12th INTERNATIONAL CONGRESS ON ACOUSTICS

12e CONGRÈS INTERNATIONAL D'ACOUSTIQUE

12. INTERNATIONALER KONGRES FÜR AKUSTIK

VOLUME / BAND IV

TORONTO, CANADA
24-31 JULY 1986
12th INTERNATIONAL CONGRESS ON ACOUSTICS

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WELCOME TO 12 ICA

This is an invitation to participate in a Congress dedicated to the broad field of acoustics in all of its richness and diversity. Our common purpose is to share knowledge, ideas and experience with one another seeking new perspectives in our areas of specialization, enlarging our view of the broad field and deepening the channels of communication among us. As hosts, we look forward to meeting colleagues from many countries and hope that they and their families will feel welcome in Toronto.

Since 1953, these International Congresses on Acoustics have flourished under the aegis of the International Union of Pure and Applied Physics reminding us that acoustics is rooted in physics. But the branches of this congenial science embrace many fields of human endeavour including physiology, oceanography, music, psychology, engineering, architecture, speech science and medicine. All of these and many others are represented in the 12 ICA Program.

Under the gentle guidance of the IUPAP Commission on Acoustics, this 12th Congress is organized by the Canadian Acoustical Association which is also responsible for three specialized Symposia associated with the Congress to be held in Halifax, Montreal and Vancouver. In parallel, we have worked with other organizations to ensure coordination between 12 ICA and kindred meetings in various places.

Welcome to 12 ICA and welcome to Canada in 1986.

E.A.G. Shaw

BIENVENUE AU 12 ICA

C'est avec plaisir que nous vous invitons à participer à un congrès consacré à ce vaste domaine qu'est l'acoustique dans toute sa richesse et sa diversité. Notre objectif est de partager nos connaissances, nos idées et notre expérience à la recherche de perspectives nouvelles dans nos domaines de spécialisation, en élargissant d'avantage notre vision de l'acoustique et en développant les moyens de communications entre nous. En tant qu'hôtes, nous souhaitons rencontrer des collègues de plusieurs pays et espérons qu'ils se sentiront les bienvenus à Toronto ainsi que leur famille.

Depuis 1953, les congrès internationaux d'acoustique ont fleuri sous les hospices de l'Union internationale de physique pure et appliquée, en nous rappelant le fait que l'acoustique prend ses racines dans la physique. Mais, les ramifications de cette science aux multiples affinités embrassent plusieurs champs de l'activité humaine, comprenant la physiologie, l'océanographie, la musique, la psychologie, le génie, l'architecture, les sciences de la parole et la médecine. Chacune d'elles ainsi que plusieurs autres figurent au Programme du 12 ICA.

Sous les conseils discrets de la Commission de l'acoustique de L'IUPPA, ce 12ème Congrès est organisé par l'Association canadienne de l'acoustique qui assume également la responsabilité de trois Symposia spécialisés associés au Congrès lesquels auront lieu à Halifax, à Montréal et à Vancouver. Parallèlement, nous avons collaboré avec d'autres organisations pour faire en sorte que soit assurée la coordination du 12 ICA et des réunions parentes qui auront lieu en divers endroits.

Bienvenue au 12 ICA et bienvenue au Canada en 1986.

E.A.G. Shaw

WILLKOMMEN ZUM 12 ICA

Dies ist eine Einladung zur Teilnahme an einem Kongress, der dem weiten Thema der Akustik mit all ihrem Reichtum und ihrer Vielfalt gewidmet ist Unser gemeinsamer Ziel ist der Erfahrungsaustausch, die Suche neuer Perspektiven in unserem Spezialfeld und eine Vertiefung der Verständigung unter uns. Als Gastgeber freuen wir uns, Kollegen aus zahlreichen Ländern zu begrüssen und hoffen, dass sie und ihre Familien sich in Toronto wohlfühlen werden.


Herzlich willkommen zum 12 ICA und in Kanada.

E.A.G. Shaw
Chairman/Président/Präsident:  
H. Myncke (Belgium/Belgique)

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W. Löchstöer (Norway)  
P. Lord (Great Britain)  
Z. Maekawa (Japan)  
A. Silwinski (Poland)  

Associate Members/Membres associés/Genossen:  
F. Kolmer (Czechoslovakia)  
M.J. Lighthill (Great Britain)  
D.Y. Ma (China)  
E.A.G. Shaw (Canada)  
J.J. Zwislocki (USA)  

Liaison:  
D. Wilkinson (Great Britain)

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J.A. Ayres ................................................................. Finance Committee/Comité des Finances
T.F.W. Embleton ........................................................ Technical Program/Programme technique
R.B. Johnston ........................................................... Financial Support/Appui financier
J. Manuel ................................................................. Secretary-General/Secrétaire-général
J.E. Piercy ............................................................... Coordinated Meetings/Événements connexes
C.W. Sherry ............................................................... President CAA/Président ACA
A.C.C. Warnock ........................................................ Advisory Committee/Comité consultatif

*Appointed by the Canadian Acoustical Association (CAA)/Nommé par l’Association Canadienne de l’Acoustique (ACA)

Technical Program Committee/Comité du Programme technique:

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G.A. Daigle, M.R. Stinson, A.C.C. Warnock

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R.B. Johnston, J. Manuel, M. Osman,  
M. Sacks, J. Swallow

Social Events/Événements sociales:

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A. Cohen, H. Kunov, J. O’Keefe,  
M.J. Pike, R. Ramakrishnan

Services and Facilities/Services et Facilités:

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A. Behar, J. Kowalewski

Accommodation:

S.M. Abel (Chairman/Président)  
C. Stevens, D. Rokas

Secretariat/Secrétariat:

J. Manuel (Secretary-General/Secrétaire général)  
H. Gidamy, C.A. Krajewski, V. Schroeter

Finance Committee/Comité des Finances:

J.A. Ayres (Chairman/Président)  
S.M. Abel, R.B. Johnston, J. Manuel

Technical Tours/Visites techniques:

H. Gidamy, J. Manuel

Exhibition:

J. Hemingway (Chairman/Président)  
J. Manuel, J.L. Manuel, W. Sydenborg

Publicity/Publicité:

M. Sacks (Chairman/Président)  
S. Kraemer

Special Services:


Translators/Traducteurs:

G.A. Daigle, M.W. Grote, R. Hétu, N. Lalande  
A. L’Espérance, J. Nicolas,  
W.G. Richarz, K. Sienssen, R. Serré
Symposia Associated with the 12th International Congress on Acoustics
Symposia associés du 12ème Congrès International d'Acoustique
Symposia in Verbindung mit dem 12. Internationalen Kongress für Akustik

- Underwater Acoustics, Halifax, July 16-18, 1986
  Chairman: H.M. Merklinger
  Secretariat: 1986 Acoustics Conferences, c/o Department of Engineering Physics, Technical University of Nova Scotia, P.O. Box 1000, Halifax, N.S., Canada B3J 2X4

- Speech Recognition/Reconnaissance de la parole, Montreal, July 21-22, 1986
  Chairman/Président: P. Mermelstein
  Secretariat: Montreal Symposium on Speech Recognition, c/o Bell Northern Research, 3 Place du Commerce, Verdun, Qué., Canada H3E 1H6

- Acoustics and Theatre Planning for the Performing Arts
  Chairman: J.P. Walsh
  Secretariat: 12 ICA Vancouver Symposium, P.O. Box 48169, Bentall Centre, 595 Burrard Street, Vancouver, B.C., Canada V7X 1N8

Independent Meetings Coordinated with 12 ICA
Réunions indépendantes coordonnées avec 12 ICA
Unabhängig mit der 12 ICA verbundene Konferenzen


- Inter-Noise 86, Cambridge, MA, USA, July 21-23, 1986

- International Symposium on Musical Acoustics (Catgut Acoustical Society), Hartford, CT, USA, July 21-23, 1986

- Conference on Non-Destructive Materials Characterization/l’Évaluation non destructive des caractéristiques des matériaux, Montréal, July 21-23, 1986

Previous International Congresses on Acoustics
Congrès internationaux d'acoustique antérieurs
Bisherige Internationale Kongresse für Akustik

1 ICA 16-24 June 1953 Delft Netherlands
2 ICA 17-23 June 1956 Cambridge U.S.A.
3 ICA 1-9 September 1959 Stuttgart F.R.G.
4 ICA 21-28 August 1962 Copenhagen Denmark
5 ICA 7-14 September 1965 Liège Belgium
6 ICA 21-28 August 1968 Tokyo Japan
7 ICA 18-26 August 1971 Budapest Hungary
8 ICA 24-30 July 1974 London United Kingdom
9 ICA 4-9 July 1977 Madrid Spain
10 ICA 9-16 July 1980 Sydney Australia
11 ICA 19-27 July 1983 Paris France
GENERAL INFORMATION

VENUE

The 12th International Congress on Acoustics is being held in the Metro Toronto Convention Centre, 255 Front Street West, Toronto, from Thursday, July 24 to Thursday, July 31, 1986. All participants and accompanying persons are invited to attend the opening ceremonies in Roy Thomson Hall, 60 Simcoe Street, at 10:00 h on July 24.

REGISTRATION

For Congress Participants the registration fee is $220 Cdn if paid by May 23, 1986 or $270 Cdn if paid later. For Full-time Graduate Students currently enrolled in degree programs, the registration fee is $100 Cdn if paid by May 23, 1986 or $135 Cdn if paid later. These fees cover a complete set of Congress publications and attendance at all Technical Sessions, the Exhibition and the Congress receptions. For single-day visitors the registration fee is $75 Cdn. This fee covers attendance at Technical Sessions and the Exhibition, and a copy of the Congress Program. For Accompanying Persons the registration fee is $70 Cdn which covers the City Tour ($1), attendance at the official opening and Congress receptions, and a copy of the Congress Program. A meeting area for accompanying persons is being provided in the Convention Centre near the Registration Desk.

Registration badges must be worn at all times for admission to the Technical Sessions, Exhibition and Congress Events.

REGISTRATION DESK

The Registration desk is located on the main floor of the Metro Toronto Convention Centre and will be open from 14:00 to 20:00 h on Wednesday, July 23 and from 08:00 to 17:00 h, Thursday, July 24 to Thursday, July 31, 1986 (weekdays only).

TECHNICAL PROGRAM

The working languages for the Congress are English, French and German. There will be no simultaneous translation of technical papers; papers will be presented in the language of the author's choice. There are three types of sessions: Plenary lecture sessions, special structured sessions, and sessions of contributed papers.

Plenary Lecture Sessions: last 45 minutes, each plenary lecture being given to the whole Congress. The invited guest speakers, and their chosen topics are:

- R.R. Goodman  Ocean Acoustics: The Remarkable Sea of Sound
- Y. Ando  Physical Properties of Sound in Rooms and Subjective Effects in Man
- D.T. Blackstock  Nonlinear Behaviour of Sound Waves
- J.E. Roux  l’Évaluation des propriétés mécaniques et structurelles des matériaux par les méthodes ultrasonores
- M.J. Griffin  Human Responses to Vibration
- G. Neuweller  Auditory Time Analysis in Echo-locating Bats
- Yu V. Gulyaev  Recent Achievements in Quantum Acoustics

Structured Sessions: lasting one-half day each. These sessions have been organized on well-defined themes and will consist of invited review or tutorial papers, contributed papers, panel discussions, demonstrations, films or combinations of these formats. The session titles and organizers are:

- Isolation acoustique des structures (C. Lesueur)
- Arctic acoustics (P.N. Mikhailovsky)
- New materials for transducers (G.C. Gaunaurd)
- Le bruit des lignes électriques à haute tension (J. Delambre)
- Signal analysis in real time including transmit-signal coding (E.C. Corliss and E.H. Brown)
- Epidemiology of occupational hearing loss: 100 years later (R. Hétu)
- Room acoustics: recent developments (M.R. Schroeder)
- Education in acoustics: discussions, demonstrations and films (J. Tichy)
- Oto-acoustics and cochlear mechanics (D.T. Kemp)
- Ultrasonic material characterization (L. Adler)
- Cavitation (W.L. Nyborg)
- Measurement of hearing protector attenuation (E.H. Berger)
- Active control of vibration (L. Meirovitch)
- Bio-response to vibration (A.J. Brummer)
- Musical instruments: very old and very new (W.R. Savage and A.H. Benade)

Sessions of Contributed Papers: A total of 20 minutes will be allowed for the introduction, presentation and discussion of each contributed paper. It is suggested that authors plan to speak for 15-17 minutes leaving time for discussion. The contributed papers will be presented in multiple parallel sessions arranged according to subject classification.

CONGRESS PUBLICATIONS

Each registered Congress Participant is entitled to receive one copy of the Congress Proceedings (three volumes), the Congress Program and the exhibition Program on arrival at the Congress. The texts of the plenary session lectures, the contributed papers and the papers prepared for presentation in structured sessions are printed in the Proceedings. The abstracts are printed in this Program. Additional sets of Congress Proceedings and Program are available from the Secretariat at $75 per set.

CONGRESS EVENTS AND SOCIAL ACTIVITIES

Thursday, July 24 10:00-12:00h  *12 ICA Opening Ceremonies in Roy Thomson Hall. The Congress will be opened by the Honourable Lincoln M. Alexander, Lieutenant Governor of Ontario. The program will include music performed by the Toronto Symphony Orchestra Brass Quintet.

Thursday, July 24 18:00-20:00h  *12 ICA Welcome Reception in Toronto City Hall.
Friday, July 25
09:30-12:00h  *Toronto City Tour for Accompanying Persons (Tour S1, Accompanying Persons: no charge, others $17.50)

Friday, July 25
18:45-22:00h  Concert and Acoustical Demonstration in Roy Thomson Hall (Tour S2, $16.50 per person)

Monday, July 28
18:00-22:00h  12 ICA Evening at the Ontario Science Centre with buffet supper. This centre is noted for the imaginative presentation of scientific principles ($20 Cdn per person including transportation, admission and buffet).

Tuesday, July 29
18:30-19:30h  *12 ICA Reception at the Royal York Hotel hosted by the Canadian Acoustical Association

Tuesday, July 29
19:30-22:30h  12 ICA Banquet at the Royal York Hotel followed by entertainment. ($40 Cdn per person)

Wednesday, July 30
20:30-22:30h  Demonstration Concert in St. Andrew's Church featuring the eight instruments of the Violin Octet developed by the Catgut Acoustical Society (donation at the door: $5)

Thursday, July 31
15:30-16:00h  *Closing Ceremony at the Convention Centre

Thursday, July 31
16:00-17:00h  *12 ICA Farewell Reception at the Convention Centre

*These events and activities are covered by the registration fees.

SOCIAL TOURS

A number of tours within the City of Toronto and to more distant places such as Niagara Falls have been arranged for accompanying persons and Congress participants. Four of these (S4, S6, S10 and S11) include visits to technical facilities. Full descriptions and prices are included in this Program. Further information is available at the Tours Desk in the Registration area.

12 ICA TECHNICAL TOURS

Several visits to laboratories and industrial facilities have been arranged for limited numbers of Congress participants. Detailed information is available at the Tours Desk in the Registration area.

12 ICA EXHIBITION

An International Exhibition of equipment, instrumentation, materials, and literature is being held in conjunction with the Congress in the lower level of the Metro Toronto Convention Centre. The Exhibition will open on Monday, July 28 at 10:00h and close at 16:00h on Thursday, July 31.

MEALS AND REFRESHMENTS

Light luncheons and beverages will be available throughout the Congress in the area adjoining the 12 ICA Exhibition (Constitution Hall C). Coffee will be provided in the Exhibition area courtesy of the exhibitors.

BANKING

Banks specializing in international currency exchange are located in the Metro Toronto Convention Centre and in the Royal York Hotel. The Convention Centre branch of the Royal Bank is open from 10:00h to 16:00h, Monday to Thursday and from 10:00h to 18:00h Friday. Travellers cheques in Canadian and U.S. dollars and major credit cards are usually accepted by hotels, restaurants and shops in all parts of Canada.

TRAVEL PLANNING

The official overseas carriers for the Congress and Associated Symposia are Air Canada and Canadian Pacific Airlines. These carriers can provide practical assistance in planning itineraries and arrange post-Congress tours in North America.

Airline telephone numbers in Toronto are:
Air Canada(service in English) 925-2311
(service in French) 969-5621
Canadian Pacific Airlines 675-2211

SECRETARIAT ADDRESS

Mail: 12 ICA Secretariat
P.O. Box 123, Station “Q”
Toronto, Canada
M4T 2L7
Telex: 062-3496 J. Manuel
Telephone: 416-965-4120 J. Manuel
RENSEIGNEMENTS GÉNÉRAUX

ENDROIT
Le 12\textsuperscript{ème} Congrès international d’acoustique aura lieu dans le Centre des Congrès du Toronto métropolitain, 255, rue Front à Toronto, du jeudi 24 juillet au jeudi 31 juillet 1986. Tous les participants et les personnes qui les accompagnent sont invités aux cérémonies inaugurales, au Roy Thompson Hall, 60, rue Simcoe, à 10h le 24 juillet.

INSCRIPTION
Pour les participants au Congrès, le droit d’inscription est de 220 $ CAN s’ils sont acquittés en date du 23 mai 1986 ou de 270 $ CAN s’ils sont déboursés ultérieurement. Pour les étudiants inscrits à temps complet à un programme d’étude de 2\textsuperscript{e} ou 3\textsuperscript{e} cycle, le droit d’inscription est de 100 $ CAN s’ils sont acquittés en date du 23 mai 1986 ou de 135 $ CAN s’ils sont déboursés ultérieurement. Ces montants donnent droit à une collection complète des publications du Congrès ainsi qu’à la participation à toutes les sessions techniques, aux expositions et aux réceptions du Congrès. Le droit d’inscription pour une seule journée est de 75 $ CAN pour visiteurs (participation aux sessions techniques et Programme du Congrès seulement). Le droit d’inscription pour les personnes accompagnantes est de 70 $ CAN, donnant droit à la visite de la ville (S1), la participation à l’ouverture officielle et aux réceptions du Congrès, ainsi que le programme du Congrès. Un local d’accueil pour les personnes invitées sera disponible au Centre des Congrès, près du bureau d’inscription.

Il faut porter l’insigne d’inscription en tout temps pour être admis aux sessions techniques et aux événements liés au Congrès.

BUREAU DES INSCRIPTIONS
Le bureau des inscriptions sera situé au Centre des Congrès du Toronto métropolitain : il sera ouvert de 14h à 20h le mercredi 23 juillet et de 8h à 17h du jeudi 24 juillet au jeudi 31 juillet (les jours de semaine uniquement).

PROGRAMME TECHNIQUE
Les langues de travail du Congrès sont l’anglais, le français et l’allemand. Il n’y aura pas de traduction simultanée des communications techniques : les communications seront présentées dans la langue choisie par l’auteur. Le programme technique du Congrès sera constitué de trois types de sessions : des séances plénières, des sessions structurées spéciales et des sessions de conférences particulières.

Séances plénières : d’une durée de 45 minutes chacune, les conférences plénières seront adressées à tout le Congrès. Les conférenciers invités et les sujets qu’ils ont choisis sont les suivants :

- M.J. Griffin
  Human Responses to Vibration
- G. Neuweiler
  Auditory Time Analysis in Echo-lcating Bats
- Yu V. Gulyaev
  Recent Achievements in Quantum Acoustics

Les sessions structurées : leur durée est d’une demi-journée chacune. Ces sessions ont été organisées autour de thèmes bien définis et comporteront des communications invitées, des conférences particulières, des discussions entre spécialistes invités, des démonstrations, des films ou une combinaison de ces approches. Les titres provisoires de ces sessions sont :

- Isolation acoustique des structures (C. Lesueur)
- Arctic acoustics (P.N. Mikhailovsky)
- New materials for transducers (G.C. Gaunaud)
- Le bruit des lignes électriques à haute tension (J. Delcambre)
- Signal analysis in real time including transmit-signal coding (E.C. Corliss and E.H. Brown)
- Epidemiology of occupational hearing loss: 100 years later (R. Hétu)
- Room acoustics: recent developments (M.R. Schroeder)
- Education in acoustics: discussions, demonstrations and films (J. Tichy)
- Oto-acoustics and cochlear mechanics (D.T. Kemp)
- Ultrasonic material characterization (L. Adler)
- Cavitation (W.L. Nyborg)
- Measurement of hearing protector attenuation (E.H. Berger)
- Active control of vibration (L. Meirowitch)
- Bio-response to vibration (A.J. Brammer)
- Musical instruments: very old and very new (W.R. Savage and A.H. Benade)

Sessions de contributions particulières : une durée totale de 20 minutes sera accordée pour l’introduction, la présentation et la discussion de chaque présentation particulière. Il est recommandé aux auteurs de prévoir 17 minutes d’exposé de façon à accorder quelque temps pour la discussion. Les contributions particulières seront présentées dans plusieurs sessions parallèles aménagées d’après la classification des catégories de communications.

PUBLICATIONS DU CONGRÈS
Chaque participant inscrit au Congrès a le droit de recevoir un exemplaire des Actes du Congrès (trois volumes), le Programme du Congrès et le Programme des expositions, à son arrivée au Congrès. Le texte des conférences plénières, des conférences particulières et des exposés de sessions structurées figure dans les Actes. Les résumés figurent dans le Programme. Des exemplaires supplémentaires des Actes du Congrès et du Programme se vendront au Secrétariat (75 $ l’ensemble).

ÉVÉNEMENTS DU CONGRÈS ET ACTIVITÉS SOCIALES
Jeudi 24 juillet
10h - 12h
*Cérémonies d’inauguration du 12\textsuperscript{ème} Congrès a Toronto, le 24 juillet 1986.

*Ouverture du Congrès par l’honorable Lincoln M. Alexander, lieutenant-gouverneur de l’Ontario. Le programme comprendra un concert
exécuté par le Quintet des cuivres de l'Orchestre symphonique de Toronto.

Jeudi 24 juillet
18h - 20h
*Réception de bienvenue du 12 ICA à l'Hôtel de ville de Toronto.

Vendredi 25 juillet
9h30 - 12h
*Visite guidée de la ville de Toronto pour les personnes accompagnantes (S1; personnes accompagnantes: sans frais, autres: 17,50 $)

Vendredi 25 juillet
18h45 - 22h
Concert et démonstration acoustique au Roy Thomson Hall (S2: 16,50 $ par personne)

Lundi 28 juillet
18h - 22h
Soirée du 12 ICA au Ontario Science Centre avec buffet. Ce centre est réputé pour ses illustrations innovantes de principes scientifiques (20 $ CAN par personne comprenant le transport, l'entrée et le buffet).

Mardi 29 juillet
18h - 19h30
*Réception du 12 ICA à l'Hôtel Royal York sous l'égide de l'Association canadienne de l'acoustique

Mardi 29 juillet
19h30 - 22h30
Banquet du 12 ICA à l'Hôtel Royal York suivi d'un spectacle. (40 $ CAN par personne.)

Mercredi 30 juillet
20h30 - 22h30
Concert de démonstration à l'église St. Andrew, présentant les huit instruments de l'Octet de violon mis au point par la Société d'acoustique Catgut (don au foyer: 5 $)

Jeudi 31 juillet
15h30 - 16h
*Cérémonie de clôture du 12 ICA au Centre des Congrès

Jeudi 31 juillet
16h - 17h
*Réception d'adieu du 12 ICA au Centre des Congrès.

*Ces événements et activités sont compris dans les frais d'inscription.

**MUSIQUE LE MIDI**

Le vendredi 25 juillet à 12h15 l'organiste Douglas Bodle présentera un récital d'une heure à l'église St. Andrew (démonstration de l'instrument à traction mécanique construit par Karl Wilhelm dans le style classique français).

Le mardi 29 juillet à 12h15 le groupe Armin Electric Strings donnera un concert-démonstration; il jouera pour la première fois un quatuor du compositeur canadien John Reid, commandé par 12 ICA et parrainé par le Conseil des Arts du Canada. Le lundi 28 juillet et le mercredi 30 juillet, à 12h15, on jouera de la musique électro-acoustique enregistrée de différents compositeurs représentant un choix de techniques numériques. Ces trois concerts seront donnés au Centre des Congrès et chacun durera 45 minutes environ. Tous les participants et les personnes qui les accompagnent sont cordialement invités.

**VISITES TOURISTIQUES**

Plusieurs visites touristiques de la ville de Toronto et d'autres endroits tels que les chutes Niagara ont été organisées pour les personnes accompagnantes et pour les participants. Quatre d'entre elles (S4, S6, S10 et S11) comprennent des visites techniques. On en trouvera la description complète ainsi que les tarifs dans le Programme. On pourra obtenir des renseignements supplémentaires au comptoir touristique près du bureau d'inscription.

**VISITES TECHNIQUES DU 12 ICA**

Plusieurs visites de laboratoires et d'installations industrielles sont organisées pour des nombres limités de participants. On trouvera des renseignements détaillés au comptoir touristique près du bureau d'inscription.

**EXPOSITIONS DU 12 ICA**

Une exposition internationale d'équipement, d'instruments, de matériaux et de littérature technique aura lieu parallèlement au Congrès, au Centre des Congrès torontois (niveau inférieur). L'exposition débutera le lundi 28 juillet à 10h, pour se terminer le jeudi 31 juillet à 18h.

**REPAS ET RAFAÎCHISSEMENTS**

On pourra commander des repas légers et des boissons tout au long du Congrès dans le local à côté de l'Exposition 12 ICA (Hall C, niveau inférieur). Du café sera servi dans le local d'exposition, gracieuseté des exposants.

**BANQUES**

On trouvera au Centre des Congrès et à l'Hôtel Royal York des banques qui se spécialisent dans les opérations de change. La succursale de la Banque Royale au Centre des Congrès est ouverte de 10h à 16h du lundi au jeudi et de 10h à 18h le vendredi. Normalement, les chèques de voyage en devises canadiennes ou américaines et les principales cartes de crédit sont acceptées dans les hôtels, les restaurants et les boutiques partout au Canada.

**PROJETS DE VOYAGE**

Les transporteurs officiels du Congrès et des Symposia Air Canada et CP Air. Leur personnel vous aider à planifier votre itinéraire, y compris toute visite en Amérique du Nord après le Congrès. Les numéros de téléphone des lignes aériennes à Toronto sont:

- Air Canada (service en anglais) 925-2311
  (service en français) 969-5621
- CP Air 675-2211

**ADRESSE DU SECRÉTARIAT**

poste: 12 ICA Secretariat, P.O. Box 123, Station "O" Toronto, Canada M4T 2L7

télé: 062-3496 (J. Manuel)
téléphone: (416) 965-4120 (J. Manuel)
ALLGEMEINE INFORMATIONEN

TAGUNGSORT


ANMELDUNG


Für den Zugang zu den Fachsitzungen, der Ausstellung und der Empfänge sind die Anmeldungszeichen zu tragen.

REGISTRATION


PROGRAMMABLAUF


Plenarvorträge: Diese Referate vor dem versammelten Kongress dauern jeweils 45 Minuten. Die Referenten und ihre Themen lauten:

- R.R. Goodman: Ocean Acoustics: The Remarkable Sea of Sound
- Y. Ando: Physical Properties of Sound in Rooms and Subjective Effects in Man
- D.T. Blackstock: Nonlinear Behaviour of Sound Waves
- J.E. Roux: l'Evaluation des propriétés mécaniques et structurales des matériaux par les méthodes ultrasonores

- M.J. Griffin: Human Responses to Vibration
- G. Neuweiler: Auditory Time Analysis in Echo-locating Bats
- Yu V. Gulyaev: Recent Achievements in Quantum Acoustics

Arbeitssitzungen: Diese Sitzungen finden jeweils halbtags statt. Sie konzentrieren sich auf ausgewählte, klar umrisseene Themen, die in der Form von Übersichts- oder Fortbildungsvorträgen, Kurzvorträgen, Diskussionen am runden Tisch, Vorführungen und Filmen behandelt werden. Die vorgeschlagenen Themen lauten:

- Isolation acoustique des structures (C. Lesueur)
- Arctic acoustics (P.N. Mikhailovsky)
- New materials for transducers (G.C. Gaunaud)
- Le bruit des lignes électriques à haute tension (J. Delambre)
- Signal analysis in real time including transmit-signal coding (E.C. Corliss and E.H. Brown)
- Epidemiology of occupational hearing loss: 100 years later (R. Héto)
- Room acoustics: recent developments (M.R. Schroeder)
- Education in acoustics: discussions, demonstrations and films (J. Tichy)
- Oto-acoustics and cochlear mechanics (D.T. Kemp)
- Ultrasonic material characterization (L. Adler)
- Cavitation (W.L. Nyborg)
- Measurement of hearing protector attenuation (E.H. Berger)
- Active control of vibration (L. Meirovitch)
- Bio-response to vibration (A.J. Brammer)
- Musical instruments: very old and very new (W.R. Savage and A.H. Benade)


KONGRESSVEREINFERTICHUNGEN


KONGRESSBEGLEITENDES PROGRAMM UND GESELLSCHAFTLICHE VERANSTALTUNGEN

Donnerstag, 24. Juli, 10.00-12.00 Uhr


Donnerstag, 24. Juli, 18.00-20.00 Uhr

*Stadtrundfahrt durch Toronto für Begleitpersonen. (Tour S1, Begleit-
personen: frei, andere Personen: Cdn$ 17,50 pro Person)

Freitag, 25. Juli, 18.45-22.00 Uhr
Konzert und akustische Vorführung in der Roy Thomson Hall; der Eintritt beträgt Cdn$ 16,50 pro Person. (Tour S 2)

Montag, 28. Juli, 18.00-22.00 Uhr
12. ICA-Abend im Ontario Science Centre mit Buffet. Das Science Centre ist für einfallsreiche Veranstaltungen wissenschaftlicher Prinzipien bekannt. Die Kosten einschließlich Transport und Buffet sind Cdn$ 20,- pro Person.

Dienstag, 29. Juli, 18.30-19.30 Uhr
*12. ICA-Emfang im Royal York Hotel, Gastgeber die “Canadian Acoustical Association”.

Dienstag, 29. Juli, 19.30-22.30 Uhr
12. ICA-Banquet im Royal York Hotel, mit anschließender Unterhaltung. (Cdn$ 40,- pro Person).

Mittwoch, 30. Juli, 20.30-22.30 Uhr

15.30-16.00 Uhr
16.00-17.00 Uhr

*Veranstaltungskosten durch die Anmeldegebühr beglichen

MUSIK ZUM MITTAG


GESELLSCHAFTSAUSFAHRTEN

12 ICA TECHNISCHE RUNDFAHRTEN
Mehrere Besuche von Laboratorien und Industrieanlagen sind für eine begrenzte Teilnehmerzahl vorgesehen. Detaillierte Informationen sind an der Registration erhältlich.

12 ICA AUSSTELLUNG

MAHLZEITEN UND ERFRISCHUNGEN
Imbisse und Getränke sind während des Kongresses in den Ausstellungsräumen im unteren Flur erhältlich. Für Kaffee wird freundlicherweise durch die Aussteller gesorgt.

GELDMUTAUSCH
Sowohl im Kongresszentrum als auch im Royal York Hotel besteht die Möglichkeit, bei den dortigen Bankfilialen internationale Währungen zu wechseln. Die Filiale der Royal Bank im Kongresszentrum ist von Montag bis Donnerstag jeweils zwischen 10.00 und 16.00 Uhr geöffnet, sowie am Freitag zwischen 10.00 und 18.00 Uhr. Reiseschecks in Cdn$ und in US$ sowie bekannte Kreditkarten werden gewöhnlich in den Hotels, Restaurants und Geschäften in allen Teilen Kanadas angenommen.

REISEPLANUNG
Den offiziellen Transport für den Kongress und die angeschlossenen Symposien übernehmen Air Canada und Canadian Pacific Airlines. Diese Gesellschaften helfen bei der Reiseplanung und arrangieren auch Rundreisen durch Nordamerika im Anschluss an den Kongress. Die beiden Gesellschaften können in Toronto telefonisch unter den folgenden Rufnummern erreicht werden:

Air Canada (auf Englisch): 925-2311
(auf Französisch): 969-5621
Canadian Pacific Airlines: 675-2211

SEKRETARIAT
Anschrift: 12 ICA Secretariat
P.O. Box 123, Station "Q"
Toronto, Canada M4T 2L7
Telexnummern: 062-3496 J. Manuel
Telefonnummern: (416) 965-4120
12 ICA SOCIAL TOURS

A wide variety of social tours have been arranged for all 12 ICA participants. The details are given below. All tours depart from and end at the Metro Toronto Convention Centre. Unless otherwise stated, if fewer than 40 persons make reservations for any tour, the organizers reserve the right to cancel the tour and refund the full price. The accompanying persons' registration fee includes the price of Tour S1.

S1 —
Toronto City Tour/Casa Loma
Friday July 25
Depart: 09:30h; Return: 12:00h

This “get acquainted” tour of Toronto will include such famous attractions as Queen’s Park, the Parliament Buildings, Old and New City Hall, St. Lawrence Market, the Eaton Centre, the Bay-King financial district, Harbourfront, Kensington Market, CN Tower, Chinatown, the neighbourhoods of Rosedale and Forest Hill, and the boutiques in elegant Yorkville.

The highlight is a guided tour of Casa Loma, the most popular tourist attraction in Toronto. This 98-room creation depicts the splendour of a European castle.

Price: $17.50 per person

S2 —
Concert and Acoustical Demonstration in
Roy Thomson Hall
Friday July 25
Demonstration: 18:45h;
Concert: 20:00h

At 18:45h, there will be a 12 ICA pre-concert lecture by Ted Schultz demonstrating the variable acoustics of Roy Thomson Hall and including a special four minute work for symphony orchestra. At 20:00h the Toronto Symphony Orchestra with conductor Newton Wayland will present a concert of popular music: “The Best of Broadway.” Price includes pre-concert demonstration.

Price: $16.50 per person

S3 —
White Water Rafting A
Depart: Friday, July 25, evening
Return: Sunday, July 27

“White Water” is the term the North American Indians used to describe river rapids. Travel down river and traverse turbulent rapids in a larger rubber raft (15 persons/per raft) for the experience of a lifetime.

Price includes two full days rafting, two nights of tent accommodation, meals, transportation and guide. Participants must bring suitable clothing, swimwear and shoes.

Price: $220.00 per person

S4 —
UTDC/1000 Islands Boat Tour
Saturday July 26
Depart: 09:00h; Return: 20:00h

Travel along the northern shore of Lake Ontario to Kingston to visit the Urban Transportation Development Corporation, designers and manufacturers of the “light

12 ICA EXCURSIONS SOCIALES

Des excursions sociales variées ont été organisées pour tous les participants. Pour de plus amples renseignements, voir ci-dessous. Toutes les excursions ont pour point de départ et d’arrivée le Metro Toronto Convention Centre. Sauf avis contraire, si moins de 40 personnes s’inscrivent à une excursion, les organisateurs se réservent le droit d’annuler l’excursion et de rembourser le prix du billet. Les frais d’inscription des personnes accompagnantes les délégués incluant le prix de l’excursion S1.

S1 —
Visite de la ville de Toronto et de Casa Loma
Vendredi 25 juillet
Départ 9h30; retour 12h

Cette visite de la ville de Toronto permettra de découvrir des endroits célèbres tels que Queen’s Park, l’Edifice législatif de l’Ontario, l’ancien et le nouvel hôtel de ville, le marché St. Lawrence, le Centre Eaton, le district financier Bay-King, Harbourfront-l’avant-port le marché Kensington, la tour CN, Chinatown, les environs de Rosedale et de Forest Hills ainsi que les boutiques de l’élégant Yorkville.

Le clou de l’excursion sera une visite guidée de Casa Loma, une habitation seigneuriale de 98 pièces construite à l’image et la splendeur d’un grand château européen.

Prix: 17,50 $ par personne

S2 —
Concert et démonstration acoustique à
Roy Thomson Hall
Vendredi 25 juillet
Démonstration : 18h45;
concert : 20h

À 16h45, Ted Schultz donnera une conférence afin d’expliquer l’acoustique variable de Roy Thomson Hall. La présentation se distinguerait par la performance d’une œuvre spéciale pour orchestre symphonique. À 20h, le Toronto Symphony Orchestra sous le baton de Newton Wayland présentera un concert de musique populaire: “The Best of Broadway.”

Prix 16,50 $ par personne

S3 —
Descente de rapide A
Départ : Vendredi 25 juillet en soirée
Retour : Dimanche 27 juillet

Être voyageur en eau vive par canot pneumatique, c’est une expérience vraiment incomparable.

Le prix inclut deux jours complets de canotage (15 personnes par canot pneumatique), deux nuits d’hébergement sous une tente, les repas, le transport et le guide. Les participants doivent porter des vêtements, costumes de bain et chaussures convenables.

Prix : 220 $ par personne

S4 —
UTDC/Les Mille-Îles en bateau
Samedi 26 juillet
Départ : 9h; retour : 20h

Le matin nous ferons un voyage au bord du lac Ontario vers Kingston afin de visiter le Urban Transportation Development Corporation. Cet établissement est bien
rapid and comfortable” transit systems currently being installed in Detroit and Vancouver.

After lunch, enjoy a tour of the 1000 Islands, departure from Gananoque. Price includes transportation, guide, UTDC, boat tour, lunch, taxes and gratuities.

Price: $50.00 per person

S5 —
Royal Ontario Museum (ROM)
Saturday July 26
Depart: 09:45h; Return: 13:30h

The Royal Ontario Museum is a world-renowned museum filled with treasures of the past. There will be an exclusive tour by ROM's knowledgeable staff with time to explore on your own.

Following the guided tour of the ROM, lunch will be served at a first class restaurant nearby.

Price: $24.00 per person

S6 —
University of Western Ontario/
Stratford Shakespearean Festival A
Saturday July 26
Depart: 08:00h; Return: 18:00h

Visit the University of Western Ontario in London to see the Boundary Layer Wind Tunnel or visit the Department of Communicative Disorders. In the afternoon visit the Stratford Festival to see the Shakespearean play “Pericles.”

Price includes transportation, guide, University tour, lunch, play, taxes and gratuities.

Price: $65.00 per person

S7 —
White Water Rafting B
Depart: Saturday, July 26, evening
Return: Sunday, July 27

“White Water” is the term the North American Indians used to describe river rapids. Travel down river and traverse turbulent rapids in a large rubber raft (15 persons per raft) for the experience of a lifetime.

Price includes one full day of rafting, one night of tent accommodation, meals, transportation and guide. Participants must bring suitable clothing, swimwear and shoes.

Price: $160.00 per person

S8 —
Ontario Place at Night
Saturday, July 26
Depart: 18:00h; Return: 22:00h

These three man-made islands located on Lake Ontario form a unique park of almost 100 acres (40 hectares), an excellent location for a relaxing and entertaining evening.

Visit the world's first IMAX theatre, “Futurepod,” and the Forum which features nightly entertainment. Try some of the many friendly pubs and restaurants with waterside patios. Price includes transportation and admission.

Price: $10.00 per person

connu pour la conception et la fabrication des systèmes de transport “légers, rapides et confortables” comme ceux en voie d’installation à Détroit et Vancouver.

Après le déjeuner, nous prendrons un bateau à Gananoque pour faire une excursion parmi les fameuses Mille-Îles. Le prix inclut le transport, le guide, la visite à l’UTDC, l’excursion en bateau et le déjeuner, tout compris.

Prix : 50 $ par personne.

S5 —
Le Royal Ontario Museum (ROM)
Samedi 26 juillet
Départ : 9h45; retour : 13h30

Le Royal Ontario Museum, de renomée mondiale, est rempli de trésors du passé. Le musée organise de remarquables expositions pendant toute l’année. Une visite exclusive en compagnie du personnel compétent du ROM vous permettra de découvrir le musée.

Après la visite guidée, on prend le déjeuner dans un bon restaurant proche du musée.

Prix : 24 $ par personne

S6 —
University of Western Ontario/
Stratford Shakespearean Festival A
Samedi 26 juillet
Départ : 8h; retour : 18h

Le matin, nous ferons un voyage à l’université Western (Ontario) afin de visiter le tunnel aérodynamique à couche limite ou le Department of Communicative Disorders. L’après-midi, nous nous rendrons à Stratford Festival pour voir la pièce de théâtre de Shakespeare “Pericles.”

Le prix inclut le transport, le guide, la visite de l’université, le déjeuner, et le spectacle, tout compris.

Prix : 65 $ par personne

S7 —
Descend de rapides B
Départ : Samedi 26 juillet en soirée
Retour : Dimanche 27

Être voyageur un eau vive par canot pneumatique, c’est une expérience vraiment incomparable.

Le prix inclut un jour complet de canotage (15 personnes par canot pneumatique), une nuit d’hébergement sous une tente, les repas, le transport et le guide. Les participants doivent porter des vêtements, costumes de bain et chaussures convenables.

Prix : 160 $ par personne

S8 —
Place Ontario le soir
Samedi 26 juillet
Départ : 18h; retour : 22h

Situées sur le lac Ontario, ces trois îles artificielles forment un parc unique d’une étendue de presque 100 acres (40 hectares). C’est un endroit merveilleux où passer une agréable soirée en vous amusant. Visitez le premier théâtre IMAX, le ‘Futurepod’ et le Forum qui offre des spectacles chaque soir. Ou bien allez dans les accueillants pubs et les restaurants dont les terrasses longent le bord de l’eau. Le prix inclut le transport et le prix d’entrée.

Prix : 10 $ par personne
S9 — Niagara Falls/Niagara-on-the-Lake
Sunday, July 27
Depart: 09:00h; Return: 17:00h

Guests will be ushered on to the coach and the journey to Niagara begins with commentary provided on route. The tour of the Niagara Area outlines highlights of the region — historical, cultural and geographical — the very reasons why Niagara Falls is one of the seven wonders of the world. After your guided tour of the scenic tunnels, you will have time to take a cruise on the Maid of the Mist at the foot of the Falls or visit other attractions such as the greenhouse. Lunch will be served at Niagara Falls.

The next stage of the tour takes us to Niagara-on-the-Lake, one of the oldest settlements in Ontario, famous for the War of 1812 fought between Canada and the United States. The town has been beautifully restored to depict its heritage. Price includes transportation, guide, scenic tunnels and lunch. Other attractions are not included.

Price: $37.00 per person

S10 — UTDC/Old Fort Henry
Sunday, July 27
Depart: 09:00h; Return: 20:00h

Travel along the northern shore of Lake Ontario to Kingston to visit the Urban Transportation Development Corporation, designers and manufacturers of the “light, rapid and comfortable” transit systems currently being installed in Detroit and Vancouver.

After lunch, enjoy a visit to Old Fort Henry built during the War of 1812. Old Fort Henry now houses an extensive collection of British and Canadian military and naval arms and artifacts.

Price includes transportation, guide, UTDC, Old Fort Henry, lunch, taxes and gratuities.

Price: $50.00 per person

S11 — University of Western Ontario/Stratford Shakespearean Festival B
Sunday, July 27
Depart: 08:00h; Return: 18:00h

Visit the University of Western Ontario in London to see the Boundary Layer Wind Tunnel or visit the Department of Communicative Disorders. In the afternoon visit the Stratford Festival to see “The Boys from Syracuse” a musical based on the Shakespearian play “The Comedy of Errors.”

Price includes transportation, guide, University tour, lunch, play, taxes and gratuities.

Price: $65.00 per person

S12 — Early Morning at the CN Tower
Monday, July 28
Depart: 07:00h; Return 08:30h

This tour is designed to return for the start of the Technical Program and other tours. Rise to the top of it all to enjoy a splendid early morning breakfast. Watch the city come to life from the highest point of all — the CN Tower.

S9 — Chutes du Niagara/Niagara-on-the-Lake
Dimanche 27 juillet
Départ : 9h; retour : 17h

Après s’être confortablement installés dans l’autobus, les invités entreprendront leur périple vers Niagara, pendant que les guides feront des commentaires en route. Une fois dans la région du Niagara, les participants commenceront une visite détaillée des points saillants de la région — historiques, culturels et géographiques — qui font des chutes du Niagara l’une des sept merveilles du monde. Le déjeuner sera servi aux Chutes du Niagara.

Nous nous rendrons ensuite à Niagara-on-the-Lake, l’une des plus anciennes colonies en Ontario et célèbre en raison de la guerre de 1812 entre le Canada et les États-Unis. La ville a été magnifiquement restaurée afin de mettre en valeur son héritage. Le prix inclut le transport, le guide, les tunnels scéniques, et le déjeuner. Les autres attractions ne sont pas incluses.

Prix : 37 $ par personne

S10 — UTDC/Old Fort Henry
Dimanche 27 juillet
Départ : 9h; retour : 20h

Le matin nous ferons un voyage au bord du lac Ontario vers Kingston afin de visiter la Urban Transportation Development Corporation. Cet établissement est bien connu pour le dessin et fabrication des systèmes de transport “légers, rapides et confortables” comme ceux en train d’installation à Détroit et Vancouver.

Après le déjeuner, nous nous rendrons à Old Fort Henry. Construit pendant la guerre de 1812, c’est maintenant un musée de guerre présentant des objets façonnés anglais et canadiens.

Le prix inclut le transport, le guide, les visites de l’UTDC et de Old Fort Henry et le déjeuner, tout compris.

Prix : 50 $ par personne

S11 — University of Western Ontario/Stratford Shakespearean Festival B
Dimanche 27 juillet
Départ : 8h; retour : 18h

L’après-midi, nous ferons un voyage à l’université Western (Ontario) afin de visiter le tunnel aérodynamique à couche limite ou le Department of Communicative Disorders. L’après-midi, nous nous rendrons à Stratford Festival pour voir “The Boys from Syracuse” une opérette basée sur la pièce de Shakespeare “The Comedy of Errors.”

Le prix inclut le transport, le guide, la visite de l’université, le déjeuner, et le spectacle, tout compris.

Prix : 65 $ par personne

S12 — Bon matin à la tour CN
Lundi 28 juillet
Départ : 7h; retour : 8h30

Tous reviendront au point de départ afin de participer au programme scientifique ou à d’autres excursions. Montez vers les cimes afin de déguster un splendide petit déjeuner. Assistez au réveil de la ville du plus haut des sommets — la tour CN.
Walk from the Convention Centre. Price includes admission to the CN Tower, guide and breakfast.

Price: $17.25 per person
Minimum: 250

S13 —
Black Creek Pioneer Village
Monday, July 28
Depart: 09:30h; Return: 15:30h

What was life like in a rural Ontario Village more than one hundred years ago? Come to the Black Creek Pioneer Village and experience the sounds and sights of a living community as costumed villagers relive life as it was in early days, in the more than thirty restored buildings. Lunch is available at the Victoria Centre. Price includes transportation, guide and admission. (Lunch not included).

Price: $12.25 per person

S14 —
Royal Ontario Museum (ROM)
Monday, July 28
Depart: 10:00h; Return: 14:00h
See Tour S5

Price: $24.00 per person

S15 —
Canada’s Wonderland
Tuesday, July 29
Depart: 09:00h; Return: 15:00h

Covering 370 acres, Canada’s Wonderland is Toronto’s newest entertainment extravaganza. Thrill to roller coasters that unnerve the most daring. Rush through a white-water canyon! Relax to the music of live broadway shows, bands and street entertainers. See Acapulco-style divers plunge off Magic Mountain.

You will be on your own to enjoy unlimited use of the numerous shows and attractions. Lunch is on your own and available at the many concessions in food areas throughout the park. The afternoon is yours to continue exploring the five theme areas. Price includes transportation, admission and all regular rides and shows.

Price: $27.00 per person

S16 —
Ste. Marie Among the Hurons/
Naval and Military Establishments
Tuesday, July 29
Depart: 09:15h; Return 16:30h

Travel by bus about 125 km north of Toronto to visit the authentically recreated structures of the 17th century community of Ste. Marie Among the Hurons, the first European community on the then western frontier. This mission was headquarters for most of North America’s French Jesuit missionaries and the nearby Martyr’s Shrine cathedral is a tribute to these missionaries. Then travel to Penetanguishene, a British Military stronghold established in 1793. The workshops and quarters of the garrison have been restored and furnished as they were in the early 1800’s when famous British units guarded the

On va à pied du centre des congrès. Le prix inclut le droit d’entrée à la tour CN, le guide et le petit déjeuner.

Price: 17,25 $ par personne
Minimum: 250

S13 —
Black Creek Pioneer Village
Lundi 28 juillet
Départ: 9h30; retour: 15h30


Price: 12,25 $ par personne

S14 —
Le Royal Ontario Museum (ROM)
Lundi 28 juillet
Départ: 10h; retour: 14h
Voir texte en S5

Price: 24 $ par personne

S15 —
Canada’s Wonderland
Mardi 29 juillet
Départ: 9h; retour: 15h


Vous pourrez à loisir assister aux nombreux spectacles. Vous pourrez acheter le déjeuner dans l’un des multiples kiosques qui parsèment le parc et consacrer l’après-midi à l’exploration des cinq sites à thème. Le prix inclut le transport, le droit d’entrée ainsi que tous les manèges et spectacles.

Price: 27 $ par personne

S16 —
Ste-Marie parmi les Hurons/
Établissements maritimes et militaires
Mardi 29 juillet
Départ: 9h15; retour: 16h30

upper Great Lakes and northwest Canada. Price includes transportation, guide and lunch.

**Price: $34.00 per person**

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**S17 — Niagara Wine Tasting Tour**

**Wednesday, July 30**

**Depart: 09:00h; Return: 17:00h**

This tour is a journey to the Niagara Fruit Belt for a wine tasting extravaganza. Our guides will give a commentary pointing out the many interesting sights en route to the wineries. Our first stop will be the quaint home of the Inniskillin Wines for a brief tour and then on to their restored barn which houses a retail shop and wine-making displays. The wine-tasting session will take place in their Champagne Room, concurrent with informal discussions and demonstrations.

After lunch we will travel to the famous Andres Winery for the second exclusive tour. The facilities of Andres Winery are state of the art and very different from the smaller scale at Inniskillin. The history of Andres Wines, their wine-making process, and a walk through the winery itself will be on the agenda. In the hospitality room an expert will demonstrate the finer details of wine tasting, with plenty of time for sampling. Price includes transportation, guide, wine tasting and lunch.

**Price: $37.00 per person**

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**S18 — Ontario Place/Harbour Tour**

**Wednesday, July 30**

**Depart: 09:30h; Return: 16:00h**

Built on beautifully landscaped, man-made islands, Ontario Place is a magnificent showplace for recreation, entertainment and education. You will be ushered into Cinesphere — a geodesic dome with a screen six stories high — for the viewing of a breathtaking film.

After the film show, you will board a glass-covered boat for a fascinating tour of Toronto's harbour. Back to Ontario Place, you will be free to roam the grounds, explore the state of the art pavilions and, if you like, try the paddle boats and roller skates. The area is ideal for children of all ages. They will enjoy the Children's Playground and Water area. Adults will find many different shows and exhibits throughout the grounds, and many restaurants in which to relax by the water. Price includes return transportation, film and boat tour of the harbour.

**Price: $19.00 per person**

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**S19 — Dinner Theatre**

**Wednesday, July 30**

**Depart: 18:00h; Return: 23:00h**

Toronto ranks third in the world for live theatre. Only New York City and London, England have more footlights than Toronto. Visit one of the fine Dinner Theatres — to enjoy a complete dinner and a live hit show: a light comedy and/or a musical.

**Price: $44.00 per person**

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**S17 — Dégustation de vin (Niagara)**

**Mercredi 30 juillet**

**Départ : 9h; retour : 17h**

Excursions dans la vallée fruitière du Niagara où nos guides vous signaleront les points d’intérêt tout au long de la route menant aux chais. Notre premier point d’arrêt sera la jolie propriété des vins d’Inniskillin pour une brève visite, suivie d’une visite de la grange rénovée où se trouvent maintenant un magasin et un étalage sur la fabrication du vin. Une dégustation de vin aura lieu dans la salle Champagne et s’accompagnera de discussions et de démonstrations.

Après le déjeuner, nous voyagerons aux chais d’Andrés pour faire la deuxième excursion exclusive. Les installations des chais d’Andrés sont différentes des installations que l’on retrouve à Inniskillin. La visite comprend l’histoire des vins d’Andrés, la méthode de fabrication du vin et la visite du chai lui-même. Dans la salle d’accueil, un expert expliquera la technique de la dégustation du vin. Le prix inclut le transport, le guide, la dégustation et le déjeuner.

**Prix : 37 $ par personne.**

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**S18 — Ontario Place/Visite du port**

**Mercredi 30 juillet**

**Départ : 9:30h; retour : 16h**

Édifiée sur de magnifiques îles artificielles, Ontario Place est l’endroit rêvé pour se détendre, assister à des spectacles et s’instruire. Vous vous rendez ensuite à la Cinesphère — dome géodésique équipé d'un écran d'une hauteur de six étages — afin d’assister à un film spectaculaire.

Après ce film, vous prendrez place à bord d’un navire à toit de verre et entreprendrez la visite fascinante du port de Toronto. De retour à Ontario Place, vous pourrez vous promener à loisir, explorer les pavillons artistiques et même faire l’essai des barques à rames et chaussures des patins à roulettes. L’endroit est idéal pour les enfants de tous âges, qui seront enchantés par le parc d’amusement et de la piscine. Les adultes pourront jouer de plusieurs spectacles et expositions et se détendre dans l’un ou l’autre des restaurants situés au bord de l’eau. Le prix inclut le transport, le film et l’excursion au havre en bateau.

**Prix : 19 $ par personne.**

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**S19 — Diner au théâtre**

**Mercredi 30 juillet**

**Départ : 18h; retour : 23h**

Toronto se classe troisième ville du monde pour son théâtre. Seules New York et Londres peuvent se vanter d’avoir plus de rampes de théâtre que Toronto. Venez passer une agréable soirée dans l’un de ces théâtres raffinés où l’on vous servira un dîner complet pendant que se joue une pièce à succès, soit une comédie ou un musical.

**Prix : 44 $ par personne.**
WEDNESDAY JULY 23

14:00  Registration/Inscription/Anmeldung
18:30  Meeting for Session Chairmen/Réunion des présidents de séances/Zusammentreffen der Sitzungsvorsitzenden. Royal York Hotel (Upper Canada Room)

THURSDAY JULY 24

08:00  Registration/Inscription/Anmeldung
10:00  12 ICA Opening Ceremony/Cérémonie d'inauguration/Eröffnungsfest. Roy Thomson Hall (60 Simcoe Street)
13:30  **Ocean acoustics: the remarkable sea of sound (R.R. Goodman). Constitution Hall A
14:35  *E1  Isolation acoustique des structures. Room 203 B and D
14:40  A1  Speaker and language differences, speaker and speech recognition. Room 203 A and C
B1  Psychoacoustics I: detection and discrimination. Room 104 A
C1  The assessment of annoyance from noise. Room 205 A and C
G1  Ultrasonic measurement techniques. Room 104 D
H1  Underwater transducers and measurements. Room 206 A and C
K1  Musical acoustics: theory and instruments from around the world. Room 104 B
18:00  12 ICA Welcome Reception/Réception de bienvenue/Begrüssung und Empfang Toronto City Hall

FRIDAY JULY 25

08:00  Registration/Inscription/Anmeldung
08:35  *H2  Arctic acoustics. Room 203 B and D
*L1  New materials for transducers. Room 104 C
08:40  B2  Psychoacoustics II: perception and localization of complex sounds. Room 104 A
C2  Machinery and equipment noise: measurement prediction and control. Room 205 A and C
E2  Sound transmission loss. Room 206 A and C
G2  Ultrasonic spectroscopy, absorption and relaxation. Room 104 D
I1  Scattering by obstacles, surfaces and turbulence. Room 203 A and C
J1  Outdoor sound propagation: topographical, meteorological and ground effects. Room 206 D
09:30  City Tour for Accompanying Persons/Visite guidée de la ville pour les personnes accompagnantes/Stadtrundfahrt für Begleitpersonen (Tour S1).
12:15  Music at Midday: Organ Recital/Musique le midi: récital d'orgue/Musik zum Mittag: Orgelkonzert. St. Andrews Church

SATURDAY JULY 26

08:00  Tour S6: University of Western Ontario — Stratford Festival A
09:00  Tour S4: UTDC — 1000 Islands/UTDC — Les Milles Îles
09:45  Tour S5: Royal Ontario Museum/Le Royal Ontario Museum
Tour S7: White Water Rafting B/Descente de rapides B
18:00  Tour S8: Ontario Place at Night/Place Ontario le soir

SUNDAY JULY 27

08:00  Tour S11: University of Western Ontario — Stratford Festival B
09:00  Tour S9: Niagara Falls/Chutes du Niagara
Tour S10: UTDC — Old Fort Henry

MONDAY JULY 28

07:00  Tour S12: Early Morning at the CN Tower/Bon matin à la tour CN
08:00  Registration/Inscription/Anmeldung
08:35  *B5  Epidemiology of occupational hearing loss — 100 years later. Room 104 C
*E4  Room acoustics: recent developments. Room 203 B and D
08:40  A3  Speech production and analysis. Room 203 A and C
B4  Hearing aids, transducers and auditory perception. Room 104 A
C4  Road traffic noise. Room 205 A and C
H3  Underwater propagation and noise. Room 206 A and C
K3  Guitar, violins and bows. Room 104 B
M2  Sound Intensity: phase shift and vectors. Room 206 D

09:30  Tour S13: Black Creek Pioneer Village
10:00  Tour S14: Royal Ontario Museum/Le Royal Ontario Museum
10:00  12 ICA Exhibition/Exposition/Ausstellung. Constitution Hall B and C
12:15  Music at Midday: Taped electroacoustic music/Musique le midi: Musique électro-acoustique enregistrée/Musik zum Mittag. Convention Centre
13:30  **Nonlinear behaviour of sound waves
(D.T. Blackstock). Constitution Hall A
14:35  *N1  Education in acoustics: discussion, demonstration and films.
Rooms 104 C and 104 D
14:40  A4  Speech synthesis and data bases.
Room 206 D
B6  Modelling the ear's response to sound I: the external and middle ear.
Room 104 A
C5  Active sound attenuation in ducts, silencers and other spaces. Room 205 A and C
D2  Vibration of supported plates.
Room 202 A and C
E5  Auditorium acoustics measurements.
Room 206 A and C
I2  Nonlinear mechanisms and effects.
Room 203 A and C
K4  Orchestral instruments, especially winds. Room 104 B
18:00  12 ICA Evening at the Ontario Science Centre/Soirée au Ontario Science Centre/Abend im Ontario Science Centre. Buses from Convention Centre/Autobus du Convention Centre/Autobus vom Convention Centre

WEDNESDAY JULY 30

08:00  Registration/Inscription/Anmeldung
08:35  *B9  Measurement of hearing protector attenuation I. Room 104 C
*D4  Active control of vibration. Room 203 B and D
08:40  A6  Timing, intonation and f0. Room 203 A and C
C8  Sound intensity measurements and identification of noise sources.
Room 205 A and C
E10  Speech intelligibility in rooms.
Room 206 A and C
G5  Nondestructive testing. Room 104 D
K5  The listener's response. Room 104 B
M3  Impedance measurements.
Room 206 D
09:00  Tour S17: Niagara Wine Tasting Tour/ Dégustation de vin
09:30  Tour S18: Ontario Place-Harbour Tour/ Visite du port
10:00  12 ICA Exhibition/Exposition/Ausstellung. Constitution Hall B and C
12:15  Music at Midday: Taped electroacoustic music/Musique le midi: Musique électro-acoustique enregistrée/Musik zum Mittag. Convention Centre
13:30  **Human responses to vibration
(M. Griffin). Constitution Hall A
14:40  B10  Measurement of hearing protector attenuation II. Room 104 A
C9  Community noise: survey and control. Room 205 A and C
D5  Nonlinear vibration. Room 202 A and C
E11  Auditorium acoustics modelling. Room 206 A and C
F1  Biomedical acoustics. Room 104 B
G6  Ultrasonics in solids. Room 104 D
I5  Acoustic waves in porous and layered media. Room 203 A and C
M4  Instrumentation and measurement.
Room 206 D
18:00  Tour S19: Dinner Theatre/Dîner au théâtre
20:30  Demonstration Concert: Violin Octet/
       Concert de démonstration: l'Octet de
       violon/Konzert: Violin-Oktet, 
       St. Andrews Church

THURSDAY JULY 31

08:00  Registration/Inscription/Anmeldung
08:35  F2  Bio-response to vibration. Room 104 C
       K6  Musical instruments: very old and very
            new. Room 203 B and D
08:40  B11  The measurement of normal and
        impaired hearing. Room 104 A
       C10  Environmental noise: measurement,
            prediction and control. Room 205
            A and C
       D6  Structure-borne sound. Room 202
            A and C
       E12  Sound fields in reverberant spaces.
            Room 206 A and C

       G7  Acousto-optics. Room 104 D
       J3  Sound generation by fluid flow and
            aeroacoustics. Room 206 D
10:00  12 ICA Exhibition/Exposition/Ausstellung.
       Constitution Hall B and C
13:30  **Auditory time analysis in echolocating
       bats (G. Neuweiler). Constitution
       Hall A
14:30  **Recent achievements in quantum acoustics
       (Yu. V. Gulyaev). Constitution
       Hall A
15:30  12 ICA Closing Ceremony/Cérémonie de
       clôture/Abschlussfeier Constitution Hall A
16:00  12 ICA Farewell Reception/Réception
       d'adieu/Abschiedsempfang. Constitution
       Hall A

**Plenary Lecture Session/Séance plénière/Plenarvorträge
*Structured Session/Session structurée/Arbeitssitzung
Co-Chairmen for Technical Sessions:

A — M. Hunt
B — R. Hétu, N. Lalande
C — G. Krishnappa
D — H. Davies
E — J.S. Bradley, J.D. Quirt
F — A.J. Brammer
G — D. Hutchins

H — G.H. Brooke
I — L.T. Russell
J — W.T. Chu
K — A. Cohen
L — G.S.K. Wong
M — J. Nicolas
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THURSDAY MORNING, 24 JULY 1986
ROY THOMSON HALL, 10:00 - 12:00
60 SIMCOE STREET
(one block north of Convention Centre)

OPENING CEREMONY
CÉRÉMONIE D'INAUGURATION
ERÖFFNUNGSFEIER

In the presence of the Honourable Lincoln M. Alexander,
Lieutenant Governor of Ontario

Greetings from Her Majesty the Queen
The Honourable Lincoln M. Alexander, Lieutenant Governor of Ontario

Welcoming Addresses

Dr. Larkin Kerwin, President Designate, International Union of Pure and Applied Physics and
President, National Research Council of Canada

Prof. Heinrick Myncke, Chairman, Commission on Acoustics, IUPAP

Dr. Edgar A.G. Shaw, President of the Congress

Musical Interlude
The Toronto Symphony Brass Quintet

Congress Announcements
Fanfare
Plenary Session 1. Ocean acoustics: The remarkable sea of sound.

Speaker: R.R. Goodman, SACLANT Research Centre, La Spezia, Italy.

Chairman: I. Dyer, Massachusetts Institute Technology, Ocean Engineering, Rm. 5-212, Cambridge, MA 02139, U.S.A.

OCEAN ACOUSTICS: THE REMARKABLE SEA OF SOUND
R.R. Goodman

Acoustics is one of the most important methods of probing the sea due to its acoustic transparency and its unique refractive character. It has been used extensively in the study of the sea floor and recent developments indicate promise in the study of ocean turbulence at large scales. The continuing development of acoustic sensing systems requires more refined models of the environmental influences on acoustic signals. Several technological advances have influenced the direction of oceanography and acoustics.

THURSDAY AFTERNOON, 24 JULY 1986

Structured session E1: Isolation acoustique des structures

Chairman and organiser: C. Lesueur, Laboratoire Vibrations-Acoustique, Institut National de Sciences Appliquées de Lyon, 69621 Villeurbanne Cedex, France

Chairman’s Introduction 14:35

Invited Papers

E1-1 14:40
RAYONNEMENT, TRANSMISSION ET REDUCTION DU BRUIT : EVOLUTION DES IDEES ET DES METHODES THEORIQUES ET EXPERIMENTALES.
C. Lesueur.

Le papier constitue l'introduction de la session structurée "Rayonnement acoustique et isolation des structures". Il s'agit donc de dégager des idées, en vue d'orienter les discussions. On examine d'abord les concepts de base applicables en pratique, l'évolution des moyens depuis 6 ans, et les possibilités d'isolation acoustique. On présente particulièrement une démarche mixte théorie-experience permettant d'agir à bon escient.

E1-2 15:10
THE SOUND TRANSMISSION OF LIGHT WEIGHT PANELS IN THE PRESENCE OF ABSORBENT REVEALS.
R.W. Guy

Experimental results are presented which demonstrate the influence of sound absorbent lining the reveal of light weight glass panels. Sound intensity measured at the entrance of the reception room is shown to decrease significantly in the presence of higher absorption at the reveal surfaces and to decrease relatively constantly along the absorbent lined path. The vibrating panel is found to be loosely coupled to the airbourne transmission path such that it may possibly be studied independently of the reception room side.
Contributed Papers

E1-3  15:40
COUPLING EFFECTS FOR THE SOUND RADIATION IN A ROOM OF TWO PLATES ASSEMBLED IN A L-SHAPE
P.M. Millot, J.-L. Guyader

The radiation factor of plates is a commonly used parameter for the computation of sound radiated by a plate or an assembly of plates. Our study, based on modal analysis, gives results for the radiation factor in a room of two mechanically coupled plates excited by harmonic mechanical forces. Our computations take into account the mechanical and the acoustical coupling effects, highlighting some large differences below the critical frequency of the plates for different types of excitation and damping of the room.

E1-5  16:20
SOUND TRANSMISSION THROUGH FOAM-LINED DOUBLE PANEL CONSTRUCTIONS
J.S. Bolton, E.R. Green

This paper is concerned with the use of partially open cell expanded polyurethane foam as a lining material in double panel constructions. This material differs from fiberglass (and open cell foams) since motion of its solid phase plays an important role in the material's acoustic behaviour. As a result the sound transmission performance of partially open cell foam used as a lining is highly dependent on the boundary conditions at the foam-panel interface: i.e., on the foam's method of attachment.

E1-4  16:00
CALCULATION OF THE TRANSMISSION LOSS OF MULTIPLE-PANEL WALLS USING A MODAL METHOD
L. Gagliardini, J. Roland, J.L. Guyader

The theory developed allows to model multiple-panel walls in a measurement laboratory. The computation takes into account the source location, the size and the composition of the wall. A validation of the calculation for a single wall is presented. The influence of some parameters, let apart in a classical approach, has been studied. The checking of double walls is under way.

E1-6  16:40
PANEL DISCUSSION
Brief presentation and discussion by panel members:
F. Fahy  J. Nicolas
M. Goulain  A. Pierce
M. Heckl

THURSDAY AFTERNOON, 24 JULY 1986
ROOM 203 A and C,  14:40 - 17:20

Session A1: Speaker and language differences, speaker and speech recognition


Contributed Papers

A1-1  14:40
SUBJECTIVE SNR MEASURE FOR QUALITY ASSESSMENT OF SPEECH CODERS - A CROSS LANGUAGE STUDY
M. Nakatsu

The subjective speech-to-noise ratio (SNR) has been proposed as a measure for overall speech quality and it has been reported that reproducibility of the results across two tests using different groups of English speakers and listeners is quite high. The purpose of this study is to confirm high reproducibility of the results across studies having different language backgrounds. No statistically significant difference between scores is found for three coder configurations serve as anchor points connecting the current test in Japan and the previous tests in Canada.

A1-2  15:00
QUANTIFICATION INTERLOCUTEUR DE LA VARIABILITE SPECTRALE INTERLANGUE
A. Landercy et B. Harmegnies

L'expérience présentée a pour objet l'étude du supplément de variabilité spectrale introduit dans le chef de locuteurs par le recours à différentes langues. Les analyses acoustiques (spectres moyens à long terme sur 400 canaux) ont été réalisées sur des sujets bilingues s'exprimant en français et en néerlandais. Les résultats obtenus sont comparés aux données antérieures relatives à la variabilité intralangue.
A1-3  15:20

EXPERIMENTAL ANALYSIS ON VARIABILITY OF SPEECH SPECTRUM OF A SPEAKER OVER TIME,
K. Nagata, H. Murakami and K. Saikawa

To investigate the causes of variability of the speech spectrum of a speaker over time, vowel sounds were analyzed into transfer-functions of vocal tracts and glottal waves by short-term LPC analysis. First, a study of the short-term LPC analysis was made, and then vowel sounds of Japanese spoken number digits uttered over one year period were analyzed. It was observed that the variability of transfer-functions is generally dominant.

A1-4  15:40

COMPARISON OF SPECTRAL SIMILARITY INDICES FOR SPEAKER RECOGNITION
B. Harmegnies and A. Landercy

The research presented deals with voice recognition of French-speaking subjects. The speakers' utterances were analysed and represented in the form of high resolution long-term spectra (constant bandwidth of 12.5 Hz). These in turn, were compared by means of four similarity indices (classical as well as original ones). The paper presents the recognition rates obtained by means of each similarity index and furnishes a ranking of the latter in terms of discriminating capacity.

A1-5  16:00

AUTOMATIC RECOGNITION OF SPOKEN SENTENCES USING A DEMISYLLABLE-BASED DYNAMIC PROGRAMMING ALGORITHM
G. Ruske and W. Weigel

An automatic speech recognition system is presented which processes spoken sentences as a chain of connected words. The system starts from an explicit segmentation into demisyllables which are classified into consonant clusters and vowels. Sentence recognition is carried out by a 1-stage Dynamic Programming algorithm based on these units. Word models are applied which allow complete syllables to be skipped or to be inserted in order to handle variations in pronunciation and segmentation. The system was tested with German sentences containing 75 different words.

A1-6  16:20

A PITCH SYNCHRONOUS WEIGHTED LINEAR PREDICTION ANALYSIS OF SPEECH
M. Yanagida and O. Kakusho

Proposed here is a means to speed up the computation process of the Weighted Linear Prediction (WLP) analysis method developed by the authors. In the proposed Pitch Synchronous Weighted Linear Prediction (PSWLDP), a single weight pattern is repeatedly employed pitch synchronously in a series of analysis frames instead of calculating weight patterns frame by frame. The simulation results on synthetic vowels show that the proposed PSWLDP attains almost the same accuracy as the prototype WLP reducing the computational time to 30%.

A1-7  16:40

OPTIMIZING PITCH PERIOD MARKERS PRIOR TO EXTRACTING FEATURES FROM ISOLATED VOWELS
N.B. Cox, V.D. Morrison and M.R. Iito

This paper discusses the use of cross-correlation for 'optimizing' pitch period startpoint markers in isolated vowel samples. When applied to /a/ vowels synthesized with jitter, shimmer and noise perturbations, cross-correlation is shown to synchronize startpoint markers with the driving function to within 1 sample point in all but the most severely perturbed waveforms and effectively compensate for pitch period misalignment sensitivity in a recently published vowel feature (the Harmonics to Noise Ratio).

A1-8  17:00

ISOLATED WORD RECOGNITION USING HMM WITH DURATION DISTRIBUTION
N. Nishimura and M. Okochi

In the conventional HMM (Hidden Markov model), temporal structure of an utterance is not well modeled. This paper presents an HMM with duration distribution of state in an explicit form. For making the training and the decoding efficient and precise, we introduced the following techniques; 1) a path constraint window controlled by trained duration probabilities, 2) smoothing of output and duration probabilities, and 3) probabilistic boundary detection by using a silence model. A recognition error rate for similar 150 words was reduced from 9.0% (conventional HMM) to 2.8% (our method).
Session B1: Psychoacoustics I: detection and discrimination

Chairman: H. Fastl, Institute of Electroacoustics, Technical University München, Arcisstr. 21, D-8000 München 2, F.R.G.

Contributed Papers

B1-1 14:40
ONSET TIME AND THE DETECTABILITY OF LONG DURATION TONES
S. M. McFadden

Most signal detection studies use short duration sounds with rapid onsets. Such studies may not predict performance in tasks requiring the detection of long duration, slowly changing sounds. This study investigated the effect of onset time on the detectability of tones between one and eight seconds. Detection performance of some observers decreased 3 dB as onset increased from 0.0005 to 2 seconds. The overall results suggest that different observers use different cues to detect the presence of a relatively long duration tone.

B1-2 15:00
AUDITORY TEMPORAL INTERACTIONS AND FREQUENCY SELECTIVITY
G.J. Fleet and J.C. Booth

The following experiments examined the ability of pure tone signals to mask single- and double-frequency probes. Masker levels were adapted to just mask the low-level probes. The results showed greater masker levels than predicted for masking the double-frequency probe conditions. Further, it was found that these results could not be explained by the detection of difference tones. The data suggest that some aspect of the temporal structure of the probes is useful for detection.

B1-3 15:20
FREQUENCY DISCRIMINATION OF TONES PRESENTED IN VARIOUS NOISE BACKGROUNDS
D. S. Emmerich, D. A. Fantini, and W. A. Brown

Frequency-discrimination experiments are described in which tones were presented in band-reject, low-pass, high-pass, or unfiltered white noise, as well as in various combinations of such noises. Taken together, the results suggest that 1) during frequency discrimination listeners are able to make use of information from the "tails" of the broad excitation patterns created by the tones, and 2) having the tones close to a sharp spectral edge in the noise impairs performance, with the degree of impairment varying as a function of the sharpness of the edge.

B1-4 15:40
ON THE DISCRIMINATION OF DEVIATION OF THE PITCH OF TONE BURSTS.
Y. Yamashita and M. Matsui

Using two successive tone bursts in which changed frequency linearly from an initial value to a final one of tone burst duration, the discrimination of the pitch of tone burst was measured by the method of adjustment. Results show that there are some differences of the discrimination between the initial frequency adjustments and the final ones, the former are larger than the later and the longer the pitch of frequency changes, the discriminations are larger.

B1-5 16:00
INTENSITY DISCRIMINATION FOR SOUNDS WHOSE INTENSITIES CONTINUOUSLY CHANGE WITH TIME
T. Nakamura

The experiment was designed to measure the differential limen for a tone as it changed continuously in a tonal stream. The result suggests that the ability to discriminate sound whose intensity changes continuously in a tonal stream would be higher than for sound presented in isolation, a situation far different from our experience in daily life. The duration effect on DL is a factor of some significance.

B1-6 16:20
GENERATION OF BINAURAL SIGNALS FOR RESEARCH AND HOME ENTERTAINMENT
C. Pömselt, J. Schröter, M. Opitz, P. L. Divenyi and J. Blauert

A convenient way of generating head-related binaural acoustic signals consists of convolving nonreverberant sound signals with measured impulse responses of the external ears. The method of obtaining these impulse responses will be described. Two applications will be discussed. In the first application, binaural signals are generated from traditional multi-channel recordings. In the second application, simulated binaural signals are used for clinical test of spatial hearing.
NEW APPROACH TO THE RISE TIME DIFFERENTIAL SENSITIVITY,
J. Smurzyński

Previous reports indicated that the Weber fraction for the rise time was about 25%. New DLS were obtained for sine waves with onset time of 10, 20, 30, 40, 50 and 60 msec. A constant stimulus method with multiple comparison in a single trial was used. The results showed high steepness of psychometric functions for each of three subject. The Weber fractions derived from the data fell in 2-13% range.

THURSDAY AFTERNOON, 24 JULY 1986
ROOM 205 A and C, 14:40 - 17:00

Session C1: Assessment of annoyance from noise
Chairman: F. Ingerslev, Technical Univ. Denmark, Acoustics Lab., Lyngby 2800, Denmark

Contributed Papers

C1-1 14:40
THE MEASUREMENT OF MEANING OF LOUDNESS, NOISINESS, AND ANNOYANCE IN DIFFERENT COUNTRIES
S. Namba, S. Kuwano and A. Schick

The connotative meanings of loudness, noisiness, and annoyance have been measured in various countries using semantic differential. Both English and German "loudness" have negative connotations, but Japanese "loudness" is quite neutral. The present experiments suggest that "loudness" is different aspects of sounds from "noisiness" and "annoyance", and depends on the nature of the sound sources.

C1-2 15:00
EXPERIMENTAL RESULTS ON ANNOYANCE OF COMMUNITY NOISES AND GROUPING OF NOISE SOURCES
M. Sasaki

This is the report of the experimental results of rating on annoyance due to community noises. The single or superposed noise are presented to subjects under studying mathematics. The sound levels, L_{Aeq} during noise exposure are about 50 - 80 dB(A). The correlation between annoyance and L_{Aeq} are observed with respect to the disturbing effects. Using these results, the factor analysis of the sound sources are made. As the results, the sound sources are classified into four groups.

C1-3 15:20
ARE FLUCTUATING SOUNDS PARTICULARLY ANNOYING?
Peter Schaefer

In search of ways to more comprehensive noise ratings we checked the influence of sound level variations on individual noise perceptions. So test persons were to adjust sine modulated white noise to unmodulated ("constant") noise signals. These sine-modulations applied directly to perceived loudness in tones. We learned from the results that sound level variations are estimated considerably more annoying (up to 11 dB in L_1) than constant sound - depending strongly on modulation frequencies. So a comprehensive noise rating procedure should observe this effect.

C1-4 15:40
NOISE UNCOMFORTABLENESS WITH OTHER ENVIRONMENTAL FACTORS
G. Horie, Y. Sakurai, T. Noguchi and N. Matsubara

A specific subjective scale such as annoyance is related to a noise level and might be affected by other environmental factors. However, the effects by those factors on a nonspecific subjective scale, "uncomfortableness", could be treated by the linear combination with their own weight scores. These weight scores for noise levels, temperatures and lighting are obtained in summer and winter by the Second Theory of Quantification of Hayashi. Finally, the effects of those factors on "uncomfortableness" can be compared on the common scale.
EXTRA-AUDITORY NOISE PROBLEMS IN EDUCATIONAL SETTINGS: STUDY RESULTS FROM DAY-CARE CENTRES FOR CHILDREN
C. Truchon-Gagnon, R. Hétu

A method of systematic observation and noise measurements was developed and applied in 6 DCCs for children, and these DCCs workers (93/105) answered to a questionnaire about noise. Significantly more stress, health and work related problems were reported in DCCs where noise was described as louder and less comfortable. High noise exposures have been found (ex.: L_{Aeq} - 8hrs between 75 & 80 dB). Number of individuals in a room, noise transmission and reverberation were identified as the major causes of noise problems.

PSYCHOACOUSTIC STUDY OF HUMAN RESPONSE TO TRANSMISSION LINE AUDIBLE NOISE,
J.E.K. Foreman

A program of long-term physical measurement and statistical analysis of audible noise from high voltage transmission lines with associated weather conditions has been undertaken. The project also entailed psychoacoustic testing of people to determine attitudinal response to this form of noise, as compared to other environmental noises, and to assess which measurement "weighting" of conventional sound measuring systems best correlates attitudinal responses with corona noise.

Thursday Afternoon, 24 July 1986

Session G1: Ultrasonic measurement techniques

Chairman: G. Quentin, Groupe de Physique des Solides, Tour 23, Université de Paris 7, 2, place Jussieu, 75251 Paris Cedex 05, France

Contributed Papers

ULTRASONIC RELAXATION STUDY USING THE PLANO-CONCAVE RESONATOR METHOD IN THE 0.1-2 MHZ RANGE
P.-K. Choi, J.-R. Bae and K. Takagi

Low frequency absorption measurements are made by the plano-concave resonator method. In this method, frequency spectrum of a longitudinal standing wave excited in the plano-concave resonator is observed using Raman-Nath light diffraction and optical heterodyne detection. Absorption spectra obtained in methyl acetate provide the values of activation enthalpy and enthalpy difference between cis and trans rotational isomers. Measurements are also made in thin egg white.

THE STUDY OF MODIFIED MSC REFLECTORS
Zhang De and Shui Yongan

The modified multistrip coupler reflector (MMSCR) is a new type of reflecting track changer, which are constitutive parts of the untuned low insertion loss filter. In order to obtain such filter with required specification and good quality, it is necessary to master the reflection rule of MMSR. In this paper, a theory is proposed to analyze the relationship between the number of MMSR strips, parameters of substrate and the reflective frequency response. The experimental results are presented.
RESONANCES D’UNE CIBLE MULTICOUCHE CYLINDRIQUE
J. Ripoche, J.L. Izbiicki et G. Maze

La "Méthode d’Isolement et d’Identification des Résonances" permet d’obtenir le "Spectre des Résonances" d’un tube plongé dans l’eau et rempli d’un liquide. Le spectre de cette structure multicouche faiblement couplée est formé par la superposition de modes propres du tube dans le vide liés aux ondes circonférentielles et aux ondes gui- dées selon l’axe, de modes propres de la colonne de liquide liés aux ondes guidées dans le liquide et de modes propres de l’interface externe eau-coque liés à l’onde de type Stoneley-Scholte.

ON ELASTIC BEHAVIOUR OF SOME POLYCRYSTALS
Kiran Shanker

A method is presented here to approximate the elastic coefficients of polycrystals from the single crystal data obtained experimentally. The experimental data on polycrystals offer considerable difficulty as ultrasonic attenuation grows unduly large. Assuming isotropy in Third Order Elastic Constants and making simplifications in the nonlinear continuum theory, lattice coupling parameters have been derived.

AMPLIFICATION OF ACOUSTO-HELICON WAVES BY APPLICATION OF AN ELECTRON DENSITY GRADIENT IN PIEZOELECTRIC SEMICONDUCTORS
S. Ghosh and D.K. Sinha

In this note we see if it is possible to amplify the acousto-helicon waves by means of electron density gradient along the direction of propagation of the waves in magnetised piezo-semiconductors. We have studied the particular mode of acoustic waves i.e. acousto-helicon waves due to its importance as a tried means for study of the structure of semiconductors and semimetals.

EXPERIMENTAL DEVICE FOR RADIATED PRESSURE MEASUREMENT
C. Cachard, G. Gimenez and D. Vray

In this paper a computerized experiment devoted to the measurement of the pressure radiated by bubbles is presented. The two parts of the experimental set-up are described. The first part is the bubble generator which produces bubbles of constant and reproducible size. The second part is the electronic device which processed the signals produced by the receiving transducer. Finally the apparatus is used to obtain the response curves (amplitude and phase) of a bubble of constant size driven by an ultrasonic wave of variable frequency.

THURSDAY AFTERNOON, 24 JULY 1986

Session H1: Underwater transducers and measurements
Chairman: L. Bjørnø, Industrial Acoustics Laboratory, Technical University of Denmark, Building 352, DK-2800 Lyngby, Denmark

Contributed Papers

H1-1 14:40
A METHOD FOR MEASURING ACOUSTIC PROPERTIES OF MARINE SEDIMENTS
M. Kimura and N. Shimizu

In the field of underwater acoustics, it is important to become aware of in situ acoustic properties of marine sediments. A method of determining the specific acoustic impedance has been reported. This paper presents a new method of determining not only the specific acoustic impedance but the sound velocity and the attenuation constant of the sedi- ment, by measuring the motional admittance of a piezoelectric transducer which is placed at the inner part of a rigid tube inserted into the sediment.

H1-2 15:00
SOME OBSERVATIONS FROM INSONIFIED UNDERWATER OBJECTS
C.Y. Tsui, G.N. Reid, G.C. Gaunaard

Monostatic and bistatic measurements were made on several underwater objects insonified normally by a pulsed, plane wave at slowly varying frequencies. The objects include solid and hollow cylinders of various sizes and compositions. The results verify many predictions of the Resonance Scattering Theory (RST) and provide a basis for underwater object identification, both for the object’s shape and composition. Measurements of sound decay, immediately after the pulse ceases to insonify the target, permit the determination of the loss constant of the material. Examples illustrate these concepts.
H1-3 15:20
DIRECTIVITY PATTERN OF A CYLINDRICAL SHELL TRANSDUCER WITH SYNTACTIC FOAM
H. Hachiya, S. Ohtsuki and M. Okujima

Underwater sound transducers are often employed under the high hydro-pressure. To realize a transducer with the desired directivity in deep sea, we devise a new transducer construction in which high-sound-speed material called syntactic foam is attached to a cylindrical sensitive element. To predict the directivity of the transducer, we give a calculation method of the directivity by the finite element analysis considering an infinite space. Numerical calculated results agree well with measured directivity patterns, and the possibility to realize the transducer with desired directivity is found out.

H1-4 15:40
ULTRASONIC UNDERWATER IMAGING SYSTEM FOR OFFSHORE UNDERWATER CONSTRUCTIONS
S. Kihara, K. Asayama, and K. Shirai

Ultrasonic underwater imaging system using sector scanning cross-array transducer, has been built and tested for offshore underwater constructions. This paper describes the imaging method and the system configuration of the newly developed ultrasonic underwater imaging system.

The results show that this system can give high quality acoustic reflection images with high resolution and low distortion.

H1-5 16:00
PHASED ARRAY PROCESSING FOR VELOCITY VARIANT MEDIA
E. M. Yeatman

A phased array system for the detection of oil spills under arctic ice is described. Array processing methods are examined for media, such as ice, of varying acoustic characteristics. A technique is presented for the unambiguous determination of both range and wave velocity, using beam steering and time domain gating. Another technique using focal ranging is discussed, and the two methods are compared. Experimental results for the former technique are presented.

H1-6 16:20
UNDERWATER SOUND MEASUREMENT USING PVDF HYDROPHONES
M. Macecek

The application of PVDF hydrophones for the measurement of beam profiles and absolute sound pressure levels for applications in underwater acoustics, medical investigations and nondestructive testing will be discussed. A review of the alternative piezoelectric solutions to the problem of making hydrophones will be used to identify the merits and pitfalls of PVDF probes. Basic design, electrical, impedance, frequency response, directivity, absolute sensitivity and durability will be addressed. Measurements will be reported on a batch of needle-like PVDF hydrophones.

[There is no text of this paper in the proceedings]

THURSDAY AFTERNOON, 24 JULY 1986
ROOM 104B, 14:40 - 17:00

Session K1: Musical acoustics: theory and instruments from around the world

Chairman: J. Kergomard, Labo. d’Acoustique, Univ. du Maine, UA 1101 CNRS, 72017 Le Mans, France

Contributed Papers

K1-1 14:40
TRAVAUX PRECURSEURS DE LA TRANSFORMATION DE FOURIER.
DE PYTHAGORE AU 19ème SIECLE. - P. A. LIENARD

"Pythagore" définit par des nombres les intervalles des sons. Les musiciens trouvèrent les lois des cordes vibrantes, qui peuvent donner simultanément plusieurs sons. Les théoriciens en écrivirent les équations et leurs solutions, sommes de fonctions trigonométriques "combinaison de courbes élémentaires de Taylor", et discutèrent sur la possibilité de représenter une courbe quelconque par une seule série.

Fourier développe en série trigonométrique une fonction périodique, et ce n'est que longtemps après que fut établie la transformation duale F(t) ⇔ F(ξ).

K1-2 15:00
A LA RECHERCHE D’UNE GAMME UNIVERSELLE
M. Barkeshli

En prenant le limma(L), comme unité de mesure pour le partage de la quarte, au lieu du ton dans la gamme de pythagore, les orientaux ont adopté depuis Safi-yod-Hin, 13e siècle, une gamme à 17 intervalles. Issue du partage du ton en L. C. L. Nos recherches récentes ont montré qu’il existe dans la musique iranienne, deux autres partages: L. C. L. et C. L. L., ce qui aboutit à une gamme à 28 degrés. Cette gamme unique contient tous les éléments des deux gammes de pythagore et d’Aristoxène, qu’on a eu tendance à accentuer pour la mélodie et l’harmonie.
THE EXTRA FORMANT, A CLUSTER OF F3 F4 F5 AND OTHERS
S. Wang

Centered on singer's formants, this paper questions some different or inconsistent results, conclusions and explanations in singing acoustics. Further discussion and tentative answers are given. This paper follows a film "Bright Timbre, Acoustic Features and Larynx Position" based upon this author's voice research as a sister presentation and a background. The main issues are: 1. The definitions of singer's high and low formants. 2. Larynx Position, singer's formants and timbre. 3. Singer's adjustment of formants. 4. The dependence of singer's formants on source, vowel, pitch and intensity.

ACOUSTICS OF SOHS ("KOTO"S)
Yoshinori Ando

Regarding several sohs (koto), their structure, frequency spectra of the tones, vibration modes and sound spectra obtained by impact of a small steel ball are investigated. It is found that 1) Most of decay curves of the harmonics show quasi-periodical fluctuation. 2) The vibration modes are alike to those of transverse vibration of a bar, but the frequency ratio is smaller than that of a bar. 3) 1/3 oct. spectra of the impact sounds have the highest level around 397Hz band. The next highest swell is observed in the region from 800 to 2500Hz bands.

HARMONIC STRUCTURE OF A NEWLY FABRICATED TAMBURA USING A SUBSTITUTE WOOD
V.L.Janakiram, K.C.Reddy, B.S.Ramakrishna

Tambara is a drone instrument used in all Indian classical music concerts. It has four strings and are tuned to 219, 292, 292 & 146 Hz (fundamentals=292). A new version of Tambara is fabricated using Silver Oak in the place of the traditionally used Jackwood and the sound out put of the Tambaras are found to be in very good agreement with each other though the shape is changed to a very great extent. It is easily portable.

AN INTERACTIVE GRAPHICAL SIMULATION FOR TEACHING MUSICAL ACOUSTICS
Martin Lamb and Garry Beirne

A microcomputer-based sound editor for teaching the physics of sound is described. Using a touch sensitive pad, students may draw in (and edit) their own waveforms and hear them as they draw. Alternatively, they may create waveforms via Fourier synthesis by manipulating a bar graph. Separate sliding controls allow the sound to be heard at different frequencies and amplitudes. Sum and difference tones demonstrate surprising non-linearities in the human auditory system. The attack, decay, sustain and release of the tone can also be manipulated graphically. The human-computer interface is made highly intuitive by the use of "intelligent" pictures. Because the sound instantly changes with the pictures, the student learns by creatively "sculpting" sounds.

VIBRATION PROPERTIES OF CHINESE MUSICAL INSTRUMENT -- INSTRUMENT -- PIPA
Chen Qinhuai and Sun Xuejin

In this paper, the vibration properties of Chinese musical instrument (pipa) have been studied theoretically and experimentally. Spectra are found for different playing techniques, playing angles and playing positions. Explanations are given for all these spectrums. Results are very useful for manufacturing, playing and teaching of pipa.
Invited Papers

H2-1  8:40
EARLY HISTORY OF ARCTIC ACOUSTICS RESEARCH
R.H. Mellen

From 1958–1962, USNUSL (now NUSC) carried out acoustic experiments at ice stations Alpha and Bravo (T3), Charlie, and ARLIS II. Analysis of propagation and reverberation data (10-1000 Hz) revealed attenuation and backscatter strengths greater by orders of magnitude than in the open ocean. Theoretical attempts at quantification of underice scattering appeared to yield reasonable values; however, recent estimates, with boundary effects taken into account, prove too small. Thus, despite a relatively extensive data base and theoretical advances, the acoustical effects of the ice cover remain poorly understood.

H2-2  9:10
ARCTIC OCEAN AMBIENT NOISE
I. Dyer

I review present understanding of ambient noise in the Arctic Ocean in terms of fundamental noise generating mechanisms. The ice cover responds to environmental forcing in various ways and radiates noise as a consequence of ice fracture or ice impact phenomena. These forces are related to the oceanography, meteorology, and ice dynamics of the Arctic. Several distinct frequency regimes of ambient noise have been identified and, within each, plausible mechanisms of noise radiation can be identified. While present understanding is far from complete, a fundamental picture is emerging.

H2-3  9:40
AMBIENT NOISE IN CANADIAN ARCTIC WATERS
J.M. Thorleifson and A.R. Penner

A review of the dominant ambient noise mechanisms in the shallow waters within and surrounding the Canadian Arctic Archipelago is presented. The ice cover, which changes significantly from one area to another and with time of year, has a major effect on the acoustic environment. The corresponding changes in the ambient noise are discussed in terms of the behaviour of the ice cover. Pressure and shear ridging caused by motion of the pack-ice under the influence of the wind is the main source of underwater noise. Under shore-fast ice conditions, wind blown snow and thermal ice-cracking are important sources.

H2-4  10:10
ACOUSTICS OF SEA ICE RIDGES
O.I. Diachok

The effective velocities and attenuation coefficients of sea ice ridges have been estimated for Arctic winter. Computed form functions, f, of sea ice cylinders (possible inputs into under-ice scattering models) were found to be much less than f for rigid cylinders, weakly dependent on ice velocity, and essentially independent of attenuation coefficients when kd<1. These results illustrate the need for an under-ice scattering theory that combines geometrical and physical properties of sea ice ridges.

H2-5  10:40
MODELLING THE EFFECTS OF ICE ELASTICITY AND ROUGHNESS ON LOW FREQUENCY ARCTIC ACOUSTICS
W.A. Kuperman, H. Schmidt and F.B. Jensen

Elastic properties and roughness of ice cover and bottom have traditionally been treated separately in Arctic acoustics. Recently a scattering theory for fluid media was extended to cover also the elastic case and implemented in a seismic/acoustic propagation model which can also provide the surface generated ambient noise field. Signal and noise can then be modeled in a consistent manner. Examples are presented for arctic propagation and for ambient noise arising from ice cracking events.

H2-6  11:10
GENERIC ULTRASONIC MODELLING OF PROPAGATION PHENOMENA ASSOCIATED WITH CANADIAN ARCTIC WATERS
G.N. Brooke AND J.R. Chansel

New experimental findings from ultrasonic models of propagation phenomena associated with Canadian Arctic waters are presented. In particular, results from two laboratory ultrasonic model studies are summarized: a) pulsed Rayleigh wave and Scholte wave scattering by lateral topographical inhomogeneities, and b) combined waveguide and topographical effects in a shallow water acoustic waveguide. Typical propagation characteristics drawn from field measurements in Barrow Strait, which motivated these model studies, are also presented.
A REVIEW OF TRISTEN EXPERIMENTAL RESULTS
F. R. DiNapoli, R. Nielsen, M. Fecher, and D. Potter

TRISTEN experiments have been conducted in each of the three distinctly different Arctic environments; (a) Pack Ice, (b) The Marginal Ice Zone (MIZ), and (c) the open water between the MIZ and the Arctic Circle. The major underwater acoustical results of the series of TRISTEN experiments, begun in 1980, will be presented.

FRIDAY MORNING, 25 JULY 1986  ROOM 104C,  8:35 - 12:00

Structured session L1: New materials for transducers
Chairman and organizer: G. Gaunaud, Naval Surface Weapons Ctr., White Oak Lab., Code R-43, Silver Spring, MD 20910, U.S.A.

Chairman's Introduction  8:35

Invited Papers

L1-1  8:40
ROTATIONAL INVARIANCE, BIASING STATES AND QUARTZ RESONATORS
H. F. Tiersten

The condition of rotational invariance has an important influence on the description of the interaction of the electric field with deformable insulators. As a result, the linear equations for small fields superposed on a bias are more general than those of linear piezoelectricity. The equation for the perturbation in eigenfrequency of a piezoelectric solution due to a bias obtained from this system has been applied in the calculation of the temperature dependence of quartz resonators, the results of which agree with measurements.

L1-2  9:10
SILICON MICROMECHANICS: NEW TECHNOLOGY FOR SENSORS
T.L. Poteat and I.J. Busch-Vishniac

An extension of silicon integrated circuit (IC) technology is micromechanics. The materials and processes of the IC revolution can be used to fabricate miniature mechanical structures for sensors and transducers. These structures are small, efficient and potentially inexpensive because of batch fabrication. Sensors and signal conditioning circuits can be made on the same die. We review the materials and processes of solid state sensors and discuss some applications. We report on details of a silicon microphone that is designed to have a sensitivity of -49 dBre 1 V/Pa at 400 Hz and be applicable to telephony.

L1-3  9:40
AMORPHOUS MAGNETOSTRICTIVE TRANSDUCER MATERIALS
K. B. Hathaway

Magnetostriuctive metallic glasses exhibit magnetomechanical coupling factors (k) approaching perfect transduction (k=i). Measurements of elastic resonance, magnetization, and permeability under applied stress and strain support a theoretical model which indicates that the observed large k values are due to the very small magnetic anistropy induced by the amorphous structure. These materials are being developed for a variety of sensor and transducer applications.

L1-4  10:10
EXPERIMENTAL STUDIES OF ULTRASONIC WAVES SCATTERING BY SOLID ELASTIC CYLINDERS AND CYLINDRICAL SHELLS
G.J. Quintin

We present the results of experimental studies of the scattering of ultrasonic waves in the MHz range by solid elastic cylinders and cylindrical shells immersed in water. Special attention is paid to the high k range with the use of short pulses for studying the "geometrical waves" in cylinders and the guided waves in cylindrical shells. A comparison is made with theoretical predictions. The good agreement between theory and experiments leads us to a solution of the inverse problem.
SECOND ORDER ELASTIC EFFECTS AND THE TORSIONAL BEHAVIOUR IN METGLAS 2605 SC TRANSUDER,
A. Hernando

Amorphous alloys present outstanding properties as transducer materials. We analyse the torsional magnetoelastic behaviour of these alloys according to: magnetic excitation of torsional modes and giant changes of the shear modulus induced by both magnetoelastic and second order elastic effects.

Contributed Paper

METHOD TO PRODUCE BROAD-BAND COMPOSITE MATERIALS
F.R. Montero de Espinosa and M. Pappalardo

Current research on new piezoelectric materials for ultrasonic imaging systems is mainly focussed on composite materials which avail themselves of the excellent properties of the piezoelectric ceramics. In this paper a method to produce broad-band composite materials is presented. The proposed method is based on the induced fracture of commercial piezoelectric plates. The experimental results are very promising, having reached a mechanical quality factor of $Q_m = 20$ with a pass-band of 45% when emitting in water with a quarter wave matching plate. This results encourage further theoretical and experimental development of the method.

Discussion 11:30

FRIDAY MORNING, 25 JULY 1986
ROOM 104A, 8:40 - 12:00

Session B2: Psychoacoustics II: Perception and localization of complex sounds
Chairman: P. Divenyi, Speech & Hearing Research (151), Veterans Administration Medical Center, Martinez, CA 94553, U.S.A.

Contributed Papers

B2-1 8:40
THE EFFECT OF AMPLITUDE ENVELOPE ON THE PITCH OF SHORT SINE-WAVE AND COMPLEX TONES
Thomas D. Rosing and Adrianus J. M. Houtsma

The pitch of a sine-wave tone having an exponentially rising or falling amplitude is judged higher than a gated sine-wave tone with the same frequency. The frequency difference for equal pitch grows with intensity and with the rate of rise or fall in amplitude. In complex tones consisting of sinusoidal components with frequencies $f_1=m+50$ and $f_2=(m+1)1+50$, the observed shifts in $f_1$ and $f_2$ are smaller than for isolated sine-wave tones with the same frequencies, and the dependence on the envelope decay rate is slight.

B2-2 9:00
PERCEIVED PITCH OF TWO-COMPONENT FM-AM TONES
S. Iwamiya and T. Miyakura

Perceived pitch of periodically FM-AM tones with two harmonic carrier components was measured as a function of the phase difference between FM and AM of each component. The pitch is shifted higher when FM and AM of the fundamental are in-phase than when they are anti-phase. The loudness-weighted pitch averaging process is supposed to be in the central auditory system and function on the basis of the modulation information of the fundamental. The pitch shift interval is varied by the interaction of the processings for modulations of each component.
STUDIES ON THE PERCEPTION OF DISTORTION IN THE LIGHT OF AN AUDITORY MODEL
M.A. Karjalainen

This paper describes experiments with a computational auditory model to study the perception of distortion in speech and audio signals. It is shown that the distortion measures based on the model have good correspondence to the results of subjective tests. Some basic rules known from the psychoacoustic theory are shown to be valid for complex distortion percepts. A practical measurement system for nonlinear distortion utilizing a signal processor is under development.

SPECTRAL DOMINANCE FOR NOISE SIGNALS WITH MONOAURAL AND DICHTHOCOMB-SPECTRA,
J. Raatgever and M.J. Bakkum

If complex signals have frequency spectra that are not harmonic, central pitch processing is supposed in a particular frequency region. This so-called dominant frequency region was reported to be near the 4th harmonic for cosine-noise. For dichotic noise signals with a comb-shaped central spectrum (according to the CB-theory), the fixed frequency region around 600 Hz will be reported as dominant. This behavior is compared to that of monaural comb-noise showing, like cosine-noise, dominance around the 4th harmonic; yet, a tendency to higher harmonics exists.

AUDITORY AFTER-IMAGES PRODUCED BY COMPLEX TONES WITH A SPECTRAL GAP
Hugo Fastl

When sounds with a spectral gap are switched off, a faint tone corresponding to the gap may be heard, called Zwicker-tone. From 52 naive subjects, 49 (94%) could hear a Zwicker-tone without prior information about the phenomenon. To produce a Zwicker-tone, complex tones should have spectral gaps at least half a critical band wide. With increasing gap width, the pitch of the Zwicker-tone shifts from the center to the low-frequency edge.

ON THE DEFINITION OF TONE COLOR, G. Kitamura.

It is called that loudness, pitch and timbre are three attributes of auditory sensation. American National Standard define the definition of timbre, but this is unclear, in many cases of research on tone color, we can't carry out the research if ARA definition of timbre is obeyed strictly. It is reasonable to replace the timbre or tone color by the following two aspects of sound.
1. aspect of identification of sound source.
2. aspect of sound impression about descriptive adjective of tone color.
It is desired to renew the concept and definition of timbre or tone color and decide the definition of tone color above mentioned ideas and independent to loudness and pitch.

SPATIALLY DEPENDENT FREE FIELD MASKED THRESHOLDS
R.W. Gatehouse

Earphones rather than free-field presentations are usually used to determine masking functions, and thus effects of spatially separating signals/maskers are not well known. Independent thresholds were obtained for 0.25, 0.5, 1.0, 2.5 and 4.0 kHz aural plane tones at 0°, 10°, 20°, 30°, 45°, and 90°. Next, masked thresholds for these signals and positions were obtained in the presence of WN bursts (2APC procedure) fixed at 0°. Masking patterns (minima, maxima, curve shape) varied with position and probe frequency. Sometimes greater masking was found with signal and masker separation than with their coincidence.

LATERALIZATION SHIFT AS A FUNCTION OF INTERAURAL DELAY AND TONE DURATION
C. Baruch, S. Giami, and M. -C. Botte

Two 1000-Hz, 60-dB SPL tones were presented in phase through earphones to different ears with an interaural delay (0 to 20 s) and, after a 40 to 2000-ms coexistence, they terminated simultaneously. On presentation of the second tone, a single intracranial fused image was heard. The results show an increasing lateralization of this image towards the lagging ear with interaural delays above a critical value of 25 ms.

THE PRECEDENCE EFFECT REVISITED: ECHO SUPPRESSION WITHIN AND ACROSS FREQUENCY BANDS
P.L. Divenyi and J. Blauert

We investigated echo suppression by measuring the discriminability of an interaural time difference in a dichotic sound (the probe) which had been preceded by another sound (the conditioner) presented diotically and in phase. Our results indicate that the echo is suppressed when the spectra of the two sounds largely overlap or when the spectrum of the conditioner is concentrated just below that of the probe, stressing the importance of monaural analysis in localization.

INFLUENCE OF AN INTERFERING NOISE ON THE LOCALIZATION OF A BAND NOISE SOURCE.
SUZUKI, Yutu and SOE, Toshio

The effect of noise on sound localization of a band noise is stated. It is cleared that the sound image shifts to the direction opposite to that of noise irrespective of the kinds of sound image, real or virtual. The shift of localized direction of a signal opposite to that of noise may be explained that a spatial masking between a sound image of the signal and the noise causes a deformation of the image, which results in biasing of a ‘perceived center’ of the signal to the opposite side of the noise.
Session C2: Machinery and equipment noise: measurement, prediction and control

Chairman: W.W. Lang, 29 Hornbeck Ridge, Poughkeepsie, NY 12603, U.S.A.

Contributed Papers

C2-1  8:40
MEASUREMENT OF NOISE EMISSIONS OF COMPUTERS AND BUSINESS EQUIPMENT - SPECIAL PROCEDURES
W.W. Lang

Significant progress has been made over the past decade in standardizing the methods which are used for measuring the noise emissions of the products of the computer and business equipment industry. Three areas of special interest at the present time involve the measurement, identification, characterization and declaration of the following types of noise emissions: discrete tones at frequencies below 10 kHz, noise emissions at frequencies above 10 kHz and impulsive noise.

C2-2  9:00
THE REDUCTION OF STRUCTURE - BORNE NOISE IN TRANSFER MACHINES
T.N. Moore

Transfer Machines consist of a large number of work stations attached to a central transfer spine. A given work station consists of a machining "head" which is supported by a "wingbase". The heads are significant generators of structural vibration which is transferred to the wingbases and radiated as noise. A study was initiated to quantity this effect using both noise and vibration measurements. These analyses resulted in inexpensive modifications to the wingbase structure which produced a significant reduction in noise amplification.

C2-3  9:20
EXHAUST NOISE CONTRIBUTION BY THE SCAVENGING FAN OF A HIGH EFFICIENCY DOMESTIC FURNACE
S.E. Brackett, W. Berends and R. Gaspar

The domestic furnace industry has implemented design changes so that the efficiency of their furnaces is in excess of 90 percent. However, some of the design changes have also introduced possible environmental noise problems. One major area of concern is the noise generated by scavenging fans. The work presented in this paper will deal with the exhaust noise contribution by the scavenging fan of a Duomatic/Olsen HCS 80/90. Furthermore, this paper discusses fan design changes so as to minimize its contribution to the exhaust noise.

C2-4  9:40
FLUID-BORNE NOISE TRANSMISSION THROUGH MULTI-TUBE HEAT EXCHANGERS
M. Purshouse

Multi-tube heat exchangers commonly consist of a large number of identical, small bore tubes arranged parallel to one another in a regular array. But some novel designs feature tubes that have a range of different lengths. The fluid-borne noise transmission properties of both types of heat exchanger will be discussed in the paper with the aid of some simple analytical models.

C2-5  10:00
CAVITATION NOISE AND VIBRATION CONTROL IN DIESEL ENGINE IN-LINE FUEL INJECTION SYSTEMS
S. D. Haddad

Diesel fuel injection systems can produce high frequency excitations resulting in high level noise and vibration and cavitation erosion in the various parts of the fuel system. This paper presents results of an analytical/experimental study conducted on an in-line jerk fuel injection system where it was shown that tappet slap is the main source of cavitation noise and vibration concluding that this phenomenon can be effectively controlled by adopting optimum tappet-bore clearance and avoidance of excessive wear.

C2-6  10:20
NOISE EMISSION FROM ROCK IMPACTS
D.O. Hughes and A.J. Doyle

The noise emission resulting from rock impacts on thick steel plates has been examined and rigid body radiation has been identified as a major noise producing mechanism. Deformation at the contact surfaces may be "point" or "line" or a combination of both. Theoretical models for rigid body radiation have been developed for spherical and cylindrical rocks which give results in good agreement with the experimentally determined values.
GERÄUSCHMINDERUNG TIEFFREQUENTER IMMISIONSANTEILE IM NAH- UND FERNBEREICH VON NASSIEBEN
H.-U. Haering, J. Schmitz

SOUND RADIATION FROM TEXTILE RING-SPINNING SPINDLES WITH MASS UNBALANCE
M. Çalışkan and A. Kahraman
Forced vibration of ring spinning spindles due to a linearly varying mass unbalance of the bobbin placed on a perfectly concentric spindle is calculated using finite elements. After the whirl orbits along the spindle axis are computed, two theoretical models to investigate the noise contribution of the spindle-bobbin system moving in the calculated whirl orbits are constructed. Sound power values and typical dipole directivity patterns for both models are obtained. It is concluded that the contribution of the system moving as described is negligible.

LEVEL OF BUS NOISE AND INFLUENCES OF ENGINE SUCTION AND EXHAUST SYSTEM
V. Tandara
The suction and exhaust systems are two out of many combustion engine and bus noise sources.
On the buses with the external noise level at 80 dB(A) it is not possible to expect a considerable reduction of the vehicle noise level only by working on the engine suction and exhaust system but it is necessary in the same time to reduce the influence of other noise sources.

NOISE REDUCTION OF THE INDUSTRIAL WASHING-MACHINES
P. Handl; V. Tandara
The noise level caused by washing machines is high. It does not depend only on the noise level of the machine itself but also on its location and the shape of the room. Noise has negative effects on the human organisms, i.e. it reduces the capability for work. The washing machine manufacturers are aware of that fact, make every effort to obtain the quietest possible and high-quality washing machines.

FRIDAY MORNING, 25 JULY 1986
ROOM 206 A and C, 8:40 - 12:00

Session E2: Sound transmission loss
Chairman: H.G. Jonasson, Statens provningsanstalt, Acoustics, Box 857, S-501 15 Boras, Sweden

Contributed Papers

E2-1 8:40
THE RELIABILITY OF SINGLE FIGURE INDICES IN APPRAISING THE ACOUSTIC PERFORMANCE OF WINDOWS
G. Kerry and C. Inman
Single figures indices are convenient and their reliability in describing the acoustic integrity of windows has been examined, in the context of an extensive research programme. For simple glasses, correlation is reasonable, but generally worsens with increasing complexity of construction. Selection, merely on the basis of single figure indices, can lead to ineffective installations and may miss the opportunity to utilise recent advances in coating technology, where special double glazing units can perform better thermally than triple glazing.

E2-2 9:00
SOUND INSULATION OF WINDOWS IN THE FIELD
H.G. Jonasson
Measurements have been carried out on different modern window constructions in the laboratory and in the field using different measurement methods. The difference have been studied. Different traffic noise spectra have been used to calculate the outdoor-indoor difference of A-weighted sound pressure levels. The correlation between this difference and R has then been studied. The results indicate a high correlation, although on different levels, and systematic differences between laboratory and field measurements.
NOISE REDUCTION OF FACADES - MORE MEASUREMENT RESULTS
Anita Lawrence

Further results of field measurement of the traffic noise reduction of typical dwelling facades are presented. It is confirmed that the traditional domestic eaves-ceiling roof system provides an important flanking transmission path rendering remedial action such as installation of double glazing ineffective. For facades providing good attenuation of traffic noise, wide-band analog recording techniques were found to give noise affected results in the higher frequency bands.

EMPIRICAL FORMULAE FOR THE SPECIFIC ACOUSTIC IMPEDANCE AND THE TRANSMISSION LOSS OF SANDWICH PANELS
Gen-hua Dai and Gang Zhou

Formulæ for the specific acoustic impedance and the transmission loss of sandwich panels are put forward by linear fitting the experimental data of various references and ours. In the two formulæ no more variables than the surface density, the frequency and the incidence angle of sound are involved, so they would be very convenient to users.

A FUNCTIONAL STATE ESTIMATION METHOD FOR A DOUBLE-WALL TYPE SOUND INSULATION SYSTEM UNDER THE EXISTENCE OF BACKGROUND NOISE AND THE PREDICTION OF RESPONSE PROBABILITY DISTRIBUTION
S.Miyata and M.Ohta

A practical method of identification and probabilistic prediction for insulation systems are proposed based on introducing a few functional parameters in relation to the well-known statistical energy analysis (SEA) method. Concretely, in order to predict the change of response probability distribution based on the characteristic improvement of a double-wall type insulation system under the existence of background noise, a new dynamical estimation method for a few functional parameters is proposed.

A DYNAMICAL IDENTIFICATION METHOD BASED ON CONDITIONED LEVEL OBSERVATIONS FOR ARBITRARY SOUND INSULATION SYSTEMS WITH AN ACTUAL RANDOM EXCITATION,
N. Nakasako, N. Ohta and K. Hatakeyama

An identification method for an arbitrary sound insulation system with arbitrary random excitations is proposed, when the input and output signals are contaminated by an additive noise. First, parameters of the insulation system expressed by a linear time series model in a power scale are successively estimated on the basis of the Bayes' theorem with a conditioned input level. Next, by use of these estimates, the probability distribution of output fluctuation is predicted for the present system with arbitrary random excitations.

UTILISATION DE L'INTENSIMETRIE DE PART ET D'AUTRE D'UN ECHANTILLON DE FACADE SOUMIS A L'IMPACT DU BRUIT DE LA CIRCULATION
J.-G. Migneron et M. Asselineau

Un élément de façade conventionnel a été installé en laboratoire en vue d'analyser son comportement en bruit continu ou fluctuant. L'analyse intensimétrique a été utilisée, tant en ce qui concerne la directivité des ondes frappant la façade, que pour établir la transparence acoustique de cette dernière ou bien le rayonnement simulé à l'intérieur du logement, dans différentes conditions d'ouverture de la fenêtre. L'exposé insiste notamment sur l'obtention directe de l'isolation par mesures intensimétriques en champ incident normal.

LIGHTWEIGHT WALL DESIGN FOR SPECIFIC STC/ABSORPTION.
T. Vass

In multi-storey buildings with subdivided floor plans (hospitals), the noise generated by services/activities would be similar in character and level in many adjacent rooms. Architects/designers often specify unnecessarily high STC ratings for the walls separating these spaces, resulting in most cases in heavy masonry or composite barriers/partitions. Experiments conducted indicate, that a lightweight wall, consisting of a thin sheet core with absorbent material of specific flow resistivity and thickness on each side, will provide the required STC ratings and will reduce significantly the reverberant sound in the rooms.

A STATISTICAL EVALUATION METHOD FOR THE OUTPUT PROBABILITY DISTRIBUTION OF SINGLE-AND DOUBLE-WALL SOUND INSULATION SYSTEMS BASED ON A MODIFIED SEA METHOD
S.Kuwahara, M.Ohta and K.Hatakeyama

A new statistical evaluation method for a sound insulation system is theoretically proposed after introducing a unified expression for the probability function of the transmitted noise fluctuation, in the orthogonal series form whose expansion coefficients reflect the input noise statistics and the acoustic character of the system based on the SEA method. Finally, the validity of the proposed method is experimentally confirmed.

A STOCHASTIC EVALUATION FOR ARBITRARY SOUND INSULATION SYSTEMS BASED ON MEASURE OF STATISTICAL INDEPENDENCY
Y.Kato, M.Ohta and K.Hatakeyama

In this paper, a new trial of the parameter estimation for arbitrary sound insulation systems has been proposed on the basis of the statistical independency between input signal and observation noise. Next, the output response probability distribution has been predicted by use of estimated parameters. Finally, the validity of the proposed method has been experimentally confirmed by applying it to the actual insulation systems.
Session G2: Ultrasonic spectroscopy, absorption and relaxation

Chairman: W. Lochstoer, Institute of Physics, University of Oslo,
P.O. Box 1048, Blindern, N-0316 Oslo 3, Norway

Contributed Papers

G2-1

HIGH FREQUENCY ULTRASONIC SPECTROSCOPY
K. Takagi, P.-K. Choi and H. Ozawa

The HR8 (high-resolution Bragg reflection) was effectively utilized for the velocity and absorption measurements in liquids and solids. The results obtained in liquid diiodoethane and tetra-chloroethylene show anomalous spectra over the range from MHz to GHz region, which were interpreted in term of vibrational-translational relaxation effect. The ultrasonic spectra up to 1.7 GHz were also obtained for longitudinal waves in sapphire.

G2-2

ACOUSTIC SPECTROSCOPY OF AROMATIC ALCOHOLS
Z. Ovlyakulyev, G. Nazarova, A. Shakparonov, N. Lezhnev

Acoustic spectra of some aromatic alcohols with single relaxation time have been studied. An analysis of the relaxation molecular mechanism has been performed using the theory of constants of actions in non-ideal systems. Probable mechanisms of formation and breakup of the active complex reaction centres have been discussed.

G2-3

VIBRATIONAL RELAXATION OF LIQUID HALOGENATED COMPOUNDS OF BENZENES AT HIGH PRESSURE
U.M. Esmakov, N.B. Lezhnev, A.A. Shamov

Vibrational relaxation of liquid halogenated compounds of benzenes in the range of pressures from 0.1 MPa to 100.0 MPa was investigated with the UHF acoustic and Brillouin spectroscopy methods. Variation of time of vibrational relaxation of these compounds was interpreted by increase of energy redistribution rate between internal and external degrees of molecule freedom.

G2-4

ACOUSTIC SPECTROSCOPY OF WATER AT ULTRA HIGH FREQUENCIES
N.B. Lezhnev

The technique of the acoustic spectroscopy of liquid water within frequency range from 300 Mc/s to 10 Gc/s using the solid state physics and laser optics achievements is discussed. The probable existence of a vibrational relaxation time (11.4 ps) has been evaluated in terms of the energy transfer in water vapor. It was found out that the contribution of this process to the whole sound absorption is negligibly small.

G2-5

ACOUSTIC SPECTROSCOPY OF OILS AND OIL PRODUCTS
K. Duryan, K. Muradov and B. Khemrajev

The paper discusses the results of measuring velocity and absorption of compressional and shear waves in oils differing in physical and chemical properties and mineral oils as well. Studies have been carried out within a wide range of frequencies and temperatures on the basis of the modern liquid state theory.

G2-6

HIGH-FREQUENCY ULTRASONIC ABSORPTION AND MOLECULAR RELAXATION NEAR THE LIQUID-Glass TRANSITION OF IONIC SOLUTIONS
K. G. Breitschwerdt and S. Gut

The propagation properties of hypersonic waves in the frequency range around 10^12 Hz have been studied by means of depolarized Raman scattering techniques. The systems investigated were aqueous depolarized Raman scattering techniques. The systems investigated were aqueous solutions which form a disordered glassy state. The ultrasonic attenuation can be described by an ordinary phonon damping and a loss mechanism due to structural relaxation.
EXTENDING THE KIRCHHOFF EMISSION/ABSORPTION LAW TO PHONON FIELDS
O. Bscorr

The Kirchhoff law represents a local energy balance and gives a relation between emission, absorption and energy density in a homogenous photon field. This relation can be extended to phonons, it is only necessary to take into account the frequency dependence of the phonon velocity and the different kinds of phonons. Furthermore, the Kirchhoff-balance will be extended from homogenous to inhomogenous fields. This method is a simple and productive tool describing transport phenomenas, esp. the heat conduction as energy transfer by phonons.

PHONON-VISCOSITY AND THERMOELASTIC LOSSES IN SEMI-CONDUCTING CRYSTALS
Kailash

Ultrasonic attenuation study has been made due to phonon-viscosity and thermoelastic mechanism in semi-conducting crystals (PbS, PbSe and PbTe) over a wide temperature region (between 50 and 500K) along different directions of propagation. It is found that the ultrasonic attenuation in the semi-conducting crystals is very important property.

ULTRASONIC ATTENUATION IN KCN
Raja Ram Yadav

Study of ultrasonic attenuation in KCN has been made starting from nearest neighbour distance and its hardness parameter. It is concluded that ultrasonic attenuation is a basic and very important property of a substance and may be used as independent geophysical parameter in oil exploration particularly in Acoustic Logging.

ULTRASONIC ATTENUATION IN SOLIDS
S.K.Kor

Ultrasonic attenuation studies have been made in metallic and dielectric crystals over a wide temperature region starting with hardness parameter, nearest-neighbour distance of the substance and using electrostatic and Born-Mayer type repulsive potentials. The attenuation due to electron-phonon interaction is obtained in noble metals. Phonon-viscosity and thermoelastic losses are obtained in metals and sodium halides. The results are discussed.

FRIDAY MORNING, 25 JULY 1986
ROOM 203 A and C, 8:40 - 12:00

Session 11: Scattering by obstacles, surfaces and turbulence
Chairman: R. Wei, Nanjing University, Acoustics Institute, Nanjing, China

Contributed Papers

I1-1  8:40
DIRECTIONAL CAUSTICS IN ACOUSTICS AND IN LIGHT SCATTERED FROM BUBBLES
P. L. Marston

Caustics were investigated for acoustical or analogous optical scattering problems. Examples include the acoustical glory of elastic spheres, the backscattering of light from bubbles in water, and the optical cusp diffraction catastrophes of penetrable spheroids. The reflection of high-frequency sound from curved surfaces or refraction by inhomogeneities are also predicted to produce transverse cusp catastrophes. A novel calculation of the shape of the outgoing wavefront producing a transverse cusp shows that the cusp is not limited to the far field.

I1-2  9:00
SCATTERING FROM AN ALUMINUM SPHERE: FABRY-PEROT ANALYSIS OF RESONANCES BASED ON THE WATSON TRANSFORMATION
K. L. Williams and P. L. Marston

The Watson transformation is applied to the analysis of backscattering from elastic spheres in water having ka>>1. Expressions for the scattering due to each class of elastic surface wave (e.g. the Rayleigh wave) are interpreted in terms of contributions from repeated circumnavigations. These expressions are summed in closed form as in the analysis of Fabry-Perot resonators. A novel synthesis of an aluminum sphere's form function is obtained by adding Fabry-Perot-like contributions (which describe resonance) to the specular reflection.
DIFFUSION ACoustique PAR DES CYLINDRES LIMITEs
J.L. Izbiicki, G. Maze and J. Hippoche

L'étude expérimentale de la diffusion acoustique par des cylindres fait apparaître deux groupes de résonances: le premier, lié à une inscription normale à l'axe du cylindre, correspond à l'excitation d'ondes circonférentielles, le second, lié à une inscription oblique, correspond à l'excitation d'ondes guidées selon l'axe. Dans ce travail, l'auteur estime sur toute sa longueur: pour un cylindre de longueur égale à cinq fois le diamètre, les résultats analogues sont obtenus; pour un cylindre de longueur égale à deux fois le diamètre, les spectres obtenus sont différents. Une étude des résonances est proposée.

RESONANCE SCATTERING FROM A VISCOELASTIC BODY
V. M. Ayres and S. C. Gaunaud

The problem of acoustic scattering from a viscoelastic body is usually approached by matching a single impedance-type or Cauchy boundary condition at the surface of the object. In this paper we contrast the solution so obtained with the exact solution obtained by the use of viscoelastic theory by matching three realistic boundary conditions on the object's surface. A viscoelastic sphere is chosen as an example. We find an expression for the surface impedance which depends on frequency, mode-order, and on material parameters.

EIGENVECTOR FORMULATION OF ACOUSTICAL SCATTERING,
M. F. Werby, G. J. Tango, and L. H. Green

By formulating the problem of acoustic scattering in terms of an eigenfunction problem, there is a number of advantages over other numerical approaches. One can employ the extinction theorem used by Waterman in the formulation of the T-matrix approach and proceed with the solution using the technology developed for eigenvalue problems, while retaining the salient properties of the extended boundary condition method. In particular, one retains uniqueness of solution, while overcoming problems that arise from ill-conditioned matrices often encountered in scattering problems. Several strategies exist that enable one to treat scattering in such a formulation for a variety of physical problems. We formulate the solution for several classes of submerged targets and compare results with T-matrix solutions.

GENERALIZATION OF LIGHTHILL'S SCATTERING FORMULA TO INCLUDE MULTIPLE SCATTERING OF SOUND BY TURBULENCE
M.S. Korman

Multiple scattering effects are included in the theoretical treatment on the scattered radiation from sound incident on a turbulent medium. The analysis for the scattered intensity begins with Lighthill's approach. Then results are compared with one of his formulas which includes the effects of single scattering. This treatment is similar to the analysis used by R.L. Fante [Rad. Sci.,17,1521-1530(1982)] which includes multiple scattering in the Booker-Gorden formula.

RANDOM SURFACE SCATTERING USING A WIENER-HERMITE EXPANSION
W.C. Meecham and W.W. Lin

By means of the Wiener-Hermite (W-H) expansion, we are able to construct stochastic field functions using the Gaussian reflecting surface as the basic element. We include three terms. Multiple reflection effects are clearly visible.

ACOUSTIC SCATTERING FROM LAYERED ELASTIC TARGETS
L.H. Green, M.P. Werby and R.P. Wooten

We report on our investigation of low frequency acoustic scattering from layered targets. Results are presented for scattering from double-layered spheres and prolate spheroids in the ka range from 0 to 12, where k is the wavenumber of the incident acoustic wave and a is the length of the semi-major axis. Comparisons are made with similar results for scattering from elastic solids, thin shells, and impenetrable targets. The dependence of the results on frequency, material parameters, and aspect ratio is discussed.

RESONANCE THEORY OF ELASTIC WAVES SCATTERED FROM AN ELASTIC SPHERE
D. Brill and G. Gaunaud

The interaction of elastic waves incident on an elastic spherical inclusion is studied with emphasis on the resonance scattering regime. The scattered amplitudes are shown to separate into a background portion containing reflected and Fresnel type circumferential waves and a resonance portion containing refracted, Rayleigh, and whispering gallery waves. This separation is demonstrated with graphical illustrations for the cases of both a nearly rigid and a nearly soft sphere.

PHASE MEASUREMENTS FROM BACKSCATTERED ACOUSTIC PULSES
R.B. Huston

The measurement of absolute phase in an acoustic backscatter system, provides the basis for various remote sensing capabilities including the remote profiling of sound speed or temperature. By digitising the amplitude and phase over each transmission period the received signal can be processed coherently to simulate larger scatterer population densities. Results from an experiment in November, 1985 have verified that stable phase signals can be obtained within discrete insonified volumes.
Session J1: Outdoor sound propagation: topographical, meteorological and ground effect

Chairman: Takehiro Isei, National Research Institute for Pollution and Resources, Kyushu Branch, 1142 Nishinogo, Usui-cho, Kaho-gun, Fukuoka Pref. 820-05, Japan

Contributed Papers

J1-1 8:40
DIFFRACTION FROM AN IMPEDANCE DISCONTINUITY
A.J. Hadry

A semi-empirical solution for the problem of diffraction of noise from an impedance discontinuity is examined. This solution has been applied by researchers to model situations and outdoor sound level measurements with difficulties appearing in extreme cases. A physical basis for the solution is presented which applies to plane waves. Experiments show that corrections taking into account sphericity of waves need to be made in certain cases. A pulse technique used to obtain the diffraction contribution is described.

J1-2 9:00
GROUND EFFECTS ON THE PROPAGATION OF ROAD TRAFFIC NOISE
D.C. Hothersall and S.N. Chandler-Wilde

The level of noise from road traffic is affected by the characteristics of the terrain between the road and the receiver position. Most of the prediction schemes for road traffic noise include allowance for the acoustic properties of the intervening ground, but usually in a very simple form. This paper describes the method of derivation of a series of contours for $L_{eq}$ predicting the attenuation of road traffic noise over ground consisting of various combinations of surface cover.

J1-3 9:20
SOUND PROPAGATION OVER A DEPRESSED ROAD HAVING FINITE IMPEDANCES.
Masaki Hasebe and Kozo Kaneyasu

Formulas are described for the estimation of sound pressure levels at locations on a shallow depressed road with finite acoustic impedances. The formulas were produced by applying Green's theorem to two imaginary boundary surfaces on the break-lines of the depressed road. As a result, it is possible to estimate the effect of the finite acoustic impedances peculiar to the surfaces constructing the depressed road. The comparison with the experimental results is excellent.

J1-4 9:40
THE EFFECT OF WIND ON OUTDOOR SOUND PROPAGATION FROM A LINE SOURCE
K. Yoshihisa and H. Tachibana

The sound propagation from a line source was studied in some theoretical considerations based on a prediction model and in a scale model experiment by using a wind tunnel. In the experiment, as a typical case, the sound propagation above a soft ground was examined under the condition that wind blows along a line source. The results show that, although a single value of vector wind plays important role in sound propagation from a point source, both wind direction and wind velocity are important factors influencing sound propagation from a line source.

J1-5 10:00
METEOROLOGICAL EFFECTS ON SOUND PROPAGATION OUTDOORS
T. Isei, N. Shikada, T. Suzuki, M. Kinoshita

To examine the effects from meteorological condition change on sound propagation outdoors, several series of model and full scale measurements have been made. From investigation of experimental results it is shown that a very small difference of propagation environment between direct and reflected wave at ground surface causes interference variation and subsequently such mechanism results in sound level fluctuation at a receiver sometimes greater than 15 dB.

J1-6 10:20
EXPERIMENTAL STUDY OF THE EFFECTS OF TURBULENT PROPAGATION ON THE LOCALIZATION OF ACOUSTIC SOURCES
D. Juvé, Ph. Blanc-Benon et M. Sidki

Experiments have been conducted in well controlled laboratory conditions to study the influence of turbulent velocity fluctuations on a high resolution imaging technique based on the properties of the interspectral matrix between the sensors of a linear array. It is shown that in conditions typical of atmospheric propagation the enhancement of the resolving power with respect to classical beamforming is limited to a factor of 4 by the randomness of the medium.
Calcul de champs acoustiques en basses fréquences
au voisinage du sol dans l'approximation parabolique
F. Jouailléc et S.M. Candel

L'approximation parabolique est utilisée pour
calculer la pression rayonnée par une source dans
l'atmosphère au voisinage du sol, en basses fréquen-
ces. Les conditions aux limites naturelles sont
étudiées en détail, ainsi que l'influence des limites
artificielles introduites par le domaine de calcul,
pour lesquelles différentes conditions sont compa-
rées. À l'aide de ce modèle, l'influence des gra-
dients de température, de vent, et des impédances
de sol, fonctions de la portée, a pu être analysée
et comparée avec les autres méthodes.

Outdoor sound propagation: solving by parabolic
approximation
G.P. Oswald

Applying parabolic approximations to the
equations describing the principles of deter-
ministic continuous media mechanics leads to
simplify their numerical computation and to
represent the sound propagation in a non
turbulent atmosphere. The corresponding
computing code combines atmospheric and
composite ground effects. Comparisons with
measurements reveal very satisfactory
($A_{max} < 2$ dB)

Transient analysis of spherical wave reflection by
plane boundary
Chen Tong

The spherical wave reflection by plane boundary
with complex impedance has been theoretically stud-
ied in time domain. An expression for impulse re-
sponse of reflection and the transient processes of
reflected and surface waves are given in this paper.

The fractal dimension of sound propagation near
the ground in a turbulent atmosphere
W. Wilken

Sound propagation in a turbulent atmosphere
is characterized by intensity and phase fluctua-
tions of the acoustic signal, due to the chang-
ing structure of the atmospheric surface layer.
The purpose of this paper is to describe the
turbulent boundary layer as well as the sound
pressure fluctuations by their fractal dimension
in order to get hints on the number of physi-
cal parameters required for description of the in-
teraction of sound and turbulence.
Plenary Session 2. Physical properties of sound in rooms and subjective effects in man

Speaker: Yoichi Ando, Faculty of Engineering, Kobe University,
Rokkodai, Nada, Kobe, 657-Japan

Chairman: H. Kuttruff, Institut für Technische Akustik, Tech. Hochschule Aachen,
Templergraben 55, Aachen, F.R.G. D-5100

Research of the perplexing problems which arise in the design of concert halls was conducted in response to the question of how best to identify and describe precisely design qualities. Utilizing different source programs, sound fields were simulated with well-defined, fully independent physical parameters of sound signals arriving at both ears. Four independent factors contributing to good acoustics have been discovered. Based upon the design theory derived here, it is possible to calculate the acoustical quality at any seat in a proposed concert hall.

FRIDAY AFTERNOON, 25 JULY 1986
ROOM 205 A and C, 14:35 - 17:20

Structured session C3: Le bruit des lignes électriques à haute tension

Chairman and organiser: J. Delcambre, Département Acoustique, EDF-DER,
1, avenue du Général de Gaulle, 92141 Clamart, France

Chairman’s Introduction 14:35

Invited Papers

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<th>C3-1</th>
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<td>LONG-TERM MEASUREMENT OF AUDIBLE NOISE AT THE SHIOBARA HVDC TEST LINE</td>
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<td>Y. Nakano and M. Fukushima</td>
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Long-term measurement of audible noise (AN) at the Shiobara HVDC test line has been conducted since 1982. The test line consists of a 4 x 3.84cm bipolar double circuit energized in the voltage range from +350kV to +600kV. In this paper the statistical AN performance is characterized by the results of this long-term test, and the measured AN level is compared with levels calculated with the various prediction methods proposed by some institutes including CRIEPI.

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<th>C3-2</th>
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<td>RESEARCH ACTIVITIES ON TRANSMISSION LINE AUDIBLE NOISE IN JAPAN</td>
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<td>M. Fukushima, K. Tanabe, Y. Nakano, S. Tomita</td>
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Audible noise from conductor corona of AC or DC transmission lines has long been studied in Japan with test lines and corona cages. Moreover, audible noise from partial discharges, such as the Single Unit Flashover, on wet contaminated insulator strings energized with AC or DC voltage has been investigated extensively. This paper introduces the present status of the research activities on transmission line audible noise in Japan, test facilities including the Akagi 1000kV and the Shiobara HVDC test lines and main results.
BRUIT EMIS PAR UN OBSTACLE CILINDRIQUE, PROFILE OU NON, PLACE DANS UN ÉCOULEMENT

H. Arbey

Après avoir analysé les mécanismes d'émission sonore de profil d'aubes placés en écoulement sain puis perturbé, nous présentons les modélisations de ces phénomènes faites par Arbey et Amiet. Une transposition de cette démarche est ensuite entreprise pour prédire le bruit émis par un obstacle non profilé placé en écoulement sain ou perturbé.

ELECTRICITE DE FRANCE RESEARCH PROGRAM ON HIGH VOLTAGE AC TRANSMISSION LINES

J. Delcambre, A. Petitjean

Electricite de France research program about noises from overhead power transmission lines will be presented. Corona noise cannot be easily reduced. Predicting formulas have been developed from experimental data and new methods of calculation are investigated. Aeolian tones from conductors have been computed. They can be reduced by increasing the distance between conductors or equipping conductors with spiral wires. Cavity tones from spacers or insulators have been characterized. They can be avoided when specific acoustic criteria are fulfilled.

LOUDNESS AND ANNOYANCE OF THE ACOUSTIC NOISE PRODUCED BY CORONA DISCHARGES IN A.C. POWER LINES.

M. Fiorina, R. Piazza, F. Rosa.

The paper describes some results of loudness and annoyance listening tests performed in Italy in the framework of the 1000 kV Project. As regards loudness, the results already obtained indicate significant differences between corona noise and other noises; possible corrections to be applied to the commonly used A-weighted levels are suggested. As regards annoyance, the investigation is still in progress and only preliminary results are reported.

AUDIBLE NOISE FROM AN ONTARIO HYDRO 500 KV TRANSMISSION LINE, J.J. Kowalewski, J. Reichman

Audible noise from transmission lines has not been a problem in Ontario Hydro—approximately 1700 km of 500 kV line are in service throughout the province. The design of these lines incorporates features for controlling the corona produced noise to relatively low levels. In order to verify the design criteria, a series of measurements were carried out at an in-service 500 kV line. This paper describes the design criteria, the method used in acquiring field data and presents the results.

EFFECT OF AUDIBLE NOISE ON UHV POWER LINE DESIGN

R. Cortina, F. Rosa

The paper intends to give a short review of current knowledge on the audible noise produced by AC power lines, taking particularly into account results of systematic investigations conducted in Italy within the 1000 kV Project. The effect of various parameters (voltage gradients, conductor characteristics, surface conditions) on the audible noise generation of a line is analyzed. Indications on the influence of audible noise on line cost are also given.

Discussion 17:00
Structured session M1: Signal analysis in real time including transmit-signal coding

Chairman and co-organiser: E. Corliss, Forest Hill Lab., 2955 Albemarle Street, N.W., Washington, D.C. 20008, U.S.A.


Chairman’s Introduction 14:35
Invited Papers

M1-1 14:40
TRENDS IN DIGITAL CODING OF SPEECH AND MUSIC
David J. Goodman

Every digital code can be judged by how well it meets the goals of low bit rate, low equipment cost and high-quality sound reproduction. Coders fall into two categories. Waveform coders preserve the original acoustic waveform while analysis/synthesis vocoders extract essential features of the source. Relative to vocoders, waveform coders have high bit rates, low costs and high quality. Today’s principal applications for waveform coders are in telephony and in digital audio. Vocoders are used, primarily by military organizations, for speech transmission over narrow bandwidth channels. Meanwhile, there is intense interest in new codes for a wide range of anticipated applications.

M1-2 15:00
VIBRATIONS EN RÉGIME TRANSLATOIRE ET INFORMATIONS
L. Pironow

Définition mathématique des signaux porteurs d’information et leur association obligatoire à une différenciation temporelle ou spatiale entre au moins deux états physiques distincts. Or, la différence temporelle des signaux acoustiques est toujours liée à un phénomène transitoire. On précise l’importance pour les êtres vivants de la perception des grands débits des informations et en conséquence la nécessité de traitement rapide des phénomènes transitoires. On précise les solutions trouvées au cours de l’évolution phylogénétique de l’ouïe pour résoudre ce problème.

M1-3 15:20
RESONANT SCATTERING OF ACOUSTIC TRANSIENTS: MOSTLY THEORY
Herbert Uberall, Susan K. Nuerich, and William Howell
Department of Physics, Catholic University
Washington, DC 20064, USA

Acoustic excitation of elastic-body resonances is described by the resonance scattering theory [RST; Flax, Dragonette, & Uberall, JASA 63, 723 (1978)]. In the scattering of transients, one may employ long pulses [Maze & Ripoche, Rev. Phys. Appl. 18, 319 (1983)] which cause the ringing of a single resonance, permitting a determination of the body’s resonance spectrum. Resonances are caused by a phase match of surface waves, and the ringing by their superposition.

M1-4 15:40
DIFFUSION ACOUSTIQUE: ANALYSE EXPERIMENTALE DU RÉGIME TRANSLATOIRE
G. Maze et J. Ripoche

L’observation des oscillogrammes des échos diffusés par des câbles élastiques montre que, lors des résonances, ces échos présentent une structure constituée de trois régimes: un premier régime transitoire, un régime permanent et, enfin, un second régime transitoire correspondant à la rémission libre de la cible. On étudie le régime forcé et le second régime transitoire. On accède au mode "n" et au coefficient de rémission des ondes circonférentielles.

M1-5 16:00
SUBTLE PROBLEMS WITH DIGITAL AUDIO
David S. Lindsay

1. Because sine waves up to 25dB below white noise can be audible, current CD’s should have less dynamic range than the highest quality LP’s;
2. Phase distortion in anti-aliasing and anti-image filters should be audible;
3. Any non-linearity in the A/D or D/A converters will cause a transiently reproduction to depend on its arrival time. I coin the term transient variation distortion (TVD) for this digital-only phenomenon.

M1-6 16:20
REAL TIME SPEECH RECOGNITION
John G. Ackenhusen

The performance of speech recognition in real time, that is, computing a recognition choice in a time comparable to the length of the spoken utterance, requires special tailoring of speech recognition algorithms and the computing structures that execute them. For example, because real time speech recognition computations are performed while speech input is in progress, stream processing algorithms, which can only act on information based on the portion of speech that has already arrived, are emphasized over block processing techniques, which can postpone decisions concerning earlier portions of the waveform until the entire speech input is available.
THE "ART" OF RTA: MANAGING THE LIMITATIONS OF
REAL-TIME ANALYSIS
E. L. R. Corliss

Trying to analyze salient features of a signal within a time-frame comparable to its duration approaches fitting a template. Thus signal analysis and decoding converge on the same limit. High-speed processing demands accurate understanding of the artifacts introduced. Signal processing boundaries must be shaded to minimize truncation and aliasing. Maximum speed can be attained only by ascertaining the minimum signal-to-noise ratio allowing adequate signal recognition.

Discussion 17:00

FRIDAY AFTERNOON, 25 JULY 1986

SESSION A2: PHONOLGY AND SPEECH PERCEPTION

Chairman: S. Kameswaran, Post Graduate Institute of Basic Medical Sciences, University of Madras, Taramani, Madras - 600 113, India

CONTRIBUTED PAPERS

A2-1 14:40
LANGUE, FILTRE ET MODÈLE
P. Martin

L'avènement de la théorie du phonème conçu comme entité n'ayant de réalité que par les oppositions significatives qu'il rend possible a eu pour effet d'entaîner la dichotomie phonétique/phonologie qui veut que la première traite de la "substance" et que la seconde traite de la "forme". Or, les traits phonétiques ne sont pas plus des faits de matière que les traits dits fonctionnels. Tout trait est un trait posé, construit et relève d'une triple abstraction: la langue elle-même, le filtre perceptive individuel et le modèle représentatif élabore par l'analyse.

A2-2 15:00
LES UNITÉS PHONÉTIQUES SONT DES ABSTRACTIONS MECONNAISSABLES AUTOMATIQUEMENT DANS LA CHAINE PARLÉE.
Laurent Santerre, Dép. de linguistique, Univ. de Montréal.

La caractérisation des unités du langage au moyen de traits distinctifs, eux-mêmes définis par des indices acoustiques, est une démarche utile et irremplaçable en linguistique théorique; mais elle est restrictive, réductrice et aberrante quand il s'agit de décrire la parole réelle. Ces définitions abstraites des unités ne sont pas respectées dans la parole courante et les traits qui devraient les distinguer n'ont pas nécessairement à se réaliser de la manière qu'on le croit trop souvent. Exemples.

A2-3 15:20
THE ACQUISITION OF CANTONSE PHONOLOGY: A PHONETIC ANALYSIS
S.-M. Tse and D. Ingram

This study presents a phonetic analysis of three young children learning Cantonese as their native language. An explicit set of quantitative criteria for the phonetic analysis of children acquiring Cantonese is proposed. Based on the results, an inventory of the early sounds acquired in Cantonese is set up.

A2-4 15:40
TEMPORAL FACTORS IN VOWEL PERCEPTION
A.J. Rosmait

Several vowel perception studies address the problem of how the listener estimates the formant frequencies, i.e., the spectral envelope peaks, from the harmonic components of the vowel line spectra. It appears that the time interval needed for vowel recognition is of the order of one glottal period. Spectra of vowels analyzed with such a short window are continuous, with peaks at formant frequencies. They do not show any harmonic structure. This suggests that spectral energy at the formant frequency is directly available to the listener.
ANALOGS TO SPEECH PROCESSING: DISCRIMINATION OF DYNAMIC, COMPLEX SOUNDS
E. B. Slawinske, D. G. Jamieson, and T. Johnson

Listeners' discrimination of changes in the duration of a brief frequency transition followed by a steady-state is best when the transition takes 30-50 ms. This effect occurs for both pure-tone stimuli and for stimuli synthesized with periodic excitation. The effect reflects masking by the steady-state "vowel" portion of the sound on the glide portion, and generalizes to a speech contrast (/b/-/w/).

PITCH OF GLISSANDOS IN SPEECH SOUNDS
C. Cave; D.J. Hirst and M. Rossi

The pitch point of frequency glissandos (FGs) of speech sounds is investigated. Previous work, using pure tones, used linear variations of frequency. In order to produce a closer approximation of speech sounds we used synthetic (LPC) vowels with FGs generated by a quadratic spline function. Our results confirm that a FG is not perceived in its totality (the pitch point is situated at about 2/3 of the FG) and show a slight but significant effect of the inflexion point. A model based on the glissando threshold is proposed.

ON THE ROLE OF SPECTRAL TRANSITION IN PHONEME PERCEPTION AND ITS MODELING
S. Furui and M. Akagi

In order to clarify the most important speech portions and physical features for vowel and consonant perception, Japanese CV syllables were truncated at various positions and presented to listeners. Comparison between the results of listening tests and spectral features reveals that a speech wave of approximately 50 ms duration including the maximum spectral transition bears the most important and essential information for phoneme perception. A 2nd-order critical damping model is proposed as a mathematical model for the perceptual mechanism of vowel target prediction based on the short-term spectral transition. Experimental results indicate that the model corresponds well to human hearing.

FRIDAY AFTERNOON, 25 JULY 1986
ROOM 104A, 14:40 - 16:20

Session B3: Impulsive noise: generation and response
Chairman: W.D. Ward, Hearing Research Laboratory, University of Minnesota,
2630 University Avenue SE, Minneapolis, MN 55414, U.S.A.

Contributed Papers

TRANSIENT RESPONSE OF HUMAN HEARING SYSTEM
Y. Sakurai

The reflection from a small rigid plane panel has a positive specular reflection followed by equivalently large negative boundary waves, and we hear only a little reflection from it. Even if it is small, these two kinds of waves have the time interval caused by their path difference. In order to explain the above experience, a transient response to continue for a certain time on our hearing system must be introduced. At the exposure of a positive rectangular pulse wave, the response of the human hearing system was obtained by pair comparison measurements.

THE DEPENDENCE OF CRITICAL LEVEL ON TIME
W. Dixon Ward, Dorisann Hånderson

In the chinchilla, an exposure level of 120 dB SPL is "critical" for exposures of 22 min or longer, producing damage that is considerably greater than that produced by single exposures of the same total energy but longer duration at lower levels. However, exposure for 8 h/day to 7.2-sec 120-dB noise bursts repeated every 12 min produced minimal PTS and hair-cell destruction even after 9 weeks of daily exposure. Clearly, the critical level depends on both single-event duration and temporal pattern, a fact that invalidates any simple scaling on exposure levels such as 115 dBA, 130 dB or 140 dB peak.
CONCEPTION D'UN SYSTÈME DE TRAITEMENT NUMÉRIQUE DES SIGNALS SONORES TRANSITOIRES DE LONGUE DURÉE ET DE HAUT NIVEAU,
N. Savan, Y. Champoux, J. Nicolas

On décrit un système de génération et de contrôle numérique des signaux de haut niveau (140 dB) et de longue durée (1 sec). Le logiciel qui gère le système donne accès à un nombre illimité de signaux, cependant le contrôle peut être effectué selon deux méthodes; simple et moyennée qui sont basées sur la connaissance de la fonction de transfert de la chaîne de son. La performance et la souplesse du système permettaient en outre la mesure de la perte auditive provisoire.

EFFECT OF TEMPORAL PATTERN OF IMPULSIVE SOUNDS ON LOUDNESS
S. Kuwano and S. Namba

Temporal pattern of impulsive sounds has a significant effect on loudness. In order to examine the effect of temporal pattern in detail, the stimuli were presented dichotically in the present experiment and the results were compared with those of our previous experiments, in which the stimuli were presented monaurally. From these results, it was suggested that temporal masking may play an important role in the perception of loudness, though other factors such as overshoot and after-effect cannot be neglected.

FRIDAY AFTERNOON, 25 JULY 1986

Session D1: Vibrations: models and methods
Chairman: G. Hübner, Reichssportfeldstrasse 16/805, D-1000 Berlin 19, F.R.G.

Contributed Papers

D1-1 14:40
EQUIVALENT MECHANICAL CIRCUITS FOR A RIGID BODY WITH A KNOWN POSITION OF THE GRAVITY CENTER
Sumio Sugawara and Masashi Konno

This paper deals with the equivalent mechanical circuits for a rigid body of which the position of the gravity center is given. These circuits are derived by two methods. One of the circuits is represented by use of the normal mode function, and the other is derived from the general equivalent circuit. The circuits are discussed in detail.

D1-2 15:00
APPLICATION OF ONE-DIMENSIONAL WAVE THEORY TO ULTRASONIC DRILL SYSTEM VIBRATION
LI Meng

When an ultrasonic drill is applied to drilling deep hole, a long tool rod must be used. The length and diameter of the tool rod will considerably affect the drill operation. One-dimensional wave theory is applied to the drill with long tool rod. We find that the drill is more efficient if the natural frequency of clamped-free tapered cone and tool rod combination is equal to that of the free-free transducer.
MEASUREMENT OF THE BURIED LENGTH OF STEEL PILE
DRIVEN INTO THE GROUND WITH ELECTROMAGNETIC IMPACT
DRIVING METHOD
S. Motooka, T. Natanabe, M. Okujima & M. Ohgaki

The authors devised an electromagnetic impact driving method of measuring the buried length of a steel pile driven into the ground. That is, measurements of frequency characteristics of sound attenuation constant in a steel pipe buried in a model bath filled with sand were made. Taking these results into consideration, field tests were performed. Consequently, it is confirmed that this method is useful for measurement of the buried length of pile.

STUDIES ON A VIBRATION-ISOLATED RADIO STUDIO MOCK-UP
T.J.B. Smith, R. Walker and C.D. Mathers

An experimental vibration-decoupled structure was built at the site proposed for a broadcasting centre to aid the design of radio studios affected by noise and vibration from underground trains. The initial test assembly consisted of a 9 tonne slab moved by jacks which enabled the effects of changes in isolator systems and void depths to be assessed. Subsequently, a 45m² enclosure was constructed on the slab for the evaluation of ground-borne noise transmission to a simulated studio. Guidance lines for practical means of reducing ground-borne noise in full-scale constructions are described.

MEASUREMENT POSSIBILITIES OF THE TRANSFER
MECHANICAL IMPEDANCE METHOD FOR INVESTIGATION
OF THE VISCO-ELASTIC MATERIALS
W. Bandera, A. Śliwiński

In the paper, the method is accurately analyzed, when an inhomogenous rod-like specimen is excited into longitudinal harmonic vibration. In particular the sandwich structure of nearly continuous change of wave impedance along the length of a sample has been examined experimentally and numerically. A comparison of both kinds of results are discussed and practical applications described.

THERE IS NO TEXT OF THIS PAPER IN THE PROCEEDINGS
FRIDAY AFTERNOON, 25 JULY 1986

Session E3: Applied room acoustics design
Chairman: Yoichi Ando, Faculty of Engineering, Kobe University, Rokkodai, Nada, Kobe 657, Japan

Contributed Papers

E3-1 14:40
ACOUSTICAL DESIGN OF SUNTORY HALL
Y. Toyota, A. Ono, M. Nagata

SUNTORY HALL is a new concert hall located in the central part of Tokyo. It has a 2,000-seat large hall for orchestral music and a 400-seat small hall for chamber music. The seating area of the large hall is divided into small blocks, such as Berlin Philharmonie.

Model experiments were carried out to adjust and determine the room shape and the location of the reflecting elements as well as to detect the detrimental echoes.

The acoustical design, the model experiments and the acoustical characteristics are described.

E3-2 15:00
SPECIAL PROBLEMS IN CHURCH DESIGN IN NORTH AMERICA
D. L. Klepper

Two distinct traditions are merged in mainstream Protestant and Roman Catholic churches. Speech intelligibility is expected to be as good as in the small "meeting houses" that typified churches in Colonial America, yet strong music programs, often featuring expensive pipe organs, require diffuse, reverberant, low-articulation-index spaces. Sophisticated electronic sound systems can help in resolving this conflict. Several types of churches and systems are discussed, along with the problems of flexibility and voices from the pews.

E3-3 15:20
ACOUSTIC RESEARCH IN THE BRITISH BROADCASTING CORPORATION
D. J. Meares

To support the design and development of a large number of studios, the BBC carries out a great deal of research into studio acoustics. Acoustic modelling, material testing, absorber designs, and research into insulation and vibration isolation are some of the topics being studied. This paper will review some of these in the light of recent experience.

E3-4 15:40
THE ACADEMY FOR PERFORMING ARTS, HONG KONG
Jeff Charles

The new Academy for Performing Arts in Hong Kong has recently been completed. It includes 3 theatres, 60 teaching and practice rooms, 10 dance studios, recital and recording spaces and a CCTV studio, all at risk from high prevailing noise and vibration levels from road traffic and underground trains.

The three-year acoustics consultancy concerned all acoustic aspects of the project, including the control of plant room noise, the design of isolated rooms, the acoustic modelling of the main auditorium and control of vibration.

E3-5 16:00
THEATRES AND AUDITORIA OF ARGENTINA
J. Gauna and G. L. Poche

Geographic and cultural characteristic determined location of classical theatres in few bigger cities, followed by minor halls. We have studied quality for speech by means of objective and subjective tests in Spanish and developed criteria comparable to S.T.I. applicable to multipurpose halls common in Argentina, to evaluate and correct acoustics for speech and music, using orchestra shells and improving useful reflections.

E3-6 16:20
ACOUSTICAL DESIGN OF THE KOBE PORT-ISLAND HALL,
MULTI-PURPOSE FOR TEN THOUSANDS PEOPLES
Z. Maekawa

The hall originally designed as a gymnasium for the Universiade '85 in Kobe, and has an acoustically awful shape consisted of a half-cylinder and two quarter-spheres. After starting its construction, the owner, municipal government, required to use multipurpose not only for sports but for any events of big scale, ceremony, exhibition, musical play, and also classical concert for ten thousands peoples. This paper presents the data of the characteristics of acoustical treatment and measured data after finishing the construction.
DESIGNING ACOUSTICALLY OPTIMUM CONFERENCE ROOMS
G. Langhout and R. Ploomp

A ray-tracing computer model was used to determine optimal conditions, with respect to intelligibility, for conference rooms. The parameters under consideration were the absorption and diffusion coefficients of the boundary surfaces, as well as the shape of the room. The best results were obtained by highly reflecting walls tilted inwards, in combination with a highly absorbing floor and a highly reflecting ceiling. In this way, as much sound as possible is brought to the listeners in a minimum of time.

FRIDAY AFTERNOON, 25 JULY 1986

Session J2: Outdoor sound propagation: mainly low frequencies and long ranges
Chairman: A.D. Pierce, School of Mechanical Engineering, Georgia Institute of Technology, Atlanta, GA 30332, U.S.A.

Contributed Papers

J2-1 14:40
SOUND PROPAGATION OVER LARGE SMOOTH RIDGES IN GROUND TOPOGRAPHY
Allan D. Pierce, Geoffrey L. Main, James A. Kearns, Daniel R. Benator, and James R. Parish, Jr.

A theory similar to those developed by Fock and others for electromagnetic wave diffraction by curved surfaces applies to acoustic propagation at low angles with the ground over an intervening ridge of finite impedance. The analysis reduces to numerical and approximate integration of Fock’s form of the van der Pol-Breymann diffraction formula. Laboratory scale experiments are in progress to test and guide the analytical developments.

J2-2 15:00
EFFECTIVENESS OF PHASE REVERSAL SOUND BARRIERS AT LOW FREQUENCIES.
M. Amran and V. J. Chvojka

Un nouveau type de barrière ouverte, qui modifie (pour les bandes de bruit de basses fréquences) la phase de l’onde incidente (de préférence de 180°), annulant de ce fait par effet d’interférences la partie diffractée du bruit incident, a été testé à l’aide d’un prototype de 2,4m de haut et 12,5m de long. Les atténuations en excès de celles d’un écran plein ont été comparées à celles obtenues par une simulation sur modèle réduit à l’échelle 1/20 et présentent les mêmes tendances.

J2-3 15:20
EXCESS ATTENUATION OF SOUND WAVES IN THE ATMOSPHERE
S. Jankovic and Z. Huljkov

It is shown in this paper that dependance of the excess attenuation of surface sound waves, generated by explosive sources, upon frequency could be expressed, for the real environment, in the form of third order polynomial. The specific values of its coefficients have been determined for particular flat terrain, partly covered by the forest, by measuring pressure level of the sound, generated by explosions, at the ranges of 700m, 1400m, 2350m, and 3600m from the source in particular direction.

J2-4 15:40
INFRASONIC ARRAY FOR THE DETECTION OF LOCAL METEOROLOGICAL EVENTS
Allan J. Zuckerman

Infrasonic data, gathered on a three-element microphone array in the frequency band 2-16 Hz, yield a class of signatures believed to be emissions from local meteorological sources (low level windshear, microbursts, etc.). An adaptive filter extracts the signals from a turbulent background and provides time delay estimates to locate the source. Spectral analysis is the basis for source identification.
INFRASOUND ORIGINATING FROM REGIONS OF SEVERE WEATHER
A. J. Bedard, J. Intrieri, and C. E. Greene

We describe measurements of infrasound in the frequency range from .25 Hz to 20 Hz with bearings from the direction of weather systems in the region of our Boulder, Colorado observatory. We use surface measurements, satellite and radar data to attempt to identify origins and generation mechanisms for infrasonic signals observed at distances varying from tens to hundreds of kilometers from the apparent sources. We show examples illustrating the various signal types and discuss possibilities for identifying the source mechanisms.

SPACE SHUTTLE SONIC BOOM SOUND EXPOSURE LEVEL SPECTRA
Robert W. Young and Frank T. Awbrey

At a site about 12 miles west of the runway, the decelerating space shuttle Atlantis, 61-B (STS-31), landing 3 December 1985 at Edwards Air Force Base in California, caused a 400-ns sonic boom whose peak sound pressure levels flat, C, and A respectively, were 132.1(B), 129.7, and 113.3 dB. The respective flat, C-, and A-weighted sound exposure levels were 121.2, 105.6, and 98.4 dB. At 200 Hz, the 1-Hz band A-weighted sound exposure level exceeded that of the background noise by 32 dB.


We present infrasonic observations of the Minor Scale High Explosive Test in two frequency bands: 0.05 to 0.15 Hz and 0.5 to 3.0 Hz. The emphasis is on data recorded at Kauai, Hawaii; data from other sites are also discussed. Analysis is made with standard time-delay and sum array processing techniques. Signal durations from 8 to 17 minutes were observed and an average travel speed was ~0.290 km/s. Deviations in observed azimuths were ~8° from the expected values. Pressure amplitudes were in agreement with predictions.

FRIDAY AFTERNOON, 25 JULY 1986
ROOM 104B, 14:40 - 17:20

Session K2: Pianos, harpsichords, tympani and bells
Chairman: T.D. Rossing, Department of Physics, Northern Illinois University, DeKalb, IL 60115, U.S.A.

Contributed Papers

THE KINEMATICAL STUDY ON THE INITIAL BEHAVIOUR OF HAMMER STRIKEN PIANO STRING
H.Kubota & Y.Nagai

Slow motion picture taken with the anamorphic optics which magnifies only the amplitude of the string visually reveals the initial behaviour of the hammer struck piano string. This is the first experiment of our kinematical study of the piano string. As the second experiment, the velocity of the string element which is located almost at a fixed end is measured. The wave form of the velocity shows that the string behaves in many ways when it is stricken with an ordinary felt hammer instead of a metal hammer.

THE PHYSICAL AND PSYCHOLOGICAL EFFECT(S) OF LID POSITION(S) OF THE PIANO ON VOLUME AND ON HARMONICS
M. A. Spencer

Measurements of latency and magnitude were taken for the full spectrum and first five harmonics at A27.5, A440 and A350. The research design included three piano sites, three microphone positions and three lid positions: top stick, tongue, and closed. The analyses of data results determined minimal volume differences in the three lid positions, compared to the amount of acute harmonic distortion and extensive time delay at the tongue and at the closed lid positions.
K2-3  15:20

ENDLESSLY RISING OR FALLING CHORDAL TONES PLAYABLE ON THE PIANO: ANOTHER VARIATION OF THE SHEPARD TONE.

R. Teranishi

It is well known that Shepard (1964) showed a set of certain complex tones bringing illusional pitch perception, and Burns (1981) presented its non-octave variation. This paper shows that the same effect can be obtained by another variation of the Shepard tone, occupying only 3 octaves band width in which 9 partials are packed together. The author explains that the circularity of pitch of such complex tones is no more than a reflexion of the physical circularity consists in the stimuli set.

K2-4  15:40

A STUDY OF THE SOUNDBOARD AND AIR CAVITY VIBRATIONS OF A ZUCKERMANN FLEMISH VI HARPICHORD,

W. R. Savage, E. L. Kottlock, and T. J. Henrickson

A Zuckermann harpsichord was used to study the vibrations of the soundboard and air space could be studied by excitation drivers, vibration detectors, and external and internal microphones. A speaker-driver mounted at the tail of the instrument is used to excite the internal air vibrations. The soundboard was excited by a small piezo-electric vibration source and the vibrations of the soundboard detected by small transducers or microphones. The air cavity and soundboard responses indicate a set of independent and coupled modes.

K2-5  16:00

TOUCH SENSITIVE CONTROLS BY HUGH LE CAINE

G. M. Young

Between 1945 and 1964 Canadian scientist and composer Hugh Le Caine designed several devices by which the operator of an electronic music instrument could directly control characteristics of sound. These devices were used primarily as level controls, enabling the operator to make immediate adjustments to the sound by varying the pressure exerted on the device. The electro-mechanical design and the musical application will be discussed.

K2-6  16:20

MODELISATION DE MARTEAUX DE PIANO

X. Boutillon

Le son d’une note de piano ne dépend que de la vitesse d’impact du marteau sur les cordes. En revanche, le contenu spectral du son émis est fortement affecté par ce paramètre. Nous proposons un modèle non-linaire du marteau de piano, en interaction avec les cordes, effectuons sa détermination expérimentale et comparons avec des mesures du mouvement du marteau et des cordes.

K2-7  16:40

KETTLE-SHAPE DEPENDENCE OF TIMPANI NORMAL Modes,

A. Tubis and R.E. Davis

Calculations of timpani normal modes based on boundary integral equation methods are carried out for a variety of cylindrically symmetric kettle shapes. The kettle is assumed to be rigid and room acoustics effects are ignored. The kettle shapes considered include cylindrical, hemispherical, hemispherical cap on a cylindrical sleeve, paraboloidal, and hemi-ellipsoidal.

K2-8  17:00

MODES OF VIBRATION AND SOUND RADIATION FROM HANDBELLS

Uwe J. Hansen, Robert Perrin, Richard W. Peterson, Thomas D. Rossing and H. John Satoff

The vibrational modes of handbells can be arranged in groups according to the number and location of their nodal circles. Modes excited by a sinusoidal driving force or by impact excitation agree well with those calculated by finite element methods. Radiation efficiency is quite low in a handbell, since the flexural wave velocity is substantially less than the speed of sound. The most significant partials have frequencies in the ratios 3:2:1.
Structured session B5: Epidemiology of occupational hearing loss — 100 years later
Chairman and organiser: R. Héu, GAUM, Université de Montréal, Pavillon Marguerite, d’Youville, C.P. 6128, Succursale A, Montréal, Québec, H3C 3J7
Chairman’s Introduction 8:35

Invited Papers

B5-1 8:40

OCCUPATIONAL DEAFNESS: WHAT WAS LEARNED DURING THE ERA OF SYSTEMATIC, NON-ELECTRONIC INQUIRY, 1875-1925
G R C Atherley and W Noble

From 1875 on, we see systematic inquiry into occupational deafness. The introduction of the vacuum-tube audiometer around 1925 heralded the electronic era. Non-electronic inquiry revealed much about the deafness caused by excessive occupational noise. The methods are those which we now term epidemiological. The insights still withstand scrutiny.

B5-2 9:00

APPLICATION OF CONTEMPORARY EPIDEMIOLOGIC METHODS TO INDUSTRIAL HEARING CONSERVATION
John Erdreich and Linda S. Erdreich

Although causality has been established between noise exposure and deafness, the role of other factors related to deafness are not fully understood. Annual audiometric examinations may form the foundation for a database to which contemporary epidemiologic techniques may be applied to examine these issues. Using a demonstration database, we will illustrate the application of these techniques.

B5-3 9:20

PROCEDURES FOR THE RISK APPRAISAL FOR NOISE-INDUCED HEARING LOSS AT THE LEVEL OF A SINGLE INDUSTRIAL SETTING.
R. Héu, R. Phaneuf

Risk assessment is the basic procedure for setting priorities for the prevention of occupational hearing loss. The dose-response relationship as formulated in the ISO-8633/1999 provides a basis for predicting noise-induced hearing loss. However, there are limits to the internal and external validity of this procedure. A complementary approach is proposed and illustrated. It relies on measures of prevalence of significant hearing loss as a function of job categories within a plant.

B5-4 9:40

PERTES D’AUDITION PAR EXPOSITION À DES BRUITS INDUSTRIELS DE $L_{	ext{Aeq}}$ COMPRIS ENTRE 85 ET 90 dB(A)
L. Thiéry, C. Meyer-Bisch, H. Arbey

Une enquête épidermiologique transversale est réalisée dans un grand atelier de tôlerie (1200 personnes). Elle porte sur 234 travailleurs qui ont subi un examen audiométrique normalisé et sont répartis en 4 classes d’âges et de durées d’exposition. Les résultats font apparaître une atteinte auditive significative sur les fréquences 3, 4, 6 kHz, dès 10 ans d’exposition. Sa relation avec les caractéristiques des bruits de l’atelier est étudiée.

Contributed Papers

B5-5 10:00

AN ANALYSIS OF THE RATE OF GROWTH OF HEARING LOSS IN THE CANADIAN FORCES
S.E. Forschaw

This study was undertaken to determine the rate of growth of hearing loss in the various Canadian Forces occupations. The results suggest that the hearing loss observed in the least hazardous noise-exposure occupations could be the result of equivalent daily exposures not greater than 85 dBA, and in the most hazardous noise-exposure occupations, from equivalent daily exposures of about 95 dBA.

B5-6 10:20

INFLUENCE DE L’ORIENTATION SCOLAIRE SUR L’ACUITÉ AUDITIVE DES ÉLÈVES
L. Paré et F. Fiflairaute

L’audition de 327 élèves du secteur professionnel et de 370 du secteur académique a été évaluée (âge: 16 à 20 ans). L’étude comporte une description des seuils auditifs de 0,5 à 6 kHz et une comparaison des seuils à 4 kHz des deux groupes. Tenant compte des différentes variables influençant l’audition, l’analyse montre que les élèves du secteur professionnel ont des seuils à 4 kHz légèrement plus élevés que ceux des élèves du secteur académique.
DESCRIPTIVE ANALYSIS OF HEARING LOSSES IN CHILDREN EXPOSED BEFORE BIRTH TO INDUSTRIAL NOISE
N.H. Lalande, R. Hétu and J. Lambert

A cross-sectional study on 4 to 10 years old children has shown a statistically significant association between the cumulative acoustic energy received before birth and the hearing threshold for the worst ear at 4000 Hz. Moreover 69% of the children with a hearing loss had a significant loss at more than one audiometric frequency and usually, the audiometric pattern differed from the one obtained with a noise-induced hearing loss acquired after birth. Theoretical and practical implications of these results are discussed.

Discussion

MONDAY MORNING, 28 JULY 1986

ROOM 203 B and D, 8:35 - 12:10

Structured session E4: Room acoustics: recent developments


Chairman’s Introduction 8:35

Invited Papers

E4-1 8:40

OBJECTIVE MEASURES AND THE CONCERT EXPERIENCE
A.H. Marshall

This review paper starts with a summary of the factors known to determine audience and performer preference in concert halls and the objective measures which have been proposed as correlates to them. Measurements on four recent halls and/or their models illustrate these objective factors. A brief discussion of an alternative approach by Ando is followed by a comparison between the objective measures and the 'Concert Experience'. The limitations of physical science in providing this experience is noted.

E4-3 9:10

INTIMACY, LOUDNESS AND SOUND LEVEL IN CONCERT HALLS
M. Barron

An objective and subjective survey of British concert halls has been undertaken. Objectively, it is found that reflected sound level in halls is not independent of position but decreases with distance from the source. Subjectively listeners fell into two groups for preference: the larger group prefer 'Intimacy', the second group prefers 'Reverberance'. 'Intimacy' is best correlated with measured total sound level. Evidence suggests that listeners may compensate for distance when they assess 'Loudness'. Design considerations are discussed.

E4-2 8:55

PROPAGATION OF STATIONARY AND TRANSIENT SOUND IN ONE- AND TWO DIMENSIONAL ENCLOSURES WITH DIFFUSELY REFLECTING WALLS
H. Kuttruff

This paper describes the sound propagation in very flat and very long enclosures. For long rooms (ducts), the steady state propagation of sound energy is studied by solving an integral equation. For flat rooms, the sound decay is determined by Monte Carlo simulation. The decay curves are substantially different from those predicted by Sabine’s formula.

E4-4 9:25

TUNABLE AND RE-TUNABLE CONCERT HALLS
Theodore John Schultz

The concept of a non-electronic concert hall that is designed to be tuned initially, and then re-tuned from time to time during its life, is relatively new. This paper discusses features common to four recent large halls designed with that end in view. We consider sound reflectors near the performers; the height of the reflector array, and individual panel angles re-orchestral presence; the quality of high string tone, and orchestral balance; also, the placement of string players near the stage apron and the use of optical methods in tuning these halls.
VARIABLE ACoustics
V. H. A. Peutz

It is well known that the acoustics required in a theatre, a concert hall, an opera theatre is quite different. Variable acoustics appears to be a self-evident solution. The results, however, of early attempts in this direction were not always satisfactory.

There was a growing tendency to doubt the feasibility of variable acoustics. More recently, however, halls with variable acoustics have been realized that showed a large objective acoustical variation and proved to be very well suited as well as concert hall, theatre, opera theatre, etc.

RECENT DEVELoPMENTS IN ROOM ACoustics
Svein Strøm

The recent developments in room acoustics will be reviewed with regard to:
- trends in functional requirements (size, shape, flexibility)
- scientific contributions (papers concerning criteria, new parameters and data for these)
- tools for design of halls and measurements of room acoustical parameters
- means of varying the acoustic properties of halls including the use of electroacoustical systems

CORRELATIONS AMONG OBJECTIVE CRITERIA OF ROOM ACoustic QUALITY
J-P. Jullien

High correlations among room acoustic quality criteria have already been observed. Here we try, with as few parameters as possible, to define a model which allows the computation of these criteria with best precision. This study has been linked to an experimental study of IRCAM's Espace de Projection, a variable acoustics hall. The agreement between the measured data and the computed values from the model is discussed. Specific conclusions are derived from the analysis of spatial criteria.

ROOM ACoustical CRITERIA: PREDICTION AND MEASUREMENT
H. Müller

Müller-BBM GmbH, Robert-Koch-Str. 11, D-8033 Planegg/Munich, W. Germany

Using sound measurement results of the new Munich Philharmonie the accuracy of the prediction of the strength coefficient, the distinctness and clarity index will be discussed. Predicted values of the strength coefficient and the clarity index from contributions of direct sound and statistical reflections are found to be consistent with measured results.

THE REFLECTION PHASE GRATING ACOUSTICAL DIFFUSOR: APPLICATION IN CRITICAL LISTENING AND PERFORMING ENVIRONMENTS
Peter O'Antonio and John H. Konnert

Reflection phase grating (RPG) diffusers, developed in the past decade, represent a new class of acoustic room treatment which offers wide-angle broadband diffusion. These new surfaces are finding widespread architectural acoustics application in the audio/video industry, performing arts facilities, churches, and home use. The paper describes the use of RPGs in the design of a recording control room and a performing arts facility.

RELATIONSHIPS BETWEEN OBJECTIVE ROOM ACUSTIC PARAMETERS AND CONCERT HALL DESIGN
A-C. Gade

Today, a number of objective room acoustic parameters exist, which quite well describe many aspects of the subjective room acoustic experience. Still, the use of these parameters in practical design has been hampered by lack of general knowledge about how they are related to the various design variables such as absorption properties and geometry of the room. In connection with recent objective surveys of existing auditoria, it has been possible to investigate some of these relationships. The paper will mainly focus on results from a survey of 21 halls in Denmark.

DIFFERENT COMPUTER MODELLING METHODS - THEIR MERITS AND THEIR APPLICATIONS
J-P. Vian

Since the beginning of the computer age, a lot of people have used their possibilities to solve the different acoustical problems encountered in room acoustics design. An historical review of the different approaches is proposed and the more recent developments are discussed. It is thought that the progress is not yet finished, and the main improvements will be in a better adjustment of the computer programs to the actual needs of the acoustical designers, together with an increased accuracy of the simulation programs for research purposes.

IN SITU ESTIMATION OF ROOM ACOUSTIC PARAMETERS
D. de Vries, A. de Sterke and A-J. Berkhout

In computational programs for the prediction of energy distributions or impulse responses in enclosures, the geometric coordinates and acoustic properties of the boundaries are required as input parameters. Conventionally these parameters are estimated with limited accuracy, from (laboratory) measurements on separate material samples. A new method is proposed to determine the above parameters i n s i t u, by inverting an appropriate number of measured impulse responses using an iterative parameter estimation technique. Theoretical background as well as preliminary results will be presented.
Within the broad field of room acoustics, this study focuses on the physical correlate of speech intelligibility in rooms. Besides some traditional measures (reverberation time, signal-to-noise ratio), the concept of the Modulation Transfer Function (MTF) will be considered, which provides a physical description of sound transmission which relates well to speech intelligibility as determined subjectively. This is substantiated by the results of several experimental studies, along with some hardware developments which originated from the MTF concept.

Based upon the subjective preference theory and some physiological data, a workable asymmetric model of auditory-brain system with correlation mechanisms is presented. This paper shows that important subjective responses to sound fields are well described in relation to magnitudes of correlations. The envelope of autocorrelation function of source signals deeply relates to sensations of the threshold of the reflection, echo disturbance, coloration, and ease of music performance. Also, the scale value of subjective diffuseness of sound fields is well described by the 3/2-power of the IACC, similar to the preference value.

MONDAY MORNING, 28 JULY 1986
ROOM 203 A and C, 8:40 - 12:00

Session A3: Speech production and analysis
Chairman: G. Neueiler, Zoologisches Institut der Universität München,
Luissenstrasse 14, 8 München 2, F.R.G.

Contributed Papers

A3-1  8:40
SPEECH ANALYSIS OF ARABIC SOUNDS USING LPC METHOD
O. Abdel-Alim, A. El-Hadidi and M. Ezz-El-Arab

For the synthesis of the arabic sounds it is important to know their main acoustic parameters. In classic Arabic there are some sounds that have no similar sounds in English and hence their parameters are not well defined. In this paper the analysis of different pairs of arabic sounds using LPC method is presented. These pairs represent the emphatic and nonephatic sounds. The results show that there are significant differences between the emphatic and nonephatic sounds concerning the acoustic parameters and the LPC parameters.

A3-2  9:00
THE CLICKS IN ZULU: ARTICULATORY AND ACOUSTIC STUDY
A. Giannini, M. Pettorino and M. Toscano

From their beginnings phonetic researches have tried to segment the speech chain into articulatory, acoustical and functional units in order to classify them into well defined categories. We examine articulations completely different from those for which traditional categories have been created. In this study we refer to the Zulu clicks. The Zulu language belongs to Nguni group of South-Eastern Bantu. According to Doke, Zulu speech sounds are divided into vowels and consonants, this last being subdivided into "plain consonants" and "click consonants".

A3-3  9:20
ACOUSTIC FEATURES OF INDONESIAN AND MALAY VOWELS,
H. Nakashima, T. Kobayashi and O. Kakusho

The formant frequencies of Indonesian(Malay) vowels are extracted from 520 speech samples by LPC method. These speech samples are Indonesian(Malay) words which have the six vowels in the initial position, and uttered by 20 speakers. The mean and standard deviations of the formant frequencies for each vowel are obtained. Secondly, there are many regional languages in Indonesia, and Indonesian is used as a common language. The results of this experiment shows that Indonesian vowel system is affected by the vowel system of speakers with the different regional background in Indonesia.

A3-4  9:40
MODELS OF FRICATIVE CONSONANTS INVOLVING SOUND GENERATION ALONG THE WALL OF A TUBE
C.H. Shadle

The acoustic mechanism of fricative consonants was investigated by the use of mechanical models, having dimensions typical of the vocal tract. Comparison of speech spectra and spectra of noise coronated by air passing through the mechanical models indicated that fricatives such as /ʃ, x/ are best modeled by an asymmetric constriction that directs air along the wall of the tube. The sound coronated appears to be mainly due to flow dipoles at the outlet of the tube, corresponding to flow separation in the vicinity of the alveolar ridge.

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PALATOGRAPHIC AND ACOUSTIC MEASUREMENTS OF THE FRICATIVE CONSONANT PAIR /s/ and /z/
M.H. Cohen and J.S. Perkell

This study concentrates on the articulatory and acoustic contrasts for the coronal fricative pair /s/ and /z/. Continuous posterior movement of the constriction location and canonic productions of /s/ and /z/ are investigated. Results suggest that the contrast between /s/ and /z/ is produced by the sudden creation of a sublingual space, causing an abrupt drop in the frequency of maximum spectral amplitude, from around 9 kHz, for /s/ to around 2.3 kHz, for /z/.

VOISEMENT ET ASSIBILATION DES OCCLUSIVES "SONORES" D'ENFANTS QUEBECOIS (ETUDE ELECTROGLOTTOGRAPHIQUE)
Jean-Pierre Goudaillier

L'analyse instrumentale (électroglottographie) de 2050 occlusives "sourdes" et "sonores" prononcées par 20 enfants québécois âgés de 6-10 ans confirme le classement en termes de moment d'apparition des vibrations laryngées (M.A.V.L.) de ces articulations, tel qu'il a pu être établi à partir d'études faites en France. Elle permet par ailleurs de montrer l'originalité des faits québécois en précisant le lien qui doit être établi entre l'assibilation des consonnes dentales "sonores" et leur voiselement.

ESTIMATION OF GLOTTAL FLOW FROM PRESSURE GRADIENT MEASUREMENTS IN THE TRACHEA AND THE PHARYNX
B. Cranen and L. Boves

We have measured pressure gradients in pharynx and the trachea during the production of the vowels /a/, /u/, and /i/. From these signals we estimated the corresponding volume flow waveforms under the assumption of plane wave propagation. By compensating for the cavities between the glottis and the measurement locations, two independent estimates of the flow at the glottis were obtained. Comparison of these estimates for the different vowels, lead to the conclusion that plane wave propagation in the pharynx must be questioned under certain conditions.

PRELIMINARY SUPPORT FOR A "HYBRID MODEL" OF ANTICIPATORY COARTICULATION
J.S. Perkell and C.-M. Chiang

Data on anticipatory coarticulation of upper lip protrusion movements from a speaker of American English are presented. Observations from these data and previous studies support a "hybrid model of anticipatory coarticulation". In this model, spatial and temporal characteristics of gestures depend on overlapping requirements of adjacent phonetic segments, implying that a general model of speech production has to incorporate context dependent effects and the overlapping and summation implied by "co-production."

THE NASOPHARYNGEAL TRACT : A TARGET FOR NASALITY.
G. Feng, C. Abry & B. Guérin

We propose that all nasal vowels should be considered as dynamic trends towards a consonantal articular target, i.e. nasopharyngeal tract. Among major solutions available in obtaining such a target for all vowels, with articulatory-acoustic simulations, two of them concern the tuning of the lowest pole: the narrowing of the nostrils (at lumen nasi) and the introduction of at least the largest sinuses (maxillaries). Confronting these alternatives with sweep tone measurements for the nasal and the nasopharyngeal tracts, we show that only the first solution can cover flexibly the two sets of data.

RELATIONSHIPS AMONG PARAMETERS OF THE GLOTTAL WAVEFORM AND INTENSITY VARIATION FOR MALE AND FEMALE SPEAKERS
E.B. Holmberg, R.E. Hillman and J.S. Perkell

The glottal wave parameters of open quotient, speed quotient, velocity of closing and period were calculated from the inverse filtered flow signal of normal, soft and loud voice for 16 male and 16 female normal adult speakers. Statistical analyses showed a significant difference between males and females for increasing intensity. No significant difference between males and females was found for decreasing intensity.
Session B4: Hearing aids, transducers and auditory perception

Chairman: R. Plomp, TNO Institute for Perception, P.O. Box 23, 3769 ZG Soesterberg, The Netherlands

Contributed Papers

B4-1  8:40
TOWARDS A HEARING AID WITH MULTICHANNEL AUTOMATIC GAIN CONTROL
R. Plomp, P.C. Anema and J.N. van Dijkhuizen

It is argued that the next-generation hearing aid should be provided with a frequency-dependent amplitude compression system with relatively large attack and release times (0.5-1 sec) in order to avoid interactions between the wanted sound (voice) and fluctuating unwanted sounds. The results of two experiments are reported, both indicating that our hearing is remarkably resistant against both steady-state and dynamic slope variations.

B4-2  9:00
COMPARING AN 8-CHANNEL COMPRESSION HEARING AID WITH CONVENTIONAL AIDS IN SPEECH-BAND NOISE
E.W. Yund, H.J. Simon, and R. Efron

A multichannel amplitude compression hearing aid system has been compared with conventional hearing aids and with unaided performance. The shape of the amplitude compression in each channel was determined individually for each subject using psychophysical methods and a theoretical model developed in this laboratory. This multichannel compression aid significantly improves the subjects' ability to recognize nonsense syllables in quiet and in speech spectrum noise.

B4-3  9:20
ETUDE ET MODELISATION D'ECOUTEURS MINIATURES DE PROTHESES AUDITIVES,
J.P. Guilhot, J.L. Charles, C. Azais

La présente étude décrit un modèle d'écouteur miniature et de charge acoustique, tous deux construits sur la base de quadripôles. L'application des modèles est envisagée pour la prévision de la pression délivrée par un écouteur dans une charge quelconque de géométrie connue. La comparaison avec les résultats expérimentaux montre la bonne fidélité des modèles décrits.

B4-4  9:40
CATEGORY SCALING OF LOUDNESS AND ITS APPLICATION TO ELECTRO-AcouSTIC TRANSDUCER-DESIGN.
Ludwig. M. Moser, Jürgen Hellbrück

A new method of loudness category scaling has been developed at the University of Würzburg. Originally we used this test to evaluate hearing aids. A much wider application though is in testing loudspeakers or headphones. We will show data of headphone tests and compare the results to other methods. The complete test is recorded on a CD Laser disc, produced by WESTRA GmbH of Germany and simple to operate.

B4-5  10:00
SIGNAL BANDWIDTH AND DYNAMICS SENSATION USING LOUDSPEAKERS AND HEADPHONES:
E. Werner

Listening to electroacoustic reproduction of natural sound sources with loudspeakers or headphones leads to different performance, e.g. of direction, distance, timbre and loudness.

The contribution deals with loudness and especially with the dynamic relationship between the electrical input range and the acoustic output range.

B4-6  10:20
LOUDNESS COMPARISON OF HEADPHONES USING A SYMMETRY METHOD
R. Sahr and E. Werner

The electroacoustic transmission ratio of headphones depends to a remarkable extent on ear dimensions and on reproducible fitting to the head. The loudness comparison method in an anechoic chamber between loudspeaker and headphone is very time consuming. The necessary time can be remarkably reduced with a known headphone capsule on one ear and the test headphone on the other ear adjusting the sound impression into the middle.
NOTES ON DUMMY HEAD MICROPHONE FOR HEAD RELATED STEREOPHONY (OSS)
T. Miura, K. Okabe and H. Hamada

We discuss the possibilities of a standardized dummy head microphone (DHM) for head related stereophony (HRST). Localization azimuth shift (IAS) and degradation of perceived image (DGI) were related to interaural difference variations (IDV). For the construction of DHMs, IDV of various spherical heads were calculated and IAS were estimated. The estimated IAS were small when varying the head size.

IMPROVING THE SPEECH-INTELLIGIBILITY BY TELEPHONING IN A NOISY ENVIRONMENT
H. W. Gierlich

During telephoning in a noisy environment noise-signals reach the ear by electrical sidetone, by acoustical sidetone, and by the direct acoustical way to the ear, which is not covered. After measuring the different sidetone-paths at several testpersons an electroacoustic filter was designed to simulate the different sidetone-paths. The influences of acoustical and electrical sidetone are shown as conducted by hearing tests. Some possibilities to improve speech-intelligibility are shown.

Monday Morning, 28 July 1986

Session C4: Road traffic noise

Chairman: A. Lawrence, Faculty of Architecture, University of New South Wales, Kensington, N.S.W., Australia

Contributed Papers

C4-1 8:40
ASSESSMENT OF ANNOYANCE FROM ROAD TRAFFIC NOISE
T. Gjestland
Acoustics Research Center, ELAB, N-7034 Trondheim-NTH Norway

We suggest a simple model for assessment of annoyance from road traffic noise. The model is based on $L_{eq}$, $L_{day}$ and the percentage of heavy vehicles. The validity of the model has been demonstrated by laboratory experiments.

C4-2 9:00
RESIDENTIAL NOISE EXPOSURE AND REACTION OF INHABITANTS AROUND ROADSIDE AREA
K. Kuno, K. Ohara, K. Takeda and Y. Mishina

Measurements of environmental noise over 24 hours nearby residence are made in Nagoya City. Associated informations around residence and reaction of inhabitants to noise environment are also obtained. About 800 samples are now stored in computer system. By using these data the influence of road on residential noise exposure is investigated to identify the region disturbed by road traffic noise. It is found that the region is up to 20 ~ 30 meters distance from trunk road in Nagoya City.

C4-3 9:20
ROAD TRAFFIC NOISE AND SLEEP. LONG-TERM EFFECTS, CRITICAL LOAD.
Barbara Griefahn

70 residents in streets with high traffic load were tested during and after 12-23 nights under noisy and quiet conditions. After noisy nights performance decreased and sleep quality was assessed to be worse. Thereafter 36 subjects were tested in the lab where traffic noises were played back ($L_{eq}$: 37-64 dBA). An equivalent noise level of 40 dBA indoors seems to be a valid critical load as far as the maximum levels do not exceed it by more than 10 dBA.

C4-4 9:40
MUTUAL RELATION AMONG ENVIRONMENTAL NOISE EVALUATION INDICES ON THE BASIS OF $L_{eq}$ and $L_{Aeq}$ EVALUATION INDICES AND ITS APPLICATION TO THE ACTUAL ROAD TRAFFIC NOISE
Yasuo Mitani and Mitsuo Ohta

This paper describes a general theory for the mutual relationship among several type noise evaluation indices in close relation to two typical indices, $L_{eq}$ and $L_{Aeq}$, in a general form including the well-known simplified relationship based on a standard Gaussian distribution as a special case. The validity of the proposed theory has been confirmed by applying it to actually obtained road traffic noise data.
MONDAY MORNING, 28 JULY 1986

Session H3: Underwater propagation and noise

Chairman: R.R. Goodman, SACLANT ASW Research Centre,
Viale San Bartolomeo 400, 19028 La Spezia, Italy

Contributed Papers

H3-1 8:40
VLF AMBIENT OCEAN NOISE VS. WIND AND WAVES,
R. H. Nichols

Data on very-low-frequency (VLF) ambient ocean noise were taken concurrently with data on wind speed and wave height at three widely-separated sites in the northeast Pacific, over a continuous 40-day period. The objective was to investigate the relative roles of winds and waves in generating VLF noise. Over the period, the noise levels correlated more strongly with windspeed than with wave height. "Diagnostic" periods of about a week were found in which variations in noise level appeared directly associated with the variations in wind speed, rather than wave height.

H3-2 9:00
SELF-SUSTAINED RESONANCES DUE TO FLOW OVER CAVITIES
S.A. Elder

The prevention of tone generation associated with flow over hull cavities is a recurrent problem in ship and aircraft performance. Toward a solution, a general approach to modeling cavity-related tone generation has been developed, based on feedback amplifier analogy. The present paper gives a differential equation for the sound field in the mouth of a self-resonant cavity. The approach provides useful insights into the windspeed threshold and scaling laws for resonator-controlled oscillation.
EXPERIMENTAL INVESTIGATIONS ON SHOCK WAVE FOCUSING IN WATER
H.M. Müller, H. Gröning

A spherical shock wave, generated by an underwater spark discharge, is focused after reflection from an elliptical surface. Shadowgraphs give an impression of the converging process, whereas for the quantitative research special pressure probes had to be designed. The influence on the focusing process is shown as a function of different reflector geometries and materials. Using a brass reflector with a large diameter to focal length ratio of D/f = 3, the pressure in the focal "spot" rises up to 1300 bar, 100 times that much as on the reflector surface.

ASYMPTOTIC THEORY OF THE TURNING-POINT CONVERGENCE-ZONES
Zhang Renhe

In underwater sound channel, there are three types of turning-points, near which different types of T-P convergence-zones are formed. Though the intensities of the 3rd-type T-P convergence-zones are weaker, they play an important part in the low-frequency, long-range fields owing to wider distribution in space. In the present paper, we mainly discuss the fields near the 3rd-type turning-points.

ACOUSTIC SOLITON AND CHAOS
Ronjue Wei, Benren Wang, Yi Mao, Xiyu Zheng, Jintian Tao and Wansun Ni

The nonpropagating soliton (Wuton) is further studied by varying the dimensions of the water trough, with results discussed and demonstrated by video cassette. Bifurcation and chaos are found, e.g. in direct-radiation loudspeaker driven at and above its rated power. Both furnish examples that are simple but elegant in experiment and intriguing in theory.

MODE DECOMPOSITION APPROACH FOR SOURCE DEPTH ESTIMATION IN SHALLOW WATER WAVEGUIDES
E.G. Shang and Y.Y. Wang

Passive source ranging and depth estimation in waveguide has been studied based on mode decomposition. In the present paper a high resolution depth estimation method by using the OD(Orthogonal Decomposition) method developed by Pisarenko has been proposed. It is found that the OD method can get high performance even for the shortest data length. Some numerical examples are presented.

ON ORTHOGONAL BEAMFORMING
J. C. Chung and A. W. Robertson

The central topic of this paper is the presentation of the eigenstructure of spatial covariance matrix in a multi-signal environment. On isotropic noise field with two plane waves, expressions have been derived to describe the eigenvector and signal direction vector behavior in terms of inner products. These inner products can be used to evaluate the beamformer performance. A comparison is made on the performance of the Orthogonal Beamformer and the Conventional Beamformer. It is found Orthogonal Beamforming may be useful for detecting signals in low signal-to-noise conditions.

COMPARISON OF MODE AND RAY THEORY USING PHASE AND GROUP VELOCITIES
D. F. Gordon and M. A. Pedersen

A method is presented in which exact normal-mode phase and group velocities are compared with phase-integral results, based on ray-theory cycle range and travel time. Profiles with a piecewise-linear, squared index of refraction are treated. For symmetric unbounded ducts or half-space surface ducts the phase-integral approximation can be made exact using non-integral n (mode number). The paper outlines several underwater acoustic ducts designed for the comparison of various modified ray theories with mode theory.

BOUNDARY INFLUENCES ON GEOMETRICAL DISPERSION,
L. Bjørne

Mechanical waveguide problems are met in relation to transmission of noise and vibration in machine structures, in offshore structures under water and in various sensor types. The exact frequency equation is derived for the dispersion of circular, cylindrical rods submerged in an inviscid fluid. The effect of fluid viscosity on dispersion and attenuation of longitudinal waves propagating in submerged rods is reported. Experimental and theoretical results indicate that dispersion is nearly unaffected by the fluid viscosity, while the attenuation rates depend on the viscous properties of the fluid.
Session K3: Guitar, violins and bows

Chairman: C.M. Hutchins, 112 Essex Avenue, Montclair, NJ 07042, U.S.A.

Contributed Papers

K3-1  8:40
FINITE ELEMENT ANALYSIS OF GUITAR TOP PLATES
G.W. Roberts

The finite element method is used to predict the vibration characteristics of a guitar top plate. Most packages and programs include beam elements with the capability to model isotropic materials only and this leads to erroneous results when modelling the spruce struts on a guitar top plate. A simple correction method which enables the isotropic beam elements to model wooden struts is explained and verified by comparison with experimental data from a strummed square spruce plate. The results indicate that this will avoid the need for any more complex solutions to the problem.

K3-2  9:00
MODE COUPLING IN THE GUITAR
B. E. Richardson and G. P. Walker

An experimental guitar has been constructed to investigate the coupling between the top plate, the back plate and the internal air cavity. Two regions of strong coupling occurred at frequencies of 100 to 250 Hz and about 400 Hz. Above 600 Hz no appreciable coupling was detected. These experiments provide valuable test data for comparison with a finite element model of the guitar which is currently under development at University College, Cardiff.

K3-3  9:20
NORMAL MODES OF ORTHOTROPIC PLATES
A.J. Hearn and M.D. Gunzburger and R.T. Schumacher

We have derived a differential equation for the normal modes of a thin, plane, orthotropic plate with plate axes oriented arbitrarily with respect to the symmetry axes of the material. We have calculated by the finite element method the normal modes and frequencies of free vibrations. A sum rule enables us to check the accuracy of the calculations and to determine for each normal mode the relative importance of the nine compliance matrix elements needed for the description of an orthotropic plate.

K3-4  9:40
PARAMETERS OF VIOLIN SPRUCE AND MAPLE RELATED TO FREE PLATE EIGENMODES
M.A. Hutchins - C.M. Hutchins

The acoustical parameters of test strips cut from spruce and maple flitches used in four conventional violins are given and discussed in relation to the tuning of the eigenmodes of the free violin top and back plate pairs. Of particular interest are the ratios of Young's modulus and the Q values along (||) and across (\perp) the grain in the spruce top plate and maple back plate of a given violin.

K3-5  10:00
A VIOLIN WITH SIXTY-FIVE HOLES IN ITS RIBS, PHASE II
C. M. Hutchins

A normal violin with sixty-five 6mm holes bored in its ribs was demonstrated at the 11th ICA in Paris, comparing tone and playing qualities when all holes were open vs all rib holes plugged with corks. It was strongly suggested that loss in tone with all holes open was primarily due to the "quadrupole effect" outside the instrument rather than to the lack of cavity modes inside augmenting the wood modes. To answer this special foam plugs were designed to fill the 65 rib holes. The violin will be demonstrated with these plugs and test results discussed.

K3-6  10:20
MEASUREMENT OF THE PARAMETERS OF BOWING
R. T. Schumacher

This paper reports measurements of the maximum bow force that still allows ordinary slap-stick, Helmholz oscillations, and on the pitch flattening that occurs for lesser bow forces. Measurements were done on three pairs of violin D strings, from three makers, with both aluminum and silver wrappings. Effects from rotational motion are included in the analysis.
K3-7  10:40

ELECTRONIC BOWS: DIGITAL AND ANALOG
Gabriel Weinreich, René Caussé

We have built two versions of a system in which the instantaneous velocity of a string is sensed optically and a corresponding programmed "frictional" force exerted electrodynamically: a digital one working at a 32 kHz sampling rate, and an analog one which is faster but less flexible in regard to programming. The experiment yields information about the physics of the bowing mechanism and has possible musical applications. A video tape will be shown.

K3-8  11:00

MEASUREMENT OF TORSIONAL MOTION OF BOWED STRINGS WITH A HELIX PATTERN ON ITS SURFACE
M. Kondo, H. Kubota and H. Sakakibara

This is a preliminary report of a new measuring device for the torsional motion of bowed strings. Make a helical pattern along the string, and illuminate it strongly with a line source of light! Then, its rotational motion appears as a translational movement of the helical pattern. An anamorphic camera is also found very useful for this purpose. Some results are given.

K3-9  11:20

ACOUSTIC CHARACTERISTICS OF A STRING QUARTET
A. Giménez/A. Marín/F. Belmar/H. Estellés

The aim of the present paper is to obtain the acoustic characteristics and diagram of directivity of a string quartet as a only source together with the instruments that compose it. The study has been carried out on all the valid scopes of musical frequencies for string instruments. A magnetic tape recorder was used for this study which supplies information to a narrow band analyser, automatically run by a minicomputer which provides the corresponding analysis of frequency.

K3-10  11:40

ACOUSTICS OF THE HIGHLAND, IRISH AND BAROQUE HARPS
Ian M. Firth

Measurements of the string lengths of the extant Highland and Irish harps show that there has been a consistent scaling rule used in the construction of the harp from the 14th, through the Baroque period to modern times. Acoustical measurements on extant instruments in museums using portable equipment show that modes of vibration of the soundboards of these instruments can be correlated. The modes of vibration of a Spanish harp of the Baroque period suggest that the modern concert harp is descended from this type.

MONDAY MORNING, 28 JULY 1986

Session M2: Sound intensity: phase shift and vectors
Chairman: G. Pavic, Institute "Rade Koncar", YU-41001 Zagreb, Yugoslavia

Contributed Papers

M2-1  8:40

PRESSURE MICROPHONES FOR INTENSITY MEASUREMENTS WITH SIGNIFICANTLY IMPROVED PHASE PROPERTIES
E. Frederiksen and O. Schultz

Pressure microphones are widely used for intensity measurements even if stringent requirements are set on similarity of their phase characteristics. Frequency range and accuracy of systems are limited by phase errors at low frequencies and in reactive fields. Microphones are therefore carefully selected to match each other in pairs. New microphone types have been developed; they are partly characterized by a significantly smaller low frequency phase spread which makes formation of closer matched pairs possible. Properties of the microphones, their phase calibration and some advantages in their use and calibration are described.

M2-2  9:00

SOUND INTENSITY MEASUREMENTS IN THE PRESENCE OF REVERBERANT FIELDS AND/OR Background NOISE
A. F. Seybert and J. A. Holt

This paper discusses the application of the two-microphone sound intensity method to the measurement of sound intensity when the sound field contains background sources. In particular, we focus on attention on the effect of microphone phase mismatch. It has been thought that phase mismatch is only a low-frequency measurement problem. However, we will show that phase mismatch may produce significant errors in the measurement of sound intensity at any frequency when background sources are present.
M2-3
9:20
MESURES DIRECTES DES EFFETS DE DIFTRACTION EN INTENSITE ACOUSTIQUE
René Pech, Peter Wagstaff

Le Laboratoire d’Acoustique de l’ENST en collaboration étroite avec le laboratoire d’Acoustique de l’UTC a développé une méthode de mesure de cette intensité acoustique qui permet de quantifier directement l’effet de diffraction des sondes, entre les microphones et ceci pour n’importe quel type de source. Les résultats obtenus semblent indiquer que cet effet est faible aussi bien pour la sonde face à face BAK 3519 que pour la sonde à microphones parallèles.

M2-5
10:00
INTENSITY VECTOR MEASUREMENTS
P. Rasmussen

The three-dimensional intensity vector can be used to give a very thorough description of a sound field. A computer controlled system for measuring the intensity vector will be described. Different data presentation methods are discussed, and examples of different applications will be given.

M2-7
10:40
LA MESURE DE L’IMPÉDANCE MÉCANIQUE
Jean-Bernard Piaud, Jean Nicolas

La mesure de l’impédance mécanique d’une liaison quelconque (rivet, boulons, soudure…) est d’un intérêt certain. Pour ce faire, une méthode de mesure du coefficient de réflexion dans le cas d’une poutre en vibration de flexion ayant des conditions aux limites quelconques est nécessaire. Deux méthodes seront donc exposées. La première nécessite la connaissance de l’accélération et de sa dérivée première. La seconde nécessite la connaissance de l’accélération en deux points quelconques. L’analyse et le calcul d’erreur pour ces deux méthodes seront présentés.

M2-8
11:00
FIELD MEASUREMENTS OF SOUND INSULATION USING A BATTERY OPERATED INTENSITY ANALYSER.
T.G. Nielsen

The measurement of sound intensity is becoming increasingly popular, and the range of applications is broadening accordingly. An impediment to the use of the sound intensity technique has, however, been the mere size and cost of the equipment. This paper presents a small, battery operated intensity analyzer that allows field measurements to be done conveniently in octaves and broadband. A measurement of sound insulation between two rooms in a building is described to illustrate the usefulness of the analyzer.

M2-9
11:20
LOCATION OF SOUND SOURCES BY SEARCHING THE MINIMUM VALUE OF ERROR FUNCTION
Masato Abe, Yoshifumi Nagata and Ken’iti Kido

This paper describes a new method to locate sound sources using many sensors. Following parameters are assumed: the number of sound sources and their spectra and positions. The spectra of the sensor outputs are estimated using above-assumed parameters under the assumption of free space. By changing the assumed parameters, the minimum value of an error function is searched, which gives us the estimates: the number of the sound sources and their spectra and positions.

M2-4
9:40
SIMULATION DE LA MESURE DE PUISSANCE VIA L’INTÉNSIMÉTRIE
Jean-Luc Aignan, Jean Nicolas

Le comportement d’une source donnée en présence d’une source perturbatrice est simulé numériquement. Leur interaction est évaluée par comparaison de la puissance de la source perturbée à celle de la source seule. Une étude paramétrique des divers types d’erreurs commises lors des mesures de puissance est également effectuée: en basse fréquence prédomine l’influence de la puissance interactive et du déphasage tandis que les erreurs de discrétisation et d’approximation fine interviennent en haute fréquence.

M2-6
10:20
INTENSITY MEASUREMENTS IN NEAR-FIELDS
G. Rasmussen

Acoustic and vibration intensity vector measurements have gained widespread interest. The understanding of energy distribution patterns is important for structural dynamic investigations and for noise reduction. Transducer configurations are presented which enable reliable measurements to be carried out in x-y and x-y-z planes.

M2-10
11:40
INFLUENCE DES CONDITIONS AUX LIMITES SUR LE FACTEUR DE TRANSMISSION MESURE PAR INTÉNSIMÉTRIE
Pauzin S, Biron D, Cordonnier P, Leconte P

Une investigation a été menée sur l’influence des conditions aux limites (matériaux de nature différente encadrant l’échantillon test) et sur la taille de l’échantillon lors de l’application de la mesure du facteur de transmission par intensité. Ces résultats sont comparés à des résultats obtenus par méthode classique et calculés par théorie, sur des panneaux dont le facteur de transmission est connu par ailleurs. Cette recherche a pour but de mieux cerner les possibilités de l’intensimétrie appliquée à ce type de caractérisation.
Plenary Session 3: Nonlinear behaviour of sound waves.

Speaker: D.T. Blackstock, Applied Research Laboratories, University of Texas, P.O. Box 8029, Austin, TX 78713-8029, U.S.A.

Chairman: L. Brekhovskikh, Department of Ocean Acoustics, Institute of Oceanology, Krasikova st. 23, Moscow B-218, USSR

NONLINEAR BEHAVIOR OF SOUND WAVES
David T. Blackstock

The primary physical mechanism responsible for the rich variety of phenomena that characterize nonlinear acoustics is dependence of propagation speed on the particle velocity u. This dependence leads to waveform distortion, which, however, is slowed by spreading and attenuation. The principal source signal considered in this review is a single pure tone. The following applications are discussed: waveform distortion, harmonic generation, shock formation, saturation, criteria for estimating the importance of nonlinear effects in spherically spreading waves, and effects on directional sources (higher harmonics as well as fundamental).

Structured session N1: Education in acoustics: discussion, demonstration and films

Chairman and organiser: J. Tichy, Pennsylvania State University, Graduate Program in Acoustics, Applied Research Lab., University Park, PA 16802, U.S.A.

Chairman’s Introduction 14:35

Several acoustical experiments, demonstrations and films will be shown. Also included will be discussion on aspects of education in acoustics by various groups.
A4-1 14:40
EFFECTS OF FREQUENCY SCALE TRANSFORMATION OF SPEECH SPECTRUM
K. Nakata and K. Nishino

Recent developments of speech technology mainly deal with a phonetic aspect of speech and a quality aspect of speech left almost unrevealed. And all of the difficult problems now we are confronting are deeply related to the quality aspect of speech.

We first define a quality of speech and discuss a way of its research, and a new high quality speech synthesis method is introduced. Some experimental results of a frequency scale transformation are presented and discussed.

A4-2 15:00
GENERATION OF CONTROLLED SPEECH STIMULI BY PITCH-SYNCHRONOUS LPC ANALYSIS OF NATURAL UTTERANCES
M.I. Hunt and C.E. Harvenberg

With the aid of a laryngograph, speech analysis by linear predictive coding (LPC) can be carried out in synchrony with glottal excitation. The technique is attractive for generating stimuli for speech perception experiments. The accurate analysis of both vocal-tract and laryngeal parameters allows selected features (including fundamental frequency, formant frequencies and timing) to be modified in a controlled manner while retaining a naturalness generally unattainable with conventional LPC or with synthesis-by-rule systems. Recordings will be played that illustrate the possibilities of the method.

A4-3 15:20
CONTROL OF SPEECH SYNTHESIZER PARAMETERS
R.D. Wright, S.J. Elliott

A comparison has been made of speech synthesis using six parameter types: parallel resonance, serial resonance, prediction coefficients, reflection coefficients, area functions and articularatory parameters. The six synthesizers can be made to produce identical steady sounds but interpolation paths between sounds will differ. Each synthesizer was tested on nonsense words spanning a wide parameter range. Problems of formant description are discussed, and a solution is presented using articularatory parameters.

A4-4 15:40
ARTICULATORY SYNTHESIZER FOR RESEARCH IN LOW BIT-RATE CODING OF SPEECH
Juergen Schroeder and Man Mohan Sondhi

High quality speech at low bit rates (e.g., 2400 bits per second) is one of the important objectives of current speech research. As part of long range activity on this problem, we have developed an efficient computer program that will serve as a tool for investigating whether articulatory speech synthesis may achieve this low bit rate. At a sampling frequency of 20 kHz, the most comprehensive version of the program, including nasality and frication, runs at about five times real time on a Cray-1 computer.

A4-5 16:00
A METHOD FOR CONNECTING SPEECH SYNTHESIS UNITS USING SPECTRAL TRANSITION MATRICES
T. Saito, Y. Matsuda and T. Kaneko

This paper focuses on the unit connection scheme in speech synthesis by rule in Japanese. Most former works employ simple connection models such as linear interpolation. However, the fact is that unit to unit transition is so complex that substantially more information is needed for smoother connection. Our approach to this problem is to use a spectral transition matrix defined for inter-unit transition. Experimental results showed that this method gives much smoother transition closer to continuous speech.

A4-6 16:20
CORPS PHONETIQUE ET RENDEMENT DES OPPOSITIONS
J.P. Tubach, L.J. Boe

Nous avons utilisé un vaste corpus de transcriptions phonétiques, représentant plus de 11 heures de discours (300000 phones), et le dictionnaire d'occurrences de mots phonétiques qu'on peut en extraire, pour étudier le rendement des oppositions de grandes classes phonétiques (voyelles, fricatives, occlusives...), et des traits distinctifs. Les résultats sont susceptibles d'applications en reconnaissance automatique de la parole (décodage acoustique - phonétique).
BDSONS : UNE BASE DE DONNEES DES SONS DU FRANCAIS.
R. Descout, J.F. Serignat, O. Cervantes, R. Carré

La BDSONS est une action du GRECO Communication Parlée. Nous présentons ici le choix des locuteurs et
des corpus, les caractéristiques des enregistrements,
l'étiquetage et la segmentation. Les enregistrements
représentent environ 4 Giga-octets. La BDSONS est
diffusée grâce à un équipement constitué d'un
convertisseur Sony PCM associé à un enregistreur
vidéo Betamax et son interface ordinateur. Un Système
de Gestion de Base de Données Relationnel réalise
l'accès aux informations de la BDSONS dont le schéma
conceptuel et les possibilités de consultation sont
également présentés.

MONDAY AFTERNOON, 28 JULY 1986
ROOM 104A, 14:40 - 17:20

Session B6: Modelling the ear's response to sound I: the external and middle ear
Chairman: T. Miura, Tokyo Denki University, 2-2 Kanda Nishiki-cho,
Chiyoda-ku, Tokyo 101, Japan

Invited Paper

B6-1 14:40
ACOUSTIC IMPEDANCE MEASUREMENTS OF
CHILDREN'S EAR
K. Okabe, S. Kanno, H. Hamada, T. Miura and
H. Funai

Ear canal input impedance of children
were measured. The subjects had normal
hearing and aged form 3 to 12 years old.
For the estimation of eardrum impedance,
ear canal dimensions were reconstructed
from the measured acoustical data. The
results show the small ear canal and the
high eardrum impedance of the children.

Contributed Papers

B6-2 15:00
DYNAMIQUE DU REFLEXE ACOUSTIQUE EN FONCTION DES PARA-
METRES DE LA STIMULATION ACOUSTIQUE CHEZ L'HOMME
D. Loth, P. Avan, C. Menguay, F. Bisaro, M. Teyssou

L'influence des paramètres du stimulus acousti-
que sur le réflexe tapétien est étudiée, par impédan-
cémbrière dans un groupe de 20 sujets normaux.
Le logiciel réalisé a permis d'obtenir une des-
cription standardisée du temps de latence et de du-
rée d'établissement, de plateau et de décroissance
du réflexe. La latence apparait comme étant reliée
linéairement au temps de montée du stimulus, tandis
que la durée d'établissement du réflexe en est rela-
tivement indépendante, dans les limites étudiées tout
au moins.

B6-3 15:20
A THREE-DIMENSIONAL MEASUREMENT OF HUMAN AURICLE
FOR THE PURPOSE OF DUMMY HEAD CONSTRUCTION
K. Fukudome and M. Matsumoto

A method of describing the 3-dimensional shape
of human auricle is presented. Applying the method
to shape of auricles of 50 male young Japanese
adults, the statistics of them are obtained. Con-
tours of auricle replicas of subjects are measured.
Measures for the statistics of pinnae, fosa of
helix, concha, and crus helles are determined,
considering the study on average pressure distribu-
tions of normal modes of auricle (Shaw, 1974).
Finally, a generating procedure of an auricle from
the obtained statistical data is described.
B6-4  15:40  
SOUND PRESSURE DISTRIBUTION IN THE EAR CANALS OF CATS  
Shyam M. Khanna, and Michael R. Stinson  

The spatial distribution of acoustic pressure in the cat ear canal is analysed. Due to standing waves and taper of the ear canal the pressure acting on the tympanic membrane and that measured by a probe microphone are spatially dependent. The measured pressure is the sum of incident and reflected components. The ratio of these components (reflection coefficient) varies widely among animals. These factors introduce uncertainties when sound pressure is used to define the input stimulus at high frequencies. Alternative ways of defining the input stimulus are explored.

B6-5  16:00  
SOUND TRANSMISSION PROPERTIES OF THE CAT EXTERNAL EAR  
A. Musicant, J. Chan and J.E. Hind  

We have measured the directional properties of the external ear of the cat for free-field stimuli. Using a computer-controlled boom, a loudspeaker can be positioned throughout the space surrounding an anesthetized cat in an anechoic chamber. An acoustic impulse is generated and the pressure recorded by a probe microphone near the eardrum. Using the FFT the pinna transformation was found to exhibit complex patterns for frequencies up to 40 kHz, with gains up to 25 dB and sharp notches down to -30 dB.

B6-6  16:20  
EARDRUM DYNAMICS, MIDDLE EAR TRANSMISSION AND THE HUMAN HEARING THRESHOLD CURVE  
Edgar A.G. Shaw and Michael R. Stinson  

Studies of eardrum vibration indicate a lack of symmetry between the anterior and posterior zones. A three-piston model is proposed in which major and minor sectors of the outer eardrum are represented as rigid pistons separately coupled to a third piston (the malleus area) with frequency-dependent mechanical coupling. The corresponding middle-ear network indicates a minimum in the malleus response curve at 2.6 kHz. This could counterbalance the effect of resonance in the external ear.

B6-7  16:40  
ACOUSTIC RESPONSE OF THE SWIMBLADDER IN GOLDFISH (CARASSIUS AURATUS)  
Mardi Cox and Peter H. Rogers  

The amplitude response of the swimbladder in the nearfield of an acoustic source is noninvasively measured using an ultrasonic vibration detection system. The ultrasonic detector is capable of measuring displacements of 25 Angstroms with 0.6 mm spatial resolution. The change in the swimbladder response after death is shown. Preliminary data showing the response of other peripheral auditory organs—the saccular and lagenar otolith and the Weberian ossicles—is also presented.

B6-8  17:00  
A DESCRIPTION OF THE HUMAN OUT EAR TRANSFER-FUNCTION BY ELEMENTS OF COMMUNICATION THEORY  
Klaus Gernsw  

The external ear influences in a significant way the signal-processing and pattern-recognitions processes in the human ear. The resonances, reflections and diffractions caused by the outer geometry—torso, shoulder, head, pinnae, cavum conchae, ear canal and eardrum—determine the outer-ear-transferfunction, whose mathematical calculation is very complex. It can be shown, that an important reduction with a negligible error is practicable by a systemtheoretical description in a model with well known systems of the communication technique.
Session C5: Active sound attenuation in ducts, silencers and other spaces

Chairman: P. Filippi, C.N.R.S., Laboratoire de mécanique et d'acoustique, 31, chemin Joseph Aiguier, 13402 Marseille Cedex 9, France

Invited Paper

C5-1 14:40
FILTER DESIGN OF ACTIVE SILencer
FOR AIR-CONDITIONING DUCTS
T. Enokida, H. Hamada, T. Miura
M. Takahashi, T. Kuribayashi, K. Asami

We proposed an active silencer capable of attenuating wide band noises in air-conditioning ducts using a FIR digital filter. It is a monopole system using dual sensing microphones (DSM). Its configuration and its filter design are described. For coping with variances of acoustic properties due to air-flow and of loudspeaker's and microphone's responses, adaptive algorithms can be applied to the system.

Contributed Papers

C5-2 15:00
A NEW APPROACH TO ACTIVE ATTENUATION IN DUCTS
L. J. Eriksson, M. C. Allie, and R. A. Greiner

The use of active sound attenuation in ducts is discussed using a system identification framework. A new approach using a recursive least mean-square algorithm is presented. This approach adaptively compensates for the effects of acoustic feedback with broadband or narrowband input signals. Provision is also made for compensation of the effects of an imperfect secondary sound source or error path transfer functions. Data are presented from a complete microprocessor-based, adaptive system using a variety of noise sources.

C5-3 15:20
ELECTRIC SOUND CANCELLATION SYSTEM
FOR AIR-CONDITIONING DUCTS,
M. Takahashi, T. Kuribayashi, K. Asami
H. Hamada, T. Enokida, T. Miura

To attenuate noise in ducts at low frequencies while avoiding large pressure drops and large unit sizes, an electronic sound cancellation system using an FIR digital filter is discussed. This system is a computer controlled monopole system with two identical microphones located upstream side and downstream side in equal distance from the cancellation loudspeaker in the duct. It can reduce acoustic feedback in the system, offering high performance in the range of 60 Hz to 1 kHz.

C5-4 15:40
ACTIVE ACOUSTIC IMPEDANCE
O. Kr.Ø. Petersen, S. Sørsdal

Both for noise control and room acoustic purposes, the use of active systems, including microphones, electronics and loudspeakers, are increasingly being used. An attractive active system would be a locally reacting acoustic impedance. In the present study, we have aimed at an active system which lowers the acoustical impedance, makes it predominantly resistive and broadens the frequency range compared to the mechanical impedance of a passive loudspeaker.

C5-5 16:00
EXPÉRIMENTATIONS ET SIMULATION NUMÉRIQUE D’UN SYSTÈME D’ANTI-BRUIT
J.L. Drugenon, C. Le Jossec, R. Le Louarn (EDF-DER)
A. Roure (CNRS-MA)

La faible efficacité des dispositifs classiques d’insonorisation (silencieux) dans le domaine des basses fréquences a conduit Électricité de France à s’intéresser aux perspectives nouvelles qu’offre l’absorption acoustique active. Un système particulier, propre au traitement des ondes planes, utilisant un filtre numérique auto-adaptatif a été développé et mis en œuvre sur une installation industrielle. Parallèlement, une modélisation numérique a permis de mieux comprendre le phénomène d’absorption acoustique active et de visualiser les flux d’énergie à l’intérieur du conduit traité.
ACTIVE NOISE ATTENUATIONS IN THREE-DIMENSIONAL SPACE
J. Shu and J. Tian

Tripole secondary sources as well as their behaviors in actual Active Noise Absorption (ANA) systems are discussed. Experiments carried out in both an anechoic chamber and a reverberation room are described. Experimental results of a practical ANA system are given. In the frequency range of 50–400 Hz, noise attenuations are obtained in all of the space. In the reverberation room, octave band-noises can be suppressed by 6–12 dB. Finally, the acoustical absorption mechanism of ANA systems is discussed on the basis of laboratory studies.

MONDAY AFTERNOON, 28 JULY 1986
ROOM 202 A and C, 14:40 - 17:00

Session D2: Vibration of supported beams and plates
Chairman: M. Heckl, Institut für Technische Akustik, Technische, Universität Berlin, Einsteinufer 27, 1000 Berlin 10, F.R.G.

Contributed Papers

D2-1 14:40
VIBRATION D’UNE POUTRE REPOSANT SUR DES SUPPORTS PERIODIQUEMMENT ESPACES
J.L. Gauer, G. Dumery, B. Rossetto

On présente un algorithme itératif qui permet de calculer les exposants de Floquet-Liapounov d’une équation différentielle linéaire homogène à coefficients périodiques (équation de Hill d’ordre n). Cet algorithme converge rapidement ; il permet de contrôler l’erreur et il fournit la solution générale sous une forme adaptée à la physique du problème considéré. On applique cette méthode au calcul des courbes de dispersion et des bandes passantes de vibration d’une poutre infinie reposant sur divers types de supports régulièrement espacés.

D2-2 15:00
ON THE OPTIMAL SUPPORT LOCATION FOR VIBRATION OF POINT SUPPORTED SHALLOW SHELLS
Y. Narita

This paper deals with effects of the support location on the free vibration of point supported shallow shells of square planform. In analysis, the Ritz-Lagrange multiplier method is used. Three types of shell curvature are considered. In numerical examples, natural frequencies of the four point supported shell are obtained and the optimal support locations are discussed.

D2-3 15:20
VIBRATION OF STRESSED ISOTROPIC AND ORTHOTROPIC RECTANGULAR PLATES USING ORTHOGONAL POLYNOMIALS IN THE RAYLEIGH-RITZ METHOD.
S.M. Dickinson, A. Di Blasio

Series composed of recently proposed, orthogonal polynomial functions are used in the Rayleigh-Ritz method to study flexural vibration problems of stressed and unstressed rectangular isotropic and orthotropic plates. It is demonstrated that the approach yields excellent results, not only for the natural frequencies but also for the rather more sensitive mode shape, shear force and bending moment distribution problem.

D2-4 15:40
EXPERIMENTAL STUDY OF FREE VIBRATION OF ANNULAR PLATES HAVING RADIAL STRAIGHT NARROW SLITS
K. Naruyama and O. Ichinomiya

The effect of the number and length of slits on the natural frequencies and corresponding mode shapes of annular plates with clamped outer edge and free inner edge having radial straight narrow slits has been experimentally examined, applying the real time technique of time averaged holographic interferometry. The first eight modes are discussed, showing the data graphically, classified into symmetric and antisymmetric modes with respect to a diameter including a slit.
D2-5  16:00

SOUND INDUCED VIBRATIONS IN PLANT LEAVES.

Sound induced vibrations have been studied in clamped leaves of three plant species using laser-Doppler-vibrometry. The leaves behave as linear systems, and are compared to clamped membranes and plates. The fundamental frequency has been measured at different radii, 25 and 68 mm. From the ratios it has been concluded that some leaves behave as membranes and others in between membranes and plates. The fundamental frequency depends on the nerve-structure, and its value is related to the water stress. The vibration patterns are studied using a LDV-scanner to be able to compare these patterns with those of membranes and plates.

D2-6  18:20

ON THE VIBRATIONS OF CIRCULAR RINGS WITH TENSION AND ELASTIC BEDDING (TIRES)
M. Heckl

The surface motion of tires can be described fairly well by the vibrations of a circular ring. It is then found that the motion can be represented by six waves (or nearfields). This representation is easier to handle than the usual normal mode expansion, because of the high damping in tire materials. The vibration patterns calculated this way will be shown in a film.

D2-7  16:40

FURTHER DEVELOPMENTS OF THE "DIRECT FINITE ELEMENT METHOD" (DFEM) DETERMINING THE SOUND RADIATION OF STRUCTURE BORNE NOISE
G. Höhner

Former papers (e.g. 11th ICA, Lyon Symposium and Inter Noise 85) gave first examples for the sound power determination according DFEM by applying the method to even plates and line sources vibrating within a large rigid screen. By this paper the method was expanded to plates and line sources vibrating freely in a gas (air). For that description the surface of the vibrating structure is replaced by a system of dipoles. Good accordance of the DFEM-results with classically obtained solutions can be stated.

MONDAY AFTERNOON, 28 JULY 1986

Room 206 A and C, 14:40 - 17:00

Session E5: Auditorium room acoustics


Contributed Papers

E5-1  14:40

SOUND FIELD PREDICTION IN A VARIABLE ACOUSTIC HALL
C. Maierur. J.P. Jullien.

A computer simulation has been developed and adapted for studying lrcam's Espace de Projection, a variable acoustic hall. The acoustical variability is achieved by choosing the type of the panels (absorbing, diffusing, reflecting) which constitute the walls and the movable ceiling. The simulation method uses ray tracing for the first reflections, a markov process to describe the sound energy propagation when the sound field is assumed to be diffuse and mirror image for the reflecting panels. The simulation gives objective criteria, which are compared to previous collected acoustic measurements.

E5-2  15:00

A COMPARISON OF OBJECTIVE ACOUSTICAL DESIGN CRITERIA BETWEEN RECTANGULAR CONCERT HALLS AND MULTI-PURPOSE PROSCENIUM HALLS
Gary W. Sieben and Roger Hansrote

A series of objective acoustical design criteria were measured in 9 auditoria. The auditoria were classified in 2 basic architectural design typologies: rectangular concert halls and multi-purpose proscenium halls of increasing size from 100 seats to > 2500 seats. Impulse measurements were performed at multiple locations in each auditorium. The data were compared both within each space and among the various halls to outline preliminary ranges of values for these new measurements.
SOME RESULTS ON PRIMITIVE ROOT DIFFUSERS
J.-D. Polack, G. Dodd, A.H. Marshall

Originally meant as simple devices for obtaining optimum diffusion in Auditoria, Schroeder's diffusers are finding new applications. However, few experimental publications support their theoretical diffusion properties. A simple technique for sine wave measurements of diffusers is described, with a new formulation of Schroeder's theory based on Huygens' Principle. They allow systematic comparisons of measurements and computations.

PARAMETRICAL MODELING FOR ACOUSTICAL PHENOMENA
O. Wartenfel

The ambition of the study is the ability to control acoustic fields. This can be achieved with a good knowledge of all the phenomena intervening in an acoustic channel. The approach considers the processes - such as synthesis, equalization and control - as convolution operations. Therefore each of the phenomena may be regarded as a linear filter that may be analyzed through signal processing. Modeling tools were elaborated to meet the following requirements: the ability to get a direct model (for synthesis purposes) and inverse model (for equalization purposes), and for both of them, a stable behavior and good fits in the spectral and time domains. Applications for loudspeakers and room reflections are reviewed.

CAPTURED SOUND
R.J. Satory

There is a phenomenon that has long been known as 'bad acoustics where a curved surface is introduced into a space with a plain surface closer to the curved surface then the centre of the curvature. Even in such situations uses can be made of the sound phenomena. This small paper is intended to identify some of the many times the phenomena occurs, where to use the phenomena; how to use the phenomena; how to eliminate the phenomena; and how to control the phenomena.

THE ESSENTIALS OF ECHOCGRAM AND TRANSIENT DIFFUSION OF AUDITORIUMS
F.N. Xiang, Z. Wang, M.L. Zhang

The essentials of transient response at any point in an auditorium are the directions, time laggings and magnitudes of the received early reflections. The coincidence between these parameters calculated for and measured in some existing auditoriums is quite well. With these parameters and coefficients of transient diffusion can be defined. Thus it is possible to examine and compare the transient responses of points quantitatively during the designing period.

APPLICATIONS OF "PSEUDO-SVD" PSEUDOINVERSE-FILTERED IMPULSE RESPONSE ESTIMATES IN ROOM ACOUSTICS,
John P. Walsh and Robert D. Essert

"Pseudo-SVD" (singular value decomposition) pseudoinverse filtering gives optimal estimates of a room's impulse response, and is applicable when the wavelet exciting the room is known and has singularities. These conditions will be true for most "explosive" sources, such as sparks or gunshots, which have periodic zeros in their spectra. This paper presents a concise overview of the theory, and the application of the method in deriving the impulse responses of auditoria and their scale models.
Session I2: Nonlinear mechanisms and effects
Chairman: A. Nakamura, Osaka University, The Institute of Scientific and Industrial Research, 8-1, Mihogaoka, Ibaraki, Osaka 567, Japan

Contributed Papers

I2-1 14:40
TIME DOMAIN PRESENTATION OF GEOMETRICAL ACOUSTICS,
Frederick D. Cotaras and David T. Blackstock

The theories of linear and nonlinear geometrical acoustics are derived from simplified versions of the lossless hydrodynamics equations in the fashion put forth by Ostrovski et al. (Sov. Phys.-Acoust. 22, 516-520, 1976). The development, which is carried out solely in the time domain, leads to an eikonal equation and a transport equation. The eikonal equation, from which an equation for the ray paths is derived, is the same for both small-signal and finite amplitude waves. The transport equation is, however, different for the two cases. It leads to a standard first-order progressive wave equation, linear for small-signal waves, but nonlinear for finite amplitude waves.

I2-2 15:00
FORMATION AND PROPAGATION OF SHOCK WAVES IN FLUIDS HAVING POSITIVE AND NEGATIVE NONLINEARITY
M. S. Cramer
Dept. of Engineering Science & Mechanics
Virginia Polytechnic Institute & State University
Blacksburg, Virginia 24061

Fluids in which the nonlinearity parameter \( 1 + \frac{B/2A}{\sigma^2} \) is known to exhibit negative nonlinearity. When both positive and negative nonlinearity occur in the same pulse or wave train, the evolution of the waveform can differ significantly from that observed in ideal gases. New nonlinear phenomena associated with these fluids will be presented and illustrated through use of the Van der Waals gas model.

I2-3 15:20
COMPUTER SIMULATION ON FUNDAMENTAL BEHAVIOUR OF PARAMETRIC AMPLIFICATION USING FINITE AMPLITUDE DISTORTION OF CARRIER
A. Nakamura

Finite amplitude distortion is simulated by computer. It is found that parametric signal with difference frequency is concerned with change of form of carrier. After shock formation of carrier, nonlinear distortion appears at shock fronts and envelop begins to change unexpectedly. Form and undesirable distortion appears in parametric signal. Linear absorption affects not only suppressing this undesirable distortion but also improving conversion efficiency.

I2-4 15:40
Propagation and reflection of finite amplitude sound beams.
We consider theoretically the propagation in an absorbing fluid of a finite-amplitude sound wave from a real axisymmetric source, and its reflection from a pressure release surface. The theory is based on the parabolic approximation of the governing equations of motion valid to small order terms in the acoustic variables. Diffraction, nonlinearity and absorption are accounted for consistently. The solution is obtained in form of a Fourier series expansion, and by using a numerical procedure described previously. Results are presented for the case of normal incidence at a planar reflector, although the theory applies to more general cases.

I2-5 16:00
NONLINEAR ACOUSTICS IN NON-NEWTONIAN FLUIDS
R.L. Powell and A. Kersulis

The harmonic generation due to the propagation of a finite amplitude planar acoustic wave in a viscoelastic fluid is theoretically described. The theory accounts for non-linear viscoelastic effects, which when small, can decrease harmonic amplitudes by up to an order of magnitude with this decrease usually being greater at higher frequencies. This provides a possible explanation of shifts in noise frequency spectra in dilute aqueous solutions of high molecular weight polymers to frequencies lower than those found for pure water.

I2-6 16:20
NONLINEAR VISCOUS EFFECTS ARISING NEAR A BOUNDARY DISCONTINUITY
Charles Thompson

The problem of nonlinear viscous flow generated by an acoustic wave traveling in proximity to a rigid boundary having a rapid variation in shape will be examined. Special attention will be given to the problems of acoustic streaming and instability in the Stokes boundary layer. The acoustic particle velocity amplitude at which instability is observed corresponds to the case where \( c^2 R^{1/2}/S^2 = O(1) \). Below this amplitude threshold acoustic waves generate the time-average motion that is called acoustic streaming. Results show that the boundary geometry plays a major role in the instability mechanisms in that an inflection point in the wall shape causes a bifurcation point according to linear stability theory.
A generalized method of extraction of the n-th order spectrum convolution terms and its application to nonlinear propagation of noise signals is examined. Results concerning the noise spectrum evolution based on Cary's model of nonlinear propagation in media with dissipation and on the said extraction procedure are presented.

Contributed Papers

K4-1 14:40
SOUND POWER SPECTRA OF ORCHESTRAL INSTRUMENTS
J. Meyer

Sound spectra of musical instruments measured as sound pressure level spectra have the disadvantage, that the levels depend on microphone position and recording room. Therefore sound power spectra of single tones (having different pitch and dynamics) have been measured in third-octave bands. Some typical properties have been evaluated, such as:
- frequency and level of the strongest components;
- level of the 3150 Hz band and slope of the envelope above 3150 Hz; frequency range, in which the level decreases not more than 10 dB below the maximum level.

K4-2 15:00
STATIONARY SOUNDING OF THE BASSOON
T.Idogawa and M.Ishibashi

Concerning the bassoon in stationary sounding, reed motion and pressure in the reed were simultaneously observed; results are presented in time domain and in frequency domain and compared with those of the clarinet; the results are peculiar to the bassoon. The impulse response of the bassoon, the inverse Fourier transform of the input impedance determined, is also described. The impulse response shows clearly the characteristics of a particular bore including finger holes. Relation between the reed motion and the impulse response is discussed.

K4-3 15:20
SIMULATION OF FLOW THROUGH A PARAMETRIZED "REED-APERTURE"
W.J. Strong, S.D. Sommerfeldt

A stylized blowing pressure source plus reed-aperture plus tube is simulated to investigate the effects of source and tube characteristics. The pressure source is represented with one of two vocal tract configurations: /a/-shaped or /i/-shaped. The rectangular "reed-aperture" is parameterized so that its time variation is independent of source or tube loading. Two "tube" loadings are simulated: a resistance and a tube with tone holes. Waveforms and spectra are calculated for source pressure, air flow, and tube pressure.

K4-4 15:40
BIFURCATIONS, DOUBLEMENT DE PERIODE ET CHAOS DANS LES SYSTEMES DU TYPE CLARINETTE
R. Caussé, Ch. Maganza et F. Laboë

Le fonctionnement des instruments à vent offre un terrain particulièrement intéressant pour l'étude des non-linéarités, fortes et bien localisées. Une analyse du mode de fonctionnement simplifié de la clarinette montre que ce système hydrodynamique doit suivre un scénario d'approche du chaos du type Feigenbaum, avec une cascade de doublements de période. Pour confirmer cela, nous avons expérimenté sur une clarinette réelle dont l'excitation non-linéaire est remplacée par un équivalent électroacoustique.
SPATIAL PERSPECTIVES ON EARLY WOODWIND BORES
R.D. Ayers and L.J. Ellason

Early woodwinds show evidence of interference among reflections of comparable strength from different discontinuities in the bore. We use impulse analysis to establish a direct connection between a simple bore shape and its acoustical behavior. Space-time diagrams provide an organizing scheme for handling multiple reflections and a convenient tool for interpreting results. Space-frequency plots of information available in standard input impedance calculations provide an alternate perspective on the interference effects.

MICRO-INTERVAL SYSTEMS FOR WOODWIND INSTRUMENTS
J. Kergomard, X. Meynial

A system shifting the scale of woodwind instruments by a quarter-tone is described. One can show one must insert in the instrument an additional length inversely proportional to frequency. This is only possible for one register at one time. This additional length is realized by an open branched pipe (acoustic mass) for flutes and conical-reed instruments and by a closed branched pipe (compliance) for clarinets. The position of the system on the instrument depends on the register. The results for Boehm-flutes and clarinets are conclusive, not introducing notable modifications of tone-color.
Structured session B7: Otoacoustics and cochlear mechanics

Chairman and organiser: D. Kemp, Institute of Laryngology and Otology, Gray's Inn Road, London, WCLX 8EE

Chairman’s Introduction 8:35

Invited Papers

B7-1 8:40
OTOACOUSTIC EMISSION CHARACTERISTICS DURING MODERATE CONTINUOUS STIMULATION- INTERMODULATION
D. T. Kemp

Stimulated acoustic emissions in the human ear canal have been examined using a 32Hz separated tone pair stimulus at moderate levels (66dB SPL). Stimulus frequency and intermodulation products have been simultaneously measured as a function of frequency, to determine latency and relative intensities. The data is consistent with a strong saturating (clipping) type nonlinear remission mechanism, as demonstrated by a model. The fine structure of the response with frequency is discussed.

B7-2 9:00
NONINVASIVE MEASUREMENTS AND MODELLING OF HUMAN INTRA-COCHLEAR HYDROSTATICS
R.J. Marchbanks, A.M. Martin and J.J. Tweed

Discussed in this paper are the causes and effects of changes in the intra-cochlear hydrostatic fluid pressure. Consideration will be given to the influence of the cerebrospinal fluid pressure on the perilymph, and the effects of hydrostatic pressure on the transmission characteristics of the middle ear. A noninvasive method of measuring the perilymphatic pressure and empirical findings with supporting mathematical models are presented.

B7-3 9:20
LATENCY OF TONE-BURST-EVOKED OTO-ACOUSTIC EMISSIONS
S. T. Neely and S. J. Norton

There is a discrepancy between the latency of transient-evoked oto-acoustic emissions (OAE) and most other estimates of intra-cochlear travel time (ICTT), if the generation of the OAE is modeled as a simple reflection of the cochlear traveling-wave. The reason for the apparent discrepancy is that the ICTT has been widely underestimated. Estimates of ICTT based on recent measurements of tone-burst evoked brainstem responses are more consistent with OAE latency and suggest that ICTT is longer than previously reported.

B7-4 9:40
THE ROLE OF THE ULTRASTRUCTURE IN THE DYNAMIC RESPONSE OF THE TYPANIC MEMBRANE
R. D. Rabbitt and M. H. Holmes

Fibrous layers of the lamina propria influence the dynamic behavior of the tympanic membrane by producing strong anisotropic extensional stiffness, while the mucous and epidermal layers are primarily responsible for a curvature dependent structural damping and relatively weak isotropic bending stiffness. By including these structural factors, the geometry, and the coupling to adjoining systems, a closed form asymptotic solution of the eardrum model is found that reproduces the experimentally observed vibrational shapes.

B7-5 10:00
OTOACOUSTIC EMISSIONS - INTERACTIONS, CORRELATION WITH THRESHOLD MICROSTRUCTURE, AND VULNERABILITY TO ASPIRIN CONSUMPTION,
G.R. Long, A. Tubis, K. Jones and E.M. Burns

Recent work on spontaneous and evoked otoacoustic emissions and their correlation with behavioural threshold microstructure is reviewed. Special attention is given to interactions among emissions, the possible interpretation of quiet threshold microstructure as a type of "internally" masked threshold, and reversible changes in the emissions and associated threshold microstructures induced by aspirin consumption.

B7-6 10:20
FORWARD AND BACKWARD COCHLEAR WAVES
J.J. Zwislocki

Normally, sound enters the cochlea through the middle ear and the oval window. It is propagated there in the form of transversal waves on the cochlear partition that runs the length of the cochlear canal. When sound reaches the cochlea through its bony walls, via bone conduction, the wave pattern remains essentially unchanged. However, when the sound source is located directly on the partition, two waves result, as was demonstrated on an electrical analog of the cochlea. One runs forward, toward the cochlear apex, the other backward, toward the oval window. There, part of its energy is reflected, producing standing waves, and part is transmitted via the middle ear to the ear canal where it can be detected.
MECHANICAL TUNING AT THE BASE OF THE CHINCHILLA COCHLEA
L. Robles, M.A. Ruggero and N.C. Rich

The basilar membrane (BM) in the mammalian cochlea acts as a mechanical filter that separates sound stimuli into their component frequencies. However, the sharpness of tuning obtained in classical BM measurements using traditional optical methods, as well as in most later ones using more sensitive techniques, was insufficient to account for frequency selectivity observed in cochlear nerve fibers in several species. We present mechanical responses, measured with the Mössbauer technique, showing that the chinchilla BM is as sharply tuned as cochlear nerve fibers with the same characteristic frequency (CF; about 8.4 kHz). The responses are nonlinear at CF and show a loss of sensitivity and tuning with time that could involve changes in feedback from outer hair cells.

TUESDAY MORNING, 29 JULY 1986
ROOM 203 B and D, 8:35 - 12:00

Structured session G3: Ultrasonic materials characterization
Chairman and organiser: L. Adler, Dept. of Welding Engineering, The Ohio State University, 190 W. 19th Avenue, Columbus, OH 43210, U.S.A.

Chairman’s Introduction 8:35

Invited Papers

G3-1 8:40
ACOUSTIC RADIATION STRESS IN SOLIDS
J. K. Cantrell and W. T. Yost

Application of the Boltzmann-Ehrenfest adiabatic principle to a self-constrained system represented by the nonlinear elastic wave equation predicts the existence of resonant modal acoustic radiation stresses in crystals. The virial theorem links the radiation stresses with structurally ordered radiation-induced static strains for a given crystalline modal energy. The existence of the static strains is confirmed experimentally in several solids. Implications to materials characterization and thermal properties of solids are discussed.

G3-2 9:10
RESONANT INTERACTIONS OF BROAD BAND PULSE ON PERIODIC CORRUGATIONS
A. Jungmann and G. Quentin

Experimental results and physical interpretations are presented to illustrate the interaction between an ultrasonic finite beam and liquid-solid boundaries with a periodic profile. The frequency dependence of the reflected or transmitted spectrum exhibits resonances at frequencies which can be correlated with the geometry of the surface and the nature of the two bonding materials. It is found that dips observed in the spectrum are produced by a beam coupled along the interface which leaks energy into the bulk of the bounding materials.

G3-3 9:40
REFLECTION FROM PERIODIC SOLID-LIQUID SURFACES
K. Mampaert, O. Leroy, J. Lepesre

It is experimentally verified that when a plane wave interacts with periodically rough S/L boundaries at normal incidence, the reflected spectrum contains several minima which are characteristics of the various parameters of the interface. An analytical approach to this problem will be discussed, in analogy with the theory pointed out by Claeyts and Leroy for L/S boundaries (J. Appl. Phys. 54 (10), oct. 1983). The frequency dependence of the reflection coefficient is calculated for various periodic structures and the correlation between the irregularities and the reflected profiles is discussed.

G3-4 10:10
APPLICATIONS OF ULTRASONIC METHODS IN PROCESS CONTROL
S.I. Rokhlin and L. Adler

Ultrasonic waves have found wide application in nondestructive evaluation and characterization of materials. Recently important new applications in real-time process monitoring and use of ultrasound sensors in automated process control systems have been recognized. Attenuation and sound velocity may be measured during processing and therefore information on product quality and material properties can be evaluated in real time and related to process conditions. In this paper we review some of these applications to weld process and composite material cure monitoring.
ASPHERICITY EFFECTS ON THE ULTRASONIC CHARACTERIZATION OF POROSITY
J. H. Rose

Recently a technique has been developed to characterize porosity in structural solids from the frequency dependence of the ultrasonic attenuation. Here the effects of pore shape on the resulting estimates for the volume fraction and average pore size are examined.

Discussion

TUESDAY MORNING, 29 JULY 1986

Session C6: Duct acoustics — theory and experiments
Chairman: P. Lord, Dept. of Applied Acoustics, University of Salford, Salford, M5 4WT, England, U.K.

Contributed Papers

C6-1 8:40
ACOUSTIC PULSATION OF PIPING SYSTEMS BY THE TRANSFER MATRIX ANDFINITE ELEMENT METHODS
C.W.S. To

The main theme of this paper is concerned with the study of a typical piping system using the digital computer program, PASAPS I, based on the transfer matrix approach and a finite element program based on the one-dimensional acoustics equation. Comparison of results from the two programs is made. It is concluded that the transfer matrix approach is much more economical to employ than the finite element method.

C6-2 9:00
DISPERSE NONLINEAR WAVE INTERACTIONS IN A RECTANGULAR DUCT
J.A. Ten Cate and M.F. Hamilton

Experiments are described in which finite amplitude sound in the plane wave mode (0,0) and first higher order mode (1,0) is generated in a hard wall rectangular duct. Two types of nonlinear wave problems are considered. The first involves the weak nonlinear interaction of a pure tone in the (1,0) mode with a pure tone of another frequency in the (0,0) mode. In the second problem we investigate the finite amplitude distortion of a pure tone generated in the (1,0) mode. Data obtained from both the bifrequency and single frequency experiments are compared with analytical results.

C6-3 9:20
A NUMERICAL METHOD FOR SOUND PROPAGATION IN THREE-DIMENSIONAL RECTANGULAR DUCTS
Zhu Zhicheng and Wang Zhiguo

The MacCormack explicit method dividing a 3-D problem into three 1-D ones has been used to solve the basic equations for determining the acoustic pressure and velocities. In this paper, several examples are presented for 3-D sound propagation in hard and soft wall ducts with or without flow. The errors examined by numerical criteria are normally less than 5%. The MacCormack method needs far less storage and is more stable. Moreover, it is easier to program and debug.

C6-4 9:40
PROPAGATION EN CONDUITE EN PRÉSENCE D’ÉCOULEMENT UNE MÉTHODE TEMPORELLE DE RÉSOLUTION
P. Espósito, V. Villavoire

Dans le cadre des études sur la génération hydro-acoustique ou aéro-acoustique du bruit dans les circuits industriels, on s’intéresse à la propagation acoustique dans les tuyauteries rigides en présence d’écoulement. Une nouvelle méthode de résolution numérique de ce problème est présentée. Elle utilise une discrétisation en éléments finis une formulation faible et la résolution à l’aide de la méthode des caractéristiques d’un problème adjointe de propagation sur les fonctions-test. Cette méthode permet de traiter correctement la propagation des ondes à partir de 6 points par longueur d’onde, ce que confirment les résultats numériques présentés.
C6-5  10:00

INFLUENCE OF ACOUSTIC WAVE PROPAGATING AXIALLY WITHIN SOUND ABSORBING LAYER IN LINED DUCTS
Zhao S.L. and Gong N.B.

The influence of acoustic wave propagating axially within the sound absorbing layer is investigated in this paper. For rectangular ducts, the expressions are derived based upon rigorous sound propagation theory. It is shown that if the sound material is rather soft or light, the damping coefficient obtained in present theory will be much lower than that predicated in current theory.

C6-7  10:40

THE USE OF THE CROSS SPECTRAL TECHNIQUE TO THE STUDY OF DISCRETE AND BROAD BAND NOISE
J. S. B. Mather and P. A. C. Medlicott

The cross-spectral analysis technique, based on digital Fourier transforms in time and space, is used to determine duct modes for the propagation of sound from two fans of widely differing performance. The results show good agreement with theory. An important conclusion is that discrete tone and narrow band energy propagates mainly in the positively rotating modes and broad band energy in the negatively rotating modes.

C6-8  11:00

CHARACTERISTICS OF THE FLOW RATE AND NOISE RADIATION OF EXPANSION MICROPORE MUFFLER
LI Peizi, MU Xiumin and WANG Hongy

A theory for calculating the flow rate of micropore muffler is proposed. We find a critical expansion ratio below which the flow only can be choked at micropores and noise in the muffler is not important compared with that radiated from micropores. Above the critical, noise produced in expansion effects the noise radiation considerably, particularly at the pressure the flow chokes at exhaust pipe only.

C6-9  11:20

DESIGN OF AN ANECHOIC CHAMBER TO MEASURE THE SOUND-POWER OF AIR CONDITIONING SYSTEM.
M. Recuero , C. Gil

This paper describes the most important characteristics of an anechoic chamber with a free field of 300 m²; the inside, the dimensions of which are 7'76 x 4'54 m is coated with fiberglass wedges of 80 x 20 x 20 cm and having a density of 50 kg/m². Its cut-off frequency is 160 Hz. The paper also presents the chamber construction details together with the techniques used in airborne and impact noise.
Session D3: Radiation from vibrating structures, fluid load and stiffened plates

Chairman: F. Fahy, I.S.V.R., The University, Southampton S09 5NH, U.K.

Contributed Papers

D3-1 8:40
COMPUTATION OF RADIATED ACOUSTIC INTENSITY PATTERNS FROM VIBRATING MODES
S. Tanabe and M. Sanada

A method for predicting acoustic intensity (AI) radiated from a vibrating structure is presented and is experimentally verified.

The method is based on boundary integral equation method using Helmholtz integral and on finite difference approximation technique according to two microphone AI measurement method. Computation of AI pattern is verified, linking with modal analysis, in comparing with the measured AI patterns at each characteristic vibration mode.

D3-2 9:00
APPLICATION OF IMPROVED INTEGRAL EQUATION METHODS TO IMPORTANT ACOUSTIC RADIATION PROBLEMS
Y. Takano and S. Shimode

The application of an improved integral equation method to important acoustic radiation problems is discussed. Conventional Helmholtz formula could not be applied to acoustic radiation problems of vibrating shells. An improved method is developed using the normal derivative form of the Helmholtz formula enabling accurate calculation of the sound field around vibrating shells. The improved equation gives unique solutions to external problems at wavenumbers near the eigenvalues of the associated interior problem.

D3-3 9:20
PUISSANCE ACOUSTIQUE RAYONNEE PAR UNE COQUE CYLINDRIQUE FINIE.
P. Smadja, F. Guisnel, A. Blaise et B. Guérin

On se propose d'étudier la puissance acoustique rayonnée vers le milieu extérieur par une coque cylindrique finie, soumise à une excitation acoustique interne ou une excitation mécanique ponctuelle. L'analyse théorique, de nature modale, ainsi que la méthode expérimentale, basée sur l'intensimétrie vectorielle, mettent en évidence des phénomènes de couplages intermodaux et l'importance de la nature de l'excitation sur le coefficient de rayonnement des cylindres.

D3-4 9:40
RAYONNEMENT ACOUSTIQUE D'UNE COQUE CYLINDRIQUE BAPFLÉE
D. Habault et P. J. T. Filippi

It is shown that the system of partial differential equations governing the shell displacement and the sound radiated pressure can be reduced to a system of integral equations along the shell boundaries. Using the Fourier series representation of the unknown functions, the integral equations are reduced to a set of algebraic equations of order 8: the coefficients are expressed by Fourier integrals. The Fourier transform of the radial shell displacement is used to determine the far-field sound pressure.

D3-5 10:00
CALCUL BIDIMENSIONNEL DE LA PERTURBATION DE RAYONNEMENT APPORTÉE PAR UNE ENCEINTE.
D. Fichot, J. M. Farot

Une source acoustique à mouvement donné est placée à l'intérieur d'une enceinte élastique. On calcule le champ acoustique lointain après résolution d'un système intégral-différentiel sur la surface de la source et de l'enceinte. La formulation intégrale rend compte de l'interaction acoustique entre source et enceinte. Le couplage fluide-structure est décrit sans approximation. L'équation intégrale sur l'enceinte présente une singularité non intégrable à traiter comme partie finie de Hadamard. Le comportement dynamique de l'enceinte est décrit par un modèle aux éléments finis de coque bidimensionnelle.

D3-6 10:20
THE EFFECT OF LIQUID LOADING ON STRUCTURE-BORNE SOUND
Yoshiiro Shimomura and Richard H. Lyon

The effect of a liquid storage tank on sound transmission through a large structure such as a ship is studied. A model experiment using a water tank suggests that it is possible to reduce sound transmission by an order of magnitude at low frequencies. Even though the sound radiation efficiency is small at low frequencies, the added mass effects of the water still play an important role in sound transmission. The reduction in the sound transmission may be accounted for by introducing an effective moment of inertia of water into the moment balance at a water-loaded junction.
D3-7 10:40
VIBRATIONS AND SOUND RADIATION OF IMMERGED STIFFENED SHELLS
C. AVALLET

This paper presents a method to compute vibrations and sound radiation characteristics of thin periodically stiffened shells immersed in a compressible fluid. Resulting program, called GAP, works in three steps: computation of system natural waves, computation of the response to an excitation by distribution on the free waves, computation of far field by Helmholtz integral formulation. GAP program uses the transfer matrix technique applied to shell and stiffeners analytical operators. With finite difference approximation for fluid equation in radial direction. Computations can be performed for k= a up to 16; computation time is independent of frequency.

D3-8 11:00
TECHNIQUE OF BLOCKING IN THE ANALYSIS OF THE RESPONSE OF LAYERED MEDIA
G. Maidanik, J. Dickey, and L.J. Maga

The dynamic system consists of a boundary over which a panel is placed; the space between the boundary and the panel is filled with a fluid as is the semi-infinite space above the panel. The response in the fluids due to various external drives is derived. The response is also derived by superposing solutions, one with the panel blocked and the other where the panel is assigned a response that acts as external sources to generate the other components of the response in the fluids. It is verified that the responses derived by the two methods are identical.

D3-9 11:20
SCATTERED ACOUSTIC NEARFIELD OF RIB-REINFORCED ELASTIC PLATE
S. I. Hayek and G. Seren

An elastic plate, which is reinforced by a welded rib, is illuminated by an incident plane wave. The acoustic nearfield of the plate is computed by asymptotic techniques which allow for surface wave propagation in the nearfield of the plate. The scattered acoustic field near the plate was shown to decay with distance from the rib-plate joint at a rate higher than that for observation points located away from the plate.

D3-10 11:40
AN INVESTIGATION OF THE SOUND POWER RADIATED FROM STIFFENED RECTANGULAR PLATES
Z. Engel and R. Panuszka

An experimental study of the radiation of acoustic energy by thin rectangular plates at flexural vibration was carried out. The adopted piston model of emission of the rectangular plate permitted the estimation of the radiation efficiency and the coefficients of the vibration distribution for the plate in dependence on the boundary conditions and parameters of the plate-ribs system.

TUESDAY MORNING, 29 JULY 1986
ROOM 206 A and C, 8:40 - 11:00

Session E6: Subjective aspects in architectural acoustics
Chairman: J. Blauert, Ruhr-Universität, Lehrstuhl AEA, Postfach 102148, 4630 Bochum 1, F.R.G.

Contributed Papers

E6-1 8:40
EARLY FRONTAL PLANE REFLECTIONS PREFERRED FOR TALKERS
M. Kleiner and A.C.O. Berntson

The talking comfort of six different synthetic sound fields were judged by 10 talkers. Three different cross sections were simulated with width xheight=20x5, 10x10 and 5x20 m² and two talking positions in each (Symmetrical and Asymmetrical). The results indicates that the S positions was preferred. However, there was no difference between the cross sections in the S positions. In the AS positions the narrow cross section was preferred.

E6-2 9:00
FRONTAL LOCALIZATION OF PERCEIVED SOUND IMAGE BY PERFORMER
I. Nakayama and T. Uehata

For obtaining a concept for the stage enclosure design for performers, localization tests with a simulated single reflection were conducted both for alto-recorder soloists and solo singers. It was found that frontal localization of the perceived sound image can be realized easily by feeding the reflection from above and behind the performer without feeding it from front. This suggests us that the reflection from a ceiling and/or a rear wall of the stage is rather effective for performers, because reflection from seats in a hall is reduced due to its long pass.
E6-3
9:20
STUDY ON THE CONDITIONS OF SOUND REFLECTION
PREFERRED BY SOLO SINGERS ON THE CONCERT STAGE
Shun-ichi Nakamura and Shotochi Shirasuna

The results of the subjective tests with a simulated reflection suggest that the reflection around [DELAY TIME=60-100 ms, ECHO LEVEL=15 db] defined as 1 m in front of a soloist is preferred as it supports and encourages their singing. Since a single "natural" reflection is not strong enough to satisfy that condition, a certain number of co-operative reflecting sounds are required in a hall provided off the stage. A reflector unit composed of three planes studied experimentally is recommended as it reflects sound towards the source at any point on the stage.

E6-4
9:40
EVALUATION SUBJECTIVE DES CARACTERISTIQUES
D'UNE SALLE A CONFIGURATION VARIABLE
J. Jouhanneau, B. Louvigné, J.D. Polack, J.P. Jullien.

En complément d'une campagne de mesures acoustiques conduite dans une salle à géométrie variable (Espace de Projection de l'IRCAM, Paris), une analyse de la discrimination subjective de différentes configurations a été effectuée. Les résultats portant sur 112 configurations montrent que l'absorption/diffusion est le facteur le plus influent de la perception discriminative. Les variations de réflexion et de hauteur du plafond sont discriminées avec une variabilité qui dépend de l'absorption totale de la salle.

E6-5
10:00
SPACIOUSNESS AND ITS (PSYCHO-)PHYSICAL PARAMETERS
F.A. Bilsen and F.H.A. van den Berg

Spaciousness is an important subjective property of concert hall acoustics indicating the sensation of being surrounded by sound and of broadening of the sound source. A survey will be given of recent psychophysical experiments to trace major psycho-physical parameters involved. For several acoustic transfer systems, different ways of processing the binaural impulse response will be dealt with in relation to a psycho physical theory of binaural interaction (the Central Spectrum theory). It will be argued that the central-spectrum modulation depth \( M \) is an appropriate predictor of spaciousness.

E6-6
10:20
IACC AND TDS MEASUREMENTS COMPARED WITH SUBJECTIVE
PREFERENCE IN BERWALDHALL, STOCKHOLM.
T. Kloow

Berwaldhallen, the Swedish Radio Symphony Orchestra's own concert studio in Stockholm, was opened 1979. This studio with 1300 seats is also used as a concert hall. The TDS-measurements (Time Delay Spectrometry) gave two main results: low level first lateral reflection and excessive low frequency attenuation. The IACC (Inter Aural Cross-Correlation) was measured with dummyhead technique, and test with subjective preference scores were carried out. The test indicates that IACC alone correlates with subjective preference due to binaural measurements.

E6-7
10:40
SUBJECTIVE EVALUATION OF LONG TERM STRENGTH OF MUSIC
JAN TRÓ

Subjective evaluations of the level sensation are normally based on short term listening, i.e. musical passages with the duration of some few seconds. This is not comparable to the listening conditions in the concert hall or in your home studio. Through several listening tests which included both headphone and live music listening, the overall long term strength of the music has been evaluated. Preliminary results show a good correlation between subjective short term and long term evaluation of the strength of music. Some aspects of level adaptation are discussed.
Session E7: Reverberation rooms

Chairman: J.L. Davy, CSIRO Division of Building Research,
P.O. Box 56, Highett, Victoria 3190, Australia

Contributed Papers

**E7-1**
8:40

**PRECISION DES MODELES STATISTIQUES UTILISES POUR LE CALCUL DES TEMPS DE REVERBERATION ET DEVELOPPEMENT D'UN LOGICIEL SUR ANALYSEUR EN TEMPS REEL**

R. Woodcock, J.-C. Migeron, M. Asselineau

Suites à une approche théorique insistant notamment sur la précision de la régression calculée, l'étude porte sur le développement d'un logiciel avec acquisition automatique sur analyseur en temps réel (au 1/3 d'octave) pour les mesures de réverbération. Le programme présenté comporte les interfaces nécessaires pour les commandes des filtres, du générateur et du multiplexeur des microphones; l'automatisation du procédé visant à la fois une plus grande précision et son intégration dans un test d'isolement STC rapide.

**E7-2**
9:00

**CORRELATION OF SQUARED PRESSURE VARIED BY A MOVING DIFFUSER IN A REVERBERATION ROOM.**

A. Imai and M. Konishi

Variance and correlation coefficient for squared sound pressure with diffuser displacement in the normal direction were theoretically and experimentally discussed. Measurements were made on simple plane square diffusers of different surface densities. The variance is proportional to the sound reflection coefficient of the diffuser. The correlation coefficient becomes zero, meaning independent sound fields, at the displacement of 0.185λ.

**E7-3**
9:20

**RANDOM NOISE IN REVERBERATION ROOMS**

J.L. Davy

This paper presents and discusses formulae for the ensemble (temporal) relative variance of the intensity of a frequency band of random noise which has been passed through a reverberation room. It is shown that as well as depending on the statistical bandwidth of the random noise and the integrating time of the averaging device, which are the only variables in the formulae if the reverberation room is excluded from the measuring chain, the relative variance also depends on the ratio of the reverberation time of the room to the integrating time of the averaging device.

**E7-4**
9:40

**AN ESTIMATION METHOD OF A REVERBERATION TIME BY USE OF A STATIONARY RANDOM INPUT UNDER THE BACKGROUND NOISE**

H. Iwashige and M. Ohba

A new type of predicting method of a reverberation time is proposed in this paper, by use of a measurement system with an arbitrary time constant and a stationary random input. Of course, the measurement of reverberation time is affected by this time constant. Furthermore, a stochastic approximation method based on the usual least-square error method is adopted for removing the effect of background noise. The validity of the proposed method is experimentally confirmed too.

**E7-5**
10:00

**REVERBERATION IN AN ENCLOSURE WITH DIFFUSELY AND SPECULARLY REFLECTING BOUNDARIES**

K. Fujiwara and S. Tanabe

The effect of a specularly reflecting boundary portion on the reverberation in an enclosure with otherwise diffusely reflecting boundaries was studied by the use of Joice's spatial energy balance equation, Gilbert's temporal energy balance equation and the mirror image method. The main result obtained is that the change of the reflection characteristics of a boundary portion can cause a change of about 20% in the reverberation time.

**E7-6**
10:20

**EXCESS ATTENUATION DUE TO PERIODICALLY-ARRANGED ABSORPTIVE MATERIALS**

D. Takahashi

Any discontinuities in the surface impedance may cause the effect of excess attenuation of sound. A well-known example of this phenomenon is the so-called 'edge effect' which denotes the dependence of sound absorptivity of a material on its area size. In this paper, excess attenuation due to periodically-arranged surface consist of two strips with different surface impedance is investigated theoretically by means of two-dimensional wave scattering model. The results are presented by showing the sound absorption coefficient in comparison with the simple averaging.
DIFFUSE FIELD QUALIFICATION BY THE TWO MICROPHONE TECHNIQUE
S.N.Y. Gerges

Acoustical measurements in reverberation rooms are all based on a diffuse field model, so far reverberation rooms qualification is based on the space variance of sound pressure level, which accounts for the amplitude gradient only. In this paper, theoretical attempt is presented to quantify the diffusivity of a sound field by the two microphone technique.

THE SOLVING OF THE HELMHOLTZ EQUATION IN LARGE CLOSED SPACES.
L. Hamon, C. Henriot, E. Luzzato, J. Planchard, N. Van Chi.

The solving of the Helmholtz differential equation in large closed spaces has often lead to very difficult limitation problems such as storage space or C.P.U. time. In order to limit the storage space needed, the space discretization is performed by means of a 3D finite difference technique. Using the biconjugate gradient algorithm for the linear system solving, allied to adapted input/output procedures, the Helmholtz problem has been dealt with for various configurations. Some results obtained for large dimension cavities are presented and discussed.

TUESDAY MORNING, 29 JULY 1986
ROOM 203 A and C, 8:40 - 12:00

Session I3: Wave motion, propagation and modes
Chairman: V.K. Kedrinskii, Lavrentiev Inst. of Hydrodynamics, Dept. Explosion Hydrodynamics, 15 Lavrentiev Prospect, Novosibirsk 630090, USSR

Contributed Papers

I3-1 8:40
DIRECTOR WAVES AND FLOW
Zhu Guoshen, Liu Xingzhou and Bai Naibing

Director waves, propagation of the disturbance of orientation of molecules in liquid crystals, was proposed by Ferguson and Brown. Our Experiments on director waves was reported, it is excited by push-formed flow, and the propagation of some dark lines was observed under polarized light. Recently, we measured the velocities of the flow along the cell. It is found that the flow reverses its direction prior to the arrival of dark lines, and explained the fact that the direction of propagation is irrespective of moving direction of the excitor.

I3-2 9:00
INSTABILITY OF MOTION OF GAS BUBBLES IN A SOUND FIELD
R. NaberGo and A. Francescutto

The shape instability of a gas bubble in water subject to an ultrasonic pressure field occurs when the pressure amplitude exceeds a threshold value which is increased by increasing the damping. The bubble is highly sensitive to this phenomenon in the frequency regions of radial resonance, i.e. for the fundamental, the ultraharmonic and the subharmonic resonances. In this paper, the threshold amplitudes are derived from theoretical calculations carried out in a first order approximation analysis.
SOUND GENERATION BY THE WATERSHOCK
A.W. Laake, G.E.A. Meier
Max-Planck-Institut für Strömungsforschung

By an abrupt acceleration of a water column, shock like pressure waves are generated. A pulse-like pressure signal with large bandwidth and amplitude is achieved. Successive reflection in the radiating system causes cavitation which suppresses further fluctuations.

ACOUSTIC RESONANCE DETUNING BY A SPHEROID
F.L. Curson and T.J. Greaves

A small spheroidal obstacle at a point r, in an acoustic resonator, detunes a given mode by an amount δf (Hz). Usually to calculate δf, one needs to know the structure of the normal modes of the resonator. However if the spheroid is small compared to the wavelength of the sound waves, then we show that δf depends only on the geometry of the spheroid and the structure of the acoustic modes near r in the empty resonator. The significance of the results for the acoustic levitation of liquid droplets in an almost weightless environment is also considered.

A RATE GYRO BASED ON THE COUPLING OF ACOUSTIC MODES INSIDE A SMALL CAVITY
M. Brunet, Ph. Herzog, H. Leblond

The assessment of inertial effects due to a rotation on an acoustic field is described as an application for gyroscopic instruments: a resonant acoustic cavity is used in order to strengthen the low amplitude of a "Coriolis acoustic pressure source", distributed only inside the boundary layers because viscous and thermal phenomena are involved. Theoretical sensitivity is better than 0.005%/s, and experiments lead us to the measurement of angular velocities in the interval 0.03%/s - 1000%/s with a very good linearity.

STUDY OF THE REFLECTION OF THE LAMB WAVES FROM THE FREE END FACE BY THE PHOTOLEASTIC VISUALIZATION TECHNIQUE
C.F. Yang, S.Y. Zhang and J.Z. Shen

By the use of the photoelastic visualization technique, several lower order modes of the Lamb wave in glass plates are visualized and identified. Photoelastic observations are then taken of the reflected propagating modes for the cases of incidence of a Lamb mode, a B0 mode and an A1 mode. The results for the first two cases agree with some of the published theoretical predictions. For the case of A1 mode incidence, a theory is developed which is based on the concept of partial waves and is shown to be able to explain our experimental findings.

OBSERVATION OF SURFACE WAVES AT WATER-POUROUS SOLID INTERFACE
P.B. Nagy, M.J. Hayes and L. Adler

The presence of ultrasonic surface waves of various modes on a water-porous solid interface is demonstrated and their velocities are measured. The experimental technique, developed earlier for a fluid-isotropic solid interface, utilized reflected broadband spectra from periodic surfaces. Usually two, and in certain cases, three minima corresponding to mode coupling of incident waves into surface waves at the water-porous solid interface are observed. The velocities of the observed surface waves are in qualitative agreement with theoretical predictions.

LOCALISATION PAR VOIE ACOUSTIQUE D'UN DÉFAUT SUR UN CABLE ÉLECTRIQUE SOUS-MARIN
D. de Montussaint, M. Pays

La recherche d'un défaut, sur les câbles du réseau électrique d'interconnexion français, se fait par échométrie. Cette méthode donne une précision insuffisante pour un câble sous-marin encaissé de grande longueur (50 km).

Une méthode de localisation a été étudiée, utilisant l'effet acoustique lié au défaut lorsque la fréquence est petite. Par des hydrophones, a été testée sur un câble encaissé à 1 m 50 sous une hauteur d'eau de 2 m. La précision du son calculée (< 500 m/s) correspond à une onde soussonique fortement atténuée dans le sédiment, donnant lieu à une onde évaussante dans l'eau. On obtient une bonne précision sur le localisation du défaut pour une distance entre les hydrophones de 10 m.

NONLINEAR ACOUSTIC EFFECTS IN A FLUID WITH SIZE-DISTRIBUTED GAS BUBBLES

The paper reviews the problems concerned with spectroscopy of gaseous microbubbles in the sea. Resonance and strong acoustic nonlinearity are basic characteristic features of bubbles that distinguish them among other suspended particles present in the sea and provide specific possibilities for the diagnostics. Resonant properties of bubbles are used in linear methods based on attenuation and scattering of sound. Nonlinear methods are concerned with the registration of the signal either at the second harmonic of the incident field or at the sum and difference frequencies.
Session L2: Sound sources: theory and measurements

Chairman: S. Yoshikawa, Technological University of Nagaoka, Kamitomioka, Nagaoka, 949-54, Japan

Contributed Papers

L2-1  8:40
CHARACTERISTICS OF THE PLANO-CONVEX ULTRASONIC TRANSUDER WITH BROAD BANDWIDTH AND FOCUSING EFFECT
T. Kobayashi

It is clarified that the plano-convex-shaped ultrasonic transducer made of piezoelectric ceramics has the features of broad frequency bandwidth, transmission and reception of a short ultrasonic pulse without backing layer and radiation of focused ultrasonic waves. Those notable features will be available for the purpose improving the lateral-distance and the time resolution in such applications as imaging and non-destructive testing.

L2-3  9:20
HIGH POWER ULTRASOUND SOURCE BY STEPPED CIRCULAR VIBRATING PLATE
T. Otsuka and K. Seya

The stepped circular vibrating plate based on two nodal circle mode was made for the frequencies of 20 and 28 kHz, the vibration displacement, sound pressure on the center axis, directivity pattern, and the visualization of ultrasound field were measured. As a result, the nodes of vibration displacement were generated at the edge of convex section, the single beam directivity pattern was obtained for both 20 and 28 kHz with the half beam width of less than 10 degrees.

L2-2  9:00
DIRECTIVITY PATTERNS OF ELECTROMAGNETIC ACOUSTIC TRANSUCERS
D.A. Hutchins and J. Hu

The directivity patterns of electromagnet acoustic transducers in aluminum have been determined experimentally, using a second, spiral transducer. The results have been compared to theory in the MHz frequency range. It will be demonstrated that a normal force source leads to efficient longitudinal radiation at the normal to the surface, but that a line shear source leads to shear radiation over a wider angular range.

L2-4  9:40
TRANSDUCTEURS D'ULTRASONS POUR HAUTE TEMPERATURE
Olivier F. Bodenmann

Certaines applications industrielles de nettoyage par ultrasons nécessitent des transducteurs capables d'opérer à des températures de l'ordre de 350°C. Diverses possibilités sont étudiées: transducteur magnétostriction réalisé à l'aide d'un alliage à haut point Curie, transducteur piézoélectrique à cristaux de Nitrate de Lithium, ou à céramiques standard (PZT) avec isolation thermique (silice) et système de refroidissement.

L2-5  10:00
ACOUSTIC CHARACTERISTICS OF SOUND SOURCE WITH CORONA DISCHARGES
H. Shibayama and K. Kido

The acoustic characteristics of the corona discharge sound source constructed by the needles and the wire gauge are demonstrated. The frequency response measured in the O' direction is very different from the one in the 180° direction. The characteristics of the corona wind concerned with these acoustic characteristics are shown. The corona discharge sound source is also useful for acoustic scale model measurements which estimate the effect of the sound due to the wind.

L2-6  10:20
BEHAVIOR OF BRIDGED OVER CORONA IN STANDING SOUND WAVE FIELD,
Tomoo Nakane and Koichiro Seya

In this paper, the bridged over corona discharge is operated in the region of corona discharge, the discharging field is located at the sound pressure node in the standing sound wave field. As a result, the form of bridged over corona is able to control by varying the sound intensity of the standing wave, and the higher the sound intensity, the wider the fan-wise bridged over corona is obtained, and also the region of bridged over corona is slightly shifted by change of sound pressure.
A MODEL DESCRIBING DIFFERENCES IN TIMBRE BETWEEN LOUDSPEAKERS
S. Bech

A model which describes differences in timbre between loudspeakers has been developed. DMG analyses show that differences in 1/3 octaves, placed in spectral parts with negative slope, are principal for the perceived differences in timbre. The long-time average 1/3 octave stimulus spectrum is found to be adequate in describing timbre for time-varying stimuli such as speech and music. The 1/3 octave spectrum is measured at the listening position in the listening room, with time constant equal to duration of stimulus. The goodness of fit for the model is found to be dependent of resolution in experimental procedure and stimuli used in the experiment. For the optimal stimuli and experimental procedure, a correlation coefficient of 0.9 was reached.

Hörbarkeit und Messung phasenbedingter lineärer Verzerrungen
P. Scherer, K. Zünkler


DESIGN METHOD FOR DIRECT-RADIATOR LOUDSPEAKER SYSTEM
BY MONTE CARLO SIMULATION
Y. Nomura and K. Fukuda

The low-frequency sound pressure response of the direct-radiator loudspeaker system is related to the system parameters composed of the elements of the equivalent circuit. In mass production of the system, the values of the parameters vary around the design values which realize a desired response, and so the realized responses deviate from the expected response. This paper proposes a new design method by Monte Carlo simulation that guarantees the response to be within the allowable region given.

MASTERSHIP OF THE ACOUSTICAL SPECTRUM OF SPARK PULSES OF CAPACITORS CHARGED AT LOW VOLTAGES
A. Moreno, L. Sánchez, J. Pfretzschnier, C. Colina

Acoustic pulses of considerable duration (400 μs and more) can be produced by multiple-sparks on graphite-metal detonators at low voltages. The maxima of the resulting spectra can then locate as low as 2 kHz, envisaging the possibility of use in building acoustics. The impulse response of graphite-metal detonators has been computed and some contributions to explain the process of energy release by sparks in these detonators are reported.
Plenary Session 4: L'évaluation des propriétés mécaniques et structurales des matériaux par les méthodes ultrasonores

Speaker: J.E. Roux, Laboratoire de mécanique physique, UA 867 CNRS, Université de Bordeaux I, 33405 Talence, France

Chairman: D. Sette, Department of Energetics, University of Rome I, Rome, Italy

EVALUATION DES PROPRIETES MECANIQUES ET STRUCTURALES DES SOLIDES PAR DES METHODES ULTRASONORES.
J.E. Roux

L'évaluation non destructive ultrasonore précède et rend possibles les contrôles industriels. La propagation des ultrasons dans les solides inhomogènes et anisotropes se modélise à partir de théories qui ont en commun le concept de continuité par morceaux et d'échelles d'homogénéisation. On montre quelques types principaux de méthodes expérimentales ainsi que l'éventail des applications possibles. L'accent est mis sur le comportement mécanique des matériaux composites et nouveaux.

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Structured session I4: Cavitation

Chairman: R.W.B. Stephens, 49 West Hill Road, Wandsworth, London SW18 1LE, England

Organiser: W. Nyborg, Dept. of Physics, Univ. of Vermont, Burlington, VT 05405, U.S.A.

Chairman's Introduction 14:35

Invited Papers

14-1 14:40
CONTRIBUTIONS OF E.A. NEPPIRAS TO THE SCIENCE OF ACOUSTIC CAVITATION
Wesley L. Nyborg

Our present knowledge of acoustic cavitation, and its significance to applied ultrasonics, owes much to the efforts of the late Ernest A. Neppiras. He was active in this area throughout his professional life, starting with the classic pair of papers published with B.E. Noltingk in 1950 and 1951. In this talk the intention is to summarize his contributions to the understanding and utilization of acoustically generated cavitation.

14-2 14:55
VAPOROUS CAVITATION
R.E. Nicholas and R.D. Finch

During the years 1969 and 1970, E.A. Neppiras worked with our group at the University of Houston on cavitation in two cryogenic liquids, nitrogen and helium (1). In this paper we will review the experimental findings as reported earlier in the literature. We will then briefly summarize the theoretical assumptions that have been made in attempts to explain these findings, and the present state of our knowledge of the consequences of the assumptions.
MICROCavitATION

Robert E. Apfel

Microcavitation refers to bubble activity on a microscopic scale. Such activity can result in desirable effects such as increased mass and heat transport, and sono-chemical effects, or undesirable effects such as damage to biological cells. We shall outline the basic ways in which microcavitation differs from larger scale cavitation, and we shall make estimates of thresholds of transient microcavitation from pulsed ultrasound, taking into account surface tension and viscosity. [Work supported by U.S. Office of Naval Research and by the National Cancer Institute, DHHS, under Grant 1 RO1 CA 39374-01]

ACOUSTICAL CAVITATION IN SEA WATER

V.A. Akulichev

Different caviation nuclei determining tensile strength of sea water are analysed and acoustic methods for measuring tensile strength of water are considered. Results of sea water tensile strength measurements at different acoustic field frequencies and in different regions of the World ocean are presented.

PERIODIC AND CHAOTIC BUBBLE OSCILLATIONS

U. Parlitz and W. Lauterborn

Numerical simulations of periodic and chaotic bubble oscillations based on the RAYLEIGH-PLESSET-NOLTINCK-NEPPIRAS-PORTSKY-Model are presented. Modern techniques developed in the Theory of Nonlinear Dynamical Systems are used to describe the complicated time and parameter dependence of the oscillations. Examples for finite and infinite period doubling cascades leading to chaos are given. A superstructure in the bifurcation set being typical for driven dissipative nonlinear oscillators is discussed.

ON MULTIPLICATION MECHANISM OF CAVITATION NUCLEI

V.K. Kedrinskii

The instability and fragmentation of pulsating cavitation bubbles are considered to give the intense increase in their density within the cavitation cluster volume. However, an analysis of the experimental data permits us to suppose that a gradual saturation of the cavitation zone with bubbles can be connected with the spectrum of their initial sizes. Numerical results compared with the experimental data on the density of nuclei make it possible to determine a formation mechanism of the cavitation zone as the velocity of saturation of this zone with detectable bubbles.

ACOUSTIC CAVITATION PRODUCED IN VITRO BY CLINICAL ULTRASOUND DEVICES

L. A. Crum

Medical ultrasound devices operated principally as diagnostic instruments, in which they generate short acoustic pulses with large pressure amplitudes, or as therapeutic units, in which they generate long pulses (or operate in a CW mode), at relatively small pressure amplitudes. Results will be presented that demonstrate that acoustic waveforms similar to those generated by these devices and operating in water produce sonoluminescence associated with acoustic cavitation.

NONLINEAR BUBBLE DYNAMICS

A. Prosperetti

Some recent progress in the mathematical modelling of large amplitude bubble motion is outlined. In the first part of the paper the problem of the radial equation in a compressible liquid is considered. A simplified formulation for the bubble interior is presented. An application to nearly isothermal nonlinear oscillations concludes the paper.

Contributed Paper

ON MULTIPLICATION MECHANISM OF CAVITATION NUCLEI

V.K. Kedrinskii

The instability and fragmentation of pulsating cavitation bubbles are considered to give the intense increase in their density within the cavitation cluster volume. However, an analysis of the experimental data permits us to suppose that a gradual saturation of the cavitation zone with bubbles can be connected with the spectrum of their initial sizes. Numerical results compared with the experimental data on the density of nuclei make it possible to determine a formation mechanism of the cavitation zone as the velocity of saturation of this zone with detectable bubbles.

Discussion 16:40
Session A5: Speech training and display


Contributed Papers

A5-1 14:40

POUR DECRÄIRE EFFICACITÉ LES PHONÉTIQUES.

After P. Delattre, efficient though not entirely explained techniques, have been established to teach English and French to the other speaking community. Thorough examination of such teaching techniques, by workers in the field of speech acoustics, is desirable, for the benefit of teaching of course, but also, on account of the general and still well-informed effort that would ensue, for that of acoustics since it would lead to more efficient definitions of pronunciations.

A5-2 15:00

EFFICIENT TRAINING OF NON-NATIVE SPEECH DISCRIMINATION WITH PERCEPTUAL FADING.
D. E. Morasan & D. G. Jamieson

We trained adult Francophones to distinguish voiced and voiceless "th" sounds using a perceptual fading technique. Brief training improved performance with natural and synthetic tokens. Results indicate that while adult Francophones rarely learn this contrast through normal exposure to English, the plasticity in these perceptual categories can be tapped with training.

A5-3 15:20

EFFECT OF AUDITORY DELAY ON AUDIO-VISUAL SPEECH PERCEPTION
P.C. Pandey, S.M. Abel, and H. Kuno

The effect of auditory delay on audio-visual perception of recorded sentence lists by untrained subjects with normal hearing was measured. The auditory presentation was monaural with a 60 dBA masking noise (multi-talker babble) and six delays (0-300 ms). For S/N = 0 dB, the effect of the delay was significant at 300 ms only, while for S/N = -10 dB, it was observable at 180 ms. Similar results were observed for subjects with some lip-reading experience. The results indicate that a moderate delay introduced by speech processing aids for lip-reading may not be disruptive. However, for lower S/N ratios, the tolerance to delays decreases.

A5-4 15:40

DISPLAYING SPEECH FOR DEEP DEAFS
G. Vilacara

The main subject of the paper is the description of an algorithm. Its purpose is to reproduce the speech signal in a coordinate system, where the main axes carry information relevant to the learning of speech by the deep deaf children. It leads to an original display, carried out by segmenting the speech signal according to its periodicity. The algorithm includes a time-domain pitch determination that processes the signal period by period. The successive slices are set into a 3D representation. If the sound is unvoiced, it is arbitrarily segmented in such a way that it avoids exceeding the limits of the display.

A5-5 16:00

SPEECH TRAINING ON A PERSONAL COMPUTER
H. Crépy, P. Desmontes, M. El Béze, G. Rouqué

Speech training devices help deaf children to monitor their voice through visual feedback rather than auditory feedback. These devices usually only offer a fixed set of functions. The IBM Paris Scientific Center speech training system uses a Personal Computer. It is thus fully programmable from user interfaces down to the signal processing level. Starting with an attractive application package (voice animated graphs and games for pitch, intensity and vowel pronunciation training), system functions can freely evolve through user programming. 100 such prototypes are already used, tested and enhanced in various countries.

A5-6 16:20

STRUCTURAL CONSIDERATIONS IN DEVELOPMENT OF A SOFTWARE-BASED REAL-TIME DIGITAL SOUND SPECTROGRAPH MACHINE
L. R. Morris

The advent of DSP microchips such as the TI TMS 32010, and the proliferation of IBM-PC type computers, with their inexpensive bit-mapped graphics and input/output peripherals, have made the software-based, real-time sound spectrograph a reality, at a cost an order of magnitude smaller than hardware versions with lesser functionality. We describe the algorithm chosen and software structures evolved to implement such a system, which can produce dual spectrograms of up to two seconds of speech within 5 seconds of speech input. Spectrograms can show simultaneous wide-and narrowband analyses of the same utterance, or equal frequency-resolution versions with differing time resolution. Or, a fixed "target" spectrogram can be compared to real-time input. Quality hard copy is obtained on standard printers.
A MODEL OF THE PERCEPTIVE PHONETICS, ATTENDED BY THE HUMAN MEMORY
S. V. Archev

The influence of the perceptive phonetics for systems with AI is actualised in
model describing: 1) HUMAN MEMORY (sensor in
stantaneous memory and imagine-bringing mem-
ory; short-term memory – direct, operative,
buffer; long-term memory, super long-term me-

ory, meta memory); 2) PERCEPTIVE PHONETICS
(The zone perceptive basis of the natural
language has been reserved in the long-term
human memory like standards and principles
of these stands)
CODING OF RIPPLED NOISE IN THE AUDITORY PATHWAY
J.H. ten Kate & M.F. van Bekkum

The study of coding of complex sounds like cosine-, comb-filtered- and multiple phase-shift noise in the 8th nerve response is relevant to binaural hearing and modern pitch theories. Delay histograms, autocorrelograms and interval histograms to rippled noise at different modulation-degrees were collected. The peak-heights at the delays in autocorrelograms were related to the synchronization of the fiber. The stimulus parameters required for the detectability of the delay in the neural response of cat were compared to those for human repetition pitch.

FOUNDATIONS OF AUDITORY PSYCHOPHYSICS
FROM INFORMATION THEORY
I.R. Nizami and K.H. Norwich

Sensory receptors of the ear (hair cells) are assumed to have an inherent uncertainty about the true intensity of a stimulus tone. Neural impulse rates, parallelled by subjective magnitude estimates, are governed by a mathematical function of this uncertainty (entropy). The decrease in neural impulse rates and subjective magnitudes (adaptation) represents the accrual of information about the stimulus tone. The strength of this approach is that it describes existing data well, and issues from a purely theoretical viewpoint.

TUESDAY AFTERNOON, 29 JULY 1986
ROOM 205 A and C, 14:40 - 17:00

Session C7: Occupational noise exposure
Chairman: T. Sone, Research Inst. of Electrical Communication, Tohoku University, 2-1-1 Katahira, Sendai, 980, Japan

Contributed Papers

GUIDELINE FOR REGULATORY CONTROL OF OCCUPATIONAL NOISE EXPOSURE AND HEARING CONSERVATION
S. Gewurtz

A working group of the Canadian Federal/Provincial Advisory Committee on Environmental and Occupational Health has developed a guideline whose objective is to assist agencies to establish and/or update their occupational noise regulations, and to promote uniformity in such regulations across Canada. The draft Guideline is designed so that it can be adopted in its entirety, modified or adopted in part to satisfy the requirements of specific agencies.

STRATEGIE POUR LA REDUCTION DU BRUIT EN MILIEU DU TRAVAIL
P. Jourisrand, R. Gamba

Les auteurs exposent pourquoi et quand traiter le bruit, comment traiter le bruit et avec qui traiter le bruit. La nécessité de mettre en place une démarche globale, participative et pluridisciplinaire apparaît comme indispensable pour atteindre des résultats satisfaisants.
C7-3
THE RELIABILITY OF PERSONAL NOISE DOSIMETERS UNDER STEADY-STATE AND VARIABLE NOISE EXPOSURE
M. Rheault and R. Héroux

Three groups of 15 industrial workers were identified according to their pattern of exposure to noise: a) steady-state, b) periodically fluctuating and c) randomly variable. A personal dosimeter was worn by each worker for three consecutive days. The long term exposure was also assessed by means of a SLM sampling procedure. The standard error of measurement of the dosimetry was 1.10, 1.56 and 2.86 dB for the three types of exposures respectively.

C7-5
REHEARSAL STUDIO ACOUSTICS AND THE SOUND EXPOSURE EXPERIENCED BY MILITARY BANDSMEN
R.B. Crabtree

Studies were conducted to determine the acoustic properties and equivalent sound pressure level distributions within the rehearsal rooms used by three military bands in the Canadian Forces. Dosimeter sampling showed that certain musicians were being overexposed within the usual 3-hour daily rehearsal. Although musically advantageous, more effective acoustic treatment of existing facilities would yield only marginal reductions in sound exposure.

C7-7
A UNIVERSAL APPROACH TO ALIGNMENT OF NOISE EXPOSURE MEASUREMENTS AND DATA
Terrence A. Dear

Exposure evaluation is critical to demonstration and documentation of regulatory compliance. Noise exposure criteria and measurement instrumentation vary around the world. Often there is a need to compare and convert survey data from one system to another without new measurements. General formulae are presented, with examples, to facilitate data and compliance information translations between sets of criteria and instrumentation. Concerns about differences among criteria sets are considered.

C7-4
UN MODELE D'ÉVALUATION ÉCONOMIQUE DES ACTIONS DE PREVENTION CONTRE LE BRUIT.
T. Schneider

Le modèle présenté a pour objectif d'évaluer la probabilité d'apparition de déficits auditifs indemnisables pour une population exposée au bruit en milieu industriel. Ces effets sanitaires sont associés aux coûts de réparation supportés par l'entreprise, ce qui permet d'évaluer le coût réel de la prévention en comparant les coûts de prévention aux coûts de réparation évités grâce à la réduction du niveau sonore.

C7-6
RÉSULTATS DES TESTS DE BRUIT DES MACHINES DE GÉNIE CIVILE DE L'INDUSTRIE "14.OCTOBRE": YUGOSLAVIE
Petković Ivan, Gojko Grdinić "14.oktobar"

Longtemps le bruit menaçait la santé de l'homme lors du travail avec les machines de génie civil. On a soulevé l'initiative pour améliorer les conditions de travail et comme résultat de ces efforts nous avons réalisé les machines ULT-160B, TG-14Q et TG-220. Comment on-a-il réussi que l'opérateur pendant qu'il travaille avec ces machines écoute le radio et qu'il reçoit 7 dB(A) moins de bruit que prescrit OSHA.
Contributed Papers

E8-1 14:40
IMPACT SOUND INSULATION DESIGN OF CONCRETE FLOOR CONSTRUCTION
Sho Kimura

As for the vibration characteristics of concrete slab in the case of floor slab impact, the impedance characteristics were investigated by the application of the driving point impedance method for the time analysis. Floor impact sound for heavy and soft impact source is determined directly by the vibration characteristics of floor slab. In this paper, the method for impact sound insulation design of floor construction considering the influence of edge fixing and the increase in rigidity as a result of beam addition was derived.

E8-2 15:00
AN ARRANGEMENT FOR DETERMINING THE INFLUENTIAL FACTORS IN MEASURING THE IMPACT SOUND INSULATION
Borislav B. Budisavljević

By this arrangement of measuring it was attempted to solve the question of determining the influential factors in measuring the impact sound insulation. The arrangement is foreseen for application in comparative measurements when it is necessary to reply to the question about the changes occurred in insulation. The procedure is applicable in the laboratory conditions.

E8-3 15:20
THE INFLUENCE OF FLOOR COATING AND QUALITY OF SIDE WALLS ON FLANKING OF SOUND
G. Rosenhouse, Y. Keller

A comprehensive examination of sound radiation due to impacts on floors was performed experimentally in a typical, modest flat. In addition, various kinds of floor covers were tried. A standard tapping machine was used and the mean square velocity of the floor and side walls was obtained by transducers.

E8-4 15:40
VARIATIONS IN SOUND TRANSMISSION DUE TO WORKMANSHIP
R.J.M. Craik

When structure borne sound transmission measurements were made in a building, parts of the building which were supposed to be built in an identical manner did not perform in the same way. The standard deviation of the performances of individual constructions was found to be ±dB for the particular building studied. Corrections for small changes in material properties, geometry, flanking transmission and measurement error made no significant difference to the variation.

E8-5 16:00
TRANSMISSION OF STRUCTURE-BORNE SOUND BETWEEN EDGE-COUPLED CONCRETE SLABS ON AN ELASTIC FOUNDATION
S. Gudmundsson

The title describes a practical sound insulation problem experienced in a certain type of Swedish terrace houses, where the slabs were coupled through a thin elastic layer. In practice the displacements on each side of the elastic layer are prevented to a certain degree by reinforcing beams and lightweight walls. The problem is first modelled in one dimension and then the model is extended to include oblique incidence of bending waves in two dimensional plates. Calculations for practical examples are presented.

E8-6 16:20
MÉTHODE DE PRÉVISION DU SON TRANSMIS PAR LES STRUCTURES ASSEMBLÉES PAR UTILISATION DE COEFFICIENTS D’INFLUENCES ENERGETIQUES.

Nous présentons une méthode de prévision du son transmis par les structures assemblées, basée sur l'utilisation de coefficients d'influences énergétiques. En premier lieu, on établit les bases de la méthode, puis l'exemple des transmissions du son par voie latérale, dans les bâtiments, est traité. Un programme de simulation numérique calcule l'indice d'affaiblissement pour des jonctions en L, T ou + et détermine le chemin privilégié du transfert énergétique. La comparaison avec l'expérience est satisfaisante.
In this paper, the sound transmission characteristic of a damped sandwich beam has been investigated. The noise reduction effect is introduced, which is defined as ratio of transmitted loss of the sandwich beam with that of the original beam. The effects of incident angles, physical parameters and geometric parameters are investigated. Results show that a sandwich beam has better noise reduction properties than a homogeneous one.
EXHIBIT HALL AND THEATER SOUND REINFORCEMENT SYSTEMS
AT THE METRO TORONTO CONVENTION CENTER, N. A. Shaw

The Metro Toronto Convention Center, Crang and Boake Architects, has numerous assembly spaces
requiring sound reinforcement systems. The facility
includes a 18,600 sq m divisible exhibit hall, a
2,600 sq m divisible ballroom, 40 meeting rooms and
a theater. The major sound reinforcement systems
are described. The exhibit hall features a reliable,
high quality, flexible system and the theater
features the first phase of a three channel
cereophonic sound reinforcement system.

TUESDAY AFTERNOON, 29 JULY 1986
ROOM 104D, 14:40 - 17:00

Session G4: Acoustic transducer fields
Chairman: A. Alippi, Instituto di Acustica, Consiglio Nazionale delle Ricerche,
via Cassia 1216, I-00189 Rome, Italy

Contributed Papers

G4-1  14:40
ULTRASOUND FIELDS FROM END EXCITED RODS
B.J. Jarosz and R.L. Clarke

The distribution of ultrasonic fields, frequencies 1.0 - 3.0 MHz, for 0.238 and 0.319 cm diameter
rods immersed and non-immersed in water have been
studied. Semi-periodic patterns radiated into water
showed three spatial frequencies as opposed to five
observed on surfaces. The three were attributed to
the lowest mode longitudinal wave, Rayleigh type
surface wave, and Stoneley wave in the fluid. Addi-
tional frequencies on the surface were interpreted
as due to non-radial components of vibration.

G4-2  15:00
DESIGN OF HIGH-INTENSITY FOCUSING RADIATORS WITH
VIBRATING PLATES OF VARIABLE STEPPED PROFILE
G. Rodriguez, J.L. San Emeterio and J.A. Gallego

Flexural axisymmetric vibrating plates of exten-
sive area with a stepped profile in one of their fa-
ces have shown to be very useful high-power ultrason-
ic radiators. The added mass of the steps makes the
displacement distribution more uniform than in a flat
plate and increases the power capacity. In addition,
if the profile of the non-stepped face is modify, by
shifting adequately the different zones, a remarka-
ble focusing effect can be obtained. This paper deal
with the design and performance of this new kind of
radiators.

G4-3  15:20
INTENSITY FIELDS OF ULTRASONIC TRANSDUCERS
H.D. Mair and D.A. Hutchins

The intensity fields of ultrasonic transducers
have been evaluated theoretically, using single
integral expressions for scalar velocity potential
and particle velocity. Predictions for intensity have
been compared to that expected from the square of the
pressure for discs, bowls and cones. As will be
shown, the agreement is worst over regions in the
nearfield at which the pressure field exhibits rapid
variations with position. The effect of these results
on the use of the pressure squared approximation for
intensity estimation will be discussed.

G4-4  15:40
SUPER-RESOLUTION OF A SYNTHETIC ACOUSTIC ANTENNA BY
PARAMETRIC INVERSION
M.-H. Boone, F. van Riel and A.J. Berkhout

The resolution of a synthetic acoustic antenna
can be enhanced considerably with the use of para-
metric inversion, based on Singular Value Decompo-
sition (SVD). The improvement is obtained by using a
priori information like an estimation of the source
positions. In practical situations the resolution can
be improved from 1.5° (which is the resolution of our
antenna without any a priori knowledge) to about
0.5°. In addition, the SVD method can be used as a
verification method for the applied source and
propagation model.
Nonlinear Distortion of a Focused Diffracted Gaussian Ultrasonic Beam
M. A. Breazeale and G. Du

Mathematical description of the effect of diffraction in a finite amplitude ultrasonic beam in a fluid is greatly simplified if one assumes a Gaussian distribution of amplitudes in the fundamental component at the origin of a cylindrical coordinate system. It even becomes possible to make a general description of a focused system as well as an unfocused one. A summary is given of recent theoretical and experimental results and their impact on physics, non-destructive evaluation, acoustical microscopy, and process control.

On Calculation of Free-Field Sound Pressure Response of an Arbitrary Shaped Horn
Dezső Gád

By way of introduction the author gives some ideas according to the generalization of Webster’s wave equation. As an example the conical horn is investigated. Further, the physical-mathematical expressions of the arbitrary shaped horn are derived. With help of this formulas the sound pressure gain and the gain of radiated sound power of the horn are determined. Finally, a few of diagrams are published which give the frequency responses of gain of sound pressure and radiated sound power.

Tuesday Afternoon, 29 July 1986
Room 206D, 14:40 - 17:00

Session L3: Microphones and Novel Transducers: Measurements and Theory
Chairman: N.H. Fletcher, Institute of Physical Sciences, CSIRO, P.O. Box 225, Dickson, ACT 2602, Australia

Contributed Papers

L3-1
Measurement of Characteristics of Condenser Microphone in High Pressure Ambient Gases
H. Suzuki and M. Ohashi

Sensitivity and frequency characteristics of typical condenser microphones are measured with an electrostatic actuator method in air and helium at several pressures of 100 kPa to 310 kPa. A noticeable amount of sensitivity loss and a few sensitivity peaks are found in the microphone response. Simulation study based on an equivalent circuit model shows that the changes in response are mainly due to the change in mechanical compliance of back cavity of microphone at high pressure.

L3-2
Piezoelectric Microphone
J. Franz

Principle, design and first fabrication results of a piezoelectrical microphone for detection of airborne sound are demonstrated. The electroacoustic transducer consists of a multilayer membrane, which is composed on a silicon wafer. The membrane has dimensions of fewer than 1 cm by 1 cm, and an overall thickness of less than 1.5 μm. The silicon diaphragm carries a 0.4-0.5 μm thick piezoelectric aluminum-nitride (AlN) film. The silicon structure is produced by means of micromachining techniques. The piezoelectric layer is deposited by reactive sputtering.
SILICON SENSOR FOR AIRBORNE SOUND
D. Hohn

Design and experimental realization of a subminiature condenser microphone is demonstrated. The sensor is a two-chip device with the outer dimensions of 1.7 x 2.0 x 0.6 mm³. One chip carries a 0.8 x 0.8 mm² silicon-nitride membrane with a thickness of 150 nm. The second chip represents the complete transducer, back plate containing the back electrode, the 2μm wide air gap spacer and the electrical terminals. Both, membrane and backplate are fabricated by means of orientation dependent silicon etchants such as KOH or EPW. Acoustical and electrical properties of the transducer are discussed.

ELECTROMECHANICAL SILICON MULTIBEAM STRUCTURES
M.F. Hrubesh

Recently developed integrated electromechanical silicon beam filters are based on the mechanical resonance of silicon beams and piezoresistive properties of silicon. They incorporate the good points of integrated circuit technology and mechanical resonators. Since the theory and design of single silicon beam filters are discussed elsewhere, this paper introduces and develops the theory of multibeam structures. The general structure consisting of r beams placed at different distances is considered and its natural frequencies and transfer functions are found.

STUDY OF MULTILAYER PIEZOELECTRIC TRANSDUCERS BY THE DIFFERENCE EQUATIONS METHOD
F.J. Chinchorreta and R. Salamon

A new method to study multilayerly matched piezoelectric transducers is presented. The method is based on representing the vibrational behaviour of the transducer in form of difference equations. One of the most outstanding aspects of this new method is that it renders the transducer time responses to any electrical excitation directly. Other important features are its use of functional block diagrams instead of equivalent electric circuits, and its application to transducers employing matchings with any number of layers of any thickness.

EVALUATED RAYLEIGH INTEGRALS FOR PULSED PLANAR EXPANDING RING SOURCES
S. I. Warshaw

We have explicitly calculated time-domain analytic and semianalytic pressure fields acoustically radiated from expanding delta-function circular ring sources imbedded in a planar rigid baffle. Certain cases yield closed analytic results, while others result in elliptic integrals, which are evaluated to high accuracy by Gauss–Chebyshev and modified Gauss–Legendre quadrature. [*Work performed under the auspices of the U.S. Department of Energy by the Lawrence Livermore National Laboratory under contract number W–7405–ENG–48.]

CALCULATING ACOUSTIC POWER OF CIRCULAR RADIATORS USING "FOURIER ACOUSTICS"
Helmut Fleischer

Complex acoustic power radiated by baffled circular vibrators is calculated in the spatial Fourier rather than in the space domain. Axi-symmetric, as well as antisymmetric vibration patterns are taken as bases. By considering "acoustic eigenfunctions", the two-dimensional problem is reduced to one dimension. The Hankel transformation to be performed then is evaluated by means of FFT techniques using the "projection-slice theorem". This approach lowers computation requirements to such an extent, that significant calculations can be performed even on inexpensive PCs.

TUESDAY EVENING, 29 JULY 1986

CONGRESS RECEPTION AND BANQUET
RÉCEPTION ET BANQUET DU CONGRÈS
KONGRESS-EMPFANG UND BANQUET

18:30 Congress Reception
Host: The Canadian Acoustical Association

19:30 Congress Banquet
Presentation of the 12 ICA Student Prizes

21:30 Entertainment
Films from the National Film Board of Canada
Structured session B9: Measurement of hearing protector attenuation

Chairman and organiser: E. Berger, E-A-R Division, Cabot Corporation, 7911 Zionsville Road, Indianapolis, IN 46268-1650, U.S.A.

Chairman's Introduction 8:35

Invited Papers

B9-1 8:40
METHODS OF MEASURING HEARING PROTECTOR ATTENUATION
E. H. Berger

Methods of measuring the attenuation of hearing protectors are summarized and reviewed. They include: real-ear attenuation at threshold (and variations thereof), nine above threshold subjective procedures, and four objective methods. Particular attention is directed towards the real-ear attenuation at threshold procedure since it is one of the most accurate and ubiquitous. This paper provides an introduction to the remaining papers in the special session on "Methods of Measuring Hearing Protector Attenuation."

B9-2 9:10
VARIABILITY AND ACCURACY OF SOUND ATTENUATION
MEASUREMENTS ON HEARING PROTECTORS
K. Brinkmann, U. Richter

Repeated measurements of the sound attenuation of two ear-muffs have been performed on a large group of test subjects using both the standardized subjective method and a semi-objective method with subminiature microphones. The results are discussed with regard to systematic discrepancies between the two methods and to the sources of random uncertainties. The variability of the subjective method is calculated for single and for repeated measurements as a function of the number of test subjects used.

B9-3 9:40
HEARING PROTECTOR TESTING—AN EEC INTER-LABORATORY COMPARISON
M.S. Shipton

Under the auspices of the European Economic Community, a five-nation intercomparison has been carried out which compared measurements on a number of different types of hearing protector made by both the subjective and the objective test methods specified by the International Organization for Standardization. The intercomparison highlighted difficulties and shortcomings with the standards and showed differences in test results between the participating laboratories.

B9-4 10:10
NORDIC ROUND ROBIN TEST ON HEARING PROTECTOR MEASUREMENTS
Torben Poulsen

Four testing laboratories in Finland, Norway, Sweden and Denmark measured in turn the attenuation of the same set of hearing protectors according to a common Nordic standard. Four earmuff-type protectors and two earplug-type protectors were measured using procedures essentially identical to ISO 4869 and ISO/DIS 6290. No significant difference between the laboratories was found for the earplug attenuations, whereas significant differences were found for the earmuffs. The objective insertion loss of the earmuffs showed an unexpected, significant laboratory difference.

B9-5 10:40
MEASUREMENT OF LEVEL-DEPENDENT ATTENUATION IN HEARING PROTECTORS
G.H. Allen and E.H. Berger

The attenuation of conventional hearing protectors is independent of sound level and thus can be accurately measured at any sound level, most reliably at low sound levels using threshold-shift techniques. However, protectors providing level-dependent attenuation must be evaluated over a range of sound levels from below 90 dB to above 150 dB SPL. Measuring procedures will be examined and illustrated with data on representative insert and circumaural level-dependent (nonlinear) hearing protection devices.

B9-6 11:10
REAL-WORLD ATTENUATION OF HEARING PROTECTORS
G.F. Smocernburg, B.H. ten Raa and A.M. Mimpem

Nowadays measurement of hearing protector attenuation is well standardized warranting reliable specifications. These specifications are based, however, on laboratory conditions in which much attention is paid to a proper fit of the hearing protector. In the field, we measured attenuation values for a twin-flange ear plug that were considerably lower than the laboratory figures. The field or real-world data also showed more variability. This variability is mainly due to intersubject differences. An effective or assumed attenuation can be calculated taking into account this variability and the intersubject variability in susceptibility to noise.
Panel Discussion 11:40

Moderator: K. Brinkmann, Physikalisch-Technische, Bundesanstalt, Bundesallee 100, D-3300 Braunschweig, F.R.G.


WEDNESDAY MORNING, 30 JULY 1986 ROOM 203 B and D, 8:35 - 12:00

Structured session D4: Active control of vibration

Chairman and organiser: L. Meirovitch, Dept. of Engineering Science and Mechanics, Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061, U.S.A.

Chairman's Introduction 8:35

Invited Papers

D4-1 8:40

MODELLING OF AN ACTIVE CONSTRAINED LAYER DAMPER
J. W. Plum and J. K. Hubbard Jr.

A constrained layer damping treatment for transverse vibrations of beams is discussed. A composite structure consisting of a base beam, viscoelastic damping layer and a piezoelectrically active constraining layer is modelled. The constraining layer is polyvinylidene fluoride, a flexible piezoelectric polymer film. Voltage dependent terms appear in the internal energy dissipation equation of the viscoelastic layer and in the boundary conditions, indicating the two ways the active constraining layer affects the beam. An active constraining is especially attractive for increasing energy dissipation from the structure at low amplitude levels and lends itself to use in closed loop feedback systems. An application to a cantilevered beam is also presented.

D4-2 9:10

SUR L'UTILISATION DE LA MODELISATION NUMERIQUE POUR L'ANALYSE DE TECHNIQUES D'ABSORPTION ACTIVE DES VIBRATIONS.
E. Luzzato

La formulation d'un modèle utilisé pour le traitement des problèmes d'Absorption Active des Vibrations (AAV) est résumée dans le cas de sources d'excitation monochromatiques et le choix des critères de minimisation est plus particulièrement analysé. La procédure est ensuite étendue au problème temporel et l'application de la théorie du contrôle optimal à l'AAV est brièvement présentée.

D4-3 9:40

MULTICHANNEL ADAPTIVE CONTROL OF DYNAMIC SYSTEMS
J. Tichy and D. C. Swanson

A general multichannel adaptive signal processing algorithm is presented for active control of the response of real dynamic systems at many points. The system is modeled as a multichannel auxiliary input autoregressive moving-average (ARMAX) process where the noise disturbance as well as the transducer characteristics are included in the system identification and control process. A recursive least-squares technique is used to estimate the ARMAX parameters which are used to compute the optimal cancellation signal inputs to minimize the measured sensor signal variances.

D4-4 10:10

APPROXIMATIONS TO DISTRIBUTED CONTROLLERS IN STRUCTURAL DYNAMIC SYSTEMS
H. Öz, H. Baruh, and L.M. Silverberg

The effects of using discrete or piecewise-continuous controllers in distributed structures are analyzed. It is shown that discretization of the control system in space is equivalent to imposing constraints on the distributed control law. Existing approaches to discretization developed by the authors are described.
VIBRATION CONTROL IN DISTRIBUTED ELASTIC MEMBERS
L. Metrovitch and J. K. Bennighof

This paper is concerned with the vibration control of a uniform rectangular membrane clamped on all sides by means of a finite number of discrete actuators. The system is discretized by the finite element method, which permits computation of control gains for near-optimal performance. Direct feedback control, in which the actuator force depends on the local state, is shown to be an attractive alternative. A numerical example demonstrates the approach and shows the performance that can be expected.

Contributed Paper

CONTROL OF THE RESPONSE OF THE FORCE ACTUATOR USED AS PART OF AN ACTIVE FORCE CONTROL SYSTEM.
J.M. Guschier

In developing an active force control system for the control of structural vibrations, an important element of the system is the control of the actuator response. Optimum control is obtained at the source, and the optimum active system would directly control the excitation transient, with a broad frequency spectrum, with a control transient that has the same frequency content in the frequency range of interest. To achieve this, the control actuator must respond in a predictable way with compensation for its characteristics. The characteristics of a force actuator are compensated for by inverting the frequency response function, obtained through prior measurements using a digital computer. The results using different inverting techniques are promising.

Discussion 11:30

WEDNESDAY MORNING, 30 JULY 1986
ROOM 203 A and C, 8:40 - 12:00

Session A6: Timing, intonation and IO

Chairman: Ph. Martin, Institut de Phonétique, 7, rue Blainville, 75005 Paris, France

Contributed Papers

A6-1 8:40
VOWEL-CONSONANT TIMING ACROSS SPEAKERS
C. Benoit & C. Abry

The timing of four French speakers, relatively to CVCV items has been studied. The signal hand-segmentation was based upon the relationship between several acoustic events interpretable in an articulatory way. By using a statistical study of the coordinations between main events, the relationship between vocalic and consonantal durations has been evaluated along the VC domain. Similar data on speech rates variations were also considered. Our results tend to show that, within the same condition of stress, the inter-speaker transitions globally follow the same rules as the intra-speaker rates variations.

A6-2 9:00
CONSONANT-TO-VOWEL DURATIONAL EFFECTS IN ITALIAN
Pier Luigi SALZA, Stefano SANDRI - CSELT (ITALY)

A professional speaker uttered 5 times 90 nonsense trisyllables in frame sentences, for assessing consonant-vowel duration effects in relation with open-closed syllable contrast. The following measures were taken: unstressed /a/, in varying consonantal contexts, and global VC durations, and C to preceding V duration ratios. Results show: vowel duration change according to following consonant voicing and articulatory class; C/V duration ratios depending on consonant phonological length; duration compensation within VC unit between voiced and unvoiced pairs.
AN ACOUSTIC STUDY OF VOWEL LENGTHENING AND PAUSING IN SYNTACTIC TIMING
P. Avery, W. Cichocki, W.J. Idsardi, K. Rice, J. Archibald

This paper reports on a study of vowel lengthening and pausing in syntactic constructions based on Selkirk’s (1984) theory of phonological structure. Rules interpret syntactic structure by inserting silent beats between words which are interpreted phonetically as vowel length or as pausing. The study supports the phonological model, showing a significant correlation between the number of silent beats and the vowel length plus pause.

L’ÉTUDE, CONSCRÈE À LA VOIX DE L’ENFANT ENTRE 8 ET 12 MOIS, MONTRA QUE DÉS 8 MOIS LA VOIX EST PARFAITEMENT STABLE ET RELATIVEMENT INFLUENÇABLE. NOUS FAISONS UNE DISTINCTION ENTRE FO-USUEL ET DYNAMIQUE DE BASE, TRÈS STABLE, FO MOYEN DES VOCALISATIONS SOLITAIRES, ALLANT DU CRI AU VOCALISATIONS SURJUGÉES TÉMOIGNANT D’UN COMPORTEMENT EXPLORATOIRE, ENFIN FO MOYEN DES INTERACTIONS AVEC L’ADULTE, OÙ L’ENFANT RANGÉ SA DYNAMIQUE VOCALE DANS LE MÉDIUM DE SA TISSUDE, CE QUI MONTRA QU’IL A SAISI CERTAINES RÈGLES DES ÉCHANGES SOCIAUX ET QUI CONSTRUIT SA VOIX EN MÊME TEMPS QU’IL CONSTRUIT SON LANGAGE.

THE INFLUENCE OF SYNTACTIC STRUCTURE ON FO PATTERNS OF CANADIAN FRENCH SENTENCES
Stephen J. Eady

This study investigated the effect of complex syntactic structures on patterns of voice fundamental frequency (F0) in sentences of Canadian French. The results show that sentences with complement clauses have a monotonic F0 declination that is similar to the pattern observed for simple French sentences. However, sentences with parenthetical phrases and coordinate main clauses exhibit a non-monotonic F0 decline that deviates from the simple declination pattern.

Fo DETECTION BY A FAST SPECTRAL COMB ALGORITHM
Ph. Martin

Since the recent availability of fast and reasonably priced hardware, Fo detection methods based on spectral analysis are becoming more and more popular. Based on Fourier analysis, the spectral comb method was proposed a few years ago as another method for reliable fundamental frequency tracking. The computational effort involved is comparable to the Cepstrum method.

A new, reorganized algorithm is proposed, which uses only the spectral peaks of the spectrum, thus reducing the computational effort typically by a factor of 6.

ACOUSTICAL ASPECTS OF SINGLE VS. DUAL FOCUS IN SENTENCE PRODUCTION
W.E. Cooper and S.J. Eady

Acoustical analyses of speech production were conducted to determine the effects of single vs. dual focus on intonational attributes of fundamental voice frequency (F0) and duration in sentences of American English. The results for seven speakers show no direct acoustical interaction between two foci in the same sentence. All focused words undergo a heightening of peak F0, and a durational increase, regardless of whether the sentence contains one or two focused items.

COMPARING DIRECT SPECTRAL MATCHING TECHNIQUES WITH FORMANT EXTRACTION ONES FOR SPEAKER RECOGNITION
A. Paolini, A. Federico, C. Iba

Statistical modeling of acoustic parameters is the basis of a well-experienced method that the authors developed for low quality telephonic speaker recognition tasks. Nevertheless the parameters extraction procedures are somewhat cumbersome and require skill and a great deal of manual interventions. The aim of this work is to test the alternative of direct spectral matching of voice frames. The computation of LPC and of the lower lines of the cepstra are performed on the voice segments on which the formants extraction was performed before. A direct comparison is therefore allowed in terms of identification scores with the different methods.
Session C8: Sound intensity measurements and identification of noise sources

Chairman: M. Crocker, Auburn University, Department of Mechanical Engineering, Auburn, AL 36849, U.S.A.

Contributed Papers

C8-1  8:40
EFFECT OF THE NUMBER OF MEASUREMENTS OF SOUND INTENSITY ON THE ACCURACY OF SOUND POWER ESTIMATION

Mei Q. Wu and Malcolm J. Crocker

In this paper the properties of the sound power estimation error introduced by approximating the integral by a finite number of sound intensity measurements was studied. The dependence of the error on the number of measurements, the distance between the source and the measurement surface, and the location of the source with respect to the sampling points was examined.

C8-2  9:00
SELECTIVE CONDITIONING OF ACOUSTIC INTENSITY MEASUREMENTS FOR SIMPLE AND MULTIPLE SOURCES

P.R. Wagstaff, R.Pech and J.C. Henrio

Selective conditioning techniques may be applied to acoustic intensity measurements by using reference signals for each source. In cases where the sources are closely grouped the rejection of the noise of neighboring sources can improve the accuracy of the measurement particularly if information is required on the power radiated by individual parts of the same machine. The conditioning can also be optimised to reject the effects of reflections and calculate the free field intensity. Experimental results are given.

C8-3  9:20
ANTENNERIE INTENSIMETRIQUE POUR LA MESURE DES CARACTERISTIQUES DE RAYONNEMENT DES STRUCTURES VIBRANTES

P.J.T. Filippi, D. Habault, et J. Piraux

The prediction of noise pollution requires the knowledge of mathematical models for the free-field sound pressure radiated by industrial or domestic sources: the total power emitted by a source, its directivity pattern, and intensity charts can easily be derived from such models. The aim of this paper is two-fold: define an experimental procedure and develop a numerical technique permitting the identification of an "a priori" chosen model.

C8-4  9:40
RAYONNEMENT ACOUSTIQUE DE STRUCTURES MECANIQUES

F. Guisnel and P. Smadja

Des codes de calcul du bruit rayonné par des structures vibrantes couplées à des codes de vibrations de structures permettront à terme de concevoir des machines moins bruyantes.

Nous présentons les formulations utilisées pour déterminer le champ acoustique rayonné par une structure et l'application d'un tel code à une machine industrielle : le corps de turbine à vapeur basse pression d'un turbo-alternateur d'une centrale électrique.

C8-5  10:00
MULTIPLE INPUT MODELS APPLIED TO INDUSTRIAL NOISE SOURCES - EXPERIMENTAL EVALUATION

D. Taillifet, P.R. Wagstaff, J.C. Henrio

Identification of the main noise sources in a multi-source industrial environment is carried out using coherence techniques. In reverberant conditions with coherent sources the choice of the correct measurements parameters is essential. Tests have been carried out in a reverberant room with loudspeakers to establish the limitations of the method and the optimum conditions for several types of source configuration. The technique has also been applied in a nuclear power station on a turbo-feed pump.

C8-6  10:20
CARACTERISATION ET LOCALISATION DES SOURCES ACOUSTIQUES PAR DES METHODES D'OPTIMISATION

G. Legros, M. Sidiki, J.P. Guilhot

Cet article présente une méthode d'optimisation utilisable pour localiser et caractériser des sources acoustiques, par des mesures d'intensité. On définit un nombre minimum de points de mesure, afin que l'algorithme converge suffisamment vite. Les concepts d’échantillonnage spatial et de couverture de la source sont introduits, et l’influence de ces paramètres en champ proche et lointain est discuté. Les résultats des mesures confirmant l’approche théorique sont présentés.
C8-7  10:40

SOUND POWER LEVELS OF NOISE SOURCES DETERMINED BY VARIOUS KINDS OF MEASURING METHODS
H. Yano, H. Tachibana and M. Koyasu

As a basic study for the drafting work of the Japanese Industrial Standards regarding sound power level measurements, various kinds of measuring methods such as the ordinary p-square method prescribed in ISO 3740 series and the sound intensity method are compared by measuring the sound power levels of four kinds of sound sources: two loudspeaker type sound sources, an aerodynamic fan sound source and a mini-compressor.

C8-8  11:00

MEASUREMENT OF ACOUSTIC ENERGY EMITTED BY IMPULSIVE SOUND SOURCES
H. Tachibana and H. Yano

Concerning transient sound sources, the way of defining and measuring their acoustic outputs have not been unified. In this paper, the Sound Energy Flux Level which represents the total sound energy emitted by an impulsive sound source is defined and its measuring methods according to the ordinary p-square method (in free field and in diffuse sound field) and the sound intensity technique are studied theoretically and experimentally.

C8-9  11:20

TRAITEMENT SPATIAL DES DONNEES OU DES IMAGES EN IMAGERIE ACOUSTIQUE DE CHAMP PROCHE.
B. Begut - P. Wetta

Les techniques d'imagerie acoustique de champ proche constituent une approche efficace pour l'identification des sources de bruit présentes sur une structure émettrice : elles sont fondées sur des traitements spatiaux spécifiques des champs acoustiques échantillonnés : intensimétrie, décomposition de Fourier spatiale, focalisation, etc., pour aboutir à une image la plus représentative possible des mécanismes générateurs de bruit. Nous présentons ici des résultats expérimentaux et des simulations montrant les performances et limitations de tels traitements dans le cas de champs acoustiques plus ou moins complexes. Une attention particulière est portée sur une méthode de traitement des images acoustiques apte à analyser la nature localisée ou étendue des champs acoustiques obtenus.

C8-10  11:40

EXPERIMENTAL ANALYSIS OF WHEEL/RAIL NOISE BY NEARFIELD ACOUSTICAL IMAGING
P. Wetta, B. Béguet

In this paper we present a nearfield acoustical imaging method applied to the localization and analysis of rolling noise sources on a wheel of a railway tracked vehicle. This method consists in using an acoustical plane microphone array (mounted on the vehicle), which may be moved depending on the wheel/rail part being investigated. A space-frequency processing of the acoustical signals given by the array then enables to evaluate the acoustical energy radiated by the considered area, in a given octave band. Furthermore the study made it possible to identify the main radiation mechanisms, associated with the rolling noise of the wheel.

WEDNESDAY MORNING, 30 JULY 1986
ROOM 206 A and C, 8:40 - 12:00

Session E10: Speech intelligibility in rooms

Chairman: V M. A. Peutz, Akustisch Adviesbureau Peutz & Associes B.V., Postbus 407, 6500 AK Nijmegen, The Netherlands

Contributed Papers

E10-1  8:40

THE RASTI METHOD FOR OBJECTIVE RATING OF SPEECH INTELLIGIBILITY.
Torben Jacobsen

The RASTI method (Rapid Speech Transmission Index) is on objective and standardized method of evaluating speech intelligibility. The foundation for the method is measurement of the Modulation Transfer Function. The method takes into account the influence from both background noise and reverbation in a room. The intelligibility is described by means of the RASTI scale going from 0 to 1. Today portable and battery powered instrumentation exists, which can perform the measurement in 8 seconds.

E10-2  9:00

RASTI MEASUREMENTS IN ST. PAUL'S CATHEDRAL LONDON
J. S. Anderson and T. Jacobsen

Speech intelligibility has been measured in terms of the rapid speech transmission index (RASTI) at St. Paul's Cathedral, London. Comparison with previously obtained subjective measurements showed quite good agreement when the source or speaker was located in the pulpit. Iso-RASTI contours are also presented in the octave bands of 500 Hz and 2000 Hz, and may be used to locate areas where he's best speech intelligibility occurs.
PRACTICAL MEASUREMENTS WITH RASTI EQUIPMENT
Per V. Brüel

Up to a short time ago subjective measurement methods were used to evaluate the intelligibility of speech in auditoria. Listeners took down the number of syllables or words which could be understood from an unknown text spoken in the room by a skilled speaker. The method was laborious, expensive and not particularly exact.

The new "RASTI" method, being a pure objective measurement method, can make these measurements of intelligibility in a fraction of the time needed by the subjective methods and with a considerably smaller spread in the results. Some measurements with "RASTI" are described here.

AN EXPERIMENTAL STUDY OF ACOUSTIC RATIO AND SPEECH INTELLIGIBILITY
Wang Jiqing and Shao Long

Several measures that involve early to late sound ratio or the so called acoustic ratio have been studied with Chinese speech. Acoustical measurements and speech intelligibility test were made in a 267 m² reverberation chamber with various arrangements of reverberation time. Results from this study indicate that four acoustical measures (Thiele's D, Nechtal's Cgg, Lochner and Burger's S/N and Schultz's R) were of similar prediction accuracy. Different types of test list and test methods were also used in this study for comparison.

OPTIMUM CONDITIONS FOR SPEECH IN ROOMS
J.S. Bradley

Data from previous speech intelligibility studies in rooms were used to determine optimum conditions for speech in terms of conventional and newer measures. As useful/detrimental ratios were found to provide the best combination of prediction accuracy and ease of calculation, optimum combinations of reverberation time and background noise levels were derived from them. An optimum reverberation time versus room volume curve similar to classical results was found. A design contour of optimum background levels versus room volume and speech source levels was calculated.

THE EFFECT OF FLOOR SLOPE ON SPEECH INTELLIGIBILITY IN RECTANGULAR ROOMS
A.Llopis, J.Linares, J.Sancho

This report studies the effect that the floor slope has on the speech intelligibility in rectangular enclosures for which it has been chosen one of these rooms with typical dimensions and distribution of materials on its boundary planes and it has been systematically varied the floor slope, beginning with the horizontal floor, obtaining in each condition the speech intelligibility in several positions of the audience area and for four different signal-to-noise ratios. It has been studied the speech intelligibility on the basis of the rapid speech transmission index (RASTI) calculated by a ray-tracing approach.

COMPARATIVE STUDY OF SPEECH INTELLIGIBILITY IN HEXAGONAL ROOMS ACCORDING TO DIFFERENT DISTRIBUTIONS OF MATERIALS ON ITS BOUNDARY PLANES
J.Linares, A.Llopis, J.Sancho

This report studies the effect that the use of different materials has on speech intelligibility in hexagonal enclosures, for which it has been chosen one of these rooms with typical dimensions. First of all it has been systematically varied the absorption coefficients of its boundary planes, while keeping the mean absorption constant. Finally it has been studied the effect of different distributions of materials when they vary the reverberation time of the room.

DIRECTIVITY OF MICROPHONE FOR STI MEASUREMENT
M. Mijić

Some new assumptions about directivity patterns of speech intelligibility, based on the well known data, are introduced in this paper. Results of the specially prepared experiment, together with the results of simple calculations based on such obtained patterns lead to the directivity factor between 5 and 6 (directivity index between 6 and 7, approximately). Such characteristic of hearing can be incorporated in STI measurement only by the use of directional microphone.

SPEECH TRANSMISSION IN REVERBERANT SOUND FIELD USING A SUPER-DIRECTIVITY LOUDSPEAKER
H. Hamada, H. Miyamoto and T. Miura T. Yoneyama

This paper describes a modified MTF-STI method for predicting Japanese sound articulation and its applications. From the experiments and computer simulations in a reverberant tunnel, the loudspeaker, especially its directivity and installed location proved to be the important points to improve the STI value and the resulting articulation for speech transmission.

PAGING SYSTEM FOR A NUCLEAR PLANT
Areg Charabegian

A new Paging and Emergency Evacuation System was designed for a nuclear power station. A comprehensive microcomputer-based acoustic analysis was performed to ensure intelligible speech coverage. Direct-to-reverberant ratio measurements were conducted for the complex areas, because use of the measured reverberation time for the acoustic calculations produced unrealistic results. Based on the results of these measurements, the critical radius was calculated for different types of speakers in various areas.

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Invited Paper

G5-1 8:40
REPLACEMENT OF AUDITORY INSPECTION TO DIGITAL PROCESSING IN THE DETECTION AND IDENTIFICATION OF FLAWS IN BALL BEARING
by Ken’iti KIDO, Masato ABE and Hiroshi KANAI
Tohoku University, Sendai 980, JAPAN

This paper describes a new method of detection and identification of flaws in ball bearing in mass production line by digital processing of vibration signal which has been carried out by skilled workers with their auditory sense. The vibration of ball bearing is picked up at the working condition and digitally analyzed. The bearings are automatically classified into four categories according to the position of flaws.

Contributed Papers

G5-2 9:00
VELOCITY DISPERSION OF RAYLEIGH WAVES ON CHROMIUM-PLATED STEEL
J. Poulilken, A. Defebvre and B. Chenni

We summarize the theoretical calculation of Rayleigh wave (R.W.) velocity dispersion in multilayered media and we apply it to the special case of chromium-plated steel. The absolute velocity measurements of R.W. are performed by the knife-edge method: in the 1-30 MHz frequency range for a chromium layer 21 μm thick deposited on 35 NCD6 steel substrate. Using the conjugate gradient numerical method, theoretical dispersion curves are then fitted on experimental ones by adjusting the mechanical parameters of both chromium and steel.

G5-4 9:40
ULTRASONIC TURBIDIMETRY
A. Defebvre, J. Poulilken and P. Marchandise

We are giving here the results of a preliminary study devoted to the detection of micron size particles, suspended in water, by diffusion of high frequency ultrasonic waves (f = 7.5 MHz). Turbidimeters, designed with one or two transducers, focusing or not, operating under various diffusion angle are compared. Electronic excitation and counting equipment are described briefly. Measurements under slow flow conditions according to the inclination of the liquid circulation tube, concentration and particle sizes of suspended matter are given.

G5-3 9:20
MEASUREMENT OF MECHANICAL ANISOTROPY OF SOLID MATERIALS BY ULTRASONIC SING-AROUND METHOD
T. IMAMURA

Mechanical anisotropy of solid materials such as injected polypropylene and extruded machinable ceramics was investigated by means of ultrasonic sing-around method. In order to clarify the anisotropy, specimens were immersed in water, and ultrasonic velocity was measured by counting sing-around period. When incidence angle to a specimen exceeds critical angle of longitudinal wave, only shear wave propagates in it. Under these conditions, the measurement was carried out by rotating the specimen. The relative velocity difference ranges up to about 10%.

G5-5 10:00
FLAW DETECTION OF BALL BEARINGS BY ANALYZING THE VIBRATION SIGNALS DETECTED BY TWO SENSORS
H. KANAI, A. YUASA, M. ABE and K. KIDO

This paper describes the new method of the detection of slight flaws on the outer ring of a ball bearing by use of two vibration pick-ups. This method is developed to make possible the detection of slight flaws on the outer ring regardless of the position of flaws. The flaws on the inner ring and on the balls are detected by the method so far proposed using a vibration pick-up regardless of the position of flaws. However, the detection of flaws on the outer ring is not always possible by the conventional method.
DIFFRACTION OF A GAUSSIAN BEAM BY A CRACK EDGE
J. G. Harris

Ultrasonic transducers operating at microwave frequencies radiate highly directional wave fields or beams that can be used to probe solids for defects such as cracks. To model this process, the compressional and shear waves reflected and diffracted from a crack edge when it is struck by a compressional Gaussian beam are calculated asymptotically. For simplicity the problem is assumed to be two dimensional. Different positions of the crack edge are considered, starting from the far field of the beam and moving inward to the near to far field transition region.

DETECTION ULTRASONEDE DE DEFATAUES-ESSAI DE REDUCTION DU BRUIT DE STRUCTURE OU DE GRAINS
E. Verbrugghe-P. Sans-C. Hottelard

Pour contoler certaines pieces sensibles des reacteurs nucleaires (broches de guide de grappe),Electricite de France met en oeuvre des methodes d'inspection ultrasonore par echos. La structure metallique a gros grains de ces pieces diffracte et diffuse le faisceau ultrasonore de controle. Ce phenomene reduit fortement le rapport signal utile sur bruit de fond et nuit a la detection d'echos dus a des defauts. Pour resoudre ce probleme, on a experimente une procedure de traitement de signal dite "par moyenage frequental". Le texte presente des exemples de signaux de broche traites et souligne certaines limites de la methode.

ACOUSTIC EMISSION MONITORING OF CRACK IN WELDED JOINT
M.K. Lim and P.M. Abraham

The use of acoustic emission is now steadily becoming accepted for safety checks on the integrity of modern highly stressed structures. Laboratory work has been conducted on the feasibility of monitoring crack in welded joint using acoustic emission. Thin mild steel plate welded specimens subjected to fatigue stresses were used in the tests. Tests carried out have shown that acoustic emission is effective in detecting the type of crack growth experienced in offshore structures.

ON TECHNIQUE OF INSPECTING WITH SOUND SPREAD
Chu Yi-ming

Here we put forward a technique of inspection with sound spread, which is an new non-conventional way of ultrasonic inspection. We have used the method of water-immersed single probe transverse wave sound spread to detect the flaw of the outer and inner surface of 10Cr13 seamless steel tubes, the thickness (t=16mm) of the wall is 27.4% of the outside diameter(Do = 58mm) and 61.5% of the inside diameter(Di = 26mm). The dissected examination of the products proves that this technique is practicable.

PRECISION IN ULTRASONIC NDT EQUIPMENT USAGE
E.D. Smith

The need for accurate ultrasonic measurements in industry are emphasized and a new calibration procedure for instruments described. In a test using artificial defects in steel blocks use of the calibration procedure reduced the sizing error from 200% to 10%.
Session K5: The listener's response

Chairman: J. Vos, TNO Institute for Perception,
P.O. Box 23, 3769 ZG Soesterberg, The Netherlands

Contributed Papers

K5-1  8:40
THE HARMONY OF MELODY
L.L. Cuddy

Melodic sequences were randomly generated from several different underlying harmonic structures—major triads or mixtures of major triads—or from unstructured chromatic sets. Perceived structure was assessed by the probe-tone technique. Obtained probe-tone profiles reflected the characteristics of the generating structure; harmonic information was abstracted despite the absence of sequential dependencies. When the underlying structure involved opponent tonalities, the constraints implied by studies of frequency identification emerged.

K5-2  9:00
EFFECTS OF TRAINING AND UNCERTAINTY ON MELODIC INFORMATION PROCESSING
A. J. Cohen, S. E. Trehub, & L. A. Thorpe

Listeners judged whether a final comparison melody differed by one semitone from three preceding standard melodies. Increases in uncertainty on the three levels of melody, trial and session significantly decreased performance but past musical experience partially overcame the effects of uncertainty on all levels examined.

K5-3  9:20
LOCAL AND ACOUSTIC FACTORS IN BACH CHORALEs
W.F. Thompson and L.L. Cuddy

Judgements of key change in Bach chorale excerpts were examined. Experiment 1 showed that identification of key change was improved when the fifth of the final triadic chord of the excerpt was omitted. Experiment 2 showed that magnitude estimates of key change were lower for clockwise than for counterclockwise movement on the circle of fifths. The effects are attributed to local and acoustic influences on judgements of high levels of musical structure.

K5-4  9:40
DEVELOPMENT OF SENSITIVITY TO THE EMOTIONAL MEANING OF MUSIC
S. E. Trehub, A. J. Cohen & M. Guerrero

Children and adults assigned the category of sad, neutral or happy to melodic patterns varying in rate and pitch (Experiments 1 and 2) as well as chord quality and frequency direction (Experiment 3). In general, happy ratings are associated with fast rates, high pitch, major chords and ascending direction. Increasing age and experience led to greater differentiation for rate and chord quality.

K5-5  10:00
A MODEL FOR THE FORMATION OF THE MUSICAL MIND
I.B. Phillips

This essay explores the concept of the musical mind and its formation. A model is presented that illustrates the components of the musical mind along with a discussion of the development (formation) of these segments into the adult musical mind. The model combines cognitive (musical thought, perception), affective (musical feeling) and psychomotor domains along with a developmental continuum from prenatal through adult musical constructs. Intelligences are also discussed.

K5-6  10:20
LABYRINTH; THE TANGLEd WAYS OF PROGRESSION AND MUSICAL PERCEPTION
David Keane

Labyrinth is a computer music composition realized at the British Medical Research Council Speech and Communications Unit (Cambridge). The work is comprised of cultivated transformations of a spoken line of Latin text. The musical thrust of Labyrinth is the impetus for an array of attractive but "labyrinthine" lines of thought on the part of the listener. Strategies utilized in the piece for engaging the listener’s objective and subjective mental processes are discussed; with particular attention being given to the value of progressive presentation of information.
LEVEL DIFFERENCE AND MUTUAL AUDIBILITY AMONGST MUSICIANS
G.M. Naylor and R.J.M. Craik

The relative level of the instrumental sounds that a musician hears are important for good ensemble. It has been found that the optimum condition is for a musician to hear the sounds of other instruments at a level of -8 to -15dB relative to the sound from his own instrument. If the other instruments are too loud then he cannot hear himself and if too quiet then he cannot hear the other(s). The range is dependent on the type of music being played.

ACCEPTABILITY OF TWO-PART MUSICAL FRAGMENTS PERFORMED IN VARIOUS TUNING SYSTEMS
J. Vos

Subjects rated overall acceptability of fragments performed according to regular twelve-tone tuning systems. Ratings were about the same for systems between and including meantone (A=5.4 cents) and Pythagorean tuning (A=0 cents); A represents tempering of main fifths. For A=2, A=7.2, and A=10 cents the ratings strongly decreased. The effect of tuning system was not affected by tempo (in the first tempo tone duration was 75% shorter than in the slow tempo). The extent to which the subjects may have based their judgments on the subjective purity of harmonic and/or melodic intervals is discussed.

WEDNESDAY MORNING, 30 JULY 1986

Session M3: Impedance measurements
Chairman: D.-Y. Maa, Institute of Acoustics, Academia Sinica, P.O. Box 2712, Beijing, China

Contributed Papers

M3-1 8:40
MEASUREMENTS OF ACOUSTIC IMPEDANCES
M.A. Dah-YOU

The methods of impedance measurement of acoustical materials are reviewed, and two new methods are proposed. The one is an extension of the classical method, in which the magnitudes of sound pressure at four points in the standing wave tube are measured and the complex impedance is obtained by a straightforward computation. The other method is based on the fact that the active and reactive parts of the intensity at the vicinity of the material and normal to its surface are proportional to the normal acoustic conductance and susceptance respectively.

M3-2 9:00
THE MEASUREMENT OF ACOUSTIC IMPEDANCE IN NORMAL AND OBLIQUE INCIDENCE WITH TWO MICROPHONES
J.F. Allard, R. Bourdier, A.M. Bruneau

A new method for measuring acoustic impedance in a free field is described. With this method, the observation of the Biot slow wave in high flow resistance plastic foams and the observation of the anisotropy in glass wool is reported.

M3-3 9:20
RAPID MEASUREMENT OF ACOUSTIC IMPEDANCE USING A SINGLE MICROPHONE IN A STANDING WAVE TUBE,
J. Pope

The traditional standing wave method of determining acoustic impedance in a tube is adapted for rapid measurements. A least-squares curve fit procedure extracts the standing wave pattern at each frequency of interest. Using a conventional standing wave apparatus and an FFT spectrum analyzer, the method permits the determination of impedance at several hundred frequencies from just 3 or 4 measurements at arbitrary locations. The method can provide results equivalent to ASTM C 384 or ASTM E 1050.

M3-4 9:40
SINGLE-MICROPHONE TRANSFER FUNCTION METHOD FOR MEASURING IMPEDANCE AND ABSORPTION IN AN IMPEDANCE TUBE
W.T. Chu

It is possible to implement impedance and absorption measurements in an impedance tube using a single microphone, thereby eliminating the elaborate calibration procedure and possible phase mismatching associated with the two-microphone transfer function technique. A periodic pseudorandom sequence is used as the noise source. Results compare favourably with those obtained by the standard method.
M3-5  10:00
UN CAPTEUR A TRANSDUCTEURS RECIPROQUES
POUR LA MESURE D'IMPEDANCES ACOUSTIQUES
A.M. Bruneau, G. Piotnik

A sensor has been built with two capacitive reciprocal transducers, one used to emit sound, the other one as a microphone. This apparatus allows a variety of acoustical impedances to be measured over a frequency range from 0.2 to 7 kHz. The functioning of this sensor and the method used for its calibration is described. The calibration was realized by taking detailed measurements of the input impedance of a cylindrical tube. Since the theoretical impedance function of such a tube is easily obtained, a comparison between theory and experiment is possible.

M3-6  10:20
EVALUATION OF THE ACOUSTICAL SOURCE IMPEDANCE IN A DUCT USING A FOUR LOAD METHOD
M.G. Prasad

This paper presents a new and simple method (termed the Four-Load Method) to evaluate the acoustical source impedance in a duct. The method uses the measured sound pressure level data for four pipes of different lengths as acoustic loads. Good results are obtained by using the source impedance (evaluated by the Four-Load Method) in the insertion loss studies of a model muffler system. Applications of the Four-Load Method to duct acoustic studies are discussed.

M3-7  10:40
RESISTIVE AND REACTIVE ACOUSTIC FIELD
CHARACTERIZATION OF ENCLOSURES VIA MODAL ANALYSIS AND IMPEDANCE ESTIMATES
M.W. Trethewey and W.S. Chiu

An experimental method to characterize the acoustic field inside an enclosure in terms of the resistive and reactive components is presented. The method uses a finite difference approximation of the sound pressure from two closely spaced microphones to estimate the specific acoustic impedance and particle acceleration. The impedance is used to separate the components and modal analysis to describe the reactive field.

M3-8  11:00
ACOUSTIC TRANSFER FUNCTION MEASUREMENT WITH A TWO-MICROPHONE RANDOM-EXCITATION TECHNIQUE
Hong R.K., Kunov H., del Rio J.A., Malone P.

Random noise is applied to determine the transfer function of a ducted acoustic network. The acoustic circuit is modelled as a linear system with sound pressures on two sides of a longitudinal impedance in series with a transverse impedance. Spectral estimates allow us to compute the transfer function, and to determine one of the impedances from the other.

M3-9  11:20
DETERMINATION OF THE LOCATION OF A REFLECTION BOUNDARY USING HILBERT TRANSFORM
Yasushi Miki

A method for determining the accurate location of the reflection boundary of an acoustic material is developed. To measure the reflection coefficient of an acoustic material, the accurate distance between its surface and an observation point must be known. From the standpoint of signal theory, the distance measurement is equivalent to the determination of the time origin of the impulse response of the reflection system. In the new method, the time origin is estimated by the use of minimum phase property and Hilbert transform relationship of the reflection system.

M3-10  11:40
MEASUREMENT OF SOUND ABSORPTION OF CORK PLATES USING A TWO MICROPHONE TUBE AND FREQUENCY SWEET EXCITATION
J.L. Bento Coelho

The paper reports measurements of sound absorption coefficients of cork plates in a two-microphone standing wave tube excited by a frequency sweep signal. FFT analysis is employed. The results compare well with those obtained in the tube excited by single frequencies and with those measured in a reverberant test chamber. The procedure is fast and reliable.
Plenary Session 5: Human responses to vibration

Speaker: M. Griffin, Human Factors Unit, Institute of Sound and Vibration Research, The University, Southampton S09 5NH, England

Chairman: H. Myncke, Lab. voor Akustiek en Warmtegeleiding, University of Leuven, Celestijnenlaan, 200D, Heverlee, Belgium 3030

HUMAN RESPONSES TO VIBRATION,
M.J. Griffin

Oscillation of the body can cause discomfort and annoyance, interfere with activities, present a hazard to health and produce motion sickness. The evaluation of vibration involves 'weightings' which reflect the relative importance of different vibration frequencies, directions and durations. Dose-effect relationships require knowledge of other factors which influence the probability and extent of the effect of interest. Current methods of evaluating vibration with respect to discomfort, annoyance, interference with activities, health effects and motion sickness are summarised.

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Session B10: Measurement of hearing protector attenuation II

Chairman: K. Brinkmann, Physikalisch-Technische Bundesanstalt, Bundesallee 100, D-3300 Braunschweig, F.R.G.

Contributed Papers

B10-1  14:40

SELECTION OF HEARING PROTECTORS
A. Behar and R. Jackson

This paper presents a method for selection of hearing protectors for large companies. It requires the use of a derived NRR (NRR 84) and results from a comfort test designed for this purpose. Worker's noise exposures are used to calculate the lowest NRR 84 that will protect a given percent of workers (i.e., 95%). The comfort test results assess the acceptance of protectors that have to score a minimum value to be selected. The paper presents practical results from the application of the method.

B10-2  15:00

ATTENUATION MEASUREMENTS OF HEARING PROTECTORS IN WORKPLACE,
A.M. Méndez, E.B. Salazar and H.G. Bontti

Measurements of attenuation of muffs and plugs types hearing protectors were performed in two industries. We study five different protectors determining their acoustic attenuation in the field. Workers wearing their own protectors were measured with and without them. The measurements of hearing thresholds were performed using noise filtered in third octaves bands. The results showed that the acoustic attenuation and the standard deviation differed from values supplied for manufacturers.
ATTENUATION OF INSERT EAR PROTECTORS IN MALES AND FEMALES
S. M. Abel, H. Kunov, P. W. Alberti and D. Rokes

The attenuation of three commonly used insert protectors including expandable foam, pre-colded vinyl and polyethylene encapsulated glass fiber, is being studied in 60 males and 60 females. All are young adults with normal hearing. Headphone detection thresholds are measured with and without the protectors worn for five one-third octave bands centered at 250, 500, 1000, 3150 and 6300 Hz. Of particular interest is whether ear plugs of various types with similarly high NRs, are equally appropriate for the smaller ear canals typically found in females.

MEASUREMENTS OF EAR PROTECTOR ATTENUATION WITH AN ACOUSTO-MECHANICAL MODEL OF THE HEARING SYSTEM
C.Giguere, H.Kunov, S.M. Abel and J.Schroeter

We have developed a head simulator to measure the insertion loss of hearing protectors. Our model is based on the KEMAR manikin and allows the assessment of hearing protector attenuation, in terms of amplitude and phase, of sinusoidal, random noise, impulsive or experimenter-specified signals, over a range of signal amplitudes. [Work conducted under a contract from the Defence and Civil Institute of Environmental Medicine, Canada.]

PERFORMANCE OF HEARING PROTECTION DEVICES AT LOW FREQUENCIES
V.J. Chvojka and C.L. Ostiguy

The performance of hearing protection devices often fails at low frequencies where an apparent amplification effect, instead of insertion loss, might be observed. Several hearing protectors were tested by a dummy head in order to investigate this deficiency at frequencies up to 500Hz. The results of this study prove clearly a spurious performance and possible amplification for the tested specimens and confirm the results already presented by Goff and Blank.

EVALUATION OF HEARING PROTECTOR PERFORMANCE IN U.K.
P.D. Wheeler

Physical performance data for a number of earmuffs has been acquired, in accordance with British Standard 6344 Part 1, which was issued early in 1984. The Standard is concerned with a test sequence in which the attenuation of a sample pair of ear muffs is measured on an artificial head prior to exposure to a vibration test, a drop test, and a headband flexing test representing 1000 fittings of the ear muff. The relationship between the new Standard and the BS 5108 REAT test, and test protocols for subjective measurement of attenuation will be discussed.

EVALUATION OF HEARING PROTECTION FOR EARMUFFS USED IN CLOSED SHOOTING FIELDS
M. Nicoli, M. Coss

An investigation on sound attenuation for earmuffs used in closed shooting fields has been carried out employing an objective method according to effective conditions. Appealing to ISO-NIOSH method maximum number of explosive events acceptable at protected ear has been calculated. Comparatively difference between experimental measurements and manufacturer's attenuation data has been calculated.

ANAMORPHICAL MEASUREMENTS ON EAR-MUFFS
J. Pfretzschner, A. Moreno

In this paper the differences among subjective, objective and semibijective insertion loss measurements on an ear-muff are compared. Diffuse and frontal free fields with an artificial text fixture and human subjects were used in this study. The results are compared with those obtained by other authors in similar conditions. The maximum concordance with subjective measurements is obtained through semibijective measurements in diffuse field.
Session C9: Community noise: survey and control

Chairman: C.A. Bakare, University of Ibadan, Ibadan, Oyo State, Nigeria

Contributed Papers

C9-1 14:40
COMMUNITY NOISE SURVEYS IN AUSTRALIA
Warren D. Renew

This paper discusses the procedures employed in carrying out community noise surveys in major cities in Australia. Comparisons are made where applicable between statistical noise levels in different cities during selected periods of the day and night. Noise levels and distributions are compared with standard criteria to determine acceptability.

C9-2 15:00
ANOMALIES IN AUSTRALIAN ENVIRONMENTAL NOISE LEGISLATION
I. W. Eddington

Anomalies which emerge from a critical analysis of Australian environmental noise legislation are identified. Implications of those anomalies are discussed. A conclusion presents comments about the general effectiveness of Australian environmental noise legislation and about whether or not the removal of all or some of the anomalies might result in an improvement.

C9-3 15:20
THE STATE OF NOISE CONTROL IN ARGENTINA
G. L. Fuchs

We compare the situation of teaching, research and technology in Argentina to that in North America. Noise control and building acoustics emerge as our first priorities. Environmental noise and building codes are discussed. Materials performance explained. Priority of façades and plan layout outlined. Industrial noise control methods presented. Criteria adopted and design checklist pointed out. Shortage of resources and education are emphasized.

C9-4 15:40
A REVISION OF THE ERCB NOISE CONTROL GUIDELINE
C. Andrew
E.H. Bolstad

There has been growing public concern over energy industry related noise levels in Alberta. Industry located in low ambient rural areas combined with the vehicles serving them have caused these noise problems. Although maximum permissible noise levels have been in force, the existing standards are inadequate. This paper outlines the new noise control guideline with the aim of earlier consideration for the design of noise control.

C9-5 16:00
LA COMMUNE ET LA LUTTE CONTRE LE BRUIT
André CROS.

L'auteur, au sein d'ACOUSTIQUE et CONSEIL (FRANCE), a mis au point une méthode qui permet de bâtir avec les Mairies des Villes de plus de 20 000 habitants un Plan Municipal de Lutte contre le Bruit, qui comporte toutes les actions que la commune, en approche globale et sur plusieurs années doit entreprendre pour réduire la nuisance Bruit sur son territoire.

C9-6 16:20
DRAFT NATIONAL ENVIRONMENTAL NOISE CODE OF CANADA
D.A. Bennewell

A "National Environmental Noise Code" is being prepared by a Working Group on Environmental Noise of the Federal/Provincial Advisory Committee on Environmental and Occupational Health. It is hoped that this code, developed through Federal/Provincial consultation, will establish a uniform national basis for dealing with environmental noise problems. The planned publication contains or identifies standards and procedures for the measurement of noise, instrumentation specifications, noise control program options, sound level objectives, noise control and noise abatement techniques.
NOISE MEASUREMENTS AND ATTITUINAL SURVEYS OF NIGERIAN CITIES

C.A. Bakare

Noise measurements were carried out in 4 major Nigerian cities to determine the extent of noise pollution. People's reaction was obtained through prepared questionnaires completed by 800 citizens. Results indicate that 82.25% were affected by noise and that vehicle traffic was the principal pollutant. Noise was ranked next to crime as a major environmental problem. The mean noise levels in 16 monitoring stations were found to be excessive thus justifying the high degree of annoyance expressed by the people.

WEDNESDAY AFTERNOON, 30 JULY 1986
ROOM 202 A and C, 14:40 - 17:20

Session D5: Nonlinear vibration
Chairman: S.I. Hayek, Pennsylvania State Univ., 224 Hammond, University Park, PA 16802, U.S.A.

Contributed Papers

D5-1  14:40
COMBINATIONS OF PERIODIC AND DISORDERED SYSTEMS: RESPONSE TO CONVECTED LOADINGS
A.S. Bansal

A general method presented for the analysis of combinations of periodic and disordered systems has been used to study the response due to pressure fields convecting over semi-infinite periodic beams joined together with and without a finite disordered beam in-between. The conditions have been identified under which the response can be large due to the resonance and the coincidence phenomena. The effect of the disorder and the conditions under which it can be neglected has also been briefly discussed.

D5-2  15:00
THE DYNAMIC BEHAVIOUR OF A COMPOSITE IMPACT DAMPER
E. Semercigil and N. Popplewell

A more efficient vibroimpact damper has been developed to reduce the excessive vibrations of light resonant structures. The new damper contains many rather than the single mass used conventionally. The masses are contained within a flexible bag so that they can move relative to each other. Consequently, standard theory, which is based upon a coefficient of restitution, inadequately describes impacts. Experiments will be described which quantify the major components of the new damper's behaviour.

D5-3  15:20
NONLINEAR MODE COUPLING IN BARS, PLATES AND SHELLS
K.A. Lege & N.H. Fletcher

Nonlinear energy transfer between the normal modes of structural elements such as strings, bars, plates and shells is a phenomenon of wide occurrence which is demonstrated strikingly in certain musical gongs. The underlying theory is discussed, and in particular the importance of sharp shape changes. Attention is given to the nonlinear generation of modes initially absent from the impulsively excited motion.

D5-4  15:40
RANDOM SUPERHARMONIC AND PRIMARY RESPONSE OF A DUFFING OSCILLATOR
Srivatsa Rajan

The third order superharmionic mean-square responses of a Duffing oscillator to narrow-band random excitation is analysed using the methods of harmonic balance and statistical linearisation. The main emphasis of the analysis is to demonstrate the effect of excitation bandwidth on the response of the oscillator. The theoretical results are compared with results obtained from digital simulation. (Work supported by NSERC, Canada).
RANDOM SUBHARMONIC RESPONSE OF A NONLINEAR OSCILLATOR
Huw G. Davies and Srivatsa Rajan

The one third order subharmonic response of a Duffing oscillator to narrow band random excitation is analysed, using a combination of harmonic balance and statistical linearisation. When the subharmonic is excited, random excursions of the excitation beyond either upper or lower limits cause the subharmonic to "jump" to the trivial zero value and remain there. Numerical simulations demonstrate these jumps and show good agreement with the analysis. (Work supported by NSERC, Canada).

BEHAVIOUR OF A NONLINEAR ACOUSTIC RESONATOR UNDER CONDITIONS OF PULSED EXCITATION
A. Alippi, M. Bertolotti, A. Ferrari, D. Sette, C. Sibilia, M. Zagrari

Theoretical predictions of the behaviour of an acoustic resonator made by a plate of InSb, under conditions of pulsed excitation have been made. First experimental results fit well with theoretical calculations in the linear range of response, that make one confident in using acoustical resonators as bistable devices, obtainable when nonlinear effects have to be taken into considerations.

MEASUREMENT OF THE NONLINEAR DYNAMIC CHARACTERISTICS OF VIBRATION ISOLATION MATERIALS
T. Pritz

In this paper the resonance method is generalized for nonlinear case to measure the dynamic modulus and the loss factor of low loss vibration isolation materials as a function of dynamic strain. Equations are derived for calculating the dynamic modulus and the loss factor from knowledge of the resonant frequency and vibration magnification measured at different strain levels.

NON-LINEAR ELASTIC BEHAVIOUR AND RESIDUAL STRESSES IN TEXTURED PLATES
M. Touratier, J.-Y. Chateplier

In this paper, we propose a method to determine the non-linear behaviour of textured thin pieces. Furthermore, we present a generalization of acoustoelasticity including the plastic strain in order to determine the residual stresses developed by the texture of material. Some applications are produced on a "baxial" specimen to obtain successively the non-linear behaviour, the residual stresses and even the applied stresses.

WEDNESDAY AFTERNOON, 30 JULY 1986

Session E11: Auditorium acoustics modelling
Chairman: S. Ström, Acoustics Research Center, ELAB, Norwegian Institute of Technology, N-7034 Trondheim-NTH, Norway

Contributed Papers

A COMPARISON OF ARCHITECTURAL ACOUSTICAL SCALE MODELS TO THEIR PROTOTYPE ROOM
Chandler E. Rozear and Gary W. Siebein

A range of psycho-acoustic indices were measured in a 1500 seat multi-purpose theater. The measurements made in the full size room were compared to measurements made in detailed 1:10, 1:40 and 1:100 scale models of the room as well as a series of progressively less refined models at 1:40 scale. A significant amount of information can be obtained from the model studies on a zone by zone basis. Alternative design concepts can be compared easily in the small scale models. Larger scale models are more appropriate for refinement of the solution.

ROOM ACOUSTIC SCALE MODELLING AT HIGH FREQUENCIES
M. Almgren

The acoustic boundary layer on a rigid surface leads to an unavoidable absorption which increases with frequency. Accordingly, the absorption coefficient of a rigid, smooth surface will always be higher in a small scale model of a room, than in full scale. The reverberation may be influenced by the layer, while the early reflections are not influenced. Cremer's approximate formula for the diffuse field absorption coefficient is accurate within 4% up to 10 kHz and within 14% up to 200 kHz.
E11-3  15:20
EXPANSION OF THE IMAGE METHOD FOR ACOUSTICAL DESIGN
OF AUDITORIA
K. Iida, Y. Ando

The accuracy of computer simulation of sound fields in auditoria based on the geometrical
acoustics is not satisfactory because of neglecting wave phenomena. In the present paper, the
transmission characteristics over the seat rows which is one of the most perplexing problems in room
acoustics is investigated. Considering attenuation of sound waves in the low frequency range, a modified
method of simulating sound fields in auditoria is proposed. Results are compared with measured values.

E11-4  15:40
A COMPARISON BETWEEN A COMPUTERIZED ACOUSTICAL
DESIGN METHOD, AN ACOUSTICAL MEASURING METHOD AND
SUBJECTIVE EXPERIENCE IN CONCERT HALLS
A. Pålsson, A. Westerlund

Ray tracing calculations in computer models are compared with measurements in completed hall. Pulse
analysis with FFT and conventional reverberation time measurement have been performed. The results
are compared with judgements from musicians, music technicians and music reviewers. Stockholm's four
biggest concert halls; Berwaldhallen, Cirkus, Konserthuset and Nacka Aula have been used in the
examination.

E11-5  16:00
APPROXIMATION OF IMPULSE RESPONSE THROUGH COMPUTER
SIMULATION BASED ON FINITE SOUND RAY INTEGRATION
K. Sekiguchi, S. Kimura and T. Sugiyama

This paper deals with the calculating estimation of the initial impulse response within an auditorium
through the computer simulation. In the calculation, the areal integrals on reflecting surfaces are found
through the application of the sound ray tracing method for the approximation of impulse response
incorporating the effect of the wave motion of sound.

The appropriateness of the new finite sound ray integration simulation system was verified through the
comparative evaluation of the measured results and the results of simulation calculation.

E11-6  16:20
COMPUTER DESIGN SYSTEM FOR ARCHITECTURAL ACOUSTICS
J. Sancho, J. Linares, A. Llopis

This report describes a method to aid on architectural acoustics design by computer and shows some
results obtained with it. Its main features are: A) Microcomputer with 64KB of RAM, 240KB in floppy disk,
graphic terminal 280x192 dots and graphic printer. b) Numerical model: 3-dimensional approach based on
ray-tracing. Sound source of non-spherical directivity. Separate study of direct sound, early reflections
and diffuse sound. c) Applications: obtaining echograms and derivation of most of the criteria used in room
acoustics.

E11-7  16:40
SIMULATION OF SOUND FIELDS IN TIME AND FREQUENCY
DOMAIN USING A GEOMETRICAL MODEL.
D. Van Maercke

Under the assumption of geometrical acoustics, sound fields in closed spaces can be described in
term of virtual sources. A cone method based on a ray-tracing technique, as a fast way to find the images, is
proposed. The time-space sound energy distribution can be obtained for pure tones or noise excitations. For
individual receiver, the transfer function and the impulse response of any hall can be estimated. Applying
appropriate model for walls’ absorption, the method can be used in architectural or underwater acoustics.
Session F1: Biomedical acoustics

Chairman: F. Dunn, Bioacoustics Research Laboratory, University of Illinois, 1406 West Green Street, Urbana, IL 61801, U.S.A.

Contributed Papers

F1-1  14:40
NONLINEAR BIOULTRASONICS PARAMETER
F. Dunn

The nonlinearity parameter B/A has been determined for several biological solutions and soft tissues. Aqueous solutions of biomacromolecules exhibit a linear relation between B/A and solute concentration, though no dependence upon molecular weight occurs. Organs exhibit B/A values approximately 7, while fat yields the highest value; around 11. Destruction of tissue structure reduces the B/A value. Thus, solute-solvent interactions and structural hierarchy contribute to the nonlinearity parameter, suggesting its usefulness in tissue characterization and imaging.

F1-2  15:00
SYSTEM FOR MEASUREMENT OF ULTRASOUND SPEED OF A LIVING TISSUE WITH A PROBE OF SMALL TRANSUCERS
S. Ohtsuki, K. Soetanto, and M. Okujima

Ultrasound speed of a living tissue is very useful information for characterizing the tissue. The range of speed is about 1400 m/s to 1600 m/s, and the speed is very sensitive to the temperature of the tissue. The ultrasound speed of tissue also depends on its blood flow. From the measurement point of view, tissue is deformable and scattering medium. Then we made a probe of small transducers. The distance of the transducers is fixed because of the deformability of tissue. The measurement system with the probe was calibrated with various kinds of liquid at 36°C. The accuracy of measured value is several meters per second.

F1-3  15:20
ESTIMATION TECHNIQUE OF ULTRASONIC RELATIVE ATTENUATION IN SCATTERING MEDIUM WITH ITS B-MODE IMAGE
K. Soetanto, S. Ohtsuki, M. Okujima, and M. Tanaka

We proposed a technique for measuring the ultrasonic attenuation constant of tissues in vivo, using the linear-scanned B-mode tomogram, which is widely employed in abdominal diagnosis. In this technique, the attenuation constant of a tissue can be estimated with measuring its attenuation related to a reference scattering phantom with known attenuation constant. The merits of this technique are independent of the sensitivity time control (STC) and almost free of the beam focussing. In this paper, some experiment results using this technique and comparison with another method are described.

F1-4  15:40
MEASUREMENT OF ULTRASONIC FIELDS OF ELECTRONIC SCAN DIAGNOSTIC EQUIPMENT BY MINIATURE HYDROPHONE SCANNING
M. Ide and E. Onodera

For evaluation of ultrasonic diagnostic equipment and for study on bioeffect of ultrasound, to know the intensity of the pulse ultrasound field generated by the equipment is important. This paper reports on the results of a study on an automatic measurement system for the pulse ultrasonic fields and the intensity of pulsed ultrasound with a calibrated miniature hydrophone. The measurements are made over a number of planes perpendicular to the beam axis. From the obtained data, pulsed ultrasound intensities can be calculated rapidly by micro-computer.

F1-5  16:00
DEVELOPMENT OF A RADIATION PROTECTION PROGRAMME FOR MEDICAL DIAGNOSTIC ULTRASOUND DEVICES, S.H.P. Bly and D.A. Benwell

This paper describes the development of the radiation protection program for medical diagnostic ultrasound devices at the Bureau of Radiation Protection and Medical Devices. As part of this program, we have surveyed manufacturers' measurements of output levels. The results indicate a wide spread in output levels, even for devices with the same claimed purpose. This suggests that unnecessary exposure due to diagnostic ultrasound may occur during clinical practice.
ÉTUDE PAR UNE MÉTHODE ULTRASONORE DE LA QUALITÉ DE SOUDURE FRICTION DANS DES COSES

P. Sans, E. Verbrugghe
Afin d'améliorer la fiabilité de la méthode de contrôle de connecteurs électriques (cosses) constitués de deux pièces métalliques soudues par frication, une méthode de discrimination des pièces à rebouter est proposée. Elle repose sur la différence des coefficients de réflexion aux interfaces entre l'aluminium, le laiton ou l'air.

THE SCATTERING OF ULTRASONIC WAVES IN POLYCRYSTALLINE COPPER
Ja.M,Soifer, N.P.Kobelev
In order to examine the theoretical models of the scattering of ultrasonic waves by grains in polycrystals the attenuation and velocity of plane longitudinal waves were measured simultaneously as a function of kD (wave number x grain radius). The measurements were performed with the copper specimens of different grain radius. The minimum was found on the dependence of wave velocity vs kD at kD ~ 1. The data obtained is in a good agreement with the calculation by Stanke and Kino.

THE ACTION OF HIGH-INTENSITY ULTRASONIC WAVES ON SOLIDIFYING METAL
O.V.Abramov
The mechanism of metal solidification in an ultrasonic field and structure changes in in-gots is described. Development of cavitation and acoustic flows in melts, nucleation and dispersion of growing crystals are discussed. The effects of material properties and solidification conditions on the effectiveness of structure refinement during ultrasonic treatment are evaluated. As an example the structure changes in steels treated by ultrasound are examined.

STRUCTURE AND MECHANICAL PROPERTIES OF CRYSTAL TREATED BY HIGH-INTENSITY ULTRASONIC WAVES
The influence of ultrasonic cavitation on the structure and mechanical properties of crystals treated in liquid us studied. It is shown that the cavitational treatment leads to an increase of dislocation and point defects concentration in the crystals. The mechanism of ultrasonic effect on structure changes is discussed. The structure changes in treated crystals result in the changes in mechanical properties.

APPLICATION OF ACOUSTIC EMISSION FOR TESTING HIGH-VOLTAGE CERAMIC INSULATORS
I.Malecki, J.Ranachowski, F.Rejmund
The subject of paper are investigations of causes of degradation of mechanical properties of ceramic insulators operating on high-tension lines. Ceramic material structure and texture was investigated. Textural systems were found responsible for accelerated degradation of mechanical strength. Parallel investigations of subcritical crack growth were carried out using double torsion method with acoustic emission recording.
SESSION 15: Acoustic waves in porous and layered media

Chairman: D.T. Blackstock, Applied Research Laboratories, The University of Texas at Austin, P.O. Box 8029, Austin, TX 78713-8029, U.S.A.

Contributed Papers

I5-1 14:40
DEPENDENCE OF SOUND VELOCITY IN SNOW ON DENSITY
Masakatsu Ohaki and Hideo Takemura

We have used a capillary model such as is commonly used in analysis of sound absorbing media, derived a theoretical equation expressing the relationship between average density of the accumulated snow and the sound velocity in it. The decrease of sound velocity with increasing snow density in the density range below 0.25 g/cm³ is a feature on which the theory and measurements agree. However, for density above 0.25 g/cm³, the measured values of sound velocity tend to increase with increasing density.

I5-2 15:00
ACOUSTIC SCATTERING IN POROUS MEDIA
Rahul Sen and Charles Thompson

The problem of acoustic scattering by a rigid obstacle in a stratified porous medium is investigated. The dimensions of the scatterer are assumed to be small compared to the acoustic wavelength, and the medium varies on a scale slow compared to the acoustic wavelength. The outer field is expressed as a WKB sequence in δ, where δ is the ratio of the acoustic wavelength to the medium variation wavelength. The method of matched asymptotic expansions is used to match the outer field to the incompressible near field. We derive results that are completely general insofar as scatterer geometry and medium variation are concerned.

I5-3 15:20
INTERACTION OF SOUND FROM A POINT SOURCE WITH A PORO-ELASTIC HALF-SPACE
K. Attenborough and T.L. Richards

The theoretical problem of spherical-wave incidence on a fluid-saturated poroelastic half-space is considered for the limiting case when the bulk modulus and density of the saturating fluid are much smaller than the elastic modulus and density of the solid. This case should be applicable to air-filled materials. A non-rigorous approach enables derivation of simple asymptotic expressions for the various wave types at grazing incidence.

I5-4 15:40
ACOUSTICAL PROPERTIES OF MULTILAYERED, HIGHLY POROUS FOAMS
R. Bourdier, J.F. Allard, C. Depollier

A new method for modeling the acoustical properties of multilayered plastic foams is presented. Each layer of plastic foam is described by a transfer matrix calculated by using Biot's theory. Free field measurements of the surface impedance are compared with predictions obtained with this method.

I5-5 16:00
WAVES IN ALTERNATING ELASTIC SOLID AND VISCOS FLUID LAYERS, M. Schoenberg and P.N. Sen

In a system of alternating parallel elastic solid plates separated by viscous fluid channels, fast and slow waves propagate parallel to the layering in the low frequency limit. Two important dimensionless parameters are 1) L, the ratio of channel width to viscous skin depth, assumed here to be large, and 2) the product of channel width to fluid wavenumber, assumed here to be small. In this regime, the modification to the wave slownesses obtained previously for the inviscid fluid case to reflect dispersion and attenuation due to fluid viscosity are both proportional to 1/L.
Contributed Papers

M4-1 14:40
BASIC SOUND LEVEL METERS FOR EDUCATION IN ACOUSTICS
A.O. Wallis; K. Attenborough

The paper covers the original instrumentation concept developed by the Open University in 1969 for the 1100 course in 1972. The course covered the fundamentals of acoustics and their application. The design features of the sound level meter chosen for the course are discussed and the subsequent redesign to better units for the second level course is evaluated. For the third phase on the 1985 second level course, an integrating meter was required and the chosen specification and design are presented and the first years experience is detailed together with statistical data on the performance spread of the units before and after student use.

M4-2 15:00
SINE BURST TESTING OF INTEGRATING SOUND LEVEL METERS
J.M. Holding, A.D. Wallis

The various methods of evaluating the dynamic performance of integrating sound level meters are briefly presented. The attributes of the multi-cycle and single-cycle tone burst tests are contrasted with the resulting recommendation that IEC804 is universally adopted. Work on the improvement of signal sources is reported. This work has led to the development of dedicated hardware and software to facilitate testing to the stringent requirements of acoustic instrumentation.

M4-3 15:20
OCTAVE- AND FRACTIONAL-OCTAVE-BAND DIGITAL FILTERING
BASED ON THE PROPOSED ANSI STANDARD
Steven B. Davis

A software implementation has been developed which is based on the proposed ANSI standard "Specification for Octave-Band and Fractional Octave-Band Analog and Digital Filters", a revision of S1.11-1966 (1976). Changes to the standard are the inclusion of digital filters, definition of octaves based on powers of both 2 and 10^4/3, and relaxation of filter symmetry requirements. An evaluation of the digital filter design elucidates the difficulties in maintaining similar specifications in the analog and digital domains.

M4-4 15:40
WIDE-BAND SAW BANDPASS FILTERS AND VARIABLE NOTCH FILTERS USING SLANTED FINGER TRANSDUCERS
S. Yoshikawa, H. Yatsuda, O. Yano, B. Yamamoto

This paper describes the wide-band linear phase SAW filters using slanted finger transducers. First, a method of designing low-loss wide-band filters is described. Then, the experimental results for the 77MHz filters with the 50-percent and 13-percent fractional bandwidths are shown. The insertion loss of these filters were 23.5dB and 14.4dB respectively. Secondly, a method of designing a notch filter and a variable notch filter is described. Then, the experimental data for the notch filters with 50-percent fractional bandwidths are presented. Lastly, this paper shows that good agreements could be obtained between the theoretical and experimental results.

M4-5 18:00
ACOUSTIC MEASUREMENT USING PERSONAL COMPUTERS
Richard E. Labot

The measurement of electroacoustic devices using personal computers will be discussed. The computer, coupled to a voltmeter, bandpass filter and signal generator is capable of replacing more conventional equipment such as level recorders and heterodyne analyzers and oscillators. This combination provides methods for assuring data validity impossible with conventional equipment. The processing power of the computer also provides extensive on line data manipulation capability. Results of applying the system to loudspeaker response and impedance measurements will be shown.

M4-6 16:20
CODAGE NUMERIQUE DU SON DE HAUTE QUALITE: EVALUATION COMPAREE
Joel Soumagne, Philippe Mabileau, Sarto Morissette (Université de Sherbrooke), Gérald Chouinard (CRC, Gouv. Canada) and David Bennett (CRC-Radio Canada)

Cet article présente quelques techniques de codage numérique du son de haute qualité (musique) ainsi que les lois d'accentuation des hautes fréquences qui y sont associées. Ces diverses techniques ont été envisagées pour une utilisation dans le système de radiodiffusion numérique directe par satellite (S.R.S.). Une évaluation de ces méthodes à l'aide de mesures objectives et de tests subjectifs est proposée.
EQUIVALENT CIRCUIT CONSIDERATION OF A PIEZOELECTRIC VIBRATORY GYRO
Masashi Konno, Sumio Sugawara and Shigeru Oyama

Electromechanical equivalent circuits for a piezoelectric vibratory gyro are introduced, and the output characteristics are calculated theoretically. An excellent supporting method is given lastly.

DESIGN OF A LABORATORY TO TEACH THE CONTROL OF NOISE AND VIBRATIONS.
C. Gil, M. Recuero

This paper presents the design of a specific laboratory for noise and vibrations control. Its purpose is educational and it is intended for the students of the third year of the speciality of "Sound and Image" in the Escuela Universitaria de Ingeniería Técnica de Telecomunicación (Universidad Politécnica de Madrid). It will include a wide variety of practicals in order to prepare the students for research and the industry world.
Structured session F2: Bio-response to vibration

Chairman: M.J. Griffin, Institute of Sound and Vibration Research, The University, Southampton S09 5NH, England
Organiser: A.J. Brammer, Division of Physics, National Research Council, Ottawa, Canada K1A 0R6

Chairman's Introduction 8:35

Invited Papers

F2-1 8:40
THE POTENTIAL THERAPEUTIC EFFECTS OF SEGMENTAL VIBRATION ON OSTEOPOROSIS
D.E. Wasserman, C.A. Phillips and J.S. Petrofsky

As with any physically destructive agent, there arises the question that under controlled conditions can segmental vibration be harnessed and used in a positive way to actually help mankind as a potentially therapeutic modality, rather than just being destructive! In an effort to answer this question, this presentation will discuss the potential therapeutic effects of segmental vibration in general, and, in particular, its application to therapeutically reducing or arresting the insidious disease osteoporosis.

F2-2 9:10
EFFECTS OF HIGH-FREQUENCY HAND-ARM VIBRATION
R. Lundström

In recent years there has been increasing interest in hand-arm vibration at frequencies above 1 kHz. One reason is that an exposure to high-frequency vibration from dentist's handpieces, ultrasound therapy devices, pedestal grinders and percussive tools has been suggested to have detrimental effects on man. A decrease in tactile sensitivity and a high prevalence of VWF has been reported. Thus, these disturbances resembled those to be expected only among workers using tools covered by ISO 5349.

F2-3 9:40
CLINICAL ASPECTS OF VIBRATION SYNDROME
I. Fyvkkö

At present it seems likely that the different components of the vibration syndrome e.g., vibration-induced white finger (VWF), numbing of the hands and arms, muscular fatigue and the presumptive bone degeneration may arise independently, and therefore they should be evaluated separately. Evidence of changes in the autonomic nervous functions of the body due to local vibration is not confirmative. Much of the diagnostic weight for VWF can be received from accurate case history, although in early changes, even the history may be atypical.

Contributed Papers

F2-4 10:10
QUANTIFYING THE NEUROLOGICAL COMPONENT OF THE HAND-ARM VIBRATION SYNDROME
A.J. Brammer, W. Taylor and J.E. Percey

Degraded tactile spatial resolution, as measured by step and gap detection using an aesthesiometer, has been found, on average, in severe cases of vibration-induced white finger. Present evidence suggests that this is due to degeneration of slowly adapting (type I) and, possibly, quickly adapting mechanoreceptors, and/or their nerve fibres. The apparatus commonly employed for measuring vibro-tactile perception thresholds in clinical studies records the sensitivity of the Pacinian corpuscles which play no role in step or gap detection, but may provide early evidence of neurological changes.

F2-5 10:30
IMPROVED ESTHESIOMETER FOR MEASURING TACTILE PERCEPTION IN HANDS EXPOSED TO VIBRATION
Z.F. Reif, D. Marshall, A.J. Brammer, J.E. Percey and W. Taylor

An improved aesthesiometer has been constructed in which a test surface is moved across a finger tip at a controlled speed and contact force. Preliminary measurements of two components of tactile spatial perception have been conducted on small groups of students and laboratory workers, and on four chain saw operators with clinical evidence of vibration-induced nerve disorders. Abnormal step or gap detection thresholds, but often not both, have been found in each of the vibration-exposed workers' hands.
PHYSIOLOGICAL NOISE AND THE DETERMINATION OF VIBROTACTILE PERCEPTION THRESHOLDS  
J.R. Percy, A.J. Bramer and W. Taylor

Vibration of physiological origin (physiological noise) has been studied when a small diameter probe, attached to a vibrator and accelerometer for the determination of vibrotactile perception thresholds, is held in contact with a finger tip. The configuration was chosen to simulate common clinical practice in determining that threshold. Simultaneous measurements of threshold and physiological noise indicate that vibrotactile thresholds throughout the frequency range 2-250 Hz may be influenced by the magnitude of this noise through masking or adaptation.

HUMAN VIBRATION EXPOSURE OF SKIDDER OPERATORS IN THE QUEBEC FORESTRY SECTOR  
P.-E. Boileau, H. Scory, J. Boutin, and J.-G. Martel

This paper presents the results of in-situ field vibration measurements carried out on skidders operating in some of Quebec's logging operations. Triaxial rectilinear vibration levels measured on the frame and at the driver-seat interface are reported. Crest factors are determined to characterize shocks, and an assessment of the severity of the exposure is made in accordance with the ISO 2631 standard. Indications are given as to potential improvements which could be made to reduce the effect of terrain-induced vibration on the operator.

THURSDAY MORNING, 31 JULY 1986

Structured session K6: Musical instruments: very old and very new

Chairman and co-organiser: W. Savage, Univ. of Iowa, Dept. Physics and Astronomy, Iowa City, IA 52242, U.S.A.

Co-organiser: A. Benade, Case Western Reserve Univ., Physics Dept., Cleveland, OH 44106, U.S.A.

Chairman's Introduction  8:35

Special Invited Lecture  8:40

K6-1

CHINESE MUSICAL INSTRUMENTS OF PRECHRISTIAN ERA  
Maa Dah-You, Chen Tong

From prehistorical time through Tang, Ya, Xia, Shang, Zhou, Qin and western Han dynasties (down to 25 A.D.), the Chinese Han people developed its music and musical instruments nearly independently, and the development entered a new stage due to the significant influence of the northern and western peoples thereafter. From Zhou dynasty (beginning at 1066 B.C.) on, music was taken as the state affair, and music and musical instrument-making flourished to a high level.
ACOUSTICS OF THE DIDJERIDU
N.H. Fletcher

The didjerida of the Australian aborigines has remained unchanged as a musical instrument for perhaps 10,000 years. It is still used extensively in tribal music and has also found its way into some contemporary popular music. It consists simply of a gently expanding hollow wooden tube of natural origin, one to two metres long, blown with the lips as in a trumpet. The one- or two-note mode repertoire is enhanced by rhythmic articulation, vowel-like timbre modifications and vocal effects. The acoustical principles of this performance technique are discussed.

BELLS WITH MAJOR THIRDS INSTEAD OF MINOR THIRDS
André Lehr

The traditional carillon-bell possesses five important partials. If the hum note has note C then the series is: C - G1 - DISI - G1 - C2. The consequence is that carillon music always sounds with a minor timbre. Many musicians don't like this; other musicians accept this particularity as typical for a carillon. Research has shown that if the DISI is replaced by E1, the consonance of a single bell and bells together is much better. A bell profile in which a major third has taken the place of the minor third, while all other partials remain the same, has been developed and appears to be a great success.

DIGITAL MUSICAL INSTRUMENTS
R.A. Moog

The proliferation of large scale digital integrated circuits has opened the way to developing new electronic musical instruments. 'Sampling Instruments' store coded representations of waveforms of complete musical sounds in ROM, for reading out at a time and rate determined by the musician. Additive Synthesis instruments store the spectral variations of musical sounds. Modulated Waveform instruments read out sinusoids at time-varying rates, while Digital Oscillator instruments read out harmonically-rich waveforms.

Discussion

WOODWINDS: THE EVOLUTIONARY PATH SINCE 1700
A.H. Benade

The acoustical design principles for woodwind musical instruments have changed enormously around 1700 and have been stable ever since. An outline of the physical bases of the newer design will be presented, along with a sketch of the evolutionary paths of several instrument families. "Rationalization" in the mid-1800s often gave "fingers convenience" with some loss of responsiveness, at times making older music difficult to play. Today, acoustics is beginning to elucidate these problems and to indicate ways of circumventing them.

CHARACTERIZING AND IMPROVING THE CATALAN WOODWINDS
J. Aguilar

A research programme is in progress to characterize the acoustical identity of the Catalan folk woodwinds: "tenora", "tenor shawm", "tile", "treble shawm" and "flabiol", high pitched pipe-, which can be regarded as a 19th Century version of ancient instruments, and to improve them without impairing their identity. Spectral analysis, transient capture and tuning measurements on actual sounds have been carried out. Acoustical impedance and impulse response have been calculated and experimentally obtained, and they are now being used to calculate "ab initio" oscillations.
Contributed Papers

B11-1 8:40

SOURCES OF VARIABILITY IN NORMAL HEARING SENSITIVITY
D.N. Robinson

Hearing threshold levels (HTL) of normal young persons range over some ±15 dB, and this range increases with age. It follows that an individual audiogram does not necessarily indicate the true amount of a hearing loss. Young and older otologically normal groups were tested by brief-tone audiometry and tone-on-tone masking as well as by conventional pure-tone audiometry. Statistical analysis showed that HTL's can be resolved into components, and that up to 2/3 of the crude variance is accountable to temporal integration and frequency selectivity.

B11-2 9:00

A DIRECT DETERMINATION FOR HEARING THRESHOLD OF BONE CONDUCTION BY USING IMPEDANCE HEAD
Zheg Jucal, Shen Yang and Shuai Zhenfing

In order to omit the error concerned the calibration of bone conductors using artificial mastoid as ordinary used, a direct determination for hearing threshold of bone conduction by using impedance head which stabilize in 1dB over 14 years is described. 106 otological normal subjects aged from 18 to 50 years were selected and tested under an audiological acoustical condition of 14dBa to 56dBa noise level as international recommendations. Results in the frequency range of 250Hz to 4000Hz show well coincidence with ISO data.

B11-3 9:20

SIMULATED HEARING LOSS: A TOOL FOR COMPARING NORMAL AND IMPAIRED HEARING, M. Florentine and S. Buus

Symptoms typical of cochlear impairments such as elevated thresholds, rapid loudness growth, and reduced dynamic range can be produced in a normal ear by presenting a spectrally shaped masking noise. However, certain aspects of spectral and temporal processing remain unchanged in the presence of masking. Thus, simulating a cochlear impairment by masking permits separating the effects of abnormal intensity perception from those of possible abnormalities in spectral and temporal processing. Psychoacoustical tuning curves and gap detection functions show both similarities and differences between real and simulated cochlear impairments.

B11-4 9:40

THE EXTRA EFFECT OF MASKER FLUCTUATIONS ON THE SRT FOR HEARING-IMPAIRED LISTENERS
J.M. Festen and R. Plomp

The speech-reception threshold (SRT) for sentences was measured for various fluctuating noise maskers with spectra equal to the spectrum of the sentences. The results indicate that hearing-impaired listeners are more much susceptible to fluctuations than normal-hearing listeners. Whereas in steady-state noise the SRT for a group of hearing-impaired listeners was about 3 dB higher than for normal-hearing listeners, this difference was almost 8 dB for fluctuating noise. The largest effect (10.5 dB) was found for reversed speech as the masker.

B11-5 10:00

IS HIGH-FREQUENCY HEARING NECESSARY FOR NORMAL LOUDESNESS GROWTH AT LOW FREQUENCIES?
R.F. Hellman and C.H. Meiselman

Loudness was measured by magnitude estimation and production for nine listeners with bilateral high-frequency cochlear losses. Within the normal-hearing region two test frequencies, a minimum of one octave apart, were studied. Despite a marked decrease in threshold sensitivity at frequencies just above the upper test frequency, the range over which loudness grows was the same at both test frequencies. As found in normal hearing, the results suggest that the loudness-growth range does not depend on the high-frequency spread of excitation.

B11-6 10:20

PSYCHOACOUSTIC PERFORMANCE IN SUBJECTS WITH DISCRETE NOISE INDUCED HEARING LOSS.
F. Lindgren

In order to study if individuals susceptible to NIHL will show a changed performance in psychoacoustic tests prior to the manifestation of the hearing loss in a pure tone audiogram, we carried out a study comprising two groups of subjects; one group consisting of normal hearing subjects, and another group with moderate NIHL. Both groups participated in our psychoacoustic test battery. The results indicated a difference in sharpness in psychoacoustic tuning curves between the groups, as well as differences in acoustic reflex thresholds.
B11-7  

t  10:40  

Bases for the Analysis of Psycho-Social Disadvantages Due to Noise-Induced Hearing Loss  
M. Lalonde and R. Hétu  

A questionnaire was developed to enquire on the family reactions to the consequences of noise-induced hearing loss. Answers from a population industrial workers were factor analysed. The results clearly show the family reactions contribute to the psycho-social disadvantages associated with hearing impairments and disabilities.

B11-8  

t  11:00  

Qualitative Analysis of Perceived Hearing Disabilities and Handicaps Among Noise-Exposed Workers  
L. Girard, R. Hétu, L.Getty.

The hearing of a group of 26 workers exposed to industrial noise for more than 5 years was tested. Then, they were interviewed on perceived hearing disabilities, coping strategies and psycho-social disadvantages resulting from temporary and permanent hearing loss. A qualitative analysis of the data allowed to draw an extensive list of perceived handicaps and of the variables that are more likely to determine their occurrence. Implications for rehabilitative services are drawn.

B11-9  

t  11:20  

Computerized Audiometry Station  
E. Colomb, J.C. Ventura, A. Pegna  

A computerized audiometry station has been developed in order to investigate psychoacoustical phenomena such as frequential masking and critical bands. The station is controlled by a HP85B desktop computer. It operates through a IEEE-488 bus. Auditory thresholds with eventual additional masking are measured using the Bekesy method. The width of critical bands is tracked by the pure tone in a frequency gap technique. The obtained results are displayed graphically and stored, allowing for statistical analysis of the accumulated data.

B11-10  

t  11:40  

Protection of Ears During Self-Utterance - A Consideration on Bone-Conducted Voice  
Kono, Shunichi, Tanaka, Hiroshi and Sone, Toshio  

Some protection mechanism against sound is observed in hearing during utterance, though its mechanism is still unclear. The utterance causes far intense bone-conducted sound in the uttering subject’s ears as compared with one caused by airborne sound, so that the mechanism such as middle-ear muscle contraction may work for protecting ears against it. From this point of view, we studied the alleviation of TTS due to external sound by adding the bone-conducted voice-like sound or band-limited noise to a subject through a vibrator attached to his forehead and showed that the bone-conducted sounds were actually effective.

THURSDAY MORNING, 31 JULY 1986  

Session C10: Environmental noise: measurement, prediction and control  
Chairman: Z. Maekawa, Faculty of Engineering, Kobe University, Rokko Kobe, 657, Japan

Contributed Papers

C10-1  

Aircraft Noise Abatement Corresponding to Town- and Regional Planning?  
Lothar G.S. Prang  

In spite of notable results in practice and research the sensibility against a/c-noise in the vicinity of airports has not yet reached tolerable proportions. This is considerably based on the dynamic development of aviation contrary to the static axioms of town- and regional planning. Moreover differing interests of economical and ecological groups impede appropriate solutions. Recommendations are proposed.

C10-2  

Measurement of Noise Emitted by Different Trains in Different Stations of Madrid Underground  
J.S. Santiago, J. Pons, E. Mateos and E. Costa  

Measurements of the noise emitted by three different types of trains of Madrid's Underground in seven stations have been made; some results showing the different spectra of the noises in two situations are presented. The data obtained have been applied to a simple model of circulation of the trains, to calculate the equivalent continuous sound levels in the platforms of the stations, for the three working shifts (6 am to 2 am), and the noise doses to which the personnel working in the stations is exposed, at the working place of the control cabin of each station.
AURAL DETECTABILITY LIMITS FOR ARMY MATERIEL
G. R. Garinther and J. T. Kalb

Noise limits for preventing ground-to-ground aural detectability of Army materiel have been developed. Those factors which affect propagation and detection of sound are discussed, along with those conditions for each factor which are most likely to be encountered in practice. The noise limits have been computed based upon the appropriate parameters. The limits are presented in 1/3-octave band levels which are not to be exceeded in any band at a stipulated distance from the materiel to provide nondetectability at a required distance.

PEAK LEVEL FLUCTUATION OF IMPULSIVE SOUND OUTDOORS
L. Schreiber and U. J. Kurze

According to statistical considerations quite some effort is required to assess the noise in the neighbourhood of shooting ranges. Varying meteorological conditions that result in a range of fluctuating sound levels (Lp, etc., or Lp') require a minimum number of independent measurements for each particular source position. In view of a possible reduction of the measuring effort, levels measured up to 800 m distance from a shooting range have been compared with levels from a shock tube, measured under well defined downwind conditions.

NOISE CONTROL AT CANADIAN NUCLEAR POWER STATIONS
M. N. Osman

The need for noise control during the design phase of nuclear power stations in Ontario, Canada has been recognized and some concentrated efforts have been deployed in the last decade. This paper describes the details of the noise control efforts including requirements, implementation and experience for both the workplace and the environment. Emphasis is given on the newest nuclear power station, Darlington 'A', being built on Lake Ontario about 50 km east of Metropolitan Toronto.

MODELE D'IMPEDANCE D'UN SOL A REACTION LOCALISEE
V. Legeay, M. Bérengier

On presente une formulation d'un modele d'impedance d'un sol plan a reaction localisee determine empiriquement afin de simuler au mieux le module du rapport des champs acoustiques mesurees en deux points de la surface du sol, alignes avec une source sonore ponctuelle, dans des conditions de propagation du sol en incidence rasante au-dessus du sol.

STANDARDIZED PROCEDURE FOR RATING INDUSTRIAL NOISE
L. N. Talbo

In the present work, a standardized procedure for rating industrial noise that affects people of nearby houses, is analyzed. In our cities, the direct interconnection between dwellings and specially small factories is usual to be found. The rating procedure is based on the determination of a margin, i.e., the increase in "A" levels due to the intrusive noise from preexisting one.
THURSDAY MORNING, 31 JULY 1986

Session D6: Structure-borne sound

Chairman: M. Koyasu, Acoustical Engineering Lab., Shinjuku 2-13-11-806, Shinjuku-ku, Tokyo 160, Japan

Contributed Papers

D6-1 8:40
RELATIONSHIP BETWEEN THE INTENSITY AND ENERGY DENSITY IN THE RESPONSE OF COUPLED ONE-DIMENSIONAL DYNAMIC SYSTEMS
J. Dickey, G. Maidanik and L.J. Maga

In a recent formalism the linear response of coupled one-dimensional dynamic systems was derived. (L. J. Maga and G. Maidanik 1983 Journal of Sound and Vibration 85, 473-488). In this work quadratic forms were defined and constructed to estimate the energy densities in the dynamic systems. In the present paper quadratic forms that estimate the intensities are also considered. The relationship between the energy densities and the intensities is examined and discussed.

D6-2 9:00
POWER FLOW BETWEEN NON-CONSERVATIVELY COUPLED OSCILLATORS
F.J. Pahy and D. Yao

Two mass-spring-damper systems are coupled together by linear elastic and velocity-proportional damping elements in parallel. The oscillators are subjected to uncorrelated white noise forces. The time-average power flow between the oscillators is found to be proportional not only to the difference between oscillator energies, as with conservative coupling, but also proportional to the individual oscillator energies. The practical implications of this behavior are investigated by numerical evaluation of the power flow equation.

D6-3 9:20
MOMENT MOBILITY OF T-INTERSECTIONS OF PLATES
Bjorn A T Petersson

A theoretical model for the description of the dynamic behaviour of T-intersections of plates, due to a moment excitation has been developed. It is found that the moment mobility is stiffness governed but with a larger relative real part than the corresponding force mobility. Theoretical results will be presented, illustrating two excitation conditions. The results are compared with those obtained for semi-infinite and infinite plates.

D6-4 9:40
COUPLING LOSS FACTORS IN CONNECTED CYLINDRICAL SHELLS
M.P. Norton and P.R. Keswick

Coupling loss factors (CLF's) describe the energy flow between coupled sets of oscillators. Experimental results for a cylindrical shell with a step discontinuity in wall thickness at its mid point are presented. They show that: (i) The behaviour of the system varies, depending on the part being excited, and in some instances strong coupling/equipartition of energy exists whilst there is light coupling in others; (ii) Negative CLF's only occur when there are large changes in modal density between contiguous frequency bands.

D6-5 10:00
SURFACE WAVES ON ELASTIC SPHEROIDS AND RELATED OBJECTS: ACOUSTIC RESONANCES

We formulate a resonance condition in integral form for surface waves on elastic spheroids, based on the assumption of phase matching after repeated circumnavigations along geodesic paths. The solution of this resonance condition determines the (complex) eigenfrequencies of the object, as well as the (real) resonance frequencies for acoustic resonance scattering.

D6-6 10:20
THE INFLUENCE OF CURVATURE ON STRUCTURE-BORNE ACOUSTICAL POWER PROPAGATION IN A CYLINDRICAL CIRCULAR SHELL
G. Pavić

The expressions for the power flow per unit surface length through a circular cylindrical shell are shown to have the same terms as the corresponding expressions for flat plates, plus an additional term which depends on the curvature of the shell. The contribution of the curvature effect on the power flow, originating partly from the coupling between the normal and the tangential motions, dominates at certain frequencies.
STRUCTURE-BORNE SOUND SOURCE STRENGTH CHARACTERIZATION
J.M. Mondot

Even though noise problems often originate from structure-borne sound sources such as machinery, methods to characterize the structural acoustic source strength of an active system are much less developed than for airborne sound. From an alternative description of the complex power transmitted from a source structure to a receiving one, a general source parameter is found. This parameter is called the source descriptor. The proposed contribution contains an overview of the theoretical background and experimental studies.

VIBRATION ANALYSIS AS A TOOL FOR PREDICTION OF MACHINE BREAKDOWN WITH MIL-GRADED WEATHERPROOF INSTRUMENTATION
M. Angelo

The idea of using the vibration signal from a rotating machine to determine health and fitness has gained a great deal of attention in the course of the last decade. The various techniques and instrumentation that have been developed are discussed here.

[There is no text of this paper in the proceedings]
PREVISION DES NIVEAUX SONORES DANS DES LOCAUX COMPORTANT DES ZONES D’ENCOREMBEMENT DIFFERENT.

J.L. Barbry, A.M. Ondet, M. Cafaxe


MODELISATION DE LA PROPAGATION DU SON DANS DES LOCAUX DE GRANDES DIMENSIONS ENCOMBRES

N. Auletta

Ce travail est un essai d’explication entre un modèle et l’expérience de la propagation du son dans les grands locaux encombrés. Nous proposons un modèle mathématique du champ sonore créé par une source unique fonctionnant dans des locaux plate en introduisant les modifications de ce champ apportées par la présence des encombrements.
La théorie a été vérifiée expérimentalement sur une maquette à échelle 1/20.

METODE INFORMATIQUE D’ACOUSTIQUE PREVISIONNELLE DANS LES LOCAUX AVEC PRISE EN COMPTE DE LA DIRECTIVITE DES SOURCES

J. Delafontaine et J. Billaud

Les auteurs ont développé une méthode informatique basée sur la méthode des rayons (réflexion spéculaire), permettant d’intégrer une forme de local quelconque, des zones d’encorembrement, la possibilité de corrections partielles, l’implantation des sources (avec leur directivité). La visualisation des calculs s’effectue sous forme de cartes de bruit en couleur.

APPLICATION OF THE IMAGINARY SOURCES METHOD TO THE REFLECTION OF SOUND FROM A SPHERE

W. Straszewics, K. Gawlas

Using the principle of angle equality the authors determine the direction of rays reflected from a sphere in the symmetry planes passing through the source. They define the partial quasi-imaginary sources lying at the intersections of the extentsions of neighbouring reflected rays and determine the equal pressure surfaces/directivity patterns. Quasi-imaginary source is defined, which extend the applicability of the computer method of imaginary sources. The analysis results are verified experimentally.
Session G7: Acousto-optics

Chairman: R. Mertens, Instituut voor Theoretische Mechanica, Rijksuniversiteit Gent, Krijgslaan 281, B-9000 Gent, Belgium

Contributed Papers

G7-1  8:40

NUMERICAL INTEGRATION OF THE TRUNCATED RAMAN-NATH SYSTEM
R. Mertens, J.-P. Ottey and W. Hereman

A numerical integration of the truncated Raman-Nath system, based on an eigenvalue method, is carried out for selected values of the Klein-Cook parameter Q (between 0.1 and 50) and for Raman-Nath's parameter ν ranging from 0 to 15. The zeroth and first order intensities thus obtained are compared with the squared Bessel function expressions and the squared sine or cosine-expressions obtained from the first order approximation method. Some seminal ideas and illustrative plots for the investigation of criteria for Raman-Nath and Bragg diffraction regimes are also presented.

G7-2  9:00

USE OF OPTICAL DYNAMICAL HOLOGRAPHY FOR ACOUSTICAL SIGNAL DETECTING
L.M. Lymanshev and V.V. Zosinov

Optical receivers based on detection phase of light are now successfully used. Wider application of such receivers depend on use of multimode light beams. Measurements of phase modulation of the beam with known technique meet difficulties that may be avoided using energy exchange of light beams in dynamical holography.

Experiments were carried with NBS crystals. Sensitivity of $2 \times 10^{-4}$ to phase modulation was achieved.

G7-3  9:20

AN OPTICAL FIBER PROBE FOR ULTRASONIC STUDIES,
F. W. Cuomo

The characterization of ultrasonic fields has utilized visualization methods and probing with miniature sensors. By schlieren imaging two-dimensional quantitative reconstruction has been achieved and three-dimensional data has been obtained with computerized transverse tomography. Recent advances in polymer science have led to the development of polyvinylidene fluoride hydrophones and new transduction mechanisms have been introduced by the application of optical fiber technology. This paper suggests the use of miniature optical fiber probes for three-dimensional ultrasonic research.

G7-4  9:40

ULTRASONIC PULSE SHAPE DEFORMATION OBSERVATION THROUGH OPTICAL PROBING
T. H. Neighbors and W. G. Mayer

Finite amplitude ultrasonic pulse optical probing is treated for arbitrary pulse shapes. A modified form of Burgers' equation is used to describe propagation. Changes in time and frequency domain characteristics are determined as a function of range, rise time, modulation frequency, and initial amplitude. Pulsed ultrasonic wave diffraction theory is used to determine the resulting changes in the farfield diffraction pattern as a technique for observing changes in spectral composition.

G7-5  10:00

ULTRASONIC ATTENUATION IN THE THICKNESS DIRECTION OF THIN POLYMER FILMS AT FREQUENCIES UP TO 1 GHz
G. M. Sessler, R. Gerhard-Multhaupt, and J. E. West

Laser-induced pressure pulses (LIAPP's) are generated by absorption of short laser pulses on the coated surface of polymer films. The LIAPP's propagate through the surface-charged or biased samples and are repeatedly reflected. From a comparison of LIAPP spectra of successive reflections, the attenuation is determined as a function of frequency. Attenuation constants per wavelength in PEP, PCTFE, PI, PVDF, PETF, and PMMA are found to be independent of frequency, but to vary strongly with material.

G7-6  10:20

INTERPRETATION OF ACOUSTICAL HOLOGRAPHY AS A DECONVOLUTION PROCESS, W. S. Gan

Acoustical holography is formulated within the framework of generalized holography using Huygen's principle and inhomogeneous Helmholtz equation. A rigorous derivation of the convolution integral for generalized holography is given. The algorithms for evaluation of convolution integral and deconvolution integral are also derived.
G7-7
10:40
EXPERIMENTAL DETERMINATION OF THE CORRELATION RADIUS OF CONCENTRATION FLUCTUATION IN THE CRITICAL MIXTURE N-AMYLIC ALCOHOL - NITROMETHANE
M. Zabowski and T. Hornowski

Values of the correlation radius of concentration fluctuation in the critical mixture n-amyl alcohol - nitromethane, obtained from Rayleigh light scattering, are reported. The dependences obtained, compared with the predictions of Fixman's and Chabane's theories, show rather good correspondence.

THURSDAY MORNING, 31 JULY 1986
ROOM 206D, 8:40 - 11:40

Session J3: Sound generation by fluid flow and aeroacoustics
Chairman: M. Strasberg, 3531 Yuma Street, N.W., Washington, D.C. 20008, U.S.A.

Contributed Papers

J3-1
8:40
DIMENSIONAL ANALYSIS OF WIND SCREEN NOISE
M. Strasberg

It is shown that data on wind screen noise in spherical and cylindrical windscreen obtained from disparate sources can be collapsed into a single universal curve if the data are plotted in non-dimensional form. Appropriate dimensionless variables are a dimensionless frequency \((FD/V)\) plotted against a sound pressure coefficient \((p_{1/3}/\rho V^2)\). In the above, \(f\) is frequency, \(D\) screen diameter, \(V\) wind speed, \(p_{1/3}\) sound pressure of the wind noise in a 1/3-octave band, and \(\rho\) fluid density.

J3-2
9:00
SPECTRUM OF NOISE FROM SHOCK-TURBULENCE INTERACTION
H. S. Ribner

This work relates to our early NACA (now NASA) studies. They predicted generation of intense noise (observed for supersonic jets) resulting from passage of turbulence through a shock wave. The first analyzed the interaction of an oblique sinusoidal “shear wave” with a plane shock. The second generalized this into a 3D spectrum analysis for turbulence encountering the shock. Numerical calculations were limited to mean square quantities and broadband noise level in dB. Herein formulas for 1D spectra are developed and evaluated numerically for isotropic pre-shock turbulence and for the resulting sound field.

J3-3
9:20
NONLINEAR EVOLUTION OF THREE-DIMENSIONAL VORTICAL DISTURBANCES IN A STOKES BOUNDARY LAYER
Kay Herbert and Charles Thompson

The stability of the Stokes boundary layer generated by an acoustic traveling wave is examined. Special attention is given to the problem of weakly nonlinear evolution of 3-D vortical disturbances. It is shown that amplitude of the disturbance is the solution of the nonlinear Schrödinger equation

\[
\frac{\partial^2 \hat{A}}{\partial z^2} + (\hat{z} + \hat{T}) \hat{A} - \hat{A} | \hat{A} |^2 = \gamma \frac{\partial \hat{A}}{\partial \tau}
\]

where \(\hat{A}\) is the disturbance amplitude, and \(\gamma\) and \(\hat{T}\) are parameters dependent on the properties of the acoustic field and boundary geometry.

J3-4
9:40
ON THE ACOUSTIC FIELD GENERATED IN A PIPE BY SEPARATED SUBSONIC AND SUPersonic FLOW.
M. K. Bull and W. T. Johnson

Measurements of internal wall-pressure fluctuations in the separated and reattaching flow downstream of an orifice plate in a turbulent pipe flow show that the ratio of rms wall-pressure to dynamic pressure in the jet issuing from the orifice does not change significantly from subsonic to supersonic flow. There are, however, changes in spectral distribution. Dramatic reductions in internal spectral levels and external acoustic radiation levels occur for small orifices. These are attributed to reduced jet turbulence intensities.
ON THE INFLUENCE OF SOURCE COHERENCE ON JET NOISE  
R.E. Musaphir and M. Zinideluk

A model of quadrupoles on a ring is used to investigate the influence of azimuthal source coherence on jet noise far field sound pressure correlations, for microphones lying on the ring plane. The analysis is restricted to low Helmholtz number. It is shown that, although the existing experimental data are not thoroughly consistent with a model of incoherent point quadrupoles, the analysis of discrepancies points rather to the inclusion of dipoles in the model than to the allowance of significant source coherence.

NOISE FROM WIND TURBINES  
S.A.L. Glegg

This paper describes a computational method which has been developed for the prediction of broadband rotor noise in atmospheric turbulence. The method is based on quite general theoretical formulations and is applied to the prediction of wind turbine noise. It has also been necessary to consider the noise radiated to the nearfield of the rotor, and the effect of scattering by the support tower. The results are compared with a detailed set of measurements made on a 20m diameter Wind Turbine.

INVESTIGATION OF SEPARATION-PHENOMENA ABOUT A CYLINDER IN HORIZONTAL FLOW  
H. Stewitt

An elliptical mirror equipped with a small loudspeaker in one of the two focal points is adjusted to generate an acoustic field of high intensity on the surface of a cylinder, mounted in a windtunnel. The intensity of this acoustic field, corresponding to the flow fluctuations, is measured by two electret microphones flushly implanted into the surface of the cylinder. The amplitude modulation as well as the phase modulation of these signals destined by spectral analysis, are investigated as functions of the free stream velocity.

STUDY ON NOISE OF AN AXIAL FLOW FAN WITHOUT STATOR  
S. Suzuki, Y. Uga and K. Komatsu

Axial fans without a stator are widely used in heat pump and cooling towers. In the present study, the authors conducted on the elements of the rotor blade by changing the chord length of the blade, the position of the maximum camber in order to make clear the effects of the blade elements on the noise reduction. Furthermore, by use of a wind tunnel they observed a separated flow on the surface of the single blade with a Schlieren device to investigate the correlation between these elements and fan noise.

COMPUTATION OF SOUND GENERATED BY A UNIFORM FLOW OVER A CYLINDER  
A. Petitjean, P. Esposito

Sound radiated by a cylinder normal to a uniform stream at the Reynolds number of 200 is computed. According to CURLE'S theory, the noise may be determined from the distribution of pressure on the surface of the cylinder. The 3D, incompressible, time-dependant flowfield is first calculated using a finite difference, splitting up method. The von Karman vortex street is spontaneously obtained; then the spectral characteristics of the sound are derived. Comparisons of these results with data of the literature show good agreement.
Plenary Session 6: Adaptive mechanisms of audition in echolocating bats.

Speaker: G. Neuwiler, Zoologisches Institut der Universität München, Luisenstrasse 4, 8 München 2, F.R.G.

Chairman: R. Beyer, Department of Physics, Brown University, Providence, RI 02912, USA

ADAPTIVE MECHANISMS OF AUDITION IN ECHOLOCATING BATS
G. Neuwiler
Based on recent behavioral and neuronal research the hypothesis is proposed that in bats echolocation is an achievement of specific time analysis in the auditory brain. In addition, bat species have adaptations for echolocation in various environments. Auditory mechanisms that bat species apply for overcoming echo-noise while foraging in dense vegetation or for echolocation over long ranges in open spaces are described.

Plenary Session 7: Recent achievements in the field of quantum acoustics.

Speaker: Yu. V. Gulyaev, Institute of Radio Engineering and Electronics, Academy of Science, Prospekt Karl Marks 18, Moscow, USSR

Chairman: R. Beyer, Department of Physics, Brown University, Providence, RI 02912, USA

RECENT ACHIEVEMENTS IN THE FIELD OF QUANTUM ACOUSTICS
Yu. V. Gulyaev, Academy of Sciences, Moscow, USSR

Theoretical and experimental work on excitation, propagation and interaction of high-frequency acoustic waves with electromagnetic fields and conduction electrons in solids is reviewed. Problems of thermal phonon kinetics in solids including impurity crystals, as well as "conjugation" effects of hypersonic attenuation are considered. The excitation of the coupled acousto-electromagnetic oscillations in crystals and in ac electric fields has been examined. Nonlinear interactions of acousto-electronic and acousto-optic solitons in crystals are discussed. The original papers on transformation of electromagnetic waves and sound in pure metals, propagation of longwave phonons in one-dimensional disordered conductors, the effect of phonon flows on a streamer electric breakdown of crystals and other related problems have been analyzed. [The text of this paper was not received in time to appear in the Proceedings.]
CLOSING CEREMONY AND FAREWELL RECEPTION
CÉRÉMONIE DE CLÔTURE ET RÉCEPTION D'ADIEU
ABSCHLUSSFÄER UND ABSCHIEDEMPFANG

15:30 Closing Ceremony

12 ICA in Review

Announcement of the 13th International Congress on Acoustics to be held in 1989

Speakers: H. Myncke, Chairman, International Commission on Acoustics
E.A.G. Shaw, President of the Congress
and others

16:00 Farewell Reception
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