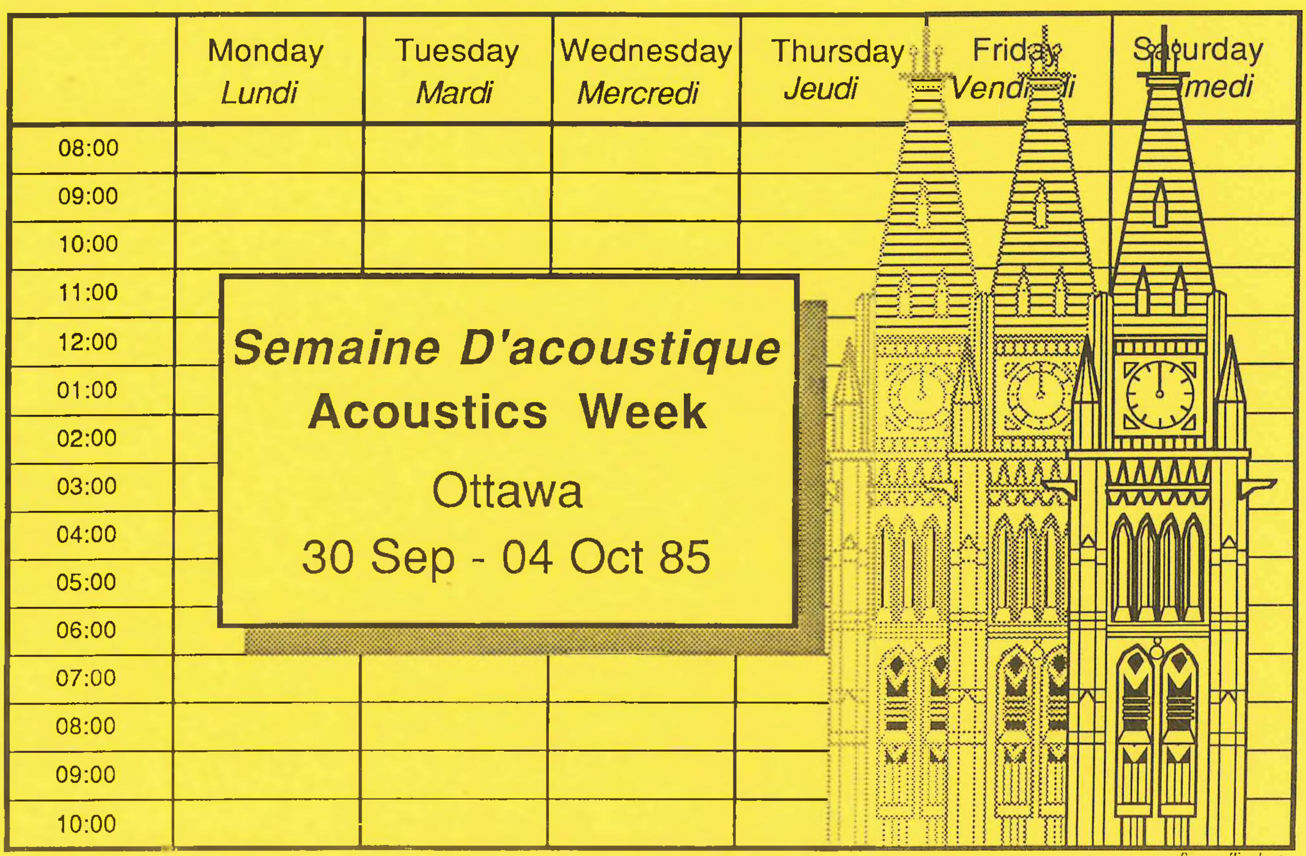

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CANADIAN ACOUSTICS publishes refereed articles and news items on all aspects of sound and vibration. Papers reporting new results as well as review or tutorial papers, and shorter research notes are welcomed in English or in French. Two copies of submission should be sent to either the Editor-in-Chief (English articles), or to the Editor (French articles). Complete information to authors concerning the required camera-ready copy is given in the first issue of each volume.

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

The final issue of CANADIAN ACOUSTICS for 1985 arrives, Acoustics Week '85 approaches, and the 12th ICA is now less than a year away. We have much acoustical activity to concern us.

As this is our last issue for the year, several unsung heroes deserve our thanks. Mike Stinson who for five years has seen that our journal gets printed and distributed has decided to retire. He certainly deserves our thanks and appreciation for an unglamorous but essential job well done for so many years. Simon Tuckett and Laurette Ernst's names are in the fine print of the inside cover but you may not appreciate their contribution. Simon and his company, Ashley Photographics, have provided front cover art work and assistance with the layout and type setting of the covers ever since our journal adopted its present format. Laurette flawlessly types all the material in the journal except for the contributed papers. Their efforts to meet impossible deadlines are all very much appreciated.

Acoustic Week '85 approaches and the abstracts of all papers submitted by the required deadline are contained in this issue. There is further information relating to Acoustics Week '85 in the "News from the President", and the nominations for new CAA officials in the news section.

Finally, you should have received a second circular for the 12th ICA. If not, contact the ICA Secretariat, telephone number of the inside rear cover.

See you in Ottawa.

EDITORIAL

Il est déjà temps de sortir le dernier numéro de l'ACOUSTIQUE CANADIENNE pour l'année 1985. Vous trouverez entre autres les sommaires soumis au congrès annuel. A ce sujet, il y a plus d'information dans la rubrique du président. La section des nouvelles contient aussi les récentes nominations au conseil d'administration et au comité directeur de l'association.

Nous voulons profiter de ce dernier numéro de l'année 1985 pour remercier certains membres de notre équipe de rédaction. Mike Stinson démissionne avec ce numéro après cinq années comme rédacteur associé à l'impression et distribution. C'est un travail ingrat mais essentiel et nous tenons tous à le remercier pour un travail qui a toujours été bien fait. Vous avez surement remarqué les noms de Simon Tuckett et Laurette Ernst à l'équipe de production. Simon et sa compagnie, Ashley Photographics, s'occupe du design artistique du frontispice de chaque numéro depuis que le journal a adopté son présent format. Laurette est la dactylo qui tappe à la machine tout le materiel sauf les articles contribués. Sans eux, nous n'aurions pas de journal et leurs efforts, sauvent devant les difficultés et une dernière limite impossible, sont très appréciés.

Finalement, nous soulignons que vous auriez du recevoir la 2e circulaire de ICA-12. Sinon, contactez le secrétariat au numéro qui se trouve à la fin du journal.

ACOUSTIC DEPTH ESTIMATION ABILITY IN MONAURAL LISTENERS[1]

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ABSTRACT

Eight clinically defined monaurals of varied loss types, levels, and etiologies were tested on a depth perception task in which they adjusted the position of a movable comparison source of one frequency until it appeared to be in physical alignment with a statically positioned standard source of a different frequency. The data were compared with the results of normally hearing subjects tested on approximately the same task, but at a different time. In practically all aspects, the data of the monaurals corroborated that of the normals, indicating that this new adjustment approach to depth study is viable. As before, the most significant variable was the initial position of the comparison source, while learning and frequency as main effects were not significant. Clearly however, the combined data of the monaurals and normals shows that the lower the frequency of the comparison relative to that of the to-be-judged acoustic depth, the more accurate the estimate. For both groups the comparison's direction of movement appears to be a factor in making correct depth estimates, and both underestimate the standard's depth for movement away from themselves and do the opposite when moving the comparison towards themselves. With one subject excluded, the analyses of the clinical factors all proved to be statistically unrelated to the ability to accurately judge depth in this manner. It is expected that with increased subject numbers and the use of bilaterally debilitated persons, there will be observable differences in the ability to accurately estimate the depth of sources.

SOMMAIRE

Huit sujets durs d'oreilles d'une façon monaurale et differencés suivant leur genre de surdité, leur degré et leur étiologie divers ont été étudiés pour leur habilité de percevoir la gravité du son. Pour mesurer cette habilité, deux sons alternants ont été présentés dans le plan médian-sagittal. Un son (de 1.0 kHz) était fixé à trois mètres du sujet et un autre (non-fixé) (soit de 0.5 ou 3.5 kHz) etait placé selon un registre

[1]This study was partially funded by a Medical Research Council of Canada Operating Grant MA6759.

qui variait au hasard. Les sujets, assis et aveuglés, devaient aligner les deux signaux manuellement avec une boîte de contrôle. Deux tests sur un total de quinze, donnés à chaque sujet avaient une fréquence référence de 0.5 kHz et 2.0 kHz chaque. Les résultats des sujets monauraux étaient semblables en tout respect avec ceux de sujets normaux examinés un an auparavant, avec cette nouvelle méthode. Ceci indique que cette méthode est valable. La variable la plus significative était la position initiale non-fixée du son. Aucune signification statistique s'est démontré par la variation de fréquence ou d'épreuve. Les données combinées des normaux et des monauraux indiquent que la gravité du son (non-fixé) avec la fréquence la plus basse était determiné avec le plus de précision. Aussi, la direction de mouvement des signaux est un facteur important pour les deux groupes afin d'apprecier la gravité du son. Finalement, les types, le degré et les causes de diminution de l'audition, ne semble pas avoir un rapport avec l'habilité des sujets à apprécier la gravité des sons.

INTRODUCTION

Recently, Gatehouse (1983) reported on a "new approach" to the investigation of auditory depth perception. Basically, the system consisted of a ceiling mounted track from which a vertical mast with a TDH-39 speaker (for "comparison" signal delivery) at its lower end, is suspended. The mast can be moved forward and backward over a distance of 8 m in an open reverberant classroom (9 x 11 m) by means of a subject held switch which activates a silent motor powering the mast. A second or (fixed position "standard") speaker sat on the upper end of a floor mounted stand 3 m from the observers' position. Blindfolded subjects, seated on a height adjustable chair that permitted alignment of their aural planes with the centre of the fixed position speaker, were asked to adjust a movable "comparison" source of one frequency until they auditorily perceived it to be in physical alignment along the median sagittal plane with an alternately sounding and statically positioned "standard" source of a different frequency. The chair was positioned so that if the subjects kept their heads steady during signal presentation and adjustment, as instructed to do, the two speakers would be on their median-sagittal plane. The task was designed, unlike most previous depth or distance estimation tasks, to have Ss judge sources that, to a minimal extent, were in dynamically changing relationships to each other, and to do the task free of any possible confounding effects of visual input.

In the initial study, normal hearing subjects listening with both ears, were given 1/3 octave narrow band signals, centered at 1.0 kHz for the standard and either 0.7 or 1.3 kHz for the comparisons, which alternated in 3-second bursts. The (IP's) initial comparison speaker positions (i.e., prior to any subject-controlled speaker movement) were at +200, +100 from, or 0 cm (already at equidepth) with the standard. The +200 cm IP was 1 m in front of the observers. With considerable individual variability, subjects could approximate the depth of the statically positioned standard by movement of the comparison. The most salient feature in depth judgement considered in this manner was the comparison's initial position (IP). Movement direction, away from or toward the perceiver, was also important. The former resulted in underestimations of the standard's true depth and the latter in overestimations. Comparison source frequency was not significant but it did interact with IP when the averaged estimated distances of the standard's depth was considered as a ratio of the total distance to achieve "true" equidepth. Finally, there were no learning effects observed for the task.

Data using this novel method largely supported those of earlier distance estimation studies (e.g., Coleman, 1968; Mershon et al., 1975, 1979 and 1980) in which, for the most part, normally hearing Ss estimated depths of statically positioned signals in non-adjustment paradigms. That is, as previously reported, observers found acoustic depth judgement was a hard task; overestimation was common when a comparison source was "close to," while underestimation of the real depth of a to-be-judged acoustic signal occurred when the comparison was "far away from" hearers, or beyond the depth of the standard. The study did not corroborate earlier findings indicating that signal frequency content was a major factor in making acoustic depth estimations.

The present study attempted to confirm or negate the Gatehouse (1983) findings and to extend the data by using other comparison frequencies. Finally, it attempted to see if and/or how much debilitated hearing (monaurality) of different loss types (i.e., Sn's, Conductives), loss levels (minimal, moderate, etc.), and different etiologies affect depth perception. There is not, to these authors' knowledge, any previous literature on depth perception in non-normal hearers.

METHOD

Subjects: Eight subjects with clinically diagnosed monaural losses of various types, levels, and etiologies, referred for testing by the second author or with the consent of other otolaryngologists. All were given pure tone (a.c.) testing (.125 to 8.0 kHz) to provide up-to-date confirmation of previous clinical findings for the purposes of classification, prior to their participation. One subject (WM), on this latter testing seemed to have considerable previously undetected loss in his "good" ear and for some analyses his depth estimating ability was not included. Descriptive data of the subjects are presented in Table 1.

Apparatus: The depth judgement apparatus was the same as that outlined in the Introduction. Signals generated via two H-P (204-D) oscillators were fed through a home-built interval timer and switch which enabled the speakers to be independently and alternately activated (3-second bursts) and thence successively through Krohn-Hite (3202) filters and an Electra SA200 amplifier to the TDH-39 speakers. A 1.0 kHz standard signal frequency was retained but the comparison signals were now 0.5 and 2.0 kHz. Signal levels (80 ± 2 dB SPL re 2 bar) at the fixed position speaker, were checked (B & K 2204 sound level meter) prior to and after each subject's daily participation. Amplifier adjustments were made where necessary.

Procedure: The procedure was similar to that of the previous study except comparison speaker initial positions (IP's) relative to the statically placed standard's, were slightly reduced by an experimental error (i.e., ±183, ±91 cm; previously the comparable IPs were 200, and +100 cm). The +183 IP in this study then was 117 cm away from the subjects' ears. All Ss received an accustomization period of 1.0 kHz signals presented once from each of the five IPs and with no adjustment of the movable source permitted. Following this, observers were blindfolded and asked to adjust the comparison speaker (signal of either 0.5 or 2.0 kHz) from the various IPs until they perceived it to be in physical alignment with the position ("0") of the 1.0 kHz standard on each trial. As in the earlier study, observers received 15 trials per each comparison signal (i.e., 3 random presentations from each of the 5 IPs). To guard against possible order effects half of the subjects were tested with the 0.5, and half with the 2.0 kHz stimulus one day and the reverse on the next test day.

Table 1. Various clinical categorizations, sample etiologies, and treatments of the monaural subjects

1 Identity (Sex; Age)	2 Loss Types	3 (Mon Ear) Average Loss (dB) Level	4 Mon. Loss Category	5 Both Ear Average Loss (dB) Level	6 Sample Etiology/ Treatment
ND (F; 19)	C	(L) 53	III	34	Mastoids; stapes replace; tympanoplasty
CC (F;19	SN	(L) 70	IV	43	Head Trauma
CH (F; 35)	C	(L) 35	I	24	Chronic Otitis Myringotomies; Tympanoplasty/Incus Graft
DP (F; 24)	M	(R) 46	II	37	SN diagnosis; Serous Otitis Myringotomies
LL (F; 20)	C	(R) 65	IV	43	Ext. Otitis Myringotomies Mastoiditis; Cholesteatoma
IB (M;24)	SN	(L) 79	IV	45	Acoustic Neuroma
AT (M; 23)	SN	(L) 67	IV	39	Pneumonia; drug treatment induced deafness
WM* (F; 34)	M	L	IV	54	SN diagnosis Menieres

Notes

<u>Loss Types</u> C= conductive; SN = sensori-neural; M = Mixed

<u>Loss Levels</u> Av. loss in dB across one (col. 3) or both (col. 5) ears on a.c. testing from 0.25 to 8.0 kHz

<u>Categories</u> < 35(I); 36-45 (II); 46-55 (III); > 56 (IV)
Col. 3 + Average loss good ear (not shown)/2 = loss level Both Ears (Col. 5)

Col. 6 Arrived at from diagnoses and treatment files: Note for DP and WM files show SN but list external and middle ear problems and reduced low frequence audiograms; thus the (M) mixed loss.

*WM File says monaural; clearly had bilateral difficulties.

The results were analyzed as before using average errors (difference (cm) between the "true" distance to "0" IP and the final or estimated position of it), and the ratio between the average estimated standard position/"true" distance to equidepth from the different IP, s. The data and discussions of them have been separated into two sections. The first part presents general factors that amplify upon those of the earlier study and allow for some comparisons of normal and monaural ability in depth judgement. The second part outlines the effects of the different clinical factors (e.g., loss levels and types) on depth estimation.

RESULTS

Table 2 shows that, in general, mean errors were smaller when the comparison source IP was between Ss and the standard ("true" equidepth position) and this occurred even when the actual distance from the standard speaker was physically the same (e.g., ±183 cm). These findings confirmed the earlier normal subjects' data.

Table 2. Average comparison speaker movement and average errors, for different initial positions and comparison source frequencies.

Initial Position (cm)	Average Comparison Movement (cm) 2.0 kHz	Average Comparison Movement (cm) 0.5 kHz	Average Errors (cm) 2.0 kHz	Average Errors (cm) 0.5 kHz
-182.9 (-2)	55.6	147.6	-127.3	-35.3
-91.4 (-1)	-4.6*	66.5	-96.0	-24.9
0	-17.5	-11.7	-17.5	-11.7
+91.4 (+1)	8.1	60.1	83.3	31.3
+182.9 (+2)	100.2	165.6	82.7	17.3

Note Errors with negative signs (-) are those where comparison was positioned aft of "0".

* On average the subjects moved this comparison stimulus in a more negative direction or farther away from the true equidistant position.

Fig. I compares the average errors of normals and monaurals for the frequencies tested. Slight differences in the IPs of the two studies have been overlooked and the data is presented as though all data was gathered at +200 and +100 cm (here all termed +2, +1). It can be seen that the tendency to greater depth alignment accuracy with the lower comparison frequency was much more pronounced here than it was for the normals. But, it must be recalled that the normals' task might have been more difficult since the comparison and standard speaker frequencies were separated by only 0.3 kHz (std. 1.0, Co.'s 1.3 and 0.7 kHz). When initial distance differences and direction of movements necessary to make estimates were equated (see ratio scores, Table 3) this trend to increasing accuracy was still evidenced.

Independent ANOVA's were computed on the average error scores collapsed across subjects to assess the effects of frequency at the different initial positions of the comparison (i.e., F x IP), and sessions or learning (i.e., L x IP). Neither frequency ($F = 0.99$) nor learning effects ($F = 0.43$) were obtained (both comparisons $df = 1$; $p > .05$). Instead in both analyses only IP of the comparison stimulus proved significant -- in frequency comparisons $F = 27.9$ and in the learning comparison $F = 27.8$ (both, df 4/28 and $p < .001$). Fig. II shows the IP effect (collapsed over all other variables) for the monaurals and the normals. The functions, despite the methodological diferences (i.e., IP and frequency changes) are quite similar. Finally, unlike the earlier study there was a F x IP interaction (F = 11.5; df 4/28; p < .001) that occurs near to the point of true equidepth.

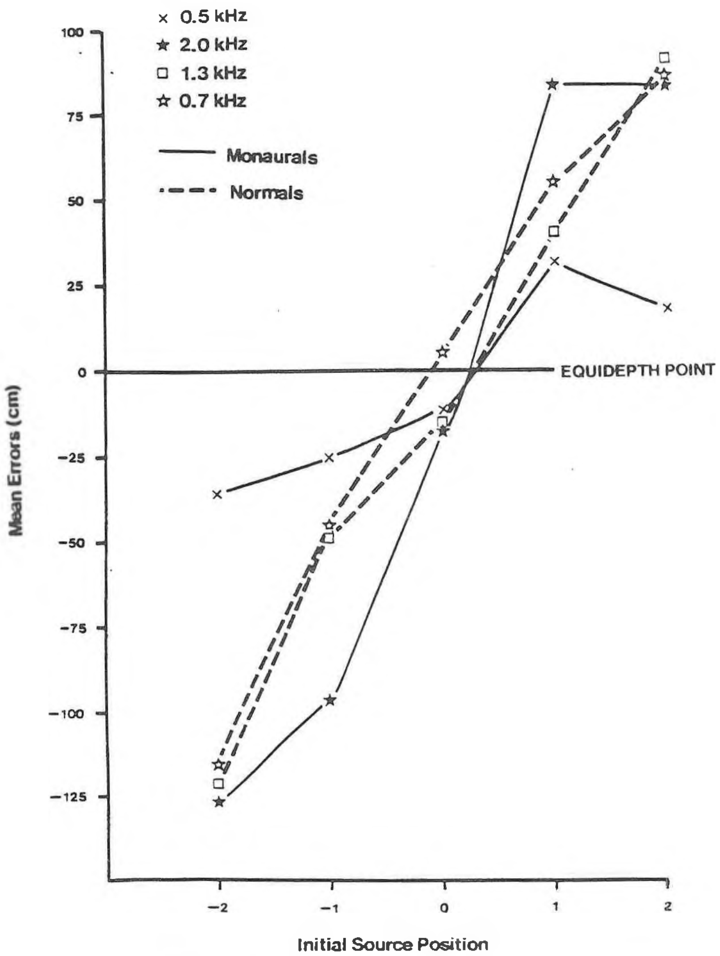


Figure I: Normal and monaural hearers' mean errors (cm) as a function of frequency

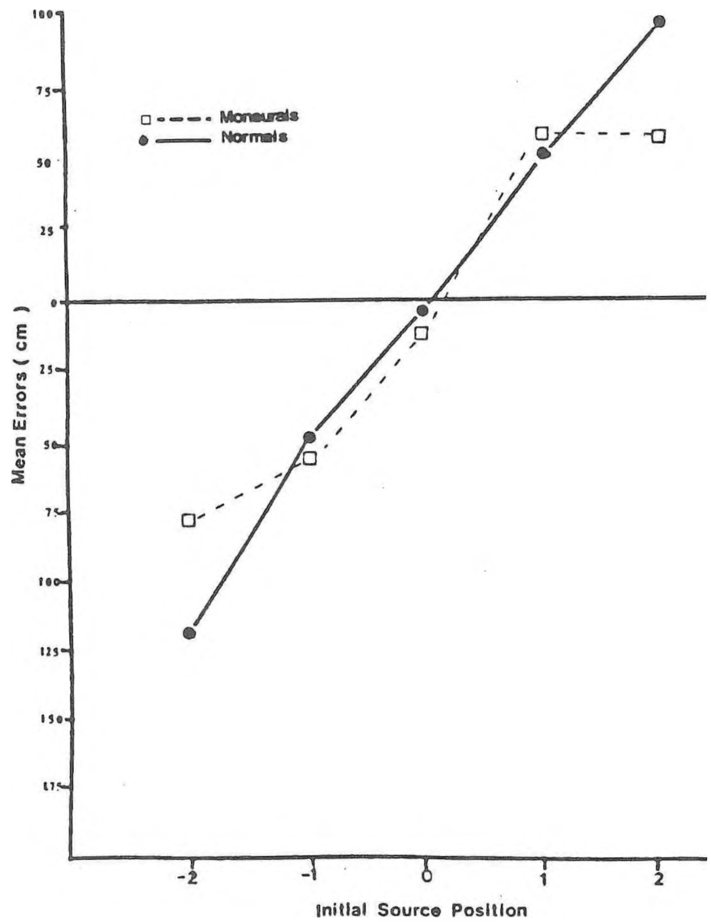


Figure II: Normal and monaural hearers' mean errors (cm) as a function of IP

Table 3. Ratio scores (average estimated distance of the "standard position "/ real distance to equidepth) for the four frequencies (1.0 kHz standard).

Initial Position*	Frequency (kHz) 2.0	1.3	0.7	0.5
-2.0	.30	.40	.43	.81
-1.0	-.05	.52	.55	.73
1.0	.09	.60	.45	.66
+2.0	.55	.55	.57	.91

Note * For ease IP's are presented as ±2.0 and ±1.0, although with normals the distances were ±200 and ±100 and with monaurals ±182.9; ±91.4.

+ 1.3 and 0.7kHz were tested in the study on normal hearers.

The one negative ratio indicates that on average subjects moved the comparison stimulus further away from "0" than its original placement.

The saliency of IP in this study pointed, as it did with normals, to the possible role in this paradigm of direction of movement in making depth estimates. With the "0" IP's omitted, it can be seen (Fig. III) that positive directional movements (towards observer) result in overestimations of the position of "true" equidepth, while negative movements yield underestimations. But, unlike the normals of the earlier study, the hearing-impaired subjects' underestimations of "0" position were not tied to the actual distance to be covered to get to equidepth. That is, they underestimated less from the closest IP to themselves and overestimated more than normals from positions nearest to actual equidepth.

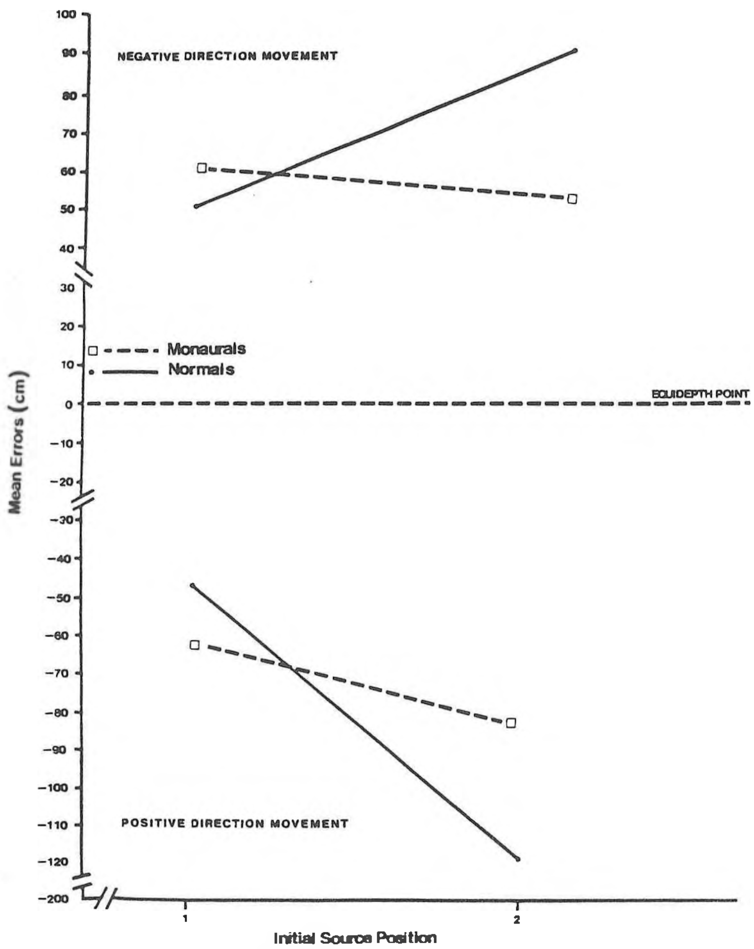


Figure III: Normal and monaural hearers' mean errors (cm) as a function of movement direction.

DISCUSSION

The trend to increasingly accurate depth perception with lowered comparison stimulus frequency is more obvious with monaural hearers than it was for normals. But, it must be remembered that the latter subjects, even with their hearing advantage, were faced with a more difficult task -- i.e., the frequency differences between the comparison sources and the standard were only 0.3 kHz, and perhaps when this close, frequency effects that might have appeared have been submerged by other factors. Nonetheless, the data on frequency effects appear supportive of Mershon and

King (1975) and Coleman (1968) who indicated that low frequency content is important in acoustic depth estimation accuracy. The specific way it is involved here however, is not so clear given that our observers were expected to judge a standard signal's depth via the changing position of a comparison source. Perhaps Ss make an initial ordinal comparison of which stimulus, the comparison or the standad, has higher frequency content. Then, for the duration of that first trial and thereafter the rest of that test day's trials in which the same comparison continues to be presented, they use the position of whichever stimulus contains the lower frequency content as the anchoring point against which to make their adjustments. In the everyday case of judging acoustic depth, where the signals are in changing dynamic and/or static relationships, a similar mechanism may work -- i.e., observers quickly assess the frequencies for which a depth judgement is required, determine which is lower, and then they focus attention upon the latter to make judgements about the signal's changing spatial depths relative to their own position.

The fact that normals and monaurals make different types of errors in judging acoustic depth (recall monaurals are more accurate than normals when IP's are farthest from the real equidepth, but slightly less accurate when the starting position of the comparison was initially close to the "0" IP) is interesting. It is almost as thoug , where binaural cues have already been reduced (median sagittal plane signal presentation), that monaurality can in some instances be an advantage. Perhaps in some way and for some signal complexes, the monaural hearers extract more distinct intensity or other information from the alternating and spatially separated signals on this plane.

In summary, this adjustment approach to acoustic depth estimation appears to give quite consistent across study results even though there were subject and methodological differences in them. That is, the results diverged very little from the originally presented findings (1983), the greatest difference being seen in the error patterns of the monaurals and normals. As well, the results appear to be consistent with other acoustic depth findings determined via other paradigms. Finally, it cannot be said that monaurals were debilitated in their auditory depth perception compared to normals, and in fact, for the 0.5 kHz stimuli they were better at it. It remains to amplify all of the relationships looked at to this point, and especially to further explicate the role of frequency in depth estimation. For example, it might have been noted that the best and poorest accuracy obtained were with frequencies that were harmonically related. Therefore this should be followed up. It is also obvious that the position(s) and frequency of the standard speaker should be varied.

CLINICAL FACTORS IN DEPTH PERCEPTION

To determine if clinical factors make a difference to acoustic depth perception, the data of all Ss except WM (Table 1) were grouped in several different ways and were subjected to unequal and small "n" ANOVA evaluations (NWAYANOVA STATLIB, University of Guelph).

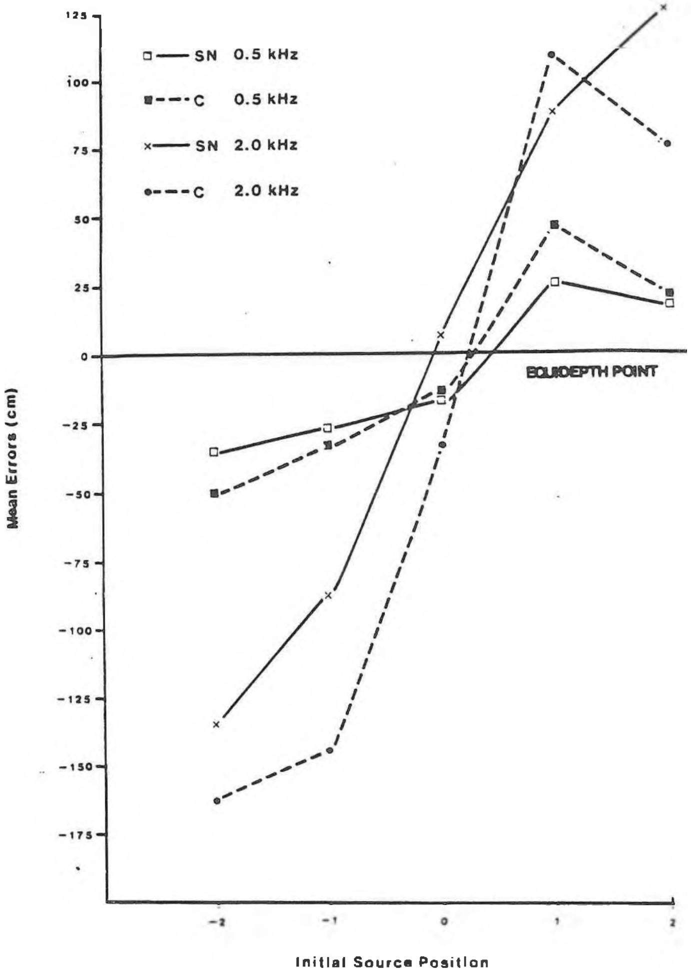
Prior to looking at the data however, the data of Table 1 should be re-examined and several things noted. First, we obtained a full range pure tone average (PTA) using eleven individual threshold points from .25 to 8.0 kHz for the left and right ears separately. The PTA determined in this way is different from usually reported ones which include only 4 or 5 frequency thresholds. Column 3 presents the monaural ear loss level arrived at this way, while column 5 presents an average for both ears.

From these, and the usual audiometric definition that hearing is considered within normal limits where the loss level is less than 25 dBHL, we placed observers into 4 monaural level categories (column 4). These were: I (average losses between 26-35 or minimal loss); II (36-45; mild); III (46-55; moderate); and IV (>56 dB). Obviously, such categorizations can present difficulties. For example, air conduction thresholds are not likely to be accurate within a few dB as implied, and individuals may thus be incorrectly classified. Subjects CH and DP for instance sit on the borders of other loss level categories. Likewise, for this sample, we have no category II Ss, and only one in category I (column 4). Etiological classifications of column 6 might also be inaccurate since they represent the first author's condensations from patient files. For example, diagnoses were not always clearly stated within the frameworks (e.g., SN, C, etc.) used here, and in some there were multiple symptoms and several treatments done over several years.

RESULTS

There were no differences in depth judgement accuracy observed by side of deafness (i.e., 5 lefts, 2 rights, $F = 2.85$, $df = 1$, $p > .15$) or by deafness type (3 CNs, 3 SNs, $F = 1.19$, $df = 1$, $p > .30$); and, loss type did not interact with either IP ($F = 0.58$, $df = 1$, $p > .40$) or with frequency ($F = 1.47$, $df = 1$, $p > .25$). But as can be seen in Fig. IV, C's appear to have more difficulty judging depth using a high frequency comparison source from the farthest IPs, while the SN's are poorest at the nearest position to their own. In general, these findings follow from those of monaural's localization ability (Gatehouse, 1976); i.e., side and type of loss do not appreciably affect spatial judgements, but there may be slight differences seen in the groups for certain spatial positions. Other research has given inconsistent results regarding degree of debility produced by different loss types in binaurally- and monaurally-impaired subjects (Bocca and Antonelli, 1976; Hausler and Levine, 1980; Hausler, Marr and Colburn, 1979; Hawkins and Wightman, 1980; Noffsinger, 1982; Quaranta, Cassano and Cervellera, 1978).

It seems reasonable that progressively greater degrees of loss should concomitantly be seen in greater depth judgements debility, especially if depth judgements are based on changing intensity information being derived from sources at different distances (Inverse Square Law). Because of this, and the loss level classification difficulties alluded to above, we grouped the subjects and analyzed the data in several unequal "n" loss level categories. Level I was not used. For example, subjects CH and DP are respectively on the upper and lower ends of categories (I and III) were considered for one analysis to be in category II, and their results compared to the depth acuity of four Ss clearly in level IV. The outcome of this and other attempts was that no significant effects of any sort were observed. However, Fig. V shows that there were non-statistical differences between the two groups in the above example. That is, there is little difference between their depth appreciation for a 0.5 kHz comparison stimulus, and the milder loss subjects do nearly as well at 2.0 kHz as at 0.5. But, level IV observers were poorer with the higher frequency comparison -- they greatly underestimate the standard's depth when positive directional movements are required and do the opposite for negative movements. Are such differences then possibly spurious effects of group size differences? Individual mean error comparisons neg [illegible] his possibility. All level IV Ss had larger errors than the two milder loss subjects at every IP except "0".



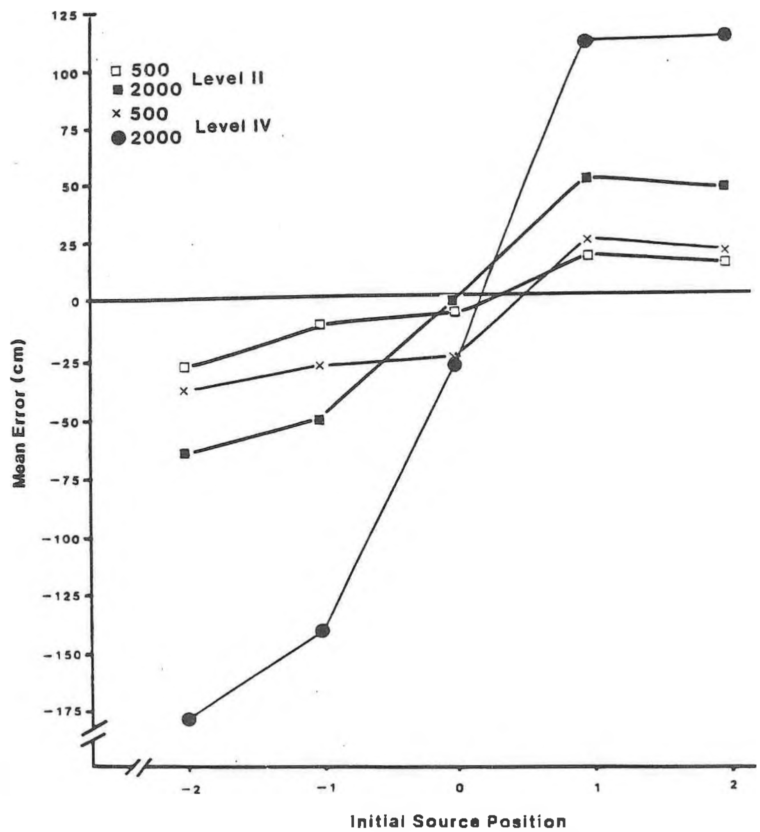


Figure IV: Mean errors (cm) of sensi-neural (SN) and conductively-impaired (C) monaurals for 0.5 and 2.0 kHz sources

Figure V: Mean errors by monaurals of loss level II and IV for 0.5 IV monaurals for 0.5 and 2.0 kHz sources

Finally, we observed no consistent patterns of errors or other relationships between similar etiological and treatment factors and the ability to judge depth. For example, there were no error similarities in the three persons who had early otitis of various forms and subsequent myringotomies. In fact, the closest error scores or accuracy indices were for the neuroma subject whose problem onset and surgical treatment occurred at about 20 years of age, and subject AT whose drug-induced deafness occurred at a very early age. At best, they are both SN's. Because of such apparent lack of concordance, no statistical evaluations were attempted.

DISCUSSION

The absence of loss levels effects was puzzling and yet not entirely unexpected. That is, it is not clear on the one hand why increasing loss levels are not more affected by increased distances and attendant loss in signal strength than they are. It would seem that the combination of high loss level, and much decreased signal strength, especially from the farthest IPs, should have provided considerable performance decrements. In fact, it did for the 2.0 kHz comparison (see Fig. V, level IV). Obviously, the relatively good depth judgement of these Ss at 0.5 kHz however, was enough to conceal any overall levels factor. On the other hand, loss severity (not defined as here) has both been and not been a significant factor in a variety of acoustic tasks (see e.s. Roser, 1966; Hausler, 1979; 1980). Gatehouse and Pattee (1983) however recently reported that binaurally-impaired observers, defined and categorized as here, did exhibit different degrees of localization ability. It could be that monaurals, having one good ear, are not very disadvantaged in judging signal depths of median-sagittal sources, just as they are not at localization (Gatehouse and Cox, 1972).

Is there any way then to explain the apparent, but not statistically poorer performance of the higher loss level subjects when judging depth with a high frequency comparison source? Perhaps the cue lies not in level per se but in loss type. That is, perhaps the fact that three of the four category IV subjects were SN's might be significant since such persons frequently have poorer high frequency resolution. Moreover, SN's have greater difficulty than other loss types in such things as binaural detection, direction, and angle discrimination (Durlach, Thompson, and Colburn, 1981; Colburn, Barker and Milner, 1982; Colburn, 1982); masked thresholds (a spread towards higher frequencies; see Martin and Pickett, 1970 for example); in broadened psychoacoustical tuning curves (e.g., Wightman, McGee and Kraemer, 1977; Zwicker and Schorn, 1978) and additional loudness summation. Recently, Florentine, Buus, Scharf, and Zwicker (1980) renamed several of these factors frequency selectivity and indicated SN's were most impaired on it. However, a loss type supposition is not easily supported here. First, audiometric testing of the three SN's used did not show any greatly reduced thresholds for 2.0 kHz that might have made their abilities to hear such tones suspect. Second, the SN's as a group were somewhat better at judging depth and particularly with 2.0 kHz comparison source than were the conductives (see Fig. IV) deaf. Whether any or several of the other factors listed above might be operating in this depth paradigm and can help explain the results is difficult to determine. In order to try and determine the effects of both loss levels and loss types more clearly, we are currently gathering data with binaurally-impaired subjects.

In summary, there were no statistical depth perception differences obtained for any of the clinical classifications. As far as loss type and impairment side this was deemed reasonable in light of some previous literature. The fact that loss levels did not seem to affect the ability to accurately judge depth was somewhat more puzzling. The data here and past findings suggest that level or degree of loss will, given increased subject numbers and bilaterally impaired observers, prove to be of importance in depth appreciation. Finally, it is also expected that etiological factors in combination with type of and degree of loss will also be found to be correlated with differential ability in depth perception.

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SOUND QUALITY IN THE CELLO*

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ABSTRACT

The perceived qualities of three cellos were rank ordered using subjective preference judgements. Median overall A-weighted sound levels were obtained at semi-tone intervals for a 3-octave range on each cello. Decreased deviations from the overall median sound level and decreased aggregate note-to-note changes in sound level were found to be ranked in the same order as perceived quality.

SOMMAIRE

Les qualités de trois violoncelles ont été classées d'après une évaluation subjective. Pour chaque violoncelle, les niveaux sonores médians globaux pondérés suivant la courbe A ont été obtenus à des intervalles d'un demi-ton pour une gamme de 3 octaves. Des déviations décroissantes du niveau sonore médian global et des variations décroissantes de note à note du niveau sonore ont été classées dans le même ordre que la qualité perçue.

INTRODUCTION

The study reported in this paper concerns the correlation between perceived cello sound quality over a range of frequencies and objectively measured note-to-note variations in the overall cello sound output. Specifically, it was proposed that increased cello quality would relate to: a) decreased deviations from the overall median sound level; and b) decreased note-to-note changes in the sound level of the cello sound.

PROCEDURE

This experiment involved a correlation between subjective and objective tests on three cellos. Some previous attempts to rate stringed instruments subjectively have used listeners' ratings on a scale of one to ten, or qualitative descriptions such as bright, soft, noble, and tight.[1] In this experiment, listeners were asked to decide

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*This paper is an invited contribution based on the report of the author, a grade 10 student, to the Ottawa Science Fair.

which of two cellos they preferred. A panel of five judges made comparisons of all 60 possible instrument and player combinations. On each cello, a scale was played over one octave from C,, (65.4 Hz) to C, (121 Hz) and in a second range from D, (147 Hz) to D (294 Hz). The panel members all had musical training, and could not see the instruments throughout the test. The distance from the cello to the listeners was similar to that used for the objective measurements. The same bow was used in all the tests.

A sound level meter was used to measure the overall A-weighted sound level at semi-tone intervals at a point 125 cm away from the instrument and directly in front of it. An A-weighting was used on the sound level meter to approximate the sensitivity of the human ear.[2] Measurements were made on three cellos for a range of three octaves. Two trials were made on each cello in a small "live" room, and one in a larger, acoustically "dead" room. The musician tried to produce the loudest possible sound on each note while attempting to regulate the bow speed with the aid of a strobe light set to flash at one-second intervals. An even bow stroke, 45 cm long, was completed in three seconds. The bow-bridge distance was visually maintained at approximately 2.5 cm. The frequency of each note was kept as accurate as possible "by ear" without technical verification.

RESULTS

In each subjective comparison of each octave, a preference was stated by each judge. Of the 40 comparisons in which it was involved, cello #1 was preferred 64% of the time over its partner. Cello #2 was preferred 38% of the time and cello #3, 47% of the time in the comparisons in which each were involved. One player always played the scale the first time, and another then played on the second instrument in the comparison, after which the panelists stated their choices. The cellist who played second was chosen 62.7% of the time in all the trials, while the one who played first was chosen 37.3% of the time. However, there were two trials for each pairing of instruments which included both orders of presentation and musician. Therefore, the tendency to choose the second instrument heard would cancel out in the overall results. It can be stated, therefore, that the panel felt that the quality of the instruments ranked in the following order: #1, #3, #2.

A-weighted sound levels were first measured for each cello on each of the three trials. Then a "resultant" curve was plotted for each cello, using the median sound level reading for each note from the three trials. These resultant median sound levels are plotted for each cello in Fig. 1. The overall median level in decibels (over all notes) was calculated for each cello, and then the aggregate of the differences from that median was obtained. When this is expressed as an average deviation from the overall median, cello #1 had an average deviation of 1.4 dBA; cello #2, 2.4 dBA; and cello #3, 1.6 dBA. If the deviations are counted from a median range (2 dBA about the actual median) rather than from the median line itself, the cellos are ranked in the same way (from least to greatest deviation): cello #1, #3, #2.

The rate of change of instrument response was calculated by taking the aggregate of the differences in sound level in decibels between each note and the adjacent note. When divided by the number of notes for which data had been obtained, an average variation in decibels between adjacent notes was found. Cello #1 had an average rate of change of 1.67 dBA, cello #2, 2.54 dBA, cello #3, 2.37 dBA. Ranked from least to greatest rate of change, the order was: cello #1, #3, #2.

CONCLUSIONS

The experiment found a correlation between string instrument quality, as perceived by a panel of observers, and patterns in the variations of cello sound output as objectively measured over a range of frequencies. The ranking of the observers corresponded to the ranking (from lesser to greater) of deviations from the overall median sound levels, and of the rate of change in sound levels between adjacent notes.

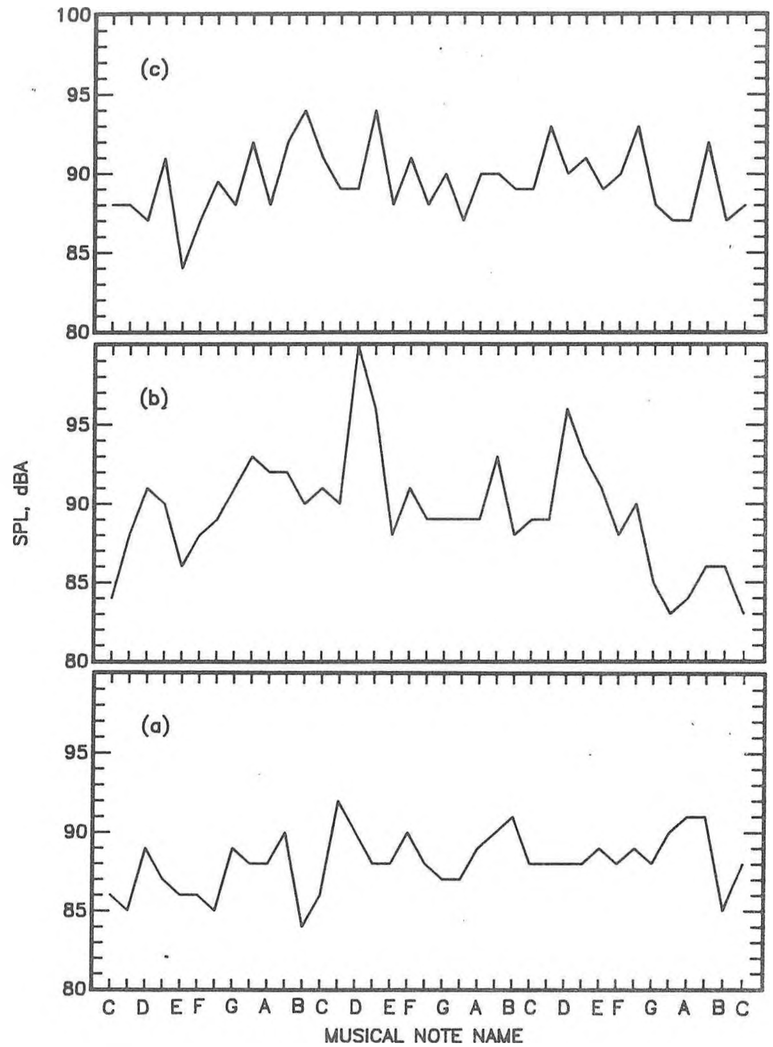

Fig. 1. Median Overall Sound Pressure Levels (SPL), (a) cello #1, (b) cello #2, (c) cello #3.

It is likely that an instrument which produces a fairly consistent loudness from note to note when a scale is played on it is thereby more pleasing to a listener than one which displays unexplained variations in loudness from note to note. It may also be that an instrument which is more consistent in its response across its range has been more skillfully made and will also have a rich complexity of resonances enhancing each note in its range in a way that is pleasing to the ear of listeners. The resonances of wooden members and air chambers will have been made to complement each other and produce a consistency in "richness" as well as loudness, throughout its range. This experiment, of course, did not make any direct measurements of the harmonic composition or timbre of the notes produced. It would be interesting to study the harmonic content of the sound produced by different stringed instruments and to explore the relationship between such an analysis and the subjective and objective measurements of this experiment.

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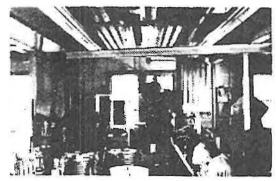

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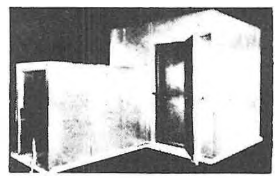

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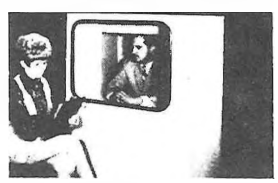

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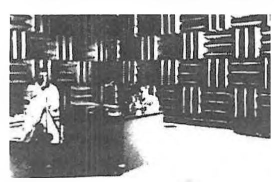

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NON-CONTACTING ACOUSTIC DISPLACEMENT SENSOR

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ABSTRACT

Most vibration transducers are sufficiently massive to induce significant changes in the system response of light-weight structures. This is not the case for non-contacting transducers. The system described herein offers a potential low cost solution for measurements of large amplitude, low frequency vibrations.

SOMMAIRE

La plupart de transmitteurs de vibration sont suffisament massive q'ils induisent des changements signifatives dans la réponse des structures poids-lègeres. Ceci n'est pas le cas pour les transmitteurs non-contactant. La système décrit ici offert une solution avec potentiel de coût raisonable pour des mesures de vibrations de grande amplitude et frequence bas.

NOMENCLATURE

k	wavenumber (m^{-1})	$\overline{\mathbf{Y}^*}$	time averaged image source position (m)
m_o	mass of vibrating object (kg)	α	reflection co-efficient
m_{ex}	mass of accelerometer (kg)	K	spring constant (kg/sec^2)
$\mathbf{X}$	observer position (m)	μ	damping constant (kg/sec)
$\mathbf{Y}$	source position (m)	ω	radian frequency (sec^{-1})
$\mathbf{Y}^*$	image source position (m)		

INTRODUCTION

In certain applications measurements of vibrating systems are complicated by the additional mass of accelerometers. In some instances, lightweight devices can be used; however, as figure 1 suggests, there appears to be a direct correlation between accelerometer weight and sensitivity [1]. Thus there is little hope of sensing small accelerations of lightweight structures with conventional accelerometers.

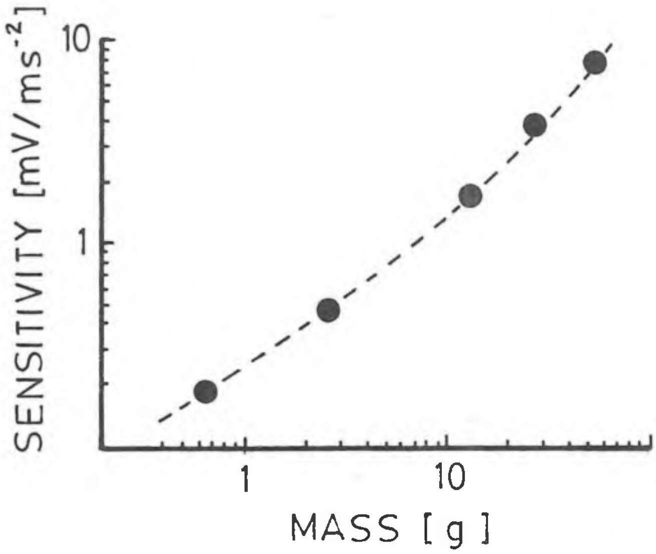

Figure 1. Voltage Sensitivity vs Weight for a Family of Accelerometers.

One can estimate the influence of the added mass by considering a lightly damped spring mass system. Addition of an external mass m_{ex} in the form of an accelerometer results in a change of the resonant frequency (ω_R) as well as the damping co-efficient (ξ):

$$\omega_R \approx \sqrt{\frac{K}{m_e + m_{ex}}} = \sqrt{\frac{K}{m_0}}\,\frac{1}{\sqrt{1 + m_{ex}/m_0}} = \frac{\omega_0}{(1+m_{ex}/m_0)^{.5}} \qquad [1]$$

$$\xi = \xi_0 \sqrt{1+m_{ex}/m_0} \quad ; \quad \xi_0 = \mu \sqrt{m_0/K}$$

In multi-degree of freedom and distributed systems there is also a change in the modal structure.

To avoid the possibility of "transducer loading" a non-contacting transducer ought to be employed. There are several types available, capacitive, inductive and optical. The first two require that the transducer be in close proximity to the vibrating object (typically a few millimeters). In addition a portion of the surface of the object must be metallic. Optical methods either track a reflected beam via a servo mechanism, or use coherent radiation (laser) and decode the doppler shifted reflection. The optical systems possess a wide dynamic range and can be used at considerable distance from the "target"; however they are rather expensive.

The system described herein is a low-cost noncontacting displacement sensor. It was designed to meet a requirement of the Aircushion Technology group at the University of Toronto Institute for Aerospace Studies (UTIAS). The prototype was built while the author was at UTIAS and all the test data reported here were taken in the aeroacoustic laboratory there [2]. The principal objective was to devise a low-cost transducer capable of measuring large amplitude (50 mm), low frequency (10Hz) motions of a scale model aircushion vehicle skirt. The theoretical background and initial testing are described below.

Theoretical Considerations

It is well known that the frequency of sound heard by an observer is governed by the frequency emitted by the sound source and the relative motion of the source and observer. Consider for example an observer at **X** and a source at **Y** (Fig. 2). An infinite, hard boundary reflects some of the sound back to the observer. The reflection is modelled by placing an image source behind the boundary which now is completely transparent.

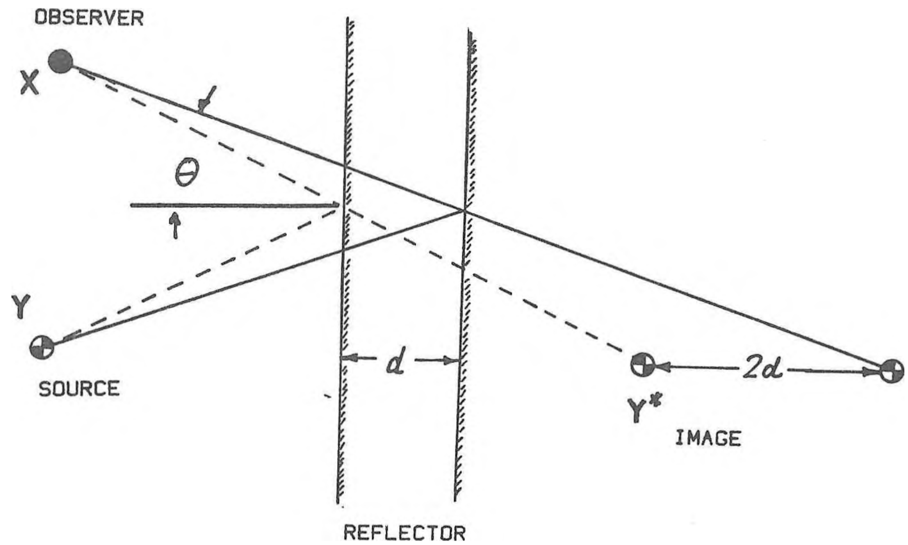

Figure 2. Idealized Configuration for Non-contacting Displacement Transducer.

A change in position of the barrier induces a change in the location of the image source. Let the source radiate a single pure tone, then the observer detects two signals, the direct wave (P_D) and the reflected wave (P_R).

$$\begin{aligned} P(X,t) &= P_D(X,t) + P_R(X,t) \qquad [2] \\ &= P_D \cos\omega t \left\{ \frac{\cos k|X-Y|}{|X-Y|} + \alpha \frac{\cos k|X-Y^*|}{|X-Y^*|} \right\} \\ &\quad + P_D \sin\omega t \left\{ \frac{\sin k|X-Y|}{|X-Y|} + \alpha \frac{\sin k|X-Y^*|}{|X-Y^*|} \right\} \end{aligned}$$

If the amplitude of vibration of the boundary (target) is small with respect to the average distances and the wavelength,

$$p \approx P_D \cos\omega t \left\{ \frac{\cos k|X-Y|}{|X-Y|} + \alpha \frac{\cos k|X-\overline{Y^*}|}{|X-\overline{Y^*}|} - \alpha\, d(t) \frac{k\cos\theta}{|X-\overline{Y^*}|} \sin k|X-\overline{Y^*}| \right\}$$
$$+ P_D \sin\omega t \left\{ \frac{\sin k|X-Y|}{|X-Y|} + \alpha \frac{\sin k|X-\overline{Y^*}|}{|X-\overline{Y^*}|} + \alpha\, d(t) \frac{k\cos\theta}{|X-\overline{Y^*}|} \cos k|X-\overline{Y^*}| \right\} \qquad [3]$$

follows. The detected signal contains both in-phase (cos ωt) and quadrature (sin ωt) components with a mean and time-varying amplitude. The variations (to first order) are linear with respect to the displacement of the target with respect to its average position.

The displacement sensitivities are

$\alpha \frac{k\cos\theta}{|X-\overline{Y^*}|} \sin k|X-\overline{Y^*}|$ [in phase] and $\alpha \frac{k\cos\theta}{|X-\overline{Y^*}|} \cos k|X-\overline{Y^*}|$ [quadrature]

respectively. All quantities are known are easily measured providing one with all the necessary information. A lock-in amplifier can be used to detect the in-phase and quadrature components. The DC or average component can be removed electronically resulting in a time-varying signal directly proportional to displacement.

Prototype Testing

A prototype system was assembled from stock components. The sound source, a tweeter, and the receiver, a Bruel and Kjaer 4135 ¼" microphone - 2618 preamplifier combination, were mounted side by side and aimed at a 20 cm x 10 cm aluminum target, instrumented with a Bruel and Kjaer 4381 accelerometer. The target was driven by a Goodmann's vibration generator. A PAR 126 lock-in amplifier served as a phasedetector and two independent oscillators provided signals to the vibration generator and the loudspeaker (Fig. 3). Although the capital cost of the equipment used is considerable, low priced alternatives may be used.

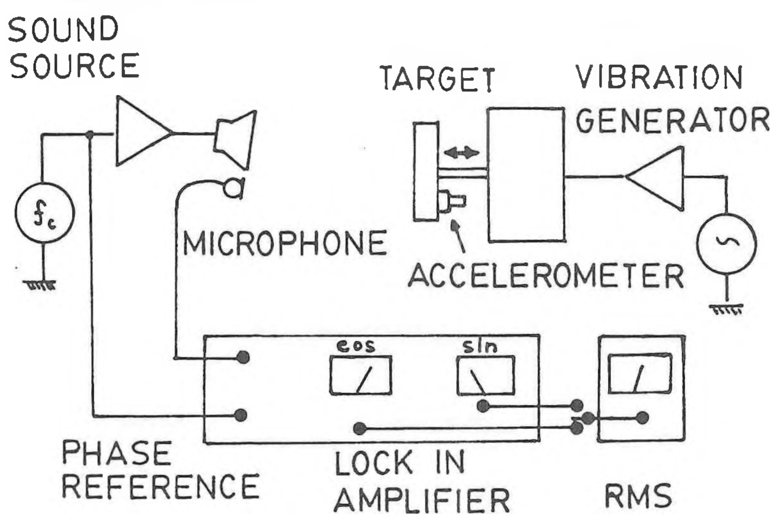

Figure 3. Prototype and Test Arrangement.

There is no need for a high performance microphone, as only relative measurements are made. An inexpensive phase-locked loop can be configured into a lock-in amplifier [3], the oscillator required to drive the loud-speaker being part of the phase-locked loop. Signal conditioning of the lock-in output is achieved via operational amplifiers driving suitable outputs. Surprisingly the prototype system worked quite well. This is illustrated by the comparison of several vibration spectra measured with the accelerometer and the remote displacement transducer, (Fig. 4). The agreement is good.

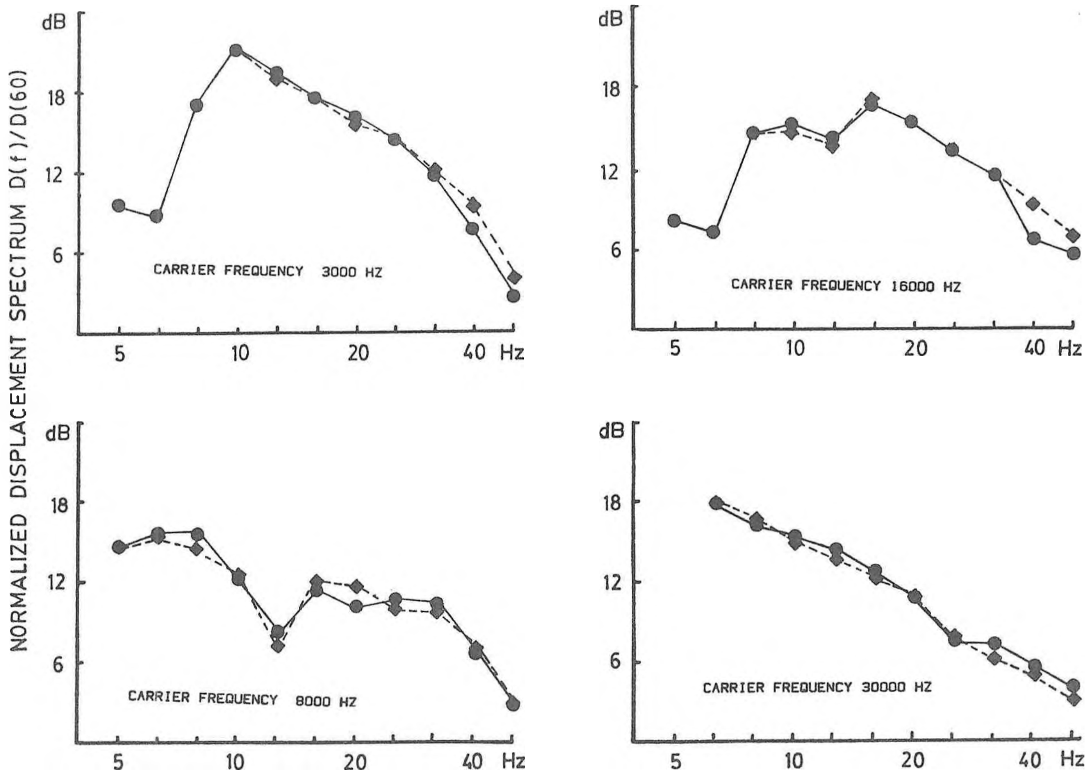

Figure 4. Comparison of Displacement Spectra Measured with i) noncontacting System ● ii) derived from accelerometer data ◆ .

One feauture of the system is the ability to cater to different measurement requirements. Small displacements can be examined by illuminating the target with a high frequency beam. Large amplitudes can be measured if low frequencies are used. In this instance the relative large wavelength of sound is an advantage.

CONCLUDING REMARKS

At the present time, precise calibration requires a number of subtle tests that may prove cumbersome to the novice. However, once the user is aware of the operating principle, the instrument can be used confidently as a remote displacement transducer.

ACKNOWLEDGEMENT

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ETUDE PAR REFLEXION DE L'IMPEDANCE D'ENTREE, SOUS INCIDENCE OBLIQUE, D'UN ECRAN ACOUSTIQUE AJOURE.

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RESUME

Un nouveau type d'écran ajouré constitué d'un emplilement de guides d'ondes a montré pour des ondes planes en incidence normale, des propriétés intéressantes dans le contrôle du bruit de basse fréquence par effet de phase. Afin d'utiliser ce nouveau système il nous fallait connaitre son comportement vis à vis d'ondes sonores en incidence oblique pour tenir compte , par exemple, de l'effet de sol. Deux méthodes de mesure par réflexion ont permis d'étudier l'effet de l'angle d'incidence des ondes sur l'impédance de l'écran acoustique ajouré déphaseur. La première, inspirée de Klein & Cops est une méthode d'ondes stationnaires dérivée de celle du tube d'impédance. L'autre méthode proposée par Ingard & Bolt mesure la pression sonore complexe à la surface de l'échantillon. Les résultats de cette étude ont montré que dans un plan vertical (perpendiculaire aux fentes d'entrée), l'impédance d'entrée du système est néanmoins indépendente de l'angle d'incidence (système localement réactif entre ±40°). Par contre dans un plan horizontal parallèle aux fentes l'impédance varie de façon beaucoup plus importante en fonction de l'angle d'incidence.

ABSTRACT

A new type of phase reversal sound barrier composed of slitted waveguides has shown remarkable noise control properties in low frequency for a plane wave at normal incidence. In order to assess the overall performance (e.g. ground effect, variable source position, etc.) it was necessary to study the effect for obliquely-incident sound wave. Two methods based on reflexion measurements at oblique incidence were applied to study the input impedance of the phase reversal barrier. The first one, successfully used by Klein & Cops, is a stationnary wave method derived from that of the impedance tube. The second method presented by Ingard & Bolt, consists in the measurements of the complex sound pressure at a point of the sample surface. The results of the study show almost no angular dependence of the system input impedance (locally reacting system within ±40°) in the vertical plane (perpendicular to the slits). On the contrary, in a horizontal plane (parallele to the slits), this angular dependence becomes appreciably stronger.

INTRODUCTION

Cette étude fait partie d'un projet de développement d'un écran acoustique de type ajouré déphaseur constitué d'un empilement de guides d'ondes. Chacun des guides possède un profil en forme de peigne (dont chacune des dents est constituée d'une longue plaquette rigide) qui forme avec le fond de l'élément inférieur (dont il est maintenu écarté), une succession de guides d'ondes à quatre cavités (Fig. 1). Ce nouveau type d'écran contrôle le bruit par un effet de phase introduit entre l'onde sonore qui le traverse et l'onde qui est diffractée par son sommet. Il introduit, pour la partie du bruit qui le traverse, alternativement une série de bandes passantes et de bandes d'arrêt, à la manière d'un filtre. La fréquence à laquelle on atteint la première bande d'arrêt, présente ici un intérêt particulier; il s'agit de la fréquence de coupure du filtre.

Pour ce type d'écran ajouré, la théorie est connue pour le cas d'ondes sonores planes en incidence normale et de nombreuses mesures en chambre anéchoique, ont déjà montré qu'il se compare favorablement avec un écran plein absorbant [1],[2],[3],[4],[5]. Comme il est nécessaire de connaître aussi son comportement en fonction de l'angle d'incidence (pour introduire, par exemple l'effet du sol) , on a cherché à mesurer l'impédance de ce système et à déterminer sa dépendance angulaire. Pour celà, on a adapté les méthodes utilisées par Klein & Cops [6] et par Ingard & Bolt [7].

Ces deux méthodes sont basées sur la répartition d'énergie sonore dans un échantillon placé contre un mur réfléchissant qui agit comme référence (dans le cas de la seconde méthode) . L'étude doit être réalisée en milieu anéchoique pour éviter les réflexions provenant de surfaces autres que celle étudiée.

Pour déterminer l'impédance et le coefficient d'absorption de l'échantillon , la première méthode étudie la superposition des ondes incidentes et réfléchies formées devant l'échantillon de façon semblable à celle du tube d'impédance. La seconde détermine les mêmes caractéristiques à partir de l'amplitude et de la phase mesurées à la surface de l'échantillon comparées à celles que l'on mesurerait contre le mur de référence seul.

Les auteurs mentionnés ici ont obtenu des résultats intéressants pour des matériaux homogènes assez absorbants pour lesquels leurs méthodes s'avèrent valides. Néanmoins ces méthodes présentent des limitations pour d'autres types de matériaux. Dans notre cas, leur adaptation, pour un échantillon réactif non homogène, peu absorbant en soi aux fréquences d'intérêt, a consisté à utiliser une couche de 0.15m d'un matériau absorbant placé entre l'écran ajouré et le mur réfléchissant. L'ensemble à tester ainsi formé devient plus absorbant et permet d'appliquer leurs techniques.

Les résultats de certaines de nos mesures (coefficient d'absorption en particulier) ont été comparés, en incidence normale avec ceux obtenus à l'aide du tube d'impédance. Celà a semblé montrer que la méthode utilisée par Klein & Cops donne des résultats plus satisfaisants que celle proposée par Ingard & Bolt pour ce cas particulier.

L'étude a permis de montrer que l'impédance d'entrée d'un tel écran déphaseur s'avère pratiquement indépendante (au moins jusqu'à plus ou moins 40 degrés) de l'angle d'incidence dans un plan normal aux fentes d'entrée, celà en dessous de la fréquence de coupure de l'écran ajouré. Par contre, elle varie de façon importante pour un angle d'incidence de plus ou moins 60 degrés dans un plan parallèle aux fentes.

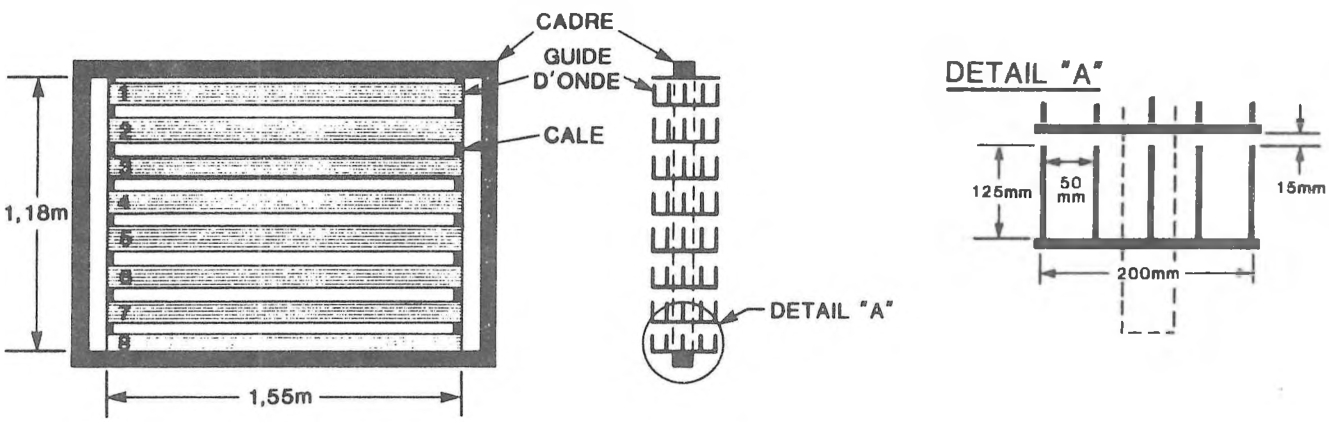


Figure 1: Description géométrique de l'échantillon

2. REVUE DES METHODES

Plusieurs méthodes différant par la technique de mesure sont disponibles pour étudier l'impédance d'un matériau sous incidence oblique. Il s'agit des méthodes: d'ondes stationnaires [6], [7], [8], de la pression sonore à la surface [9],[10], impulsionnelle [11],[12],[13] et d'intensimétrie [15]. Les méthodes utilisées dans cette étude sont résumées dans la référence [14].

Malheureusement, on rencontre assez souvent certaines limitations dans leur application comme par example la bande de fréquence (dimensions insuffisantes de l'échantillon par rapport à la longueur d'onde impliquée) , le coefficient d'absorption trop grand ou trop petit, la structure nonhomogène, etc....

C'est pourquoi dans notre cas d'un échantillon non-homogène, réactif et quasi-réfléchissant il a fallu augmenter son absorption par l'application entre l'écran ajouré et la paroi réfléchissante de référence d'une mousse polyuréthane absorbante.

2.1 Klein & Cops

Cette méthode inspirée de la méthode du tube d'impédance, consiste à mesurer, en chambre sourde la distance d1 (fig. 2) de l'échantillon testé (s'appuyant sur une surface solide) au premier minimum de pression acoustique p_{min} , et le rapport des pressions acoustiques minimum et maximum $p_{min} \backslash P_{max}$ des ondes stationnaires formées devant l'échantillon . Cette méthode suppose que les ondes incidentes et réfléchies se superposent pour former des ondes stationnaires. La pression acoustique complexe peut s'écrire:

$$p = \frac{e^{ikr_1}}{r_1} + \frac{e^{ikr_2}}{r_2} \left[(1 - R_p)F + R_p \right] \qquad \{1.0\}$$

où Rp est le coefficient de réflexion complexe, r1 et r_2, les distances indiquées sur la figure 3 et k le nombre d'ondes. Pour des angles d'incidence inférieurs à environ 60 degrés et des distances r_1 et r_2 assez grandes par rapport à la longueur d'onde, on peut admettre une simplification : le terme F qui tient compte de la sphéricité de l'onde peut être négligé et on obtient:

$$p = \frac{e^{ikr_1}}{r_1} + \frac{e^{ikr_2}}{r_2} R_p \qquad \{1.1\}$$

le coefficient de réflexion Rp s'exprime par:

$$R_p = R_o e^{i\psi} = \left| \frac{Pr}{Pi} \right| e^{i\psi} \qquad \{1.2\}$$

où p_i et p_r sont les pressions sonores des ondes incidentes et réfléchies respectivement, Ro et ψ sont le module et la phase de ce coefficient. Cette pression acoustique permet de calculer l'impédance si on utilise une méthode analoque à celle du tube d'impédance. Elle suppose la distance x, de l'extrémité de la sonde à la surface de l'échantillon (Fig.3) assez petite par rapport aux distances r_1 et r_2 de façon à pouvoir écrire l'approximation suivante:

$$r_1 = h - x\cos\theta$$
$$r_2 = h + x\cos\theta \qquad (1.3)$$

h et x sont des distances identifiées sur la figure 3 et θ est l'angle d'incidence. L'impédance acoustique spécifique a pour expression:

$$Z = \frac{\rho c \tanh(\psi)}{(1 + i/hk)\cos\theta} \qquad (1.4)$$

ρc est l'impédance de l'air. La mesure nous donne la distance du premier minimum d_1 et la pression acoustique de ce minimum p_{min}. On détermine ensuite la pression acoustique du maximum suivant p_{max} de la même façon pour obtenir enfin le rapport: $r = p_{min} \backslash p_{max}$ (dB). Ces valeurs permettent de calculer l'impédance et le coefficient d'absorption; on calcule d'abord les résultats intermediaires d_2, u et v.

$$d_2 = d_1 + \frac{\pi}{2k\cos\theta} \qquad (1.5)$$

$$u = \frac{1}{2}\ln \frac{e^{-d_1\cos\theta/h} + r\,e^{-d_2\cos\theta/h}}{e^{d_1\cos\theta/h} - r\,e^{d_2\cos\theta/h}} \qquad (1.6)$$

$$v = \pi + kd_1\cos\theta \qquad (1.7)$$

et enfin:

$$\frac{Z}{\rho c} = \frac{[kh\,(kh \sinh 2u + \sin v)] - i\,[kh\,(\sinh 2u - kh \sin v)]}{2\cos\theta\,(1 + h^2k^2)\,[\cosh^2 u - \sin^2 v]} \qquad (1.8)$$

$$\alpha = 1 - \left| \frac{Z\cos\theta - \rho c}{Z\cos\theta + \rho c} \right|^2 \qquad (1.9)$$

Ces formules provenant d'une théorie simplifiée d'ondes sphériques sont supposées rester applicables pour les conditions (r_1, r_2 et l'angle d'incidence) citées plus haut.

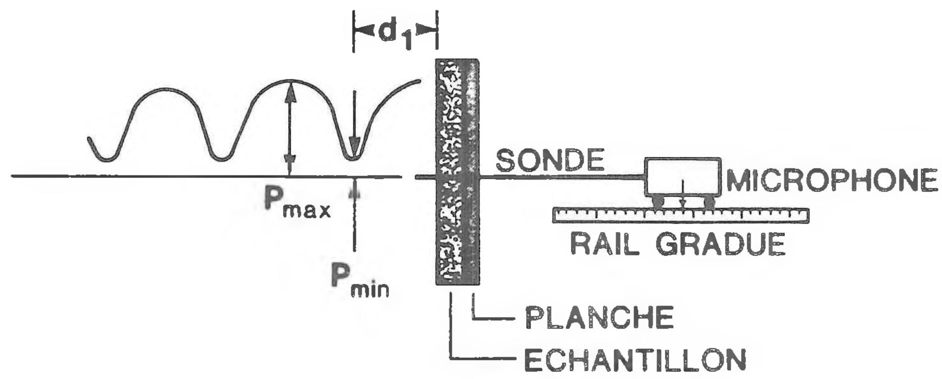


Figure 2: Formation de l'onde stationnaire devant l'échantillon

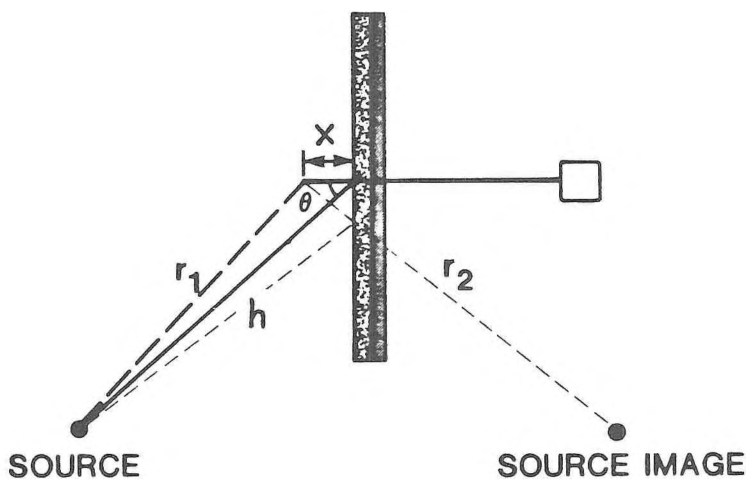


Figure 3: Disposition de la source et de l'échantillon sous incidences obliques

2.2 Ingard & Bolt

La méthode de Ingard & Bolt aussi connue sous le nom de "méthode de la pression sonore à la surface" permet de déterminer l'impédance et le coefficient d'absorption à partir du rapport de la pression sonore p_2 en un point donné à la surface de l'échantillon couvrant le mur de référence avec la pression p_1 à la surface de ce dernier seul (Fig. 4).

Théoriquement, pour un mur parfaitement réfléchissant (mur de référence), la pression p_1 est le double de la pression incidente p_I sans déphasage introduit entre les deux.

La méthode suppose que le montage est de dimensions suffisamment grandes comparé à la longueur d'onde pour permettre de supposer des réflexions sur un plan infini. Le calcul de l'impédance normalisée et du

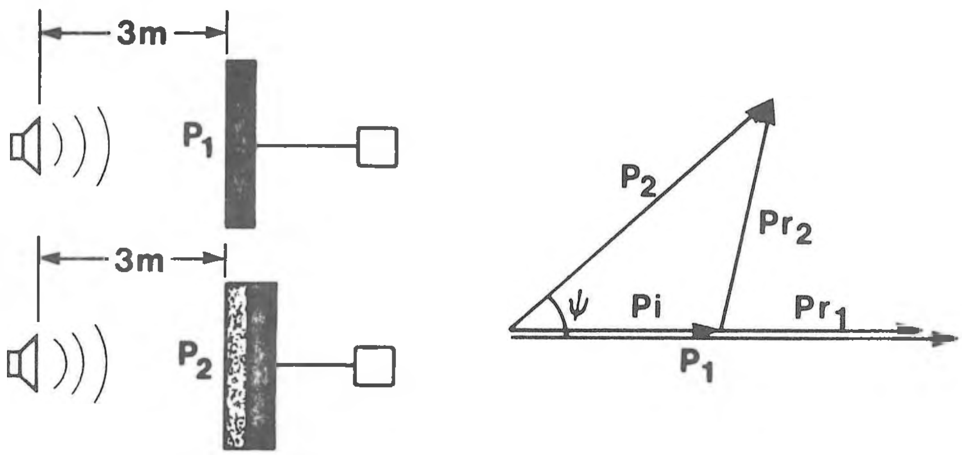


Figure 4: Superposition des pressions sonores-p à la surface de l'échantillon

p_i - onde incidente $\qquad p_1 = p_i + p_{r1}$

p_{r1} , p_{r2} - ondes réfléchies $\qquad p_2 = p_i + p_{r2}$

coefficient d'absorption s'exprime ensuite en fonction de p_1, p_2 et ψ mesurés, par les relations suivantes:

$$\frac{Z}{\rho c} = \frac{[(p_2/p_1)\ (\cos\psi - p_2/p_1] + i\ [(p_2/p_1)\ \sin\psi]}{[(\cos\psi - p_2/p_1)^2 + \sin^2\psi]\cos\theta} \qquad (2.0)$$

$$\alpha = \cos^2\psi - 4\ [(p_2/p_1) - 1/2\ \cos\psi]^2 \qquad (2.1)$$

où $Z/\rho c$ est l'impédance normalisée (415 MKS rayls), α est le coefficient d'absorption , θ est l'angle d'incidence, et ψ est le déphasage entre les pressions p_1 et p_2.

3. ETUDE EXPERIMENTALE

L'étude expérimentale a été effectuée sur une maquette à l'échelle 1/4 dans la chambre sourde.

3.1 Echantillon testé

L'échantillon étudié, composé des guides d'ondes empilés (chaque guide représente une demi-cavité du filtre passe-bas située sur un plan réfléchissant) a été réalisé en Plexiglass. Ce matériel fut choisi pour faciliter le montage et assurer à la fois une bonne étanchéité et la rigidité des guides d'ondes constituant le modèle.

Chacun de ces guides composé de longues lamelles est vu de profil comme un peigne à cinq dents (Fig. 1). Une surface plane réfléchissante au-dessous de ce peigne permet de former avec lui une série de fentes régulièrement espacées. Les guides (dont les dimensions sont indiquées sur la Fig. 1) sont fermés sur leurs côtés latéraux par deux plaques rectangulaires. La structure dissymétrique de l'écran dans le plan vertical et les dimensions de l'échantillon par rapport à celles de la chambre sourde nous ont obligé à le déplacer pour pouvoir l'étudier dans la bande des angles d'incidence d'intérêt entre -60 et +60 degrés.

3.2 Adaptation des méthodes

Comme déjà mentionné dans le chapitre 2, les deux méthodes ne fonctionnent bien que dans des conditions restreintes. Dans notre cas, l'échantillon réactif ne possède pas suffisamment d'absorption. C'est pour celà qu'un matériau absorbant (mousse de polyuréthane de propriétés d'absorption déja mesurées) a été appliqué derrière l'échantillon afin d'augmenter l'absorption de l'ensemble.

En effet, au dessous de la fréquence de coupure de l'écran (600 Hz environ), zone de principal intéret (première bande passante), ce dernier laisse passer l'énergie sonore et, seul, n'aurait pas constitué un échantillon facilement mesurable.

3.3 Montage et mesures

Chacune des deux configurations présentées à la figure 5 a fait l'objet de notre étude. Les montages expérimentaux ne diffèrent que dans le positionnement du récepteur et les appareils utilisés (Fig. 6). Pour les différentes configurations les mesures ont été effectuées de -60 a +60 degrés par pas de 10 degrés. Un haut-parleur (la source de bruit) a été placé à environ 3 mètres des échantillons testés afin de simuler des ondes approximativement planes au niveau de ceux-ci. La distance entre ces derniers et la source devant être suffisante par rapport aux longueurs d'onde considérées pour que les méthodes soient applicables (surtout celle des ondes stationnaires). Cette source était déplacée tout en restant à distance fixe du centre des échantillons. A titre de vérification un échantillon de mousse polyuréthane (le matériau absorbant supplémentaire) a aussi été mesuré en incidence normale au tube d'impédance.

Pour les mesures avec la méthode utilisée par Klein & Cops,

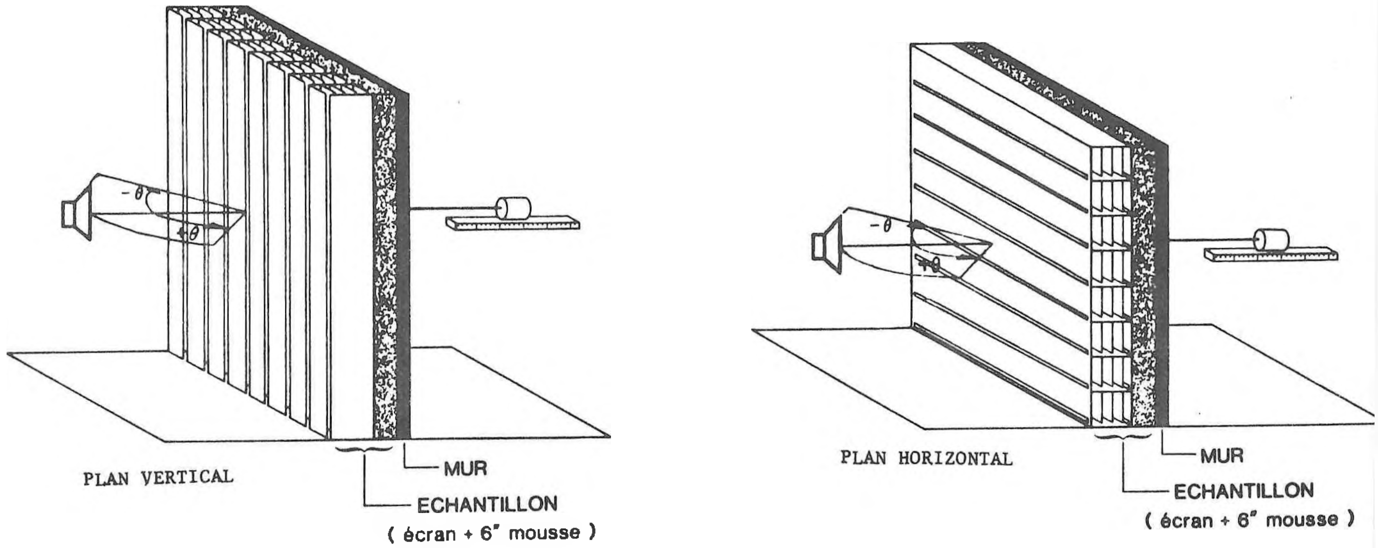


Figure 5: Configurations testées

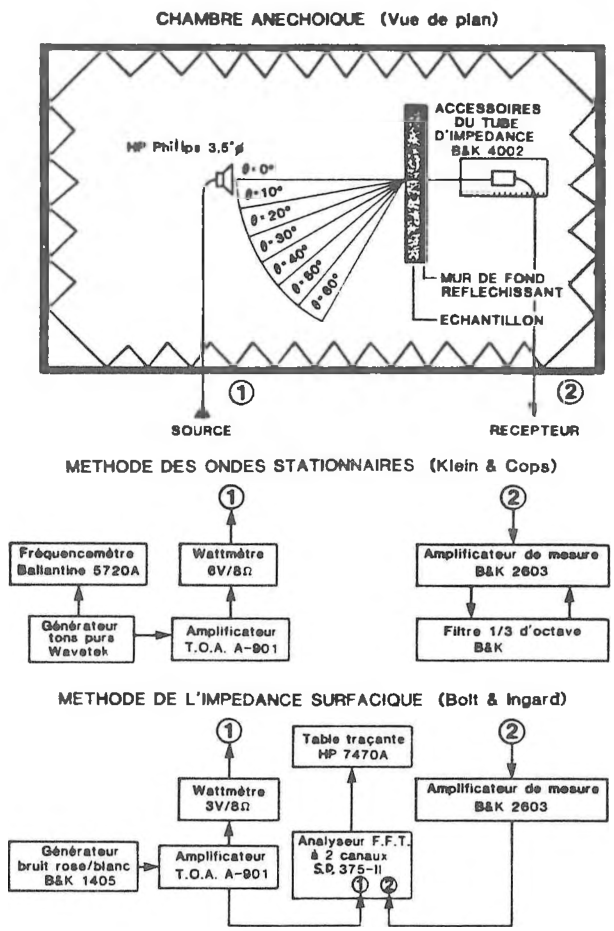


Figure 6: Schéma du montage expérimental

le signal étant constitué de tons purs de même niveau sonore aux fréquences centrales des tiers d'octave comprises entre 250 et 1kHz. On a cherché les niveaux maximum et minimum de la pression sonore de l'onde stationnaire et leur distance à l'échantillon étudié, celà à toutes les fréquences d'intérêt.

En ce qui concerne la mesure effectuée par la méthode d'Ingard et Bolt, on a utilisé une source de bruit aléatoire (la bande de fréquence restait la même). Contrairement à la méthode précédente, le récepteur restait fixe aux surfaces testées. Cette mesure a été faite en deux étapes dans des conditions anéchoiques. On a considéré tout d'abord le signal électrique appliqué à un haut-parleur (source du bruit), comme une référence virtuelle en supposant que sa réponse devrait suivre identiquement les variations possibles du signal d'alimentation. Cette référence est bien sûr nécessaire puisque les mesures avec et sans l'échantillon ne peuvent être réalisées simultanément. De plus, cet arrangement permet de considérer et de corriger numériquement ces variations. On évalue ainsi le rapport des amplitudes ΔLp et le déphasage $\Delta\phi$ introduits par la présence de l'échantillon. Ces mesures sont effectuées à l'aide d'un analyseur à bandes étroites FFT à deux canaux.

La première étape consiste à mesurer le rapport des amplitudes ΔLp_1 et le déphasage $\Delta\phi_1$ sur le mur de fond réfléchissant tandis que la deuxième mesure de façon analoque ΔLp_2 et $\Delta\phi 2$ à la surface du mur recouvert par la mousse polyuréthane et l'écran ajouré.

La distance de la source au récepteur est maintenue constante pendant les mesures. Comme déjà mentionné, l'utilisation de cet absorbant à été indispensable pour que l'ensemble "mousse-écran ajouré déphaseur" présente aux ondes sonores assez d'absorption pour que la théorie soit applicable.

Les valeurs ΔLp_1, ΔLp_2, $\Delta\phi 1$ et $\Delta\phi 2$ permettent d'obtenir aisément le rapport final des amplitudes ΔLp et le déphasage final $\Delta\phi$ par les formules suivantes.

$$\Delta Lp = 20\log\frac{\Delta p_1}{\Delta p_2} = 20\log(p_2/p_1) - 20\log(p_o/p_o^1) = 20\log(p_2/p_1) - C_1$$

$$\Delta\phi = \Delta\phi_2 - \Delta\phi_1 = (\phi_2 - \phi_o^1) - (\phi_1 - \phi_o) = (\phi_2 - \phi_1) - C_2$$

ou "$C_1 = 20\log(p_o/p_o^1)$" est l'écart entre les signaux électriques

et "$C_2 = \phi_o - \phi_o^1$" l'écart du déphasage introduit entre ceux signaux

4. RESULTATS ET ANALYSES

Les résultats expérimentaux, utilisant les deux méthodes sont tracés sur des graphiques en fonction de l'angle d'incidence, pour des fréquences comprises entre 250 et 800Hz. Il s'agit de l'impédance normalisée complexe (module Z et phase Φ) et du coefficient d'absorption α (Fig. 7 à 10).

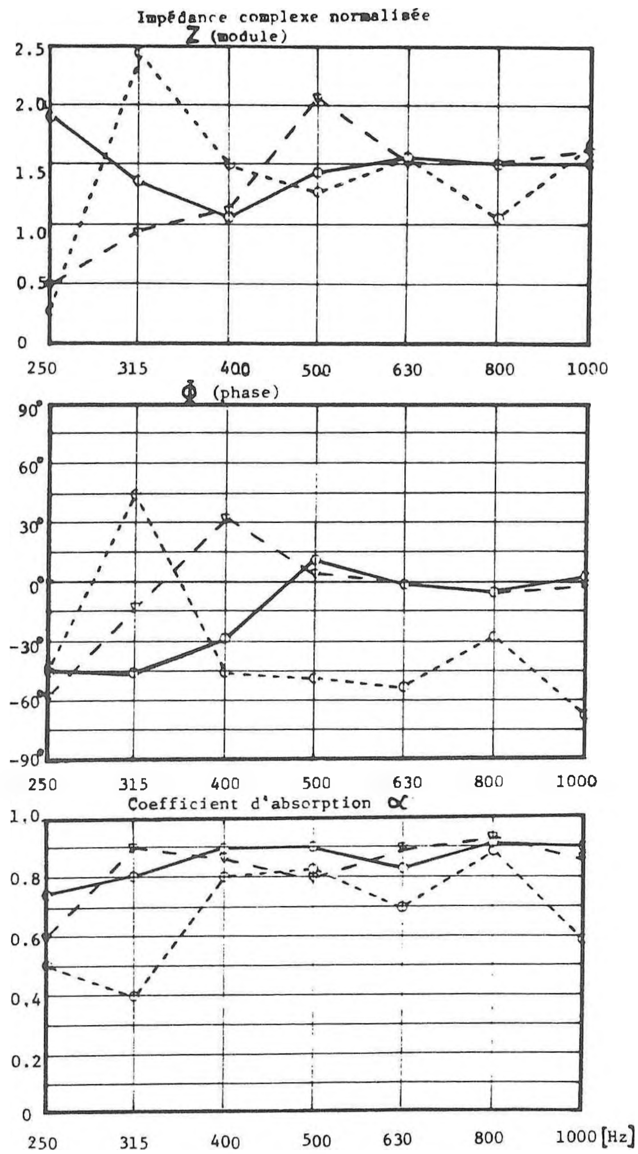
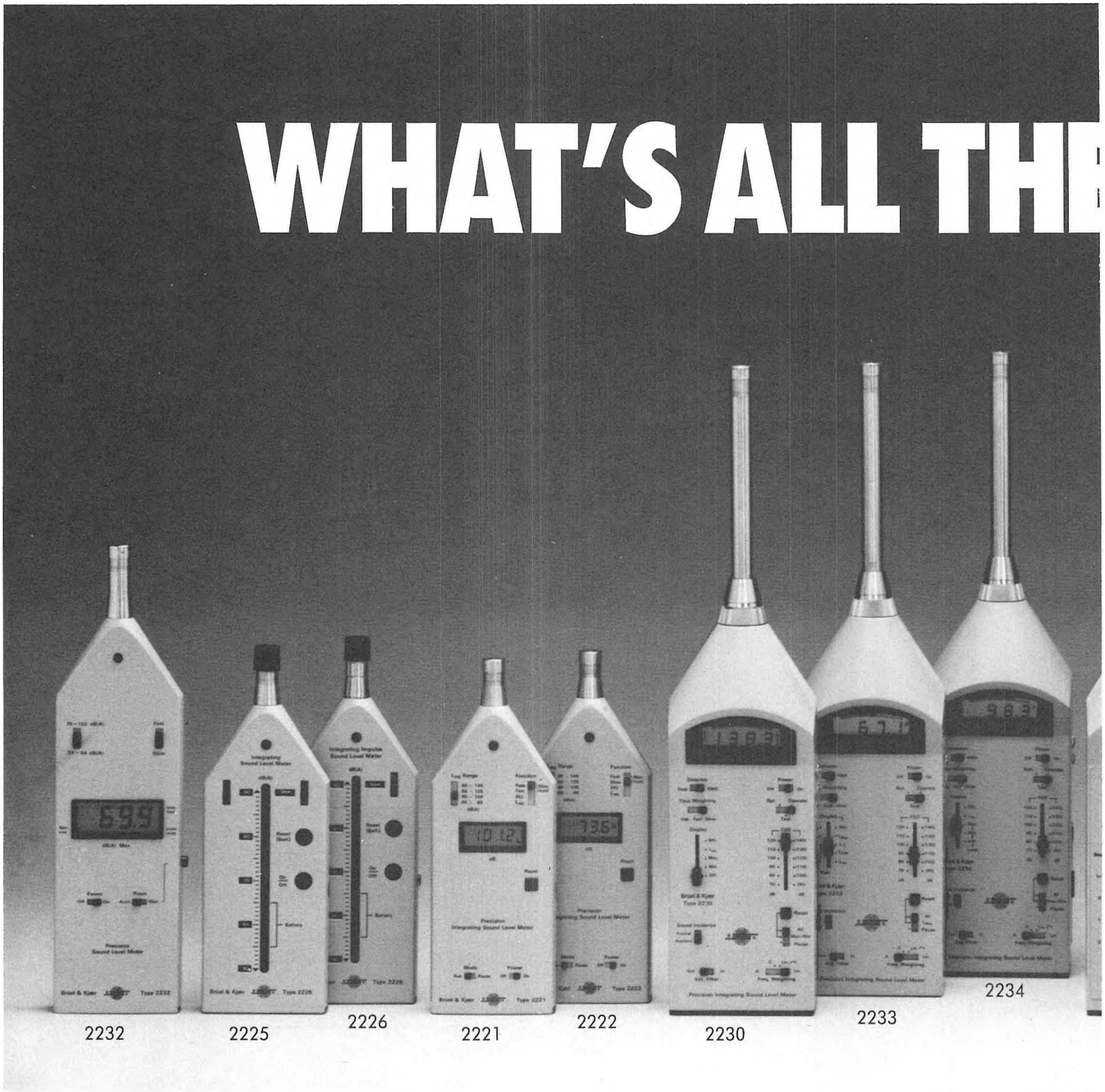


Figure 7: Comparaison des méthodes utilisées avec celle du tube d'impédance en incidence normale

(———) tube d'impédance
(- - -) méthode d'ondes stationnaires
(.....) méthode de l'impédance surfacique



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4.1 Mesures préliminaires

Des mesures préliminaires ont dû être effectuées car l'écran ajouré, présentant un comportement acoustique assez complexe, il serait alors difficile de juger de la validité des méthodes utilisées. Pour cela on a d'abord cherché à les appliquer à un échantillon simple homogène absorbant (une couche de 0.15m de mousse polyuréthane) et un essai, en incidence normale, au tube d'impédance, a été réalisé à titre de vérification. La comparaison des résultats (l'absorption surtout) obtenus à l'aide des différentes méthodes (Fig.7) montre que c'est celle utilisée par Klein et Cops qui s'applique le mieux dans ce cas. Ces courbes reproduisent avec assez de précision celles obtenues par le tube d'impédance. Quant à la méthode d'impédance surfacique (Ingard & Bolt), les résultats qu'elle nous permet d'obtenir sont très différents suggérant que cette méthode ne s'applique pas convenablement à ce cas surtout aux basses fréquences.

4.2 Méthode des ondes stationnaires (Klein & Cops)

Les résultats obtenus à l'aide de cette méthode (Fig.8) demontrent généralement une faible dépendence angulaire (surtout la phase) de l'ensemble "mousse-écran"dans le plan vertical (parallele aux fentes d'entrée) dans la bande passante
(f < 630Hz). Cela indiquerait un comportement "localement réactif" dans cette bande de fréquences. Par contre cette dépendence devient notable dans le plan horizontal (parallèle aux fentes d'entrée). Les courbes dans ce plan présentent bien sûr une symétrie par rapport à l'incidence normale. Dans le plan vertical, malgré la dissymetrie géometrique de l'écran, les courbes montrent tout de même en général vers un comportement assez symetrique de l'impédance. Cet écran est acoustiquement transparent dans ses bandes passantes.

Il laisse passer la plus grande partie de l'énergie sonore au-dessous de la première fréquence de coupure (bande de fréquence de 250 à 500 Hz). Puis dans l'intervalle des fréquences comprises entre 630 et 800Hz, il se trouve dans sa bande d'arrêt fondamentale . Son coefficient d'absorption y est beaucoup plus faible; il s'y comporte un peu comme un matériau réfléchissant semblable à un écran plein par exemple (mais son comportement est global et assez complexe).

Discussion

Néanmoins la méthode souffre des limitations suivantes rencontrées lors des mesures:

1 A- 250 et 315 Hz, la longueur d'onde est de l'ordre de grandeur des dimensions du montage lui-même, d'ou une erreur

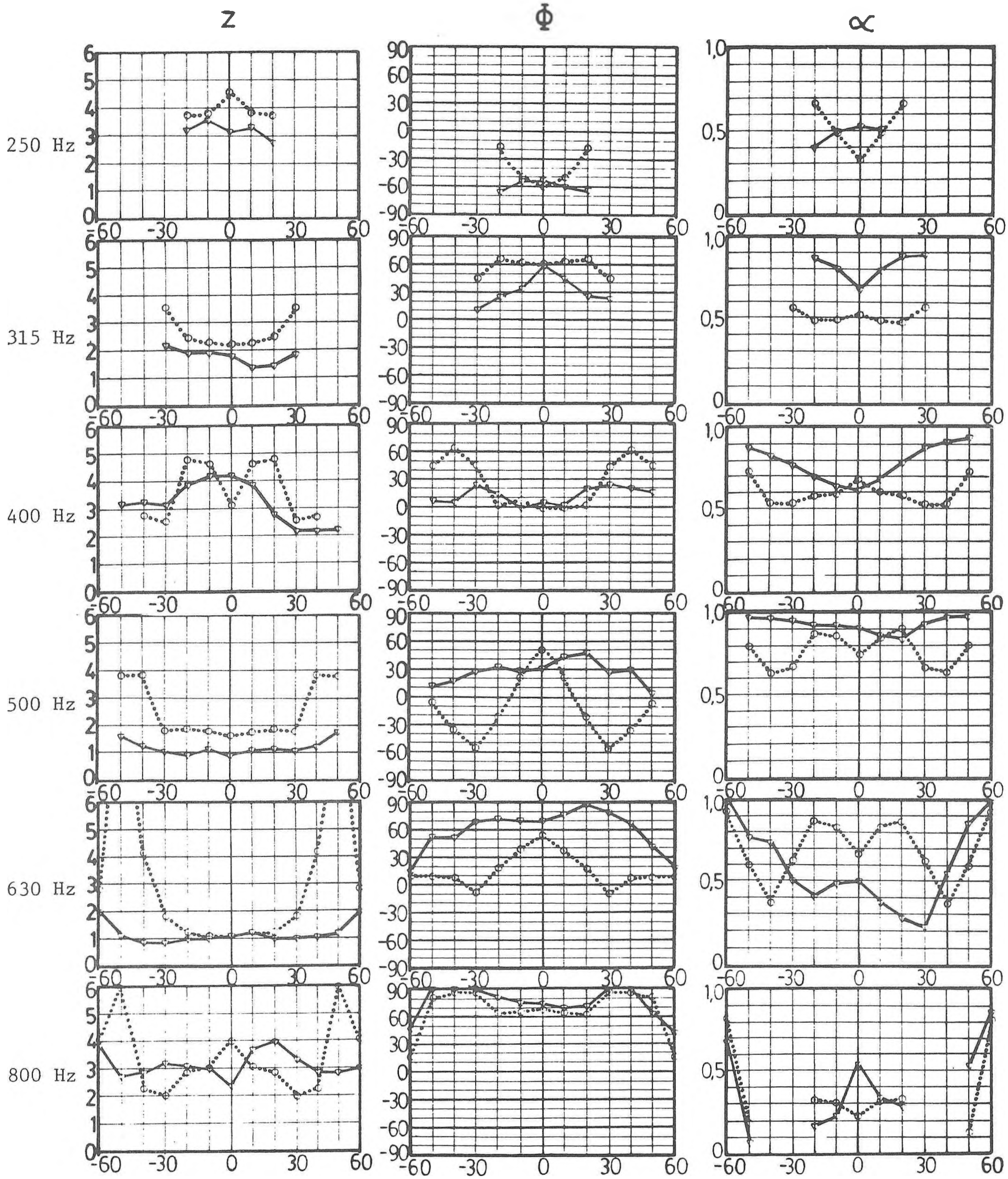

Figure 8: Dépendance angulaire du comportement acoustique de l'échantillon mesurée par la méthode d'ondes stationnaires (Klein & Cops)

(———) plan vertical
(.....) plan horizontal

possible appréciable dûe à la distance x négligée. Dans le même ordre d'idées, les distances r_1 et r_2 ne sont pas beaucoup plus grandes que la longueur d'onde à ces fréquences, la terme de sphéricité F a aussi été négligé à tord, lors des calculs dans ce cas. Ce problème est encore empiré du fait que l'échantillon "voit" sa surface efficace (sa grandeur dans le plan de mesure) exposée à la source diminuer lorsque l'angle d'incidence θ augmente ($x = x\cos\theta$). Cet effet ne permet pas d'évaluer les propriétés d'impédance dans la plage d'incidence complète (jusqu'à + ou -60 degrés) à 250 et 315 Hz (la longueur de la sonde aurait été insuffisante de toute manière pour cela). Ce problème ne s'applique généralement pas pour les fréquences supérieures à 315Hz.

2 Surtout dans le cas du plan horizontal, des "effets de discontinuité des bords" peuvent etre introduits à incidence fortement oblique (tels qu'expliqués par Ingard & Bolt dans leur étude [9]).

3 Des "effets d'ondes stationnaires latérales" possiblement excitées entre les bords dans les cavités, pourraient survenir en incidence fortement oblique (50 et 60 degrés) dans le plan horizontal parallèle aux fentes. Il est évident que ce dernier effet (difficile à évaluer expérimentalement) ne pourrait pas se produire avec un écran de longueur très grande.

4 L'effet de résonateur d'Helmholtz pourrait se produire à incidence fortement oblique surtout dans la bande d'arrêt (augmentation du coefficient d'absorption).

4.3 Méthode d'impédance surfacique (Ingard & Bolt)

Les mesures préliminaires ont montré l'application restreinte de cette méthode pour un cas particulier de mesure en incidence normale.

En ce qui concerne les résultats avec l'écran ajouré (Fig.9), on constate que cette méthode ne recoupe pas parfaitement la prémiere surtout à cause de la structure de l'échantillon fortement hétérogène (voir surtout les coefficients d'absorption). Néanmoins ces résultats complètent ceux obtenus aves la méthode précedente. L'information générale qu'ils fournissent permet de constater de façon globale ici aussi, que les variations de l'impédance sont beaucoup plus petites dans le plan vertical que dans le plan horizontal (pour lequel il existe une forte dependence angulaire).

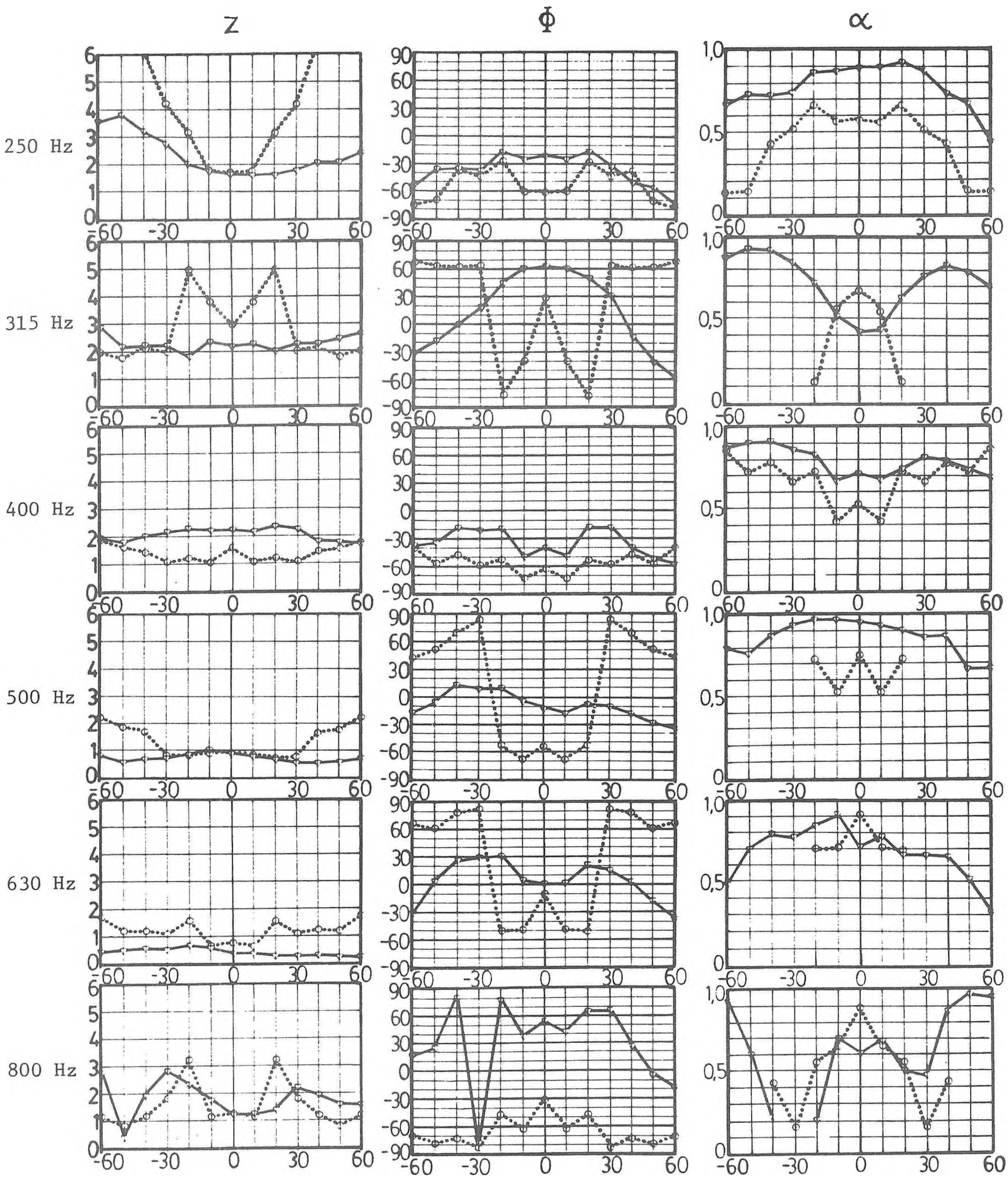

Figure 9: Dépendance angulaire du comportement acoustique de l'échantillon mesurée par la méthode de l'impédance surfacique (Ingard & Bolt)

(———) plan vertical
(.,....) plan horizontal

Discussion

Les anomalies dont souffre cette méthode peuvent être provoquées par les causes suivantes:

1 L'écran ajouré est un échantillon fortement hétérogène et sa surface n'est pas vue dans son ensemble au point de mesure puisqu'on "reste" à sa surface avec cette technique. On mesure donc localement ses propriétés d'impédance à un point situé dans un orifice à l'entrée du guide. Des anomalies peuvent se produire à cause de l'inadaptation d'impédance d'entrée (mismatch impedance) à ce point particulier du au changement des vitesse particulaires. Dans le même ordre d'idées, il peut s'y produire un effet semblable physiquement à une turbulence.

2 Des "effets de discontinuité des bords","effets d'ondes stationnaires latérales" et du type "résonateur d'Helmholtz" peuvent aussi se produire tout comme avec l'autre méthode. (chap.4.2)

5. CONCLUSIONS

Nous avons cherché l'influence de l'angle d'incidence des ondes acoustiques sur l'impédance d'entrée d'un écran ajouré déphaseur. Il semble à la lueur des expérimentations et des théories adaptées à nos besoins que, au moins sous un angle de 40 degrés dans le plan vertical cette impédance d'entrée varie peu dans la bande passante fondamentale en fonction de l'angle d'incidence. On peut en conclure que notre système ajouré est localement réactif dans ce plan d'incidence et dans cette plage de fréquence d'intérêt. D'autre part si l'on fait la même étude dans un plan horizontal (parallèle aux fentes) on s'apperçoit que l'impédance d'entrée du système est beaucoup plus sensible à l'angle d'incidence dans cette bande passante.

Une autre étude basée sur la mesure d'énergie acoustique transmise par ce système d'écran ajouré semble recouper les résultats d'étude par réflexion. Les résultats complets en seront publiés dans un très proche avenir.

6. REMERCIEMENTS

Cette étude a été effectuée a l'aide des subventions P-8317 et A-1146 du CRSNG. Nous remercions aussi M. G. Ostiguy, Ph.D. et le département de génie mécanique qui ont permis d'accomplir cette étude.

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PROGRAM FOR CAA MEETING

PROGRAMME POUR LA REUNION DE L'ACA

OCTOBER 3 – 4 OCTOBRE
CHIMO INN, OTTAWA

THURSDAY OCTOBER 3

Session A: Speech and Hearing I **9:00 – 12:00 a.m.**

Chairman: M.J. Hunt, National Aeronautical Establishment, N.R.C., Ottawa

VALIDATION OF A SCALE OF THE SUBJECTIVE QUALITY OF TELEPHONE VOICE TRANSMISSIONS

B.R. Shelton, M.W. Pocock and A.J. Campbell

Design Interpretive, Bell Northern Research, Ottawa, Ontario, Canada

The most widely used scale of the quality of voice transmission channels is the Bell Labs Grade of Service model. Transmission quality is represented by a value R, determined by four parameters of conventional transmission networks. Circuit noise, transmission loudness loss, delay path time, and echo attenuation are combined in the calculation of R. All four parameters are used for toll connections where delay paths are appreciable (greater than 50 milliseconds), and only loss and noise are needed to characterize transmissions in a local network. An experiment was conducted to examine the validity of the parameter R as a subjective scale of telephone voice quality. Recorded voice messages were degraded by transmission through simulated circuits, and subjects made category ratings of each transmission. The results indicated that the R rating of the transmission is linearly related to both the Thurstonian Case IV scaled solution and the mean opinion score (MOS) obtained from the category ratings of subjects. The data provide strong evidence that the transmission rating R is a valid description of the subjective quality of voice communication channels. The validation justifies the use of R to quantify the quality of telephone communication, and provides a well-defined metric by which the quality of voice channels can be controlled in the laboratory.

MEASURING THE PERFORMANCE OF CONNECTED-WORD SPEECH RECOGNIZERS

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Isolated-word recognizers make single responses to single-word inputs. Comparison of responses and inputs allows overall performance to be measured and also allows information to be gathered on the confusions being made. Connected-word recognizers produce sequences of output symbols in response to sequences of words input. When errors occur there is often no clear correspondence between the two sequences, which are often of unequal length, and it is not possible to deduce unambiguously what combination of insertion, deletion and substitution errors occurred. Connected-word speech recognition algorithms contain internal information on the word boundaries deduced by the recognizer. If such information can be accessed, it can be used to make a much more informed analysis of the errors. A fully automatic dynamic-programming algorithm is described for scoring the output of a connected-word recognizer in the light of word boundary position information.

EFFECTIVE VOCABULARY CAPACITY OF AUTOMATIC SPEECH RECOGNIZERS: I. PROBLEM

M.M. Taylor

Defence and Civil Institute of Environmental Medicine, Downsview, Ontario, Canada

The performance of an isolated word recognizer is notoriously hard to evaluate. Designers and manufacturers usually report the error rate over some standardized vocabulary, perhaps over a population of talkers. That measure requires many thousands of utterances in order to evaluate a reasonably accurate recognizer; even so, the results are hard o generalize to different vocabularies. Effective vocabulary capacity (EVC) is a measure that is intended to be independent of test vocabulary and to require no more than a few tens of utterances. Word recognizers can therefore be assessed under realistic rather than laboratory conditions. EVC can be measured for untrained as well as for trained talkers. It can serve as a probe for rapid evaluation of the effects of changing environmental noise, task vocabulary, or the algorithm used to process speech data.

The EVC measure is based on the idea that the similarities reported by a recognizer can be treated as distances in some multidimensional space where the vocabulary items are represented as points. Utterances lie near to the points representing "their" templates, and far from the points representing other templates. The distributions of utterances around their templates determine error volumes. An ideal vocabulary would be one in which the error volumes for neighbouring vocabulary items touch but do not overlap. The EVC measure determines how many items such a vocabulary could have for a given talker using a given machine. Typically, fewer than 50 utterances suffice to evaluate a recognizer.

EFFECTIVE VOCABULARY CAPACITY OF AUTOMATIC SPEECH RECOGNIZERS: II. SOLUTION

L. Vignault Rasiulis, *Z. Jacobson*

Bureau of Management Consulting, Ottawa, Ontario, Canada

J. van de Vegt

Defence and Civil Institute of Environmental Medicine, Downsview, Ontario, Canada

We present a method for estimating the effective vocabulary capacity (EVC) of automatic speech recognizers. The method is based on algorithms suggested by Schonemann and Gold and by Schiffman and Falkenberg, and is valid for devices that measure the Euclidean distances between an utterance and various stored templates. Given data obtained from a working speech recognition system, the main steps required to arrive at a useful measure of EVC are as follows. 1) Transform the data and calculate the dimensionality of the machine. 2) Mass center the resulting distance data. 3) Use principal components to derive intermediate matrices, whose product will yield utterance and template coordinates. 4) For each dimension of the template space, calculate the occupied range and the average miss of a template by an utterance. 5) EVC is the product, per dimension, of the range divided by the miss.

AUTOMATIC SPEECH RECOGNITION USING A COCHLEAR MODEL

C. Lefèbvre and M.J. Hunt

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At the 1984 IEEE ICASSP meeting Seneff described a computational model of the cochlear consisting of a bank of digital filters followed by half-wave rectifiers and agc components and by a set of generalized synchrony detectors (gsd's) that respond to coherence in the signal at the centre frequency of the channel. We have added adjacent-channel cross-correlation and modified the gsd. This results in improved sensitivity to formants in noise and allows human frequency masking measurements to be replicated quantitatively. The model is being tried as the front-end of a speech-recognition system. Performance on quiet, undistorted speech is comparable to that obtained with a conventional representation, but when the test material is subjected to linear distortions or the addition of noise, the cochlear model shows a marked advantage. The reasons for the superior performance of the cochlear model are discussed.

AUTOMATIC SEGMENTATION AND LABELLING OF KNOWN SPEECH

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A rule-based system is proposed to automatically segment and label speech of known text using phonetic units. The system is designed to facilitate statistical studies and formal analysis of the speech signal. It may also be used to construct phone dictionaries for speech recognition.

The system consists of three modules: a top-down component, a bottom-up component and a search component. The top-down module builds a network of the different possible phonetic transcriptions from the orthographic transcription of the utterance. This network is called the phonological network since phonological rules are used to generate it. The bottom-up module is divided into three parts. First, we calculate a set of acoustical parameters such as zero-crossing rate, short-time energy, energy differences and spectral differences. Next, based on this set of parameters, an automaton pre-labels each frame according to its broad phonetic class. Finally, a set of acoustical rules determines frames at which there is a transition between phonetic classes. The search module finds the best phonetic transcription proposed in the phonological network by firing the appropriate acoustical rules. A branch-and-bound search based on probabilistic criteria is used to control the search.

After initial system training, tests on new speakers reading new texts yielded 82were found for spontaneous speech.

UN AVENIR POUR LA DETERIORATION METHODIQUE DE LA PAROLE DE SYNTHESE DE HAUTE QUALITE

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Des progrès viennent d'être faits dans la synthèse de la parole de haute qualité. Une équipe de l'Université de Montréal et un laboratoire du CNRS (le LIMSI à Orsay) réalisent maintenant de la parole de synthèse qu'il est difficile de distinguer de la parole naturelle. Cette synthèse nécessite non seulement une analyse plus fine, mais des rajustement très nombreux des paramètres de commande dont les résultats à la synthèse sont chaque fois comparés avec l'original et avec l'avant-dernière synthèse. La comparaison se fait au niveau de la perception et des mesure d'analyse.

L'intérêt de cette synthèse de qualité est multiple. 1) Des tests de perception peuvent être très rigoureusement contrôlés tout en ayant la qualité de la parole humaine authentique. 2) On pourra à l'avenir dégager les indices acoustiques de la parole. On ne les connaît pas ou si peu. Ce sont des configurations relationnelles spectrales qui ne sont pas indépendantes des caractères physiques des locuteurs; ce ne sont surtout pas des valeurs absolues et simples, valables pour chaque phonème et pour tout le monde en toutes circonstances. 3) Quand on connaîtra mieux les indices acoustiques de la parole, on aura fait un grand pas dans la programmation de la synthèse par règles pour faire parler les ordinateurs "comme du monde." 4) La synthèse fine permettra sans doute de faire des progrès plus rapides dans la reconnaissance automatique du langage, en aidant à la simulation de la perception du langage réel. 5) Les domaines de recherches seront considérables: ce sont la description des

indices acoustiques de la parole et des champs de variations stylistiques, la définition des seuils de perception, la caractérisation de la parole individuelle et de l'empreinte vocale.

On présentera les illustrations sonores.

SINGER'S FORMANT AND THE EXTRA FORMANT

S. Wang

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This paper is a sister presentation and a further discussion of this author's video-film "Singing Voice: Bright Timbre, Acoustic Features and Larynx Position" which is also presented in this symposium. Based upon the measured results of high/low larynx locations during singing of different styles, this paper will further present the various patterns of the singer's high formant and give a tentative acoustic explanation. It will also comment on Sundberg's concept of the singer's formant and his lowering larynx explanation.

VIDEO FILM - SINGING VOICE: BRIGHT TIMBRE, SINGERS' FORMANTS AND LARYNX POSITION

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Intended for people interested in voice science and voice pedagogy, this video-film is based upon my research which shows that bright timbre, especially in high voices, can be produced by trained singers in different singing styles (Chinese, Western early music, and Western operatic) with different laryngeal position but similar acoustic features - two to four high energy peaks in the spectrum, including an extra formant (the so-called "singing formant") near $F-3$ and F_4 in the bright timbre frequency range.

The supporting data comes from perceptual judgement of timbre, measurement of larynx position, and spectral analysis of various trained tenors' voices.

My results which differ from those of Shipp and Izdebski (1975) and Sundberg (1974, 1977) and others are: 1) laryngeal height is not a reliable way to distinguish a trained singer from an untrained one; not all trained singers maintain the low laryngeal position; 2) in both the high and the low laryngeal styles of singing, trained singers are capable of producing bright timbre and its associated acoustic features; lowering of the larynx therefore does not explain the production of brightness; there is no reason to conclude that singing with a high larynx necessarily produces a voice of poor quality (at least in respect to brightness) or poor vocal health.

Session B(i): Audio-visual Presentation — 9:00 – 9:40 a.m.

AN AUDIOVISUAL OVERVIEW OF CANADIAN ACOUSTICS

R. Newman and Friends

Toronto Chapter, CAA

The purpose of the presentation is to describe with audiovisual aids the multidisciplinary nature of the field of acoustics as realized in engineering, earth sciences, life sciences and the arts. Drawing primarily upon research and the professions across Canada, examples are given of work in underwater sound, bioacoustics, hearing, psychoacoustics, musical acoustics, room and theatre acoustics, noise, sonic and ultrasonic engineering. The presentation as well introduces concepts of physical acoustics, hearing conservation, noise measurement and control, audiometry, auditory physiology and architectural acoustics. The presentation can be developed for use in the high school or college classroom as an introduction to knowledge about acoustics, and fascinating career possibilities. Suggestions from audience members will be most welcome.

Session B(ii): Building Acoustics — 9:40 – 12:00 a.m.

Chairman: To be announced

UTILISATION DE L'INTENSIMETRIE POUR L'ETUDE DU COMPORTEMENT D'UNE FACADE SOUMISE A L'IMPACT DU BRUIT DE LA CIRCULATION

J-G. Migneron et M. Asselineau

C.R.A.D., Université Laval, Québec, Québec, Canada, G1K 7P4

Depuis plusieurs années le Laboratoire d'acoustique de l'Université Laval poursuit des travaux de recherche sur la pénétration du bruit de la circulation dans les logements voisins des principaux corridors de transport. En fait, le projet subventionné principalement par le CRSNG, comporte deux volets, soit l'analyse du comportement physique d'un mur de façade exposé au bruit de la circulation et la perception des résidents soumis à cet impact. Pour se soustraire aux nombreux problèmes soulevés sur le terrain, c'est un élément de façade conventionnel qui a été installé dans le porte échantillon du Laboratoire; la principale difficulté consistant à recréer les champs acoustiques propres aux deux espaces sonores séparés par l'enveloppe d'un bâtiment. Préalablement, dans les conditions de chambres réverbérantes, l'indice STC a été mesuré, ainsi que le comportement de l'isolement pour différentes ouverture de la fenêtre.

L'analyse intensimétrique de phénomène complexe de transmission au travers d'une paroi composite est apparue un complément souhaitable pour la recherche, tant en ce qui concerne le contrôle de la directivité des ondes frappant la façade, que la transparence acoustique de cette dernière ou bien le rayonnement simulé à l'intérieur du logement, ce dernier se trouvant compliqué lorsque la fenêtre à l'essai présente un certain angle d'ouverture. Néanmoins, l'utilisation des mesures intensimétriques appliquées au cas d'un échantillon de façade pose des problème bien particuliers, ceci parce que l'échantillon comporte nécessairement des surfaces dont les pertes de transmission sont différentes, des fuites et des formes géométriques complexes qui provoquent des réflexions ou des diffusions.

L'exposé, en plus de rapporter ces expériences, tentera d'établir un parallèle entre les résultats obtenus des mesures conventionnelles en pression (STC) et ceux découlant du bilan des puissances acoustiques reçue et transmise, établi à partir des mesurs intensimétriques pour l'ensemble de l'échantillon et pour sa partie pleine seulement. Enfin, l'exposé abordera l'utilisation de l'intensimétrie pour la mesure des bruits fluctuants comme ceux de la circulation automobile.

SUMMARY OF A YEARS' EXPERIENCE USING INTENSITY AS AN EVERYDAY TOOL

A.E.D. Hughes

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Originally planned in 1981, the acoustic laboratory at Beckers Lay-Tech Inc. was intended to contain both a traditional STL suite and an additional large volume reverberation room for absorption measurements. The advent of a commercially available intensity measuring system led to a complete revision of those plans. A single reverberation room with an adjacent quiet laboratory area, have proven to be adequate when used in conjunction with intensity measurement capability.

A NEW SIGNAL FOR ACOUSTIC MEASUREMENTS

W.T. Chu

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Although the pseudo-random sequence has been used frequently as a substitute for the conventional white noise generators employing gas discharge tubes or temperature-limited diodes, its periodic nature has not been exploited for acoustic measurements in the past until the late seventies. In this paper, we will describe how the periodic pseudo-random sequence can be used advantageously with modern digital signal processing for fast and accurate acoustic measurements, especially in the field of architectural acoustics.

ABSORPTION MEASUREMENT VARIABILITY IN CONTROLLED LABORATORY TESTING

G. Kiss and G. Faulkner

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The Mechanical Engineering Acoustics and Noise Unit, fondly becoming known as the "MEANU", a recently acquired acoustics facility by the University of Alberta has been operating now for one year. An evaluation of the laboratory's facilities, procedures and complement of equipment has been reviewed and upgraded with regard to the requirements of various ASTM and ANSI acoustical standards. The results of various sound absorption tests conducted in accordance with ASTM C423-84a will be presented including a comparison of test results conducted on the same specimen at both the MEANU and the National Research Council's Division of Building Research. In addition, the sound absorption of a commercial wall covering fabric in various mountings will be presented. Results will show the effect of incorrectly prepared mountings of specimens as well as the effect of the fabric applied over top of fiberglas insulation as used in the case of space absorber panels.

ABSORPTION CORRECTIONS FOR TRANSMISSION LOSS MEASUREMENTS

A.C.C. Warnock and R.E. Halliwell

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Measurements of sound transmission loss made using nine different methods to estimate the effects of room absorption are reported. A single wall specimen was used in five different positions in the opening of a laboratory sound transmission loss test suite. Four different levels of room absorption were used. The conventional decay method is shown to work well in all cases as does a method using a sound source with a known power to estimate the room absorption. A method using a sound pressure level near the source and the room average, the near-far method, did not work as well.

TITLE TO BE ANNOUNCED

M.J. Morin

MJM Acoustical Consultants, Montreal

A PROPOSAL FOR SOUND TESTING PRIOR TO OCCUPANCY OF MULTI-FAMILY DWELLINGS

H. Gordon Pollard

Delta, British Columbia, Canada

The STC (Sound Transmission Class) of a construction does not include the adverse effects of "flanking transmission." Less confusion would exist if building codes referred to the NIC (Noise Isolation Class). NIC tests are less time consuming and less expensive. Samplings of completed constructions should be field tested, prior to occupancy of multi-family dwellings, to measure overall acoustic privacy. If test results indicate that the minimum NIC rating has not been met, remedial steps should be taken. Measurements obtained should be filed at building inspectors' offices and available for public scrutiny. Impact noise can be measured in the field according to existing IIC (Impact Isolation Class) standards using readily available equipment. Any occupant whose unit has not been field tested, should have the right to require a field test of his unit. If the construction is acceptable, the cost of the test is his responsibility, otherwise, the building owner must pay for it and improve construction.

Session C: Room Acoustics 1:30 – 3:30 p.m.

Chairman: To be announced

SPEECH INTELLIGIBILITY IN CLASSROOMS

J.S. Bradley

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Speech intelligibility tests and acoustical measurements including several newer quantities were made in occupied classrooms. Octave band measurements of background noise levels, early decay times, and reverberation times as well as various early-to-late sound ratios were obtained. Various octave band useful-to-detrimental ratios were calculated as well as the speech transmission index derived from modulation transfer functions. The interrelationships among these measures were considered, and the best predictors of speech intelligibility scores were identified. Useful-to-detrimental ratios were again found to be successful predictors of speech intelligibility scores, combining both the influence of room acoustics and signal to noise ratios in one relatively simple quantity.

CLASSROOM ACOUSTICS: THE RESULTS OF A SURVEY CARRIED OUT BY THE TASK FORCE ON CHILDHOOD HEARING-IMPAIRMENT

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In 1981, the multidisciplinary Task Force on Childhood Hearing Impairment was formed under the aegis of the Department of Health and Welfare. Its aim was to develop guidelines for the prevention, early diagnosis and management of hearing-loss in children. Two Canada-wide surveys were administered to each provincial department of health and education. This paper will report on part of the education survey which dealt with classroom acoustics. The fundamental premise in the acoustical design of any classroom is that the level of the speech signal to be perceived by the student must be sufficiently higher above his threshold of hearing than the ambient noise. The intelligibility of speech in a classroom is related not only to the hearing thresholds of the student but also to background noise, reverberation time and speech to noise ratio. Although the effects of these variables on speech intelligibility are known, the results of the survey indicated that there were no systematic modifications in classroom acoustics for integrated hearing-impaired students in any of the provinces. Some provinces reported acoustic modifications for residential schools and some day classes in public schools. The recommendations of the Task Force will be discussed.

INVESTIGATIONS CONCERNING THE ACOUSTICS OF SMALL ROOMS

M. Pocock

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As part of a program to enhance the performance of handsfree products, a study was undertaken to explore the influence of room acoustics on the quality of speech recorded in a small reverberant room with a single microphone. A number of measurements have been performed using a Time Delay Spectrometry system, which allowed the examination of selected portions of the room response. The initial results of these investigations will be presented, and some possible relationships between this objective data and subjective assessments of speech recorded in the room will be discussed.

ACOUSTICS AND NOISE CONTROL IN ALBERTA RECREATION FACILITIES – DESIGN GUIDELINES

E. Rebke

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An investigation was initiated by Alberta Recreation and Parks to study existing acoustical conditions within rural recreation facilities. The use of these facilities for cultural and business activities, as well as recreation, has increased the demand to provide a good acoustical environment. Four types of facilities were investigated: arenas, curling rinks, swimming pools and community halls. Methods and materials to effectively reduce reverberation, echo and noise were formulated. Reasonable cost, acoustic efficiency and the compatibility of these acoustic materials to existing environmental conditions were considered. The use of properly designed sound reinforcement systems formed an integral part of the acoustic design for the larger facilities and general requirements for these have been defined. Mechanical/electrical noise has also been studied and commented upon.

MEAN FREE PATH EXPRESSION FROM IMAGE SOURCE THEORY

G. Lemire

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This study is an extension of our earlier work on prediction of sound levels in rectangular rooms from image source theory (NCEJ, 24(2), 1985) and was initiated after the publication of a paper by Auletta (Revue d'Acoustique, 69, 1984) on the same topic but with a different approach. In our earlier work we derived a formulation of the image method which permits to identify the order of any image sources. From this firmulation we derived analytically and verified numerically an expression of the mean distance from image sources of order n ($n \gg 1$) to a receiver. The m.f.p. expression results from the difference between mean distances at orders n + 1 and n, and is related to the room diagonal. It yields values of the m.f.p. similar to those given by classical formulation in the case of near cubic rooms. Its figures however differ increasingly as the room shape becomes elongated, where the classical formulation is known to become invalid due to its assumptions. According to the data of Auletta the new expression permits to reduce the systematic difference between sound power levels measured under free and reverberant field conditions. This work has been done under a Ph.D. program granted by the Institut de Recherche en Santé et en Sécurité du Travail du Québec.

FACTORY NOISE RESEARCH AT CAMBRIDGE UNIVERSITY

M. Hodgson

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This paper will review the main results of research into factory sound fields carried out at Cambridge University over the past several years. The characteristics of, and the main factors determining, the sound propagation and the reverberation time in factories are presented. In particular, the obstacle effect resulting from the presence of machines, etc. and the influences of the enclosure shape and construction are elucidated. Methods for predicting factory sound fields are reviewed and evaluated, with emphasis on physical scale modelling. Priorities for future work, which will form the partial basis for future research by the author at l'Université de Sherbrooke are discussed.

Session D: Protection from Noise and Vibration — 1:30 – 3:50 p.m.

Chairman: D.A. Benwell, Environmental Health Centre, R.P.B., Health and Welfare Canada, Ottawa.

A KUNSTKOPF EVALUATION OF HEARING PROTECTION DEVICES

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The paper describes the performance of several ear protectors, such as those of muff-type or insert-type, which have been put to the efficiency test by a "Kunstkopf" (artificial head) situated in an anechoic chamber. The kunstkopf "Wikkee" is briefly introduced followed by insertion loss measurements of the protectors. In spite of generally efficient aural protection (about 20 dB and more) at high frequencies, the performance of the protectors becomes very spurious at low frequencies where an apparent amplification effect (instead of insertion loss) can be observed. This low frequency range is discussed as a point of particular interest. Furthermore, some aspects of directivity for head orientation versus sound source are mentioned.

The overall performance of ear protectors is a function of: a) cushion insertion loss (muffs); b) shell insertion loss (muffs); c) fit (muffs) or seal (plugs) on ears.

The IL deterioration can be particularly influenced by: a) spring pressure (muffs); b) adaptation to the subject's head (muffs); c) cushion efficiency deterioration with extended use (especially foam filled muffs); d) excessive hairs (muffs); e) loosening of seal because of head or jaw motion (plugs); f) lack of sealing with extended use (plugs).

SELECTION OF HEARING PROTECTORS

A. Behar and R. Jackson

Ontario Hydro, Pickering, Ontario, Canada, M1L 1W3

Over 400 different models of hearing protectors are available today in the U.S.A. Many of them can be purchased in Canada. They all belong to the well known types of muffs, cap-mounted muffs, plugs and semi-inserts. Potential users are usually well aware of the type that will better serve their needs. However, the task of selecting the particular model is usually left either to the most vocal of the salesmen or is limited to the use of the protector with the highest NRR.

The quality of a protector is a function of its attenuation as well as to the comfort experienced by the user. Information on noise attenuation is supplied by the manufacturer as a frequency response table (or curve) or as a NRR. They are obtained through tests performed according to well-known standards. Comfort, however, is not usually measured, since there are no guidelines, least of all standards, that could be followed. One way of measuring comfort is by using questionnaires similar to one developed in Ontario Hydro.

With the results from the questionnaire and with the attenuation, one can undertake the task of selecting hearing protectors. To do so, first the attenuation has to be matched with the noise levels existing in the workplace. That can be done using properly derated values of NRR. Protectors that have "passed" this test should be rated with relation to their comfort so a final list of approved devices can be prepared.

This paper will present practical details on the questionnaire and on the selection process used in Ontario Hydro.

DESIGN AND SELECTION OF ARTIFICIAL SKIN FOR A NEW ACOUSTICAL TEST FIXTURE

C. Giguere, H. Kunov, S.M. Abel, J. Schroeter, G. Willmot, and B.S. Myers

Institute of Biomedical Engineering, University of Toronto, Toronto, Ontario, Canada, M5S 1A4 and Silverman Hearing Research Laboratory, Mount Sinai Hospital, Toronto, Ontario, Canada, M5G 1X5

In recent years, there has been an increasing interest in the development of microphone-based techniques to evaluate the performance of hearing protective devices (HPD's). They seem to provide the best approach for impulse noise attenuation measurements. An acoustical test fixture (ATF) is being developed based on a modification of the KEMAR manikin, to be suitable for measurements with earmuffs and earplugs. Among the many parameters determining its performance are the mechanical properties of human tissues in contact with the protector, as recognized by previous investigators. Their work will be reviewed, as well as the results of a computer simulation of a human skin-HPD system. We have developed a simple technique to characterize appropriate mechanical properties of human skin. Results on 16 subjects permitted the selection of our artificial silicone rubber skin. This material was implemented as a two-phase circumaural skin and single-phase interaural skin in our ATF. (Work supported by the Defence and Civil Institute of Environmental Medicine, Canada.)

PROBLEMES DE BRUIT EN GARDERIE. I - NIVEAUX D'EXPOSITION SONORE ET MEFAITS

C. Truchon-Gagnon et R. Hétu

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P. Morisset

Ecole d'Architecture de l'Université de Montréal, Montréal, Québec, Canada, H3C 3J7

Une recherche-action sur les causes, manifestations et solutions des problèmes de bruit en garderie a été effectuée: il s'agissait de répondre à de nombreuses demandes sur cette problématique inexplorée, suscitant des inquiétudes depuis un certain nombre d'années. L'exposition sonore a été évalué dans 7 garderies: les LA_eq-8heures mesurés varient entre 75 et plus de 80 dB, les niveaux-crêtes - L_pA - étant plus élevés de 25 dB en moyenne. Des LA_eq supérieurs à 85 dB (pour la durée totale de certaines activités) et des L_pA atteignant 120 dB ont été mesurés dans certains types d'aménagement (voir "Problèmes de Bruit en Garderie. II - Analyse des Causes et Solutions"). Par ailleurs, une centaine d'employées-és de 6 de ces garderies ont répondu à un questionnaire; plus de bruit d'une garderie est "inconfortable" ou "intense" selon ses travailleuses-eurs, plus elles-ils rapportent de méfaits du bruit sur des aspects importants de leur travail (ex.: communication) et sur leur bien-être (fatigue, tension, maux de tête, etc.) pendant ET après le travail, s'additionnant de désavantages dans leurs relations inter-personnelles. Les comportement des enfants sont aussi affectés par le bruit, selon 98% des répondantes-ants.

PROBLEMES DE BRUIT EN GARDERIE. II - ANALYSE DES CAUSES ET SOLUTIONS

C. Truchon-Gagnon et R. Hétu

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Une recherche-action a été effectuée dans 7 garderies (voir "Problèmes de bruit en garderie. I - Niveaux d'Exposition Sonore et Méfaits"). Les principales SOURCES des bruits identifiés comme dérangeants ou pénibles à tolérer dans ce milieu sont: les cris et pleurs, impact d'objets et sons de certains jouets (ex.: flûtes). Chacun de ces bruits peut atteindre des niveaux élevés ($\hat{L}_pA$ jusqu'à plus de 120 dB), leur fréquence d'occurence étant de plusieurs centaines de fois par jour, dans certains milieux. Parmi ces bruits, les cris et les pleurs sont ressentis comme étant les plus stressants. Les facteurs identifiés, associés à une plus grande intensité ou fréquence de ces bruits dans certaines des garderies (plus de méfaits du bruit y étant aussi rapportés) relèvent d'abord de l'AMENAGEMENT DES LOCAUX; ces facteurs sont principalement: la dure de réverbération, de degré d'étanchéité acoustique des locaux, le nombre de personnes regroupées par local, la distance entre ces personnes et l'état des surfaces (de jeu, etc.). Des solutions ont été expérimentes: par exemple, après correction de la réverbération, le LA_eq-8heures d'un groupe a été abaissé de 77 à 72 dB, de façon durable. Il a aussi été constaté que certains facteurs d'ORGANISATION PEDAGOGIQUE contribuent significativement à réduire le bruit A CONDITION que l'aménagement soit adéquat.

YOUTH RECREATIONAL ACTIVITIES AND THEIR IMPACT ON OCCUPATIONAL HEARING CONSERVATION PROGRAMS

V.J. Throckmorton

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A study of hearing levels and recreational noise exposure patterns was carried out on 342 Grade 12 students. No hearing loss of functional significance was detected. Eighteen audiograms of clinical concern were noted, but these results were felt to be due to causes unrelated to noise. The most prevalent audiometric configuration was high-frequency spikes at 6000 Hz predominantly on the left side. The possibility of high-frequency spikes being an early indicator of noise susceptibility is acknowledged, but their existence is of no social significance. It was not established that Walkmans, a topic of special interest, are contributing to noise induced hearing loss. With the possible exception of shooting, youth recreational patterns are not likely to negate occupational hearing conservation programs.

IMPROVED AESTHESIOMETER FOR MEASUREMENT OF TACTILE IMPAIRMENT IN HANDS EXPOSED TO VIBRATION

D. Golianu and Z.R. Reif

Mechanical Engineering Department, University of Windsor, Windsor, Ontario, Canada

A.J. Brammer and J.E. Piercy

Physics Division, National Research Council Canada, Ottawa, Ontario, Canada, K1A 0R6

W. Taylor

Department of Community Medicine, University of Dundee, Scotland

Previous studies have shown the tactile spatial resolution of the finger-tip, as measured by sensitivity to step height and gap width, to be degraded by daily exposure to vibrating tools such as chain saws or jack-leg rock drills. The instrument used for these measurements has usually been a version of the basic Renfrew aesthesiometer developed by Carlson et al. (J. Occup. Med. **21**, 260-268 (1979)). We have developed this instrument further with the aim of a more objective and sensitive test for such neurological damage. The movement of the platten has been motorized to provide a precise velocity, and the mounting improved to make the application force more accurate. Preliminary measurements on a small group of normal subjects indicates the resolution of gap width to be substantially improved to about the 1.0 mm obtained previously by the demanding laboratory techniques of Johnson and Philips (Neurophysiol. **46**, 1177-1191 (1981)).

FRIDAY OCTOBER 4

Session E: Musical Acoustics — 9:00 – 12:00 a.m.

Chairmen: L.L. Cuddy, Department of Psychology, Queen's University, Kingston.
A.J. Cohen, Centre for Research in Human development, University of Toronto, Mississauga.

I. Perception

PERIODICITY - PITCH PERCEPTION AND HUMAN TEMPORAL-LOBE FUNCTION: POSSIBLE IMPLICATIONS FOR PERCEPTION OF HARMONIC RELATIONS

R.J. Zatorre

Montreal Neurological Institute and Hospital, McGill University, Montreal, Quebec, Canada, H3A 2B4

In order to study the neuroanatomical substance for periodicity pitch (PP) perception, groups of subjects who had undergone left or right temporal-lobe excision for the relief of intractible epilepsy were tested, along with normal control subjects. In some cases the excisions included all or part of Heschl's gyri, the primary auditory receiving area. The task required the subject to indicate if the pitch of a pair of complex tones rose or fell. Stimulus tones were constructed so that the distribution of spectral energy would be equal within a pair, but the periodicity pitch would differ (e.g., a complex with 300, 600 and 900 Hz components versus one with 300, 500, 700 and 900 Hz components).

A control task involved full complex tones with energy at the fundamental. All subjects were able to perform well on the control task. On the PP task patients with a right-temporal lobectomy including excision of Heschl's gyrus committed significantly more errors than normal control subjects. Patients with left-temporal excisions or with anterior right-temporal excisions sparing Heschl's gyri were unimpaired. These results suggest a crucial role for the right Heschl's gyri and surrounding cortex in mediating PP perception in humans. The relevance of these results to the perception of harmonic relations will be explored.

INFANT'S PERCEPTION OF MUSICAL RELATIONS IN SHORT TRANSPOSED TONE SEQUENCES

A.J. Cohen, L.A. Thorpe, and S.E. Trehub

University of Toronto, Erindale Campus, Mississauga, Ontario, Canada, L5L 1C6

Infants between 7 and 11 months of age were tested for their ability to discriminate a repeating background 5-note melodic pattern from a minimally different pattern. In contrast to our earlier work, background melodies began on five different notes: i.e., they were transpositions. In Experiment 1, the standards and comparisons were based on major and minor triad roots differing from each other by one semitone. Discriminability of the major background versus the minor comparison exceeded that of the minor background versus the major comparison. In Experiment 2, in addition to the major versus minor and minor versus major conditions, major versus augmented and augmented versus major conditions were examined. The major and augmented sequences differed again by just one semitone from each other. Discriminability was highest for the major versus augmented condition and lowest for the augmented versus major condition with major versus minor and minor versus major conditions falling between. The observed asymmetries imply the priority of certain tonal configurations for infants and are consistent with the notion of the special significance of frequencies related by small integers. The experiments also demonstrate the ability of infants to encode specific frequency-ratio relations in a musical context.

SIGHT READING OF MUSICAL NOTATION: A NEO-PIAGETIAN INVESTIGATION

A.M. Capodilupo

Ontario Institute for Studies in Education, Toronto, Ontario, Canada, M5S 1V6

The present study was designed to explore the premise that musical sight reading is a cognitive task, the acquisition and performance of which are developmentally sequenced and constrained by factors common to all such tasks, namely, existing cognitive structures and working memory capacity.

Case's Neo-Piagetian Theory of Intellectual Development was used as a framework for the investigation. Four graded levels of the sight reading task were constructed to be appropriate to Case's four substages of middle childhood. The most basic level (0) necessitated an identity judgment between two marked notes. The remaining levels required the coordination of specific cognitive structures as follows: level (1) the identity of and distance between notes; level (2) the distance between notes and the concept of either interval or sharp; level (3) distance, interval and sharp information integrated in an elaborated fashion.

Children aged 4, 6, 8 and 10 were trained and tested at each level of the task provided that they remained successful. Results indicated that the theory provided an effective predictor for the progression of sight reading performance through middle childhood. A linear relationship was evident between age and level of performance. Children exhibited successful performance on levels up to and including, but not beyond, that which was designed to correspond to the particular age group to which they belonged. It was concluded that the performance of music from written symbols is dependent upon the child's intellectual competence.

THE ROLES OF SKILL, STRATEGY, CHORD QUALITY, AND TONALITY IN A CHORD MATCHING TASK

J.V. Clifton, R. Inch, and N. Charness

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Several studies have found differences between musicians and nonmusicians in sensitivity to many musical dimensions. As in much skill research, the advantage of skilled musicians is most evident for conventional material. The present study replicates yet qualifies these findings.

Musically skilled and unskilled people listened to 96 synthesized organ chord pairs, and judged if both were the same chord (e.g., G+) in any inversion, or different. Skilled musicians could discriminate same chords in different inversions (e.g., G+, G+) from same quality (mode) chords in different keys (e.g., G+, A+). Their performance on atonal material was much poorer, but above chance.

Nonmusicians could not discriminate as instructed, but instead were above chance at judging chord quality (same or different) of tonal pairs. They showed no discrimination among atonal pairs.

Both groups' performance on different quality tonal chords was enhanced when the chords did not suggest a common tonal centre (e.g., G+, E- versus G+, F-).

Musicians' tendency to respond same to atonal different pairs was unaffected by whether the chords matched quality (i.e., they did not revert to typical unskilled strategy), but increased with the number of note chroma shared by the chords.

Musicians consistently apply an analytic strategy, though with less effectiveness to unfamiliar material. Nonmusicians are surprisingly sensitive to complex cognitive musical dimensions such as tonal chord quality and tonal centre.

PERCEPTION OF CHORDS WITHIN AND WITHOUT A MUSICAL CONTEXT

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The perceptual implications of different chord constructions were examined. All chords were derived from the major triad in root position. Triadic chords contained all three notes of the triad. Dyadic chords eliminated either the third or the fifth of the triad. Chords were presented in varying levels of musical context: 1) no context condition: chords were presented in isolation; 2) minimal sequence condition: pairs of chords were presented; 3) sequence condition: chords were presented in the final chord position of Bach chorale excerpts. In the final condition, chorale sequences varied in their musical complexity. Several tasks requiring attention to different levels of musical structure were employed. Psychoacoustical considerations of chords within and without a musical context will be discussed.

II. Computer Applications

THE USE OF CONFUSION MATRICES TO IMPROVE COMPUTERIZED EAR TRAINING

M. Lamb

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We use the confusion matrix in computer-assisted eartraining to focus attention on the particular problems of individual students. It enchances the technique of 'drill-and-practice' by reducing the time spent on material which the student can do with ease. For example, tabulating each of the students' responses to a given musical chord with respect to the actual musical chord presented, allows the program to eliminate those areas in which the student has shown proficiency. Similarly, tests responded to incorrectly are identified by the programme which then increases the probability of their being presented again. Both student and teacher have access to the thorough analysis of perceptual strengths and weaknesses provided by a print-out of the confusion matrix together with an explanation in plain English produced by the programme. Because the emphasis is directed toward difficult problems, the actual score of the student is likely to be low. In order to measure student progress, a score is also estimated, using probability theory, for the hypothetical condition of equal probability of all examples, that is, had the computer not weighted the examples toward the areas of the student's inadequacy. The software is implemented on an Apple Computer with an additional synthesizer board.

COMPUTER MUSIC SYSTEMS: A TOOL FOR THE COGNITIVE REQUIREMENTS OF MUSIC COMPOSITION

B. Hermann

Ontario Institute for Studies in Education, Department of MECA, Toronto, Ontario, Canada, M5S 1V6

This paper reports on findings coming out of a study recently done investigating the cognitive processes in music composition. The study was done in four Grade 7 and 8 classrooms and involved the use of the alphaSyntauri "Simply Music" music composition tool.

The computer is seen as an important aid to learning in the music education classroom in particular benefiting music composition activities. With the assistance of the computer the compositional decision making strategies - planning, revision, and development of ideas, can be facilitated, and the compositional building-blocks or knowledge structures can be strengthened. The development of revision strategies can be assisted through the ease of revision offered by the music and sound editor. In addition, the computer can facilitate the development of evaluation procedures through ease of aural evaluation offered by immediate and accurate feedback data. The computer music tool offers to the teacher an extension of resources for teaching and exploring compositional building-blocks - in particular timbre and musical acoustics.

This paper presents a model of the cognitive processes in composition revision. The internal reflection required in revision can be modelled in terms of interactions between representations in two problem spaces: the representation of the intended sounds and the representation of the actual sound. This type of activity is consistent with recent notions of composing as a form of problem-solving. The model consists of the COMPARE, DIAGNOSE, and OPERATE cognitive processes in revision.

A teacher intervention strategy classified as "procedural facilitation" was used in conjunction with the computer to help children gain voluntary control over their mental effort in the COMPARE, DIAGNOSE, and OPERATE tasks by providing them with simplified executive procedures that allow children to switch their attention between different levels of processing without losing hold of the task as a whole.

Formal evaluations of the procedures used illuminate parts of the composing process that do not emerge from thinking-aloud protocol analysis and indicate gains in quality of evaluations and the choice of remedial tactics used by the students. Formal evaluations also revealed a marked increase in the understanding of concepts related to musical acoustics through the use of the computer music system as a tool for instruction.

A COMPUTER-MEDIATED PIANO KEYBOARD MONITORING SYSTEM

E.D. Graham and B.L. Wills

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T.N. Topper

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Accomplished musicians exhibit many forms of highly skilled behaviour which, if measured and analyzed, can provide new insights into human information processing and motor output. Piano performance is especially interesting since it demands a rich repertoire of spatial and temporal coordination skills. Fortunately, musical output from the piano is a direct consequence of key and pedal manipulations which, if monitored suitably, can provide a complete record of musical performance.

The system described here, called the Piano Monitoring System, captures the required keyboard activity information from a grand piano. Optical-electronic sensors, fitted unobtrusively beneath the piano keys, provide continuous outputs proportional to key positions. A micro-computer monitors sensor outputs, performs analog to digital conversion and data compression, and stores time-position information. Keys of interest can be pre-selected, and the level of information detail for each key specified. Resulting data are transferred to a mainframe computer system for analysis.

Preliminary trials have shown the Piano Monitoring System to be an effective experimental tool. To date it has been used in studies investigating various aspects of musical performance. These results are to be presented initially at conferences on psychomotor behaviour.

THE IMAGE AND AUDIO SYSTEMS AUDIO WORKSTATION: DEVELOPING NEW TOOLS FOR AUDIO AND MUSIC RESEARCH

B.W. Pennycook, J.H. Kulick, D. Dove

Queen's University, Kingston, Ontario, Canada

The need for more powerful tools at the Defence and Civil Institute for Environmental Medicine (DCIEM) for the encoding, storage, processing and retrieval of audio signals and for investigations into audio perception, and modelling of the auditory system, etc., as described by Pennycook (1982) has led to the development of a new computer architecture designed specifically for audio applications – The Image & Audio Systems Audio Workstation.

The Workstation can be divided into two parts: the UNIX host, including support software, a wide variety of programs from CARL (UCSD), and the Queen's University Computer Music Facility; and the Audio Processing Unit (APU). The APU consists of a control section and several Processing Elements (PE's). The PE's are a unique single-board design utilizing the TI TMS32020 DSP chip, separate program and data memory, table-lookup hardware, 2 SCSI interface ports and a parallel interface port.

This paper will present a general overview of the experimental environment at DCIEM and the role of the Workstation. A discussion of software development of the Workstation will include a description of: UNIX utilities and applications running on a MACINTOSH under UNITY (Human Computing Resources version of BSD 4.1) on a NSC 32016 Single User Workstation; control utilities for time-critical communication between the host and the APU; a generalized scheme for graphic specification of Workstation tasks plus partially or wholly automated distribution of the tasks among several parallel processors.

The presentation will close with a description of two configurations of the IAS system: a board-level configuration whereby a single PE can reside in a UNIX Multibus computer, and the APU level which includes two or more Processing Elements.

Session F: Building Vibrations 9:00 – 11:40 a.m.

Chairman: H. Rainer, Division of Building Research, NRC, Ottawa.

NOISE AND VIBRATION IN BUILDINGS FROM UNDERGROUND RAILWAYS

S. Kraemer

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A review of recent developments in prediction and control methods used in West Germany will be presented. The effectiveness of various vibration isolating track designs are compared, both theoretically and in practice. The results of measurements in tunnels and buildings are compared with predicted vibration levels at the wheel-rail interface, on the tunnel structure, in the propagation path through the ground and in buildings. The digital, multi-channel measurement and analysis instrumentation used in this work is described. Structural modelling, based on simple electrical circuit analogues and implemented on a digital frequency analyzer is discussed. Laboratory measurement of the dynamic stiffness of resilient track products, using a 100 ton hydraulic testing machine, is described. Structural vibration response in buildings and the radiation of low frequency noise in rooms are discussed.

VIBRATION CAUSED BY FREIGHT TRAINS IN RESIDENTIAL AREAS - A CASE STUDY

M.R. Noble

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Double-tracking of a main railway line through Kamloops, B.C. has given rise to numerous complaints of unacceptable vibration, building damage, etc. from residents who have become increasingly militant over the past year. A study was undertaken on behalf of the Citizen's Committee to measure the objective and subjective parameters of this disturbance, to examine the source mechanisms, comment on the extent of the disturbance and explore potential mitigation strategies. Data collection included a social (attitude) survey, detailed two-channel FFT measurements, and area-wide integrated vibration surveys.

Ground vibration was measured close to the track and at distances up to 950 m. The dependence of the transmitted vibration on distance, weight of train, speed, and track bed composition was investigated. The ground transmitted vibration spectra were strongly peaked in the 6-11 Hz region, and had a bandwidth of approximately 3 Hz. Levels were above the human perception threshold at distances of up to 300 m. One significant finding was that the newly constructed part of the roadbed produced vibration levels 9 to 18 decibels higher than the existing track.

We will present a synopsis of the measurement strategy, instrumentation, and criteria for acceptable vibration levels in residential developments. Results to be presented will include a breakdown of data from some 120 freight train passbys, both unit trains and mixed freights, and will examine sources of variability in the vibration signature. Methods of mitigating the perceived community impact will be briefly discussed.

SEISMIC REQUIREMENTS OF VIBRATION ISOLATORS

R.A. Strachan

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Mr. Strachan will briefly review the implications of impact forces in vibration isolators having a clearance between elements, and the difficulties in predicting failure mechanisms. Some recent studies conducted on the seismic shake table in the UBC Civil Engineering Department will be referenced.

The difficulties in interpreting and applying the requirements of the National Building Code of Canada 1985 will be discussed. The pros and cons of using elastomer restraints, in place of the more traditional spring isolators, will be reviewed both qualitatively and quantitatively.

TWO CASE STUDIES OF UNUSUAL BUILDING VIBRATION

A.D. Lightstone

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One involves the design of a special multi-room laboratory facility with all room boundaries constructed of 6 mm steel plate. The resulting environment, in addition to being reverberant would exhibit severe transmission of impact sounds as well as significant "ringing" due to vibration of the steel plate surfaces. The effects have been likened to being inside a church bell. A damping design using surface-applied sheet metal to mitigate the vibration effects has been arrived at experimentally using a partial mock-up.

The second involves mitigation of vibration in a portion of the 31st floor of a building with a 50,000 gal/min cooling tower system on the 35th floor. The source is considered to be water flowing under free fall from the cooling towers to a holding tank directly on the 33rd floor. No significant vibration was evident in the holding tank or on its floor. Isolating the water system except for the tank did not resolve the problem. Resonances in the structure were concluded to be the main problem. Altering the stiffness of the vibrating floor was shown to solve the problem.

A QUIET AND EFFECTIVE VIBRATION ATTENUATOR FOR BORING BARS

N. Popplewell and S.E. Semercigil

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Boring presents a critical problem of tool chatter because of the commonly used large length-to-diameter ratios, l/d, of the cutting tool. Although chatter could be avoided by decreasing the cutting speed, this method is usually impractical for typically large values of l/d. On the other hand, the use of an impact damper may allow high cutting speeds and a large l/d. Conventionally, a solid piece of metal is placed at the tip of the boring bar with a clearance. The motion of this auxiliary mass opposes and attenuates the boring bar's vibrations if the clearance is chosen properly. However, it has been observed that the vibration attenuation of the conventional impact damper depends upon the amplitude of the cutting forces and l/d. Moreover, the repetitive collisions of the auxiliary mass produce a noisy operation. On the other hand, a modified impact damper, employing a composite auxiliary mass, has been observed to be quieter and more effective than a conventional impact damper. Approximately 2 mm diameter spherical lead shot were packaged in a deformable plastic bag and used as the auxiliary mass. Machine shop tests showed that a boring bar equipped with such a bean bag damper produced the largest depth-of-cuts before chatter as compared to both a solid boring bar and a bar with an optimal-clearance conventional damper.

VIBRATION REDUCTION FROM AC COMPRESSORS IN A COMMERCIAL BUILDING

H. Forester

Forester Controls

After converting a storage area into office space, the building tenant complained of floor vibrations which were traced to dual reciprocating air conditioning compressors in the basement floor below. The original design was essentially corect, with properly designed resilient mounts and flexible couplings. All attempts to measure the path of the vibrations were fruitless, as it was not possible to discern whether the measured vibrations were originating in the compressor piping or were being transmitted from the floor above back into the piping. A successful retrofit was achieved at minimum cost using a number of unorthodox methods, that consisted of stiffening the floor above to alter its natural resonant frequency and by adding additional flexible supports to the piping and mechanical components.

VERTICAL DYNAMIC FORCES PRODUCED BY WALKERS

J.H. Rainer and G. Pernica

Division of Building Research, National Research Council Canada, Ottawa, Ontario, Canada, K1A 0R6

Vertical dynamic forces produced by walkers were measured from load cells applied to the centre of a 17 m long test floor, thus permitting the study of forces from continuous trains of footsteps. The measurements showed walking forces to be a combination of wave trains of harmonics with frequencies of integer multiples of the walking rate and having decreasing amplitudes. The dominant low frequency contributions are contained within the first three to four harmonics.

A parameter study of the harmonic amplitudes, called the "dynamic load factor," showed that a peak value of 0.56 is reached at 2.4 Hz for the first harmonic, 0.24 at 5.4 Hz for the second, and 0.12 at around 7.8 Hz for the third harmonic. The variation of the peak amplitudes with three subjects was slight, but there was an increase in the measured variation of α with walking stride at 2.0 and 2.4 Hz. Use of induced floor vibrations for independent verification of the dynamic load factor for the first harmonic showed good agreement with those measured directly.

HIGHER MODES OF VIBRATION RESPONSE OF LONG-SPAN FLOORS

J.C. Swallow

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Problems of annoying vibration of long-span floors have often been reported. The vibration is not of structural consequence, but often arises from normal activities on the floor. The problem is generally associated with modern light-weight floors, typically steel joist - steel deck - concrete construction. A knowledge of natural frequency, amplitude and damping ratio is needed to predict the acceptability of the floor. Existing prediction techniques usually concentrate on the fundamental vibration mode. However, some floors show significant response in higher modes. This paper describes a model of a rectangular, simply supported, one-way floor, as an orthotropic plate, from which is calculated the fundamental and higher mode natural frequencies. Predictions of natural frequencies and measurements are compared for four floors and good agreement is found. Surprisingly, in two cases, the higher natural frequencies differ only slightly from the fundamental, which suggests such modes will be important in the overall response of the floor.

Session G: Speech and Hearing II — 1:30 – 4:50 p.m.

Chairman: To be announced

A DIGITAL VOICE SPECTROGRAPH SYSTEM

W. Burchill, B. Gagnon, B. Harron, S. Shlien

Department of Communications, Communications Research Center, Ottawa, Ontario, Canada, K2A 8S2

A digital voice spectrograph system has been developed for the IBM PC using the TMS32010 signal processor. Its advantages over analog spectrographs are its low cost and flexibility. Speech is sampled between 8 and 20 kHz and stored in the PC memory. Six hundred spectral cross-sections are computed and displayed in about 5 seconds from 20000 speech samples. The user interface of the system is programmable in Fortran or Pascal. Computer aided instruction courseware was developed for teaching a novice to read speech spectrographs. The system may be used as a test bed for developing speech recognition and speech synthesis devices.

FACILITIES FOR RESEARCH AND EDUCATION IN PSYCHOACOUSTICS AT CALGARY †

D.G. Jamieson

Speech and Audition Laboratory, Department of Psychology, University of Calgary, Calgary, Alberta, Canada, T2N 1N4

Five years ago, the Speech and Audition Laboratory was established in the Department of Psychology at the University of Calgary to provide a focus for psychoacoustics and speech research in Western Canada. The Laboratory now houses facilities to support most types of contemporary speech, psychoacoustics, and audiology research. These facilities include a full complement of Bruel & Kjaer measurement and test equipment, including spectrum analyzers, auditory test station, and full TDS system; a Digital Equipment Corporation Vax 11/730 with a variety of signal processing and speech synthesis/analysis hardware and software, as well as software for experimental control and data analysis; three fully-interfaced DEC PDP 11/23 computers, with a large amount of applications software; a digital sound spectrograph; and a number of microcomputers. Researchers presently using the facilities of the laboratory include linguists, computer scientists, psychologists, a physicist, and a biologist. The laboratory currently supports researchers at four universities and three hospitals, who are working in nine areas of research: normal psychoacoustic function, normal speech perception, normal speech production, analysis of animal cries, analysis of respiration noise, attention, hearing impairment, speech-language disorders, and language learning. The presentation will review some of the major features of the Laboratory and highlight some of our current research.

†Laboratory development was supported by funds from the Alberta Advanced Education Endowment Fund, the Alberta Heritage Foundation for Medical Research, Bruel and Kjaer, Kay Elemetrics, the Natural Sciences and Engineering Research Council of Canada, and the University of Calgary.

SENSITIVITY OF CAT CORTICAL NEURONS TO LINEAR MODULATIONS OF THE FREQUENCY OF ONGOING TONES

D.P. Phillips and M.S. Cynader

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Human speech sounds are rich in spectral elements whose frequencies are modulated over time. These frequency modulations (FMs) may occur at the onset of speech sounds, or as modulations of ongoing signals. The central neural coding of FM pulses, i.e., sounds in which the FM occurs at stimulus onset, has been described in detail, but there has been no systematic study of cortical neuron responses to FMs that occur as variations of ongoing signals. In the present study, single cat cortical neurons were studied with stimuli consisting in a 2 kHz-wide, linear FM ramp initiated 200 ms after the onset of a constant frequency

tone. The center frequency of the FM ramp was systematically shifted in and around each cell's excitatory frequency response range, and sensitivity to both directions of FM was assessed quantitatively.

Cortical neurons manifest their selectivity to tone frequency in a highly peaked spike count-versus-frequencyfunction. FMs were effective in eliciting spike discharges only if the FM excursion encompassed at least part of this excitatory pure tone response range and if the direction of FM was towards the cell's best frequency. For each neuron, the strength of direction preference for any given FM was strictly correlated with the steepness of the frequency response function over the frequency range traversed by that ramp. Response to FMs covering exclusively the low- or high-frequency slopes of the frequency response function displayed near perfect preference for ascending and descending FMs respectively. FMs traversing the center of a cell's frequency response range evoked comparable responses in both FM directions. These data suggest that embedded FMs were effective only if they represented an "effective amplitude modulation" of the preceding signal, consistent with the rapidly adapting nature of auditory cortical responses. This is in marked contrast to pulsed FMs, responses to which appear to be dominated by neural events evoked at pulse onset.

NARROW BAND NOISE MODULATION SENSITIVITY: THRESHOLD ESTIMATES USING TWO PSYCHOPHYSICAL METHODS

V. Cuccaro, R. Byers and B.W. Tansley

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The perception of sound patterns is believed to be initiated by the neural coding of successive short-term amplitude spectra; produced by the frequency-to-place transformation that occurs in the cochlea. As each frequency in the sound spectrum maps to a relatively narrow spatial region of the basilar membrane, any change in a sound stimulus (a prerequisite for information to be present in the sound) results in a change in the spatial pattern of excitation of the hair cells as a function of time. Using a specially-built computer controlled 16 channel vocoder/exciter we have measured the sensitivity to sinusoidal modulation of narrow-band noises over a range of noiseband carrier centre frequencies from 200 Hz to 8300 Hz and a range of modulation frequencies from 0.5 Hz to 32 Hz. Modulation detection thresholds were estimated using both the method of adjustment, P.E.S.T. and a method that combines the two. Results of these tests are compared with each other and to published modulation detection data from ours and other laboratories. These data form the baseline measurement set for further studies of modulation sensitivity in normally- and abnormally hearing individuals.

VISUAL CONTRAST SENSITIVITY DURING EXPOSURE TO MUSIC AT 107 dB SPL

T.J. Ayres and P.R. Hughes

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It is generally believed that intense sound does not affect perceptual performance in sensory modalities other than hearing; in a recent study, however, we found a significant decrement in visual gap resolution acuity during exposure to music presented at 107 dB SPL. In order to explore this in greater detail, visual contrast sensitivity functions were determined for 18 subjects while listening to music at either 70 or 107 dB SPL. The method of decreasing contrast was used to measure the threshold for sinusoidal luminance gratings viewed from .5 meters (with spatial frequenies of .5, 2, 4, 8 and 16 cycles/degree) and 7.6 meters (4, 8, 16 and 24 c/d). No significant effects of noise level were found at any spatial frequency or viewing distance. Explanations for the discrepancy between the gap-resolution and contrast-sensitivity results will be considered.

ETUDE EXPLORATOIRE DE L'EFFET DU CONTENU SPECTRAL DES BRUITS IMPULSIONNELS SUR L'ACQUISITION DE FATIGUE AUDITIVE

C. Laroche et R. Hétu

Ecole d'Orthophonie et d'audiologie, Université de Montréal, Montréal, Québec, Canada, H3C 3J7

Grâce au développement d'un système de génération de signaux impulsionnels contrôlés par ordinateur, il est maintenant possible d'évaluer la contribution du contenu spectral des impulsions sonores par des mesures de fatigue auditive (DTS: décalage temporaire des seuils auditifs). Pour ce faire, il a fallu mettre au point une méthodologie en déterminant 1-l'effet cible en terme d'ampleur de DTS, 2-un critère de fiabilité de l'acquisition de ce DTS cible dans le temps, et 3-une stratégie pour obtenir l'effet recherché dans un minimum de temps. Cette méthodologie a été développée et mise à l'essai pour trois signaux impulsionnels de contenus spectraux différents s'étendant de 300 à 1000 Hz pour le signal A, de 300 à 3000 Hz pour le signal B et de 300 à 4000 Hz pour le signal C. Les courbes d'acquisition de fatigue auditive démontraient qu'un DTS asymptotique de l'ordre de 10 dB était atteint après environ 30 minutes d'exposition. Pour obtenir ce même effet, le niveau de pression de crête des signaux B et C devait être environ 10 dB inférieur à celui de signal A. Ainsi, le contenu spectral semble un paramètre important à considérer dans l'élaboration de critères de nocivité des bruits impulsionnels.

PULSATION THRESHOLD MEASUREMENTS WITH HEARING-IMPAIRED LISTENERS

T.J. Ayres

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When two auditory stimuli are alternated rapidly, under some conditions one of the stimuli may appear to be on continuously; as the level or other characteristic of either stimulus is adjusted, the point of transition between illusory continuity and correctly-perceived discontinuity is called the pulsation threshold. Most previous research employed listeners with normal or

mildly-impaired hearing. The present study explored the possibility of measuring the pulsation threshold in moderately to severely impaired ears.

A tone and a narrow-band noise (masker) centered at the same frequency were alternated at 3.3 c/s. A listener with a pure-tone threshold of 105 dB SPL at the frequency tested (500 Hz) never reported the illusory continuity: the tone went directly from inaudibility to pulsation as its level was raised (or as masker level was lowered). Listeners with thresholds of 80 and 82 SPL, on the other hand, clearly perceived the continuity, and they were able to adjust levels to perform pulsation threshold measurements. It appears that a sensori-neural hearing loss of up to 80 dB SPL does not necessarily preclude the continuity illusion, although pulsation thresholds may be difficult to measure because of the restricted dynamic range of continuity and of overall hearing. (Work supported by the Deafness Research Foundation.)

HEARING AND SPEECH PERCEPTION WITH A TEMPORARY SINGLE-CHANNEL COCHLEAR IMPLANT

S.M. Abel, S-M. Tse, H. Kunov, G. Chua, and J. Nedzelski

Department of Otolaryngology, University of Toronto, Toronto, Ontario, Canada

In an effort to gauge possible success with a permanent multi-channel cochlear implant, nine bilaterally deaf adults were implanted surgically with a single ball electrode, placed in close proximity with the round window niche. Over a period of one week, measurements of current threshold for three stimulating waveforms, upper tolerable levels, and gap detection thresholds were made. Studies of speech perception included discrimination of: 1) short versus long, continuous versus interrupted, rising versus falling, and higher versus low pitch for vowel sounds; 2) stress placement; 3) question versus statement; and 4) consonants. Gains in tracking free running speech were also assessed. Analyses of the data, currently in progress, focus on a comparison within subjects with the results obtained using conventional aids and correlations among diverse measures of audition. The relationship to some results with the permanent device will be highlighted.

FREQUENCY-INTENSITY SELECTIVITY OF CAT AUDITORY CORTEX NEURONS STUDIED WITH TONE, NOISE AND COMBINED TONE-NOISE STIMULI

D.P. Phillips

Department of Psychology, Dalhousie University, Halifax, Nova Scotia, Canada, B3H 4J1

Single neurons in the cat's primary auditory cortex are excited by tonal stimuli over limited frequency ranges centered around a characteristic frequency (CF) to which each cell is most sensitive. If the spike rate (i.e., response strength) of a cortical neuron is studied as a function of the intensity of an excitatory tone pulse, then two broad cell groups are found. Monotonic neurons have rate-intensity functions that asymptote towards ceiling maxima. These cells display V-shaped excitatory frequency-intensity domains and are generally excited by wide-spectrum noise pulses. Nonmonotonic cells have highly peaked rate-intensity functions and usually do not respond to high intensity tones. These neurons have circumscribed excitatory frequency-intensity stimulus domains and generally do not respond to wide-spectrum noise pulses. These latter data suggest that the excitatory stimulus domains of nonmonotonic cells are flanked by others that provide inhibitory inputs.

The responses of cortical neurons to acoustically-mixed, simultaneously gated tones and noise reflect the balance of excitatory and inhibitory events evoked by the two elements of the combined stimuli. For monotonic cells, unless the noise intensity itself is such as to elicit a saturated spike rate, its masking effect on tone responses may be overcome by increments in tone level. The tone responses of nonmonotonic cells are suppressed in an intensity-dependent fashion by simultaneously gated noise. This suppressive effect cannot be overcome by increments in tone level because high intensity tones are, for these neurons, also inhibitory.

EFFECTS OF CONTINUOUS WIDE-SPECTRUM NOISE MASKS ON TONAL SENSITIVITY OF CAT AUDITORY CORTEX NEURONS

S.E. Hall and D.P. Phillips

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In the anaesthetized cat's auditory cortex, single neurons are sharply tuned to tone frequency, and have intensity dynamic ranges usually less than 30 dB in breadth. In the presence of continuous wide-spectrum noise, a neuron's dynamic range for characteristic frequency tones (CF: the frequency to which a cell is most sensitive) is shifted towards higher intensities. The magnitude of this shift is linearly related to the sound pressure level (SPL) of the background noise. In the present study, we have examined cortical cell response to wide ranges of tone frequency-intensity pairings in the presence and absence of noise with a view to determining the generality of background noise effects across a cell's total excitatory frequency-intensity response area.

For CF tones, the dynamic range shift incurred by noise of any specific SPL was almost always greater than that occurring at neighbouring frequencies. In general, these dynamic range shifts were accompanied by increases in the cell's thresholds. Since these threshold shifts were also usually greatest nearest CF for any given noise SPL, threshold tuning curves obtained in the presence of masking noise showed a modest but consistent broadening by comparison with those for unmasked tones. In addition, masking noise often resulted in a compression of a neuron's intensity dynamic range, particularly at CF. That is, the SPL range over which spike rates increased from minimum to maximum was often narrower in the presence of noise, suggesting a cortical manifestation of loudness recruitment.

PROPAGATION DANS LES RESEAUX ACOUSTIQUES IRREGULIERS

C. Depollier

Laboratoire d'acoustique de l'Université du Maine, France

Le phénomène de localisation d'Anderson est encore peu connu en acoustique; il présente pourtant un grand intérêt du point de vue fondamental, lié aux avantages de certains milieux macroscopiques (possibilité de choix arbitraires de désordres pour l'expérimentation, connaissance de bons modèles théoriques prenant en compte les effets de dissipation), mais aussi du point de vue des applications.

Les milieux que nous avons étudiés sont assimilables à des milieux unidimensionnels, le désordre portant sur la nature et/ou la position des discontinuités placées de façon discrète dans un milieu continu régulier; ainsi: 1) un tuyau sonore percé de trous latéraux ouverts dont les dimensions sont voisines de celles d'un instrument de musique à vent; aux basses fréquences, ce milieu est en première approximation l'analogue d'un filtre passe-haut électrique constitué de cellules comprenant une self en série et une self en parallèle, ou encore d'un solide vérifiant l'équation de Kronig-Penney, ou encore d'un système de masses placées sur des ressorts; 2) un tuyau sonore muni de systèmes résonants en dérivation, utilisés notamment comme silencieux; 3) des milieux poreux stratifiés, dans lesquels peuvent se propager deux ondes longitudinales couplées quand its sont périodiques; 4) des réseaux de tuyau "en échelle," dans lesquels plusieurs ondes longitudinales peuvent se propager.

Les méthodes sont à la fois la simulation par calcul numérique, le calcul approché et l'expérimentation. La simulation numérique se fait en calculant des chaînes de multidipôles (quadripôles, quadri-dipôles, ...), avec et sans dissipation. Les calculs approchés ont été appliqués à certains cas, comme les forts désordres, ou les faibles désordres rencontrés près de fréquences singulières pour lesquelles il n'y a pas de localisation (l'une des grandeurs caractérisant un quadripôle, pression ou vitesse acoustiques demeurant constante tout au long de la chaine). Enfin, l'expérimentation a été menée sur un tuyau percé de cheminées latérales fermées, le désordre portant sur leurs longueurs, les effets de localisation se faisant sentir pour la plupart des fréquences sur une dizaine de cellules.

Enfin, des études sur des milieux bidimensionnels ont commencé, portant notamment sur un tuyau percé de trous latéraux ouverts dont l'intéraction extérieure n'est pas négligeable.

Session H: Noise sources and Propagation — 1:30 – 4:30 p.m.

Chairman: To be announced

IMPEDANCE D'ENTREE D'UN ECRAN AJOURE DEPHASEUR SOUS INCIDENCE OBLIQUE

V.J. Chvojka, L-P. Simard et M. Amram

Ecole Polytechnique, l'Université de Montréal, Montréal, Québec, Canada, H3C 3A7

Un nouveau type d'écran ajouré constitué d'un emplilement de guides d'ondes a montré pour des ondes planes en incidence normale, des propriétés intéressantes dans le contrôle du bruit de basse fréquence par effet de phase. Afin d'utiliser ce nouveau système il nous fallait connaitre son comportement vis à vis d'ondes sonores en incidence oblique pour tenir compte, par exemple, de l'effet de sol. Deux méthodes de mesure par réflexion ont permis d'étudier l'effet de l'angle d'incidence des ondes sur l'impédance de l'écran acoustique ajouré déphaseur. La première, inspirée de Klein & Cops est une méthode d'ondes stationnaires dérivée de celle du tube d'impédance. L'autre méthode proposée par Ingard & Bolt mesure la pression sonore complexe à la surface de l'échantillon. Les résultats de cette étude ont montré que dans un plan vertical (perpendiculaire aux fentes d'entrée), l'impédance d'entrée du système est néanmoins indépendente de l'angle d'incidence (système localement réactif entre +40). Par contre dans un plan horizontal parallèle aux fentes l'impédance varie de façon beaucoup plus importante en fonction de l'angle d'incidence.

STUDY, BY TRANSMISSION, OF THE EFFECT OF THE INCIDENCE ANGLE ON THE INSERTION LOSS AND PHASE LAG INTRODUCED BY AN INTERFERENCE PRODUCING SOUND BARRIER

M. Amram

Département de génie physique, Ecole Polytechnique, Montréal, Québec, Canada, H3C 3A7

A waveguide filter sound barrier has shown good interference properties when receiving plane wave at normal incidence. This was achieved by lagging the transmitted (retardated) part of a low frequency noise of about a 180 degree phase angle respectively to the diffracted part of this noise above the barrier. To be able to evaluate this new device in real conditions, it was necessary to investigate its performance at any angle of incidence, in order, for example, to introduce ground effect. Insertion loss type measurements have been performed in any anechoic enclosure within an anechoic chamber. Measurements have shown almost not any angle dependency from −60 degrees to +60 degrees in a plane perpendicular to the input slits of the waveguides. However, the same type of measurements performed at angle in the center slit plane have shown that the device performances (insertion loss and phase lag) were much more dependent on the plane wave incident angle. A new theory inspired from Christiansen and Fahy has shown quite good matching with experimental measurements.

IDENTIFICATION ET REDUCTION DU BRUIT DANS LES SCIERIES

S. Desjardins et J. Nicolas

Université de Sherbrooke, Sherbrooke, Québec. Canada

J.G. Martel

I.R.S.S.T.,Montreal, Québec, Canada

Les auteurs ont procédé à l'identification systématique des sources de bruit dans différentes scieries du Québec. Les procédés sont généralement tous au-dessus des normes du 90 dB(A) pour 8 heures. Parmi les quelques correctifs proposés dans la littérature très peu sont applicables parce qu'il s'agit de solutions de type laboratoire ou de changements trop coûteux. Un procédé retiendra particulièrement l'attention: l'éboutage. On présentera une analyse de l'influence de la vitesse d'opération, des types de scies (avoyé ou carbure). Cinq solutions possibles seront comparées au point de vue technique, pratique et économique. La solution optimum choisie a été essayée in situ dans deux usines et les résultats obtenus seront présentés.

Pour terminer, l'importance éventuelle d'un traitement acoustique des locaux sera discutée grâce au modèle de calcul prévisionnel basé sur le méthode des sources images.

NUMERICAL CALCULATION OF THE SOUND RADIATED BY A PISTON MEMBRANE

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The radiation of sound by a piston membrane enclosed in an infinite baffle is generally evaluated by Fresnel or Fraunhofer approximations. The purpose of this presentation is to evaluate the radiation with a simple numerical method.

The present approach deals with numerical instead of physical approximations. The numerical solution of the Huygens integral becomes delicate when the observer is very close to the piston, but generally a 16 points Gauss-Legendre formula gives very good results at distances greater or equal to the longest dimension of the piston.

The application of the numerical method to a line source of finite length underlines the inaccuracies of the physical approximations in certain conditions, particularly along the axis perpendicular to the center of the rod.

A numerical solution of the Fresnel integral is less restrictive than analytical approximations regarding the position of the observer, thus enabling the calculation of radiated pressure with sufficient accuracy for any frequency.

INFLUENCE OF A PULSATING MOVING MEDIUM ON ACOUSTIC PULSATION OF PIPELINES

C.W.S. To

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In the past analysis and simulation of pressure pulsation of exhaust mufflers and pipelines have mainly been confined to cases without and with a steady mean flow. In practice, for example, the flow from a multi-cylinder engine or compressor in a pipeline may pulsate. Consequently, there is a need to model the system with a pulsating flowing medium. Four-pole parameters for a uniform piping system containing a pulsating moving medium are presented and used to investigate the influence of such a medium on the acoustic pulsation in a simple system. The different effects of a steady mean flow and a pulsating moving medium are highlighted in this paper.

IDENTIFICATION OF IN-DUCT NOISE SOURCES

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There are many industrial situations in which noise sources generate noise in ducts or piping systems. Examples are compressors and fans in the case of external equipment and valves, tees, elbows or restrictions that generate noise due to turbulent flow. This paper describes a feasible testing method that allows the characterization of the source in terms of a single frequency-dependent source parameter that is a function of the source strength only and independent of downstream load impedance. The test procedure involves the measurement of the internal impedance of the source and auto-spectra of pressure at a reference location when the source is connected to the semi-anechoic load.

Post-processing of the data by computer yields the source parameter characteristics and predicts the pressure auto-spectra at any station of any new and different duct system. Noise levels have been predicted and compare well with actual pressure measurements for a variety of noise sources. Thus it is possible for a particular source to predict with good accuracy the resulting noise spectra throughout any arbitrary duct system.

PREDICTION OF IN-DUCT NOISE FROM COMBINED SOURCES

H.S. Alves and A.G. Doige

Department of Mechanical Engineering, The University of Calgary, Calgary, Alberta, Canada, T2N 1N4

In gas pipeline systems various elements are responsible for generating randomly varying acoustic noise. The dynamic pressure can lead to excessive mechanical vibration and pulsation throughout the pipeline. This paper describes an experimental method to predict noise levels at any station when various noise sources are present in the system.

The test procedure consists of separately measuring the internal impedance and pressure (auto-spectrum) at a reference location of each source, when connected to a semi-anechoic termination. These frequency dependent quantities are a function of the noise-producing element only and independent of upstream or downstream piping configuration.

By using a small desk-computer this data is processed and the pressure spectra is calculated at any location of a given system with one or more sources acting simultaneously. Noise levels can then be predicted for any station in the system. These predictions have been compared to actual measured pressure levels with excellent agreement.

This method can be a valuable tool to assess the effects of modifications of existing installations or as a guideline to the design of pulsation free pipelines.

ENCLOSURES TO CONTROL NOISE FROM HEAT PUMPS

J.D. Quirt

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Noise from residential heat pumps frequently generates complaints from neighbours. Barriers or enclosures are a possible means of reducing such noise. To evaluate the effectiveness of enclosures, several designs were tested on four different heat pumps. The tests were supplemented by scale-model laboratory studies to examine more systematically the effect of enclosure details and reflection from nearby surfaces. The implications of these results are discussed.

ON THE INTEGRATION OF OCCUPATIONAL NOISE EXPOSURE

E.A.G. Shaw

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In the new ISO document DIS 1999, which is now awaiting publication, noise exposure is defined as "... the time integral of the squared A-weighted sound pressure over a specified time period (T) ..." where "the period T ... is usually chosen so as to cover a whole day of occupational exposure to noise (commonly 8 hours, ...) or a longer period that is to be specified, for example, a working week." Several hypothetical patterns of occupational noise exposure, each chosen to produce an equivalent continuous A-weighted sound level of 90 dB when measured over the 40-hour work week, are closely examined from various points of view including possible concern over chronic TTS.

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12th INTERNATIONAL CONGRESS ON ACOUSTICS

Toronto, July 24-31, 1986

CALL FOR PAPERS

Copies of Circular 2 were mailed to all members of the Canadian Acoustical Association in July. All those wishing to submit a contributed paper were asked to complete the Preliminary Abstract Form (Form B) and send it to the Secretariat in Toronto by August 31, 1985. Prospective authors who missed this deadline should mail their preliminary abstracts to the 12ICA Secretariat (P.O. Box 123, Station "Q", Toronto) without further delay. Preliminary abstracts are for the use of the Technical Program Committee only and are not for publication. Instructions and special paper will be mailed to authors in October. The firm deadline for manuscripts is January 31, 1986.

Two questions pertaining to eligibility have arisen in connection with the 12ICA Student Prize scheme (see Canadian Acoustics 13, 56, July 1985). These concern graduate students who will complete their theses before July 1986 and Canadian graduate students studying outside Canada. It is my intention to recommend that students in both categories be declared eligible for the 12ICA Prize.

Edgar A.G. Shaw
Chairman
12ICA Executive Committee

BOOK REVIEW

Donald C. Gasaway: Hearing Conservation
Prentice Hall, Inc., New Jersey, 1985
318 pages, $59.95

This is a practical book that anyone involved in developing and/or running industrial hearing conservation programs will find useful. Its fifteen chapters are easy to read yet vigorous and above all, very well referenced. The alphabetical index at the end of the book helps one rapidly locate the different subjects of interest.

The first chapter of the book reviews the history of hearing conservation programs during the last thirty years, thus providing information that is seldom found elsewhere. Next to it is a chapter that deals with physics of noise as related to hearing conservation. It is a short and quite concise chapter. The hearing mechanism as well as the effects of noise on humans is developed in the next three chapters. Several illustrations of a superior quality help to understand the complex mechanism of hearing, without getting into much detail.

The core of the book is the next ten chapters. They cover essentials such as hearing tests, hearing protection and documentation. Each one of the different subjects is examined in depth, providing very well referenced, up-to-date information. The many years spent by the author in running hearing conservation programs are clearly shown in the way the subjects are developed in those chapters. Another result of his experience are some of the chapters not found usually in similar books. This reviewer found chapter six, "How to Successfully Educate, Indoctrinate, and Motivate Workers," particularly interesting. In its eighteen pages, the reader will find excellent advice and practical tips. In the same line is the final chapter fifteen, "Evaluating and Fine-Tuning the Elements that Comprise a Program," where the author deals with the everlasting question of deciding if the resources spent in hearing conservation programs are well spent.

Obviously, no book is perfect and this one is no exception to the rule. Chapter seven deals with noise exposure assessment and does not provide clear guidance as to how to perform the assessment. It leans heavily toward describing hazard criteria instead of guiding the reader through them. There are more questions than answers in a subject of such importance. Although the author specifies that "This discussion does not deal with details of instrumentation or measurement techniques," this reviewer thinks that this is one of the cornerstones of the hearing conservation programs and should have been treated as such.

In summary, even with such omissions, this is an excellent book that should be on the shelf of practicing industrial hygienists or persons responsible for the hearing conservation in industrial establishments.

Alberta Behar

NEWS FROM THE PRESIDENT

Hope I will meet you in Ottawa at our next annual Acoustical Week from 30 September to 4 October. The week promises to be a very interesting one with three different seminars, our annual two-day symposium of papers, a meeting of two committees on acoustical standards and of course our own annual meeting and dinner.

Our Toronto chapter has had another very active year and has made several new friends from similar associations to ours. It is hoped that they will join us in our hosting of the 12 ICA.

The organizers of the 12 ICA have had a few anxieties the past year due to changing personnel and contract foul-ups. Edgar Shaw, however, has managed in spite of these problems to keep us headed in the right direction. You soon will be asked, if you have not already, to help make this ICA meeting one of the best ever. My international contacts indicate that they are very impressed with our organization. Let's make this meeting live up to their expections.

A couple of years ago in Vancouver, we passed a resolution indicating that our association was in favour of seeing changes in the National Building Code with respect to the acoustical requirements. Now is the time to react so that changes will be made to the 1990 Code. Gordon Pollard has been trying his best to have changes made to the British Columbia Code but has yet to have a hearing. I would welcome any suggestions.

Next year our annual week will disappear but we must have an annual meeting to elect our officers and new directors. Do you have any suggestions for a date and venue? The following year I suggest we meet in Calgary providing we can find someone to act as our meeting convenor. I would appreciate hearing from a volunteer.

Hope you have had a super summer and see you in Ottawa.

Cameron W. Sherry
President

CAA NOMINATIONS

The bylaws of the Canadian Acoustical Association require that the past-president nominate persons to fill vacancies that occur on the Board of Directors and Officers of the Association.

Past-President, Tom Northwood, has advised us that he will make the following nominations during the 1985 annual business meeting: President, Cameron Sherry (continuing); Executive Secretary, Deirdre Benwell (continuing); Editor, John Bradley (continuing); Treasurer, Tom Ho (continuing).

Directors: Two of our directors, Sharon Abel and Leslie Russell, retire this year. To replace them, Nicole Lalande (University of Montreal) and Winston Sydenborgh (H.L. Blachford Limited) will be nominated to serve for a four-year term.

Further nominations are invited and should be in the hands of the Executive Secretary (Deirdre Benwell), together with the consent of the nominees to serve, prior to the 1985 annual business meeting.

NOMINATIONS DE L'ACA

Selon les réglements de l'Association Canadienne d'Acoustique, l'ancien président doit nommer des personnes pour occuper les postes vacants au conseil d'administration et au comité directeur de l'Association.

L'ancien président de l'ACA, Tom Northwood, nous a appris qu'il nommera les personnes suivantes pendant la réunion général 1985: Président, Cameron Sherry; Secrétaire, Deirdre Benwell; Editeur, John Bradley; Trésorier, Tom Ho.

Directeurs: Deux de nos directeurs, Sharon Abel et Leslie Russell, démissionnent cette année. Pour les remplacer, Nicole Lalande (Université de Montréal) et Winston Sydenborgh (H.L. Blachford Limited) seront nommés pour servir une période de quatre ans.

Autres nominations sont invitées et doivent être reçues avec le consentement des nominés par le Secrétaire (Deirdre Benwell) avant la réunion générale 1985 à Ottawa.

CAA SLIDE PRESENTATION ON CANADIAN ACOUSTICS

The CAA Membership Committee is compiling slides and audio examples to support an audio-visual presentation on Acoustics in Canada. Slides of various work settings, research settings, equipment, innovative technology, applications of acoustics in real-life situation, and straightforward graphical representations are welcome. Materials should be intelligible to people from a wide variety of backgrounds. The source of all materials and sponsoring agency, if applicable, will be acknowledged in the presentation.

Please send from one to ten slides, accompanying audio demonstration if applicable, and explanatory text to Mr. Ron Newman, Bruel & Kjaer, Canada Ltd., Suite 71D, 71 Bramalea Road, Bramalea, Ontario, L6T 2W9.

REGIONAL CHAPTERS

If you are interested in initiating a new Regional Chapter of the CAA, some of the following material might be helpful: a) the CAA constitution; b) sample programs of regional chapter meetings held elsewhere; c) a list of CAA members in your area; d) a list of professors and researchers in acoustics in post-secondary institutions in your area. Please write Dr. Annabel Cohen, Centre for Research in Human Development, Erindale Campus, University of Toronto, Mississauga, Ontario, L5L 1C6.

CAA PAMPHLET

Copies of the CAA pamphlet are available from Dr. Annabel Cohen (address above).

THE CAA WELCOMES THE FOLLOWING NEW MEMBERS

Mr. D.B. Archer, Dr. Ben Barkow, Simon Bargetzi, Mr. Rene Benoit, J.W. Boutilier, Mr. Catelli, David Chapman, Mr. Robert Clarke, Mr. M.A. Collins, Dr. T. Craggs, Mr. Kevin J. Deevy, Mr. Sylvio Desjardings, Mr. L. Droin, George S. Dudas, Mr. Michael Dunn, Mr. Alan Eckel, Mr. Dale Ellis, Mr. P.J. Folan, Dr. Shal Gewurtz, Mr. Shalini Gupta, Mr. Ian D. Hartley, Half Nelson Systems, Inc., Ms. Kathy Hoffmeyer, Mr. Brian Howe, A.E.D. Hughes, Mr. Michael Kaye, Mr. Klaus Kleinschmidt, Mr. K.G. Knoll, Dr. Steven Kraemer, Robert Lapensée, Ms. Jennifer Lewis, Mr. M. Macecek, Ms. Kathleen Magwood, Jorge Menyhart, Fethi Metalsi-Tani, Mr. T. Bryant Moodie, Mr. M. Morin, Mr. Alasdair G. Mckay, Mr. Marek Mieszkowski, H.M. Merklinger, Ms. Tani Nixon, Mr. B. Noon, Mr. Daniel Ouellet, Mr. B.P. Pathak, Mr. Soren Pedersen, K. Periyathamby, Mr. J-B. Piaud, Mr. Srivatsa Rajan, Dr. P.R. Staal, Mr. Barry Roberts, Professor Ronald Sims, Mr. K. Vye, Mr. Larry Westlake, Dr. Amanda Walley, Mr. A. Staffer, Ms. Leigh Thorpe, Ms. Joan Westland, P. Zakarauskas.

CANADIAN ACOUSTICAL ASSOCIATION TORONTO CHAPTER AGENDA FOR 1985/86 SEASON

All meetings are held in the Ontario Hydro Auditorium (700 University Avenue, Toronto) and start at 19:00 hr.

Tuesday, 10 September 1985
Topic: Environmental Noise
Convenors: C. Krajewski and Andy McKee

Tuesday, 12 November 1985
Topic: Hand-Arm Vibrations
Convenors: M. Barman and S. Abel

Tuesday, 26 January 1985
Visit to the Acoustical Laboratory,
Ontario Research Foundation
Convenors: W. Sydenborgh and A. Behar

Tuesday, 18 March 1986
Topic: Cochlear Implants
Convenors: S. Abel and A. Behar

Note: The number of meetings has been reduced to only four because of the International Acoustical Conference, that will keep us very busy as the month of July approaches.

A. Behar

INTERNATIONAL CONFERENCE ON SPEECH INPUT/OUTPUT: TECHNIQUES AND APPLICATIONS

Papers are now requested for the 1986 International Conference on Speech Input/Output to be held at the Institute of Education, London, from 24 to 26 March 1986. The Conference is being organized by the Institution of Electrical Engineers (IEE) in collaboration with the Royal Society of Medicine, the British Society of Audiology, the Institute of Acoustics and the Royal Society for Disability and Rehability.

The Conference will focus on research development and applications in the area of speech input to and output from machines. Those wishing to offer a contribution should submit a synopsis of one side of A4 paper by 15 October 1985 to: Conference Services, IEE, Savoy Place, London, WC2R 0BL, U.K.

INTER-NOISE 86 CALL FOR PAPERS IS ISSUED

INTER-NOISE 86 will be held on the campus of the Massachusetts Institute of Technology on 21 to 23 July 1986. Sessions are planned ranging from issues of noise regulation, compliance, and worker protection to fundamental aspects of noise generation and measurement. Papers are especially sought in newer areas of concern such as machinery monitoring and diagnostics, complex acoustic mobility measurement and computational methods for sound radiation and vibration transmission. The conference will, however, cover all areas of noise control engineering.

The deadline for the receipt of abstracts is 14 October 1985. Abstracts should be mailed to Professor Richard H. Lyon, Chairman, INTER-NOISE 86, INTER-NOISE 86 Secretariat, MIT Special Events Office, Room 7-111, Cambridge, Massachusetts, 02139, U.S.A.

NEW BOOKS

Indirect Imaging: Measurement and Processing for Indirect Imaging
J.A. Roberts, Ed.
Cambridge University Press
New York, NY, 1984

Bases of Hearing Science, 2nd ed.
John D. Durrant and Jean H. Lovrinic
Williams and Wilkins
Baltimore, 1984

Biological Effects of Ultrasound: Mechanisms and Clinical Implications W.L. Nyborg (chairman), P.L. Carson, F. Dunn, D.L. Miller, M.W. Miller, and M.C. Ziskin (NCRP Scientific Committee 66)
National Council on Radiation Protection and Measurements
Bethesda, MD, 1983

Hearing: Its Psychology and Physiology
Stanley Smith Stevens and Hallowell Davis
American Institute of Physics
New York, 1983

Spatial Hearing: The Psychophysics of Human Sound Localization
Jens Blauert
MIT Press
Cambridge, MA, 1983

Noise Sources in Ships: Vol. 1 - Propellers
A.C. Nilsson and N.P. Tyvand, Ed.
Nordforsk Pub.
Oslo, 1981

Hearing and Balance in the Elderly
Ronald Hinchcliffe, Ed.
Churchill Livingstone, Inc.
New York, NY

Noise and Society 1984
D.M. Jones and A.J. Chapman
John Wiley & Sons Limited

Introduction to Random Vibrations
N.C. Nigam
M.I.T. Press

Mikrofon-Aufnahmetechnik
Michael Dickreiter
Hirzel Verlag

Acoustic Emission
James R. Matthews
Gordon & Breach Science Publishers
New York

Vertical Seismic Profiling, Part A: Principles
Bob A. Hardage
Geophysical Press Ltd.
London

Vertical Seismic Profiling, Part B: Advanced Concepts
M. Nafi Toksoz and Robert R. Stewart, Eds.
Geophysical Press Ltd.
London

Deconvolution
Anton Ziolkowski
International Human Resources Development Corporation
Boston, 1984

Sound and Structural Vibration: Radiation, Transmission and Response
Frank J. Fahy
Academic Press, Inc.

Secure Speech Communications
Henry J. Beker and Fred C. Piper
Academic Press, Inc.

Fundamentals of Speech Signal Processing
Shuzo Saito and Kazuo Nakata
Academic Press, Inc.

Underwater Acoustics: A Linear Systems Theory Approach
Lawrence J. Ziomek
Academic Press, Inc.

Phonological Acquisition and Change
John L. Locke
Academic Press
New York, 1983

Seismic Instrumentation
Maurice Pieuchot
Geophysical Press Ltd.
London

The Phonetic Bases of Speaker Recognition
Francis Nolan

Cambridge University Press
New York, 1983

Acoustic Waveguides: Applications to Oceanic Science
Allan Boyles.
Wiley-Interscience Publishers

CANADIAN ACOUSTICAL PUBLICATIONS

RECENTLY PUBLISHED CANADIAN ACOUSTICAL MATERIAL IS LISTED BELOW AS AN INFORMATION SERVICE. PLEASE INFORM THE EDITOR OF OTHER NEW CANADIAN ACOUSTICAL PUBLICATIONS.

Title, Publisher (and Address if not a Journal) Author(s), Reference and Date

Helicopter Noise Level Tests, Camel Point - Victoria, B.C.
K.C. Simpson
Transport Canada - PNRP
Air Navigation System Requirements
880-800 Burrard Street
Vancouver, British Columbia
TP6654E
July 1985

Aircraft Noise - Baseline Study, Kamloops Airport, B.C.
K.C. Simpson and A.A. Hart
Transport Canada - PNRP
Air Navigation System Requirements
880-800 Burrard Street
Vancouver, B.C.
TP6042E
February 1985

Insertion Loss of Suspended Decorative Cylinders
J.S. Bradley
National Research Council Canada
Division of Building Research
Ottawa, Ontario
BRN 231
June 1985

Technical Translation
New Results on the Acoustics of Concert Halls
D. Gottlob, K.F. Siebrasse, M.R. Schroeder
DAGA '75, p. 467-470 (Proceedings, German Acoustical Association
Meeting, 1975)
Translated by: J.S. Bradley
National Research Council Canada
Division of Building Research
Ottawa, Ontario
TT 2112
1985

Technical Translation
Acoustical Absorption Coefficient in a Diffuse Field of a Plane,
Rectangular Material of Finite Dimensions Placed on an Infinite
Perfectly Reflecting Surface
J.F. Hamet
Revue D'Acoustique, Vol. 17, No. 71, p. 204-210, 1984
Translated by: A.C.C. Warnock
National Research Council Canada
Division of Building Research
Ottawa, Ontario
TT 2113
1985

Comment réduire la transmission des bruits entre les logements
A.C.C. Warnock
National Research Council Canada
Division of Building Research
Ottawa, Ontario
BRN 44F
March 1985

Sound Transmission Loss of Masonry Walls - Tests on 90, 140, 190, 240
and 290 mm Concrete Block Walls With Various Surface Finishes
A.C.C. Warnock and D.W. Monk
National Research Council Canada
Division of Building Research
Ottawa, Ontario
BRN 217
June 1984

Sampling Statistics of Sound Fields in Reverberation Rooms: Pure Tone
Excitation
W.T. Chu
National Research Council Canada
Division of Building Research
Ottawa, Ontario
BRN 229
April 1985

Vibrations in Buildings
J.H. Rainer
National Research Council Canada
Division of Building Research
Ottawa, Ontario
CBD 232
May 1984

Vibrations dans les bâtiments
J.H. Rainer
Conseil national de recherches Canada
Division des recherches en bâtiment
Ottawa. Ontario
CBD 232F
novembre 1984

Effect of Rotation on Motion Measurements of Towers and Chimneys
J.H. Rainer
National Research Council Canada
Division of Building Research
Ottawa, Ontario
BRN 230
June 1985

Vibration Amplitudes in the Inuvik Powerhouse
G. Pernica, V.R. Parameswaran and G.H. Johnston
National Research Council Canada
Division of Building Research
Ottawa, Ontario
NRCC 24480
May 1985

Vibration White Finger Disease Among Tree Fellers in British Columbia
R.L. Brubacker, C.J.G. Mackenzie, P.R. Eng, and D.V. Bates
Journal of Occupational Medicine
Vol. 25, No. 5, 403-408
May 1983

CALENDAR 1985/86

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

1-4 October 1985
Architectural Acoustics
Strbske Pleso, Czechoslovakia

13-17 October 1985
79th Audio Engineering Society Convention
New York, NY, U.S.A.

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

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

12-16 May 1986
Acoustical Society of America
Cleveland, OH, U.S.A.

14-18 July 1986
ICA Satellite. Acoustical Imaging and Underwater Acoustics

21-22 July 1986
ICA Satellite. Units and Their Representation in Speech Recognition
Montreal. Canada

21-23 July 1986
INTER-NOISE 86
Boston. MA, U.S.A.

24-31 July 1986
12th International Congress on Acoustics
Toronto, Canada

2-4 August 1986
ICA Satellite, Acoustics and Theatre Planning
Vancouver, Canada

21-26 September 1986
10th Congress on Building Research
Washington, DC, U.S.A.

8-12 December 1986
Acoustical Society of America
Anaheim, CA, U.S.A.

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