The 2005 International Congress and
Exposition on Noise Control Engineering

Congress Programme and Abstracts

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Rio de Janeiro, Brazil
07 - 10 August 2005

The International Institute of Noise Control Engineering
Technical Society Brazilian Acoustics Society
Federation of Brazilian Engineering Societies

i-ince

SOBRAC

FENASE

Welcome Message

Dear Colleagues,

It is with great pleasure that we host the Internoise 2005 Congress being held from 7 to 10 August 2005 which is sponsored by I-INCE and organized by the Brazilian Acoustical Society (SOBRAC) together with the Ibero-American Federation of Acoustics (FIA). The Congress venue will be the SOFITEL Hotel on the beautiful Copacabana beach in Rio de Janeiro, Brazil. The main theme of the Congress is ENVIRONMENTAL NOISE CONTROL, but technical papers in all areas of noise and vibration control are very welcome.
This may be your first visit to South America but we doubt it will be your last. At this Internoise 2005 Congress, you will not only exchange information with your international colleagues, but will also be able to discover the high potential for noise and vibration control engineering in South America. Brazilian industry is ever-increasing, with products such as passenger jet airplanes, and some of the largest automotive assembly plants in the world, representing major brands. And these are but two of the many categories of South American products for which noise and vibration technology plays a very important role regarding reliability, comfort and quality. Other categories include hydroelectric and thermal power plants, food industries, domestic appliance manufacturers, construction companies, and many others.
Recently, as a consequence of the worker's union activities and political changes, a team of government health and safety officers has been created and now enforces noise and vibration limits in industry. In addition to noise and vibration limits in the workplace, the federal and local governments have specified new environmental limits for noise in residential and other noise sensitive areas. Effort is been focused on product sound quality improvement in many of the industries.
The birth and growth of SOBRAC in the last 21 years, has occurred in parallel to the increasing level and size of the academic and technical community, dealing with acoustics and vibration in Brazil. A significant number of universities and research centers, both governmental and private, have created divisions and labs to address our area, noise and vibration control being the main field of application.
All of these activities require training and consulting, measurement and analysis equipment, noise and vibration prediction tools, control materials and manufacturing technologies for noise and vibration solutions. Internoise 2005 will provide the opportunity to exchange ideas and make contact with emerging activities on this large continent. We expect a very rich exhibition of worldwide noise and vibration equipment, software, and materials for noise and vibration control. Pre-congress courses and distinguished speakers will provide information on up-to-date technologies in the field. We thus welcome you to Internoise 2005, where you will have a fruitful and enjoyable time in beautiful, tropical Brazil.

Samir N. Y. Gerges

President - Internoise 2005

Contents

Congress Programme

General Information

Banquet on Tuesday 9 August 2005

The Congress dinner will take place on Tuesday 9 August 2005 at the PORCÃO Rio Flamengo beach restaurant (Infante Dom Henrique Avenue, Aterro do Flamengo). Barbecue and grills of the best Brazilian meat will be served on the table until you have had enough to eat (usually there are red and green signs which with you indicate to the waiter, Green means 'need more' and Red means 'stop'). Salads, hot and cold dishes are self service. Drinks include the famous Brazilian Caipirinha, beer, fruit cocktail and soft drinks. Wine can be ordered and is not included in the banquet price.
The restaurant overlooks the beautiful tropical beach, the statue of Christ (*Cristo Redentor*) and the Sugar Loaf mountain (*Pão de Açucar*). Typical shows and dance music will be provided, including Samba. Buses will depart from SOFITEL from 18:30 h to 19:00 h.

Climate and clothing

Rio de Janeiro enjoys beautiful weather all year round, with an average daily temperature in August of 15 to 30 °C. You will normally not need formal clothing, such as suit and necktie, but short sleeved shirts or blouses, light trousers and maybe a "pullover" or an extra layer are recommended.

Disclaimer

The organising committee accepts no liability for any injuries or losses incurred by participants and/or accompanying persons, nor for loss of, or damage to, any luggage or personal belongings.

Lunch/Coffee breaks

Coffee breaks with a choice of beverage and box lunches are included in the congress registration fee and will be served on Monday, Tuesday and Wednesday at the Sofitel Foyer (Level E).

Money and credit cards

The official Brazilian currency is the REAL (R$). The approximate exchange rate (July 2005) is one USD ≈ 2.4 R$, one euro €≈ 2.81 R$, one Yen ¥ ≈ 0.02 R$ and one English Pound £ ≈ 4.2 R$. The Brazilian Real is divided into 100 centavos. Bank notes are 100, 50, 10, 5, and 1 R$. Coins are 1 real or 50, 25, 10, 5 and 1 centavo. All banks and money exchange companies accept traveller's cheques and foreign currency. It is advisable to take traveler's cheques or currency in USD or EUROS as this is more readily exchanged than other currencies. Banking hours are from 10:00 to 16:00 h, Monday to Friday. It is recommended that you change a small amount of money on arrival to pay the taxi, etc. Major credit cards are accepted everywhere. Cards such as MasterCard, American Express, Dinner Club and VISA are accepted in the majority of hotels, shops and restaurants. Note that most cashpoints (ATM-cash machines) are out of service from 22:00 to 6:00.

Multimedia Desk

The multimedia desk with facilities for preview and upload of presentations, and e-mail access will be situated in the Ipanema room. Opening hours are from 09:00 to 18:00 from Sunday 7 August to Wednesday 10 August.

Note to smokers

Smoking is prohibited in all session rooms and all congress areas, and also in any indoor place in Brazil.

Taxi

We recommend the use of taxis for your daily transfers between your hotel and SOFITEL and the tours you will do in Rio de Janeiro. You should be aware that the amount indicated on the taximeter will not always be the amount you are expected to pay. Look for a separate sheet taped to the window which will tell you how the amount on the meter is related to the actual fare. You can also arrange a fixed fare with the taxi driver.

Safety

Like any large city, Rio has safety problems that tourists should be aware of. In addition to the usual defensive behavior needed when travelling in big cities, some particular hints may be useful for the Rio experience:

- When going to the beach, don't take valuables, and don't leave your belongings unattended while bathing, wear inexpensive sandals
- Avoid the display of jewelry or cameras, when strolling alone or in small groups
- Leave your passport, aeroplane tickets and valuables in the safe in your room, if provided or the hotel safe. Take with you only what you need to spend, and one credit card, if needed. A copy of the passport ID page is sufficient as a document for a tourist
- An efficient tourist police system is in action, and the seashore in Rio is carefully watched. In the case that you are approached by thieves, do not react, avoid stirring violence. Report any trouble to the nearest police station as fast as possible.

Millions of inhabitants and thousands of tourists move around daily in the city without any trouble. Just be reasonably careful and have a nice stay in this marvelous city.

Tipping

In most restaurants and bars a 10% service fee (*taxa de serviço*) is added to the bill. More sophisticated places may add on 15%. If service is not included that fact will be stated at the bottom of the bill (*serviço não incluído*). There is no VAT in Brazil. Taxi drivers do not expect a tip, but it is normal to round up the final price.

Useful adresses and telephone numbers

Sofitel Av. Atlântica, 4240 - Copacabana, Rio de Janeiro, phone: (0XX[1]21) 2525-1232

Tourist Information Service Alô Rio (English and Portuguese spoken), phone: 2542-8080, 2542-8004, 0800-7071-808

Police phone: 190

Tourist-Police (24h) Av. Afrânio de Melo Franco, 159 c/rua Humberto de Campos, 315 - Leblon, phone: 3399-7170

Varig Intl. Airline at Galeão International Airport: phone: (0XX21)3398-2356 or phone: (0XX21)3398-5050

[1] XX is the code of the operator to choose when calling from other Brazilian cities. Code 21 (Embratel) will always work.

Speaker Information

Distinguished Lectures The presentation time for Distinguished Lectures will be 60 minutes in total length (50 minutes for the lecture and 10 minutes for questions).

Invited and Contributed Papers Each presentation will be 20 minutes in total length (15 minutes for the presentation, 3 minutes for questions and 2 minutes for changeover). Make sure that you are able to stay within this time limit. A synchronised time sound signal will be heard in each room at the end of these intervals. Beam projectors and computers with MS Office XP will be provided in each room for the presentations. You must bring your presentation in electronic format either on CD-ROM or on a USB storage device, and transfer the presentation to the computers in the multimedia room (Ipanema Room). The Presentation must be supplied as either MS PowerPoint or PDF slide show. To ensure that fonts used in your file are available for your presentation, you have to save your PowerPoint file with embedded fonts, or generate the PDF file with embedded fonts. The transfer of your presentation must be carried out in the multimedia desk prior to the session. After the session we will delete your file. Please present yourself to the session chairs at the beginning of each technical session so that he/she knows that your presentation will take place according to the schedule.

Please be present in your presentation room at least 5 minutes before your lecture.

Wireless Network

During Internoise 2005 Wireless Network Access (WLAN) will be provided within the congress area.

Organisation

We are pleased to present the Proceedings and the Congress Programme and Abstracts of the 2005 International Congress and Exposition on Noise Control Engineering - Internoise 2005.

The Congress Programme and Abstracts contain the abstracts of 527 papers published on the Proceedings CD, maps for your orientation within the Sofitel neighbourhood and detailed plans of the Sofitel congress facilities. You will find information on the short courses and the distinguished lectures to be given at Internoise 2005. 81 sessions (79 oral, 2 poster sessions) on 37 topics have been organized by prominent acousticians. We are very grateful for their efforts in gathering timely and interesting research results.

All papers and abstracts are published as submitted by the authors who are responsible for their content. Finally, on behalf of the whole organising committee, we would like to thank all authors and speakers.

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William D'Andrea Fonseca

Progamme Summary

You will find a detailed time schedule for short courses, distinguished lectures and technical sessions on page 16.

Saturday 6 August 2005

09:00 - 17:00 h	i-ince Board of Directors Meeting (Room: Business Master 145)
11:00 - 17:00 h	ICA Board of Directors Meeting (Room: Business Master 136)

Sunday 7 August 2005

09:00 - 17:00 h	Short course 1 (Room: Lagoa), 2 (Room: Arpoador) and 3 (Room: Botafogo), p.43
08:30 - 12:00 h	Congress Selection Committee Meeting* (Room: Business Master 145)
10:00 - 13:00 h	FIA Board of Director Meeting - Sofitel*
13:00 - 16:00 h	I-Ince General Assembly (Room: Rio 1)
08:00 - 17:00 h	Registration - Sofitel, Foyer
17:30 - 19:30 h	Opening Ceremony and Distinguished Lecture 1 (Room: Rio 1+2), see p.45
19:30 - 21:30 h	Cocktails - Sofitel Foyer
19:30 - 21:30 h	Chairpersons dinner - Miramar Hotel

* Members only

Monday 8 August 2005

08:30 - 09:30 h	Distinguished Lecture 2 (Room: Rio 1+2), see page 49
09:30 - 10:00 h	Coffee Break
10:00 - 12:00 h	Technical Sessions
10:00 - 12:00 h	Workshop 1: Global Noise Policy - Copacabana Praia Hotel, Room: Salão Nobre, see page 38
12:00 - 13:00 h	Lunch/Technical Division 1: Emission and Noise Control Elements (Room: Botafogo)
12:00 - 13:00 h	Lunch/Technical Division 2: Vibro-Acoustics and Vibration Control (Room: Flamengo 1)
12:00 - 13:00 h	Lunch/Technical Division 3: Immission (Room: Flamengo 2)
12:00 - 13:00 h	National Hearing Conservation Association Meeting, NHCA Open House (Room: Lagoa), see page 38
13:00 - 14:00 h	Distinguished Lecture 3 (Room: Rio 1+2), see page 80
14:00 - 15:40 h	Technical Sessions
15:40 - 16:00 h	Coffee Break
16:00 - 18:00 h	Technical Sessions
14:00 - 18:00 h	Workshop 1: Global Noise Policy - Copacabana Praia Hotel, Room: Salão Nobre, see page 38
18:20 - 19:20 h	TSG 2 (Room: Flamengo 1), 3+6 (Room: Flamengo 2) and 4 (Room: Botafogo) meetings*

* Members only

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Tuesday 9 August 2005

08:00 - 15:30 h	Workshop 2: Aircraft Noise Certification - Copacabana Praia Hotel, Room: Salão Nobre, see page 38
08:30 - 09:30 h	Distinguished Lecture 4 (Room: Rio 1+2), see page 125
09:30 - 10:00 h	Coffee Break
10:00 - 12:00 h	Technical Sessions
12:00 - 13:00 h	Lunch/Technical Division 4: Instruments and Analysis (Room: Flamengo 1)
12:00 - 13:00 h	Lunch/Technical Division 5: Requirements and Policies (Room: Flamengo 2)
13:00 - 14:00 h	Distinguished Lecture 5 (Room: Rio 1+2), see page 146
14:00 - 15:40 h	Technical Sessions
15:40 - 16:00 h	Coffee Break
16:00 - 18:20 h	Technical Sessions
19:00 - 23:00 h	Banquet, (Buses departure from Sofitel from 18:30h to 19:00h)

Wednesday 10 August 2005

08:30 - 09:30 h	Distinguished Lecture 6 (Room: Rio 1+2), see page 185
09:30 - 10:00 h	Coffee Break
10:00 - 12:00 h	Technical Sessions
12:00 - 13:00 h	Lunch/Meeting next Congress Planning Committee (Room: Arpoador)
13:00 - 15:40 h	Technical Sessions
15:40 - 16:00 h	Coffee Break
16:00 - 17:40 h	Technical Sessions
18:00 h	Closing Ceremony (Room: Rio 1+2)
18:00 - 20:00 h	I-Ince Board of Directors Meeting* (Room: Ipanema)

* Members only

Technical Topics and Chairpersons

Topic	Chairpersons	see pages
Active Noise and Vibration Control [AC]	Eduardo Bauzer Medeiros, J. Stuart Bolton	186, 204
Aeroacoustics (AR]	Marvin Goldstein, Serge Lewy	147, 163
Aircraft Interior Noise and Technology [AN]	Dominique Collin, Carlos Grandi	165, 188
Airport noise [AP]	Adriana B. Amarante, Delia Dimitriu, Jan Schumacher	50, 81, 102
Assessment and Strategies for Managing Noise [AS]	Bernard F. Berry, Lawrence S. Finegold	206
Assessment of Noise: Temporal Aspects in the Psychological Evaluation of Single and Combined Noise Sources [AT]	Hugo Fastl, Sonoko Kuwano	126, 149
Building Acoustics (Facade, Regulation, Comfort, Insulation, Control, etc.) [BA]	Elvira B. Viveiros, Gustavo Melo, Jacques Roland, Stelamaris R. Bertoli	82, 104, 128, 150, 167, 190, 209
Community Response and Exposure Criteria for Complex Environmental Situations [CR]	Irene Van Kamp, Lex Brown	213
Community Noise around Airports: Technical Aspects [CT]	Jules G. Slama, Max de Castro Magalhães	191
Community Noise around Airports: Human Aspects [CH]	Ichiro Yamada, Michel Vallet	232
Costs and Benefits [CB]	Jacques Lambert, William W. Lang	233
Ducts and Pipes [DP]	Jorge P. Arenas, Manohar L. Munjal	215
Environmental Noise Problems and Approaches [EP]	Antonio Perez-Lopez, J.L. Bento Coelho, Maria Luiza Carvalho, Paulo H.T. Zannin, Sergio Beristain	52, 84, 107, 130
General Acoustics [GA]	Antoni Sliwinski, Gilles Daigle, Ilona Ali Bláhová	192, 218
General Vibration [GV]	José R.F. Arruda, Roberto Jordan	109, 131
Hearing Protectors [HP]	Elliott H. Berger, Warwick H. Williams	54, 85
Instrumentation and Standards [IS]	Ronaldo Dias, Walter E. Hoffmann	220

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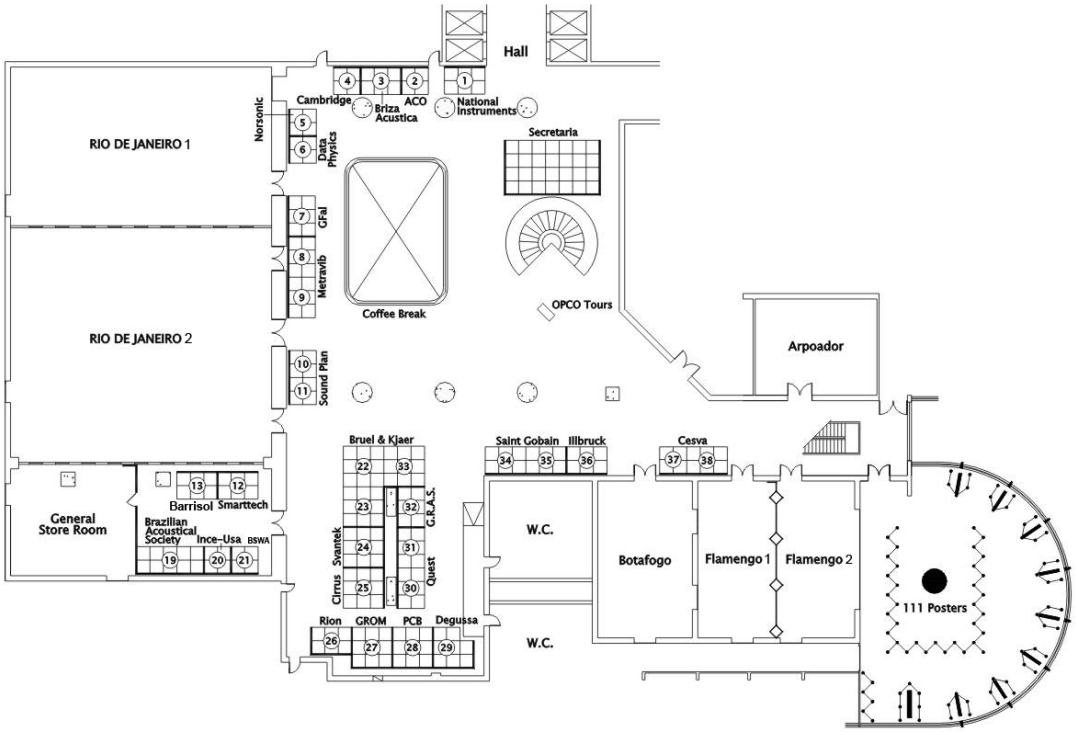
Topic	Chairpersons	see pages
Measurements in Room and Building Acoustics [MR]	Francisco Parentes, Michael Vorländer, Swen Müller	55, 87, 111
Metrology (Instruments, Measurements, Standards, Uncertainty, etc.) [MT]	George Wong, Gustavo P. Ripper	152, 168
Noise Barriers [NB]	Fabio Arruda, Marco A. M. Vecci	170
Noise Measurement Techniques [NT]	Gilberto Fuchs, Peter Wagstaff	57, 88
Numerical Techniques (FEM, BEM, IFEM, SEA, etc.) [NU]	Allice Botteon, Jorge P. Arenas, Marcelo Magalhães, Phil Shorter, Svend Gade	133, 153, 172, 194
Outdoor Noise [ON]	Davi Akkerman, Mario R. Serra	114
Physiological Health Effects Resulting from Environmental Noise Exposure [PH]	Peter Lercher, Thais Morata	116, 135
Psychoacoustics [PA]	Ana Cláudia Fiorini, Raquel Fava de Bitencourt	155
Responses to Changes in Noise [RC]	Irene Van Kamp, Lex Brown	72
Room Acoustics [RA]	Roberto A. Tenenbaum, Sylvio Bistafa	138, 157, 174, 196
Sound Power (Measurements, Uncertainty, Standards, etc.) [SP]	Gerhard Hübner, Honorio Lucatto	223
Sound Quality [SQ]	Jan Stepanek, Patricia Davis, Stephan Paul	176, 198
Soundscape and Community Noise [SC]	Brigitte Schulte-Fortkamp, Gaetano Licitra, Marion Burgess	140, 158, 178
Tyre/Road Noise [TY]	Rajendra Singh, Ulf Sandberg	201, 226
Transportation Noise (Air, Road, Rail, Marine Vehicles, etc.) [TN]	Jordi Romeu, Keith Attenborough, Vivian Silva Mizutani	141, 160, 180
Ultrasound [UL]	Flávio Buiochi, Rodrigo Costa-Félix	73, 97, 118
Urban Sound Propagation and Evaluation [US]	Jian Kang, Tor Kihlman	229
Vehicle Noise Vibration and Harshness (NVH)[VN]	Helcio Onusic, Takeshi Abe	75, 98, 120, 143, 161,
Vibration Isolation and Damping [VI]	Balakrishna Thanedar, Luvercy Azevedo	77, 98

Exhibitors

Exhibitor	Origin	Stand
01dB METRAVIB	France	8 and 9
ACO Pacific, Inc.	USA	2
Barrisol do Brasil	Brasil	13
Briza Acustica	Brazil	3
Brüel & Kjaer	Denmark	22, 23 and 33
BSWA Technology Co. Ltd.	China	21
Cambridge Collaborative	USA	4
CESVA Instruments S.L.	Spain	37 and 38
Cirrus Research plc.	UK	25
Data Physics Corporation	USA	6
Degussa Röhm GmbH & Co.KG.	Germany	29
GfaI	Germany	7
G.R.A.S. Sound & Vibration	Denmark	32
GROM Equipamentos Eletromecânicos	Brazil	27
Quest Technologies	USA	30 and 31
Illbruck Sonex Industrial Ltda.	Brazil	36
National Instruments Brasil	Brazil	1
NORSONIC AS.	Denmark	5
PCB Piezotronics Inc. and Larson Davis Inc.	USA	28
Rion Co. Ltd.	China	26
Saint Gobain Vidros S.A.	Brazil	34 and 35
Smarttech Servicos e Sistemas Ltda	Brazil	12
Sound Plan LLC	USA	10 and 11
SVANTEK Sp.zo	Poland	24

without stand: 3M Brasil · E-A-R / Aearo Company · EMBRAER · ESI Group



Time Schedule for Short Courses, Distinguished Lectures and Technical Sessions

Sunday 7 August 2005

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16:00-18:20	Busin. Master 145	Session GV1: General Vibration	109
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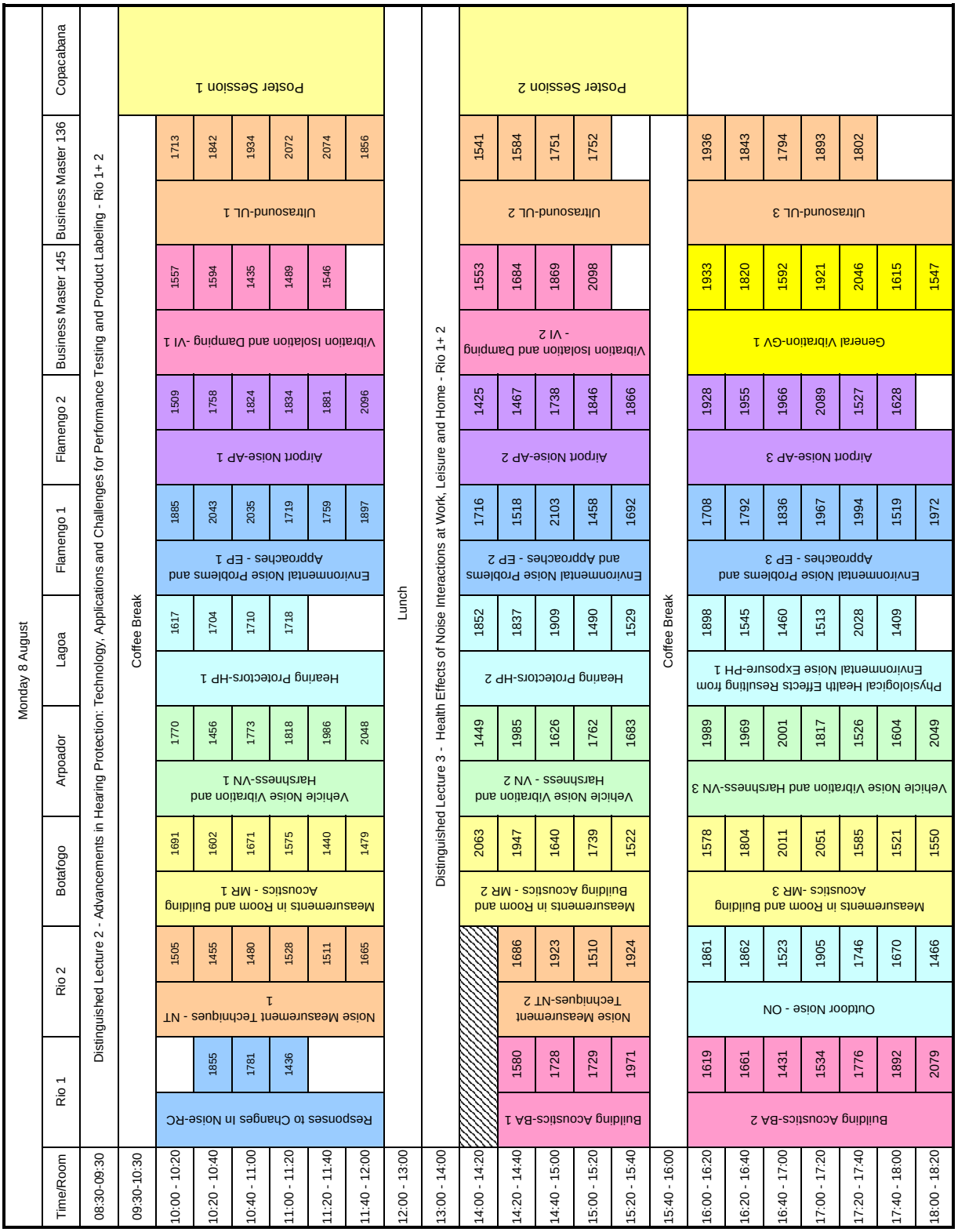
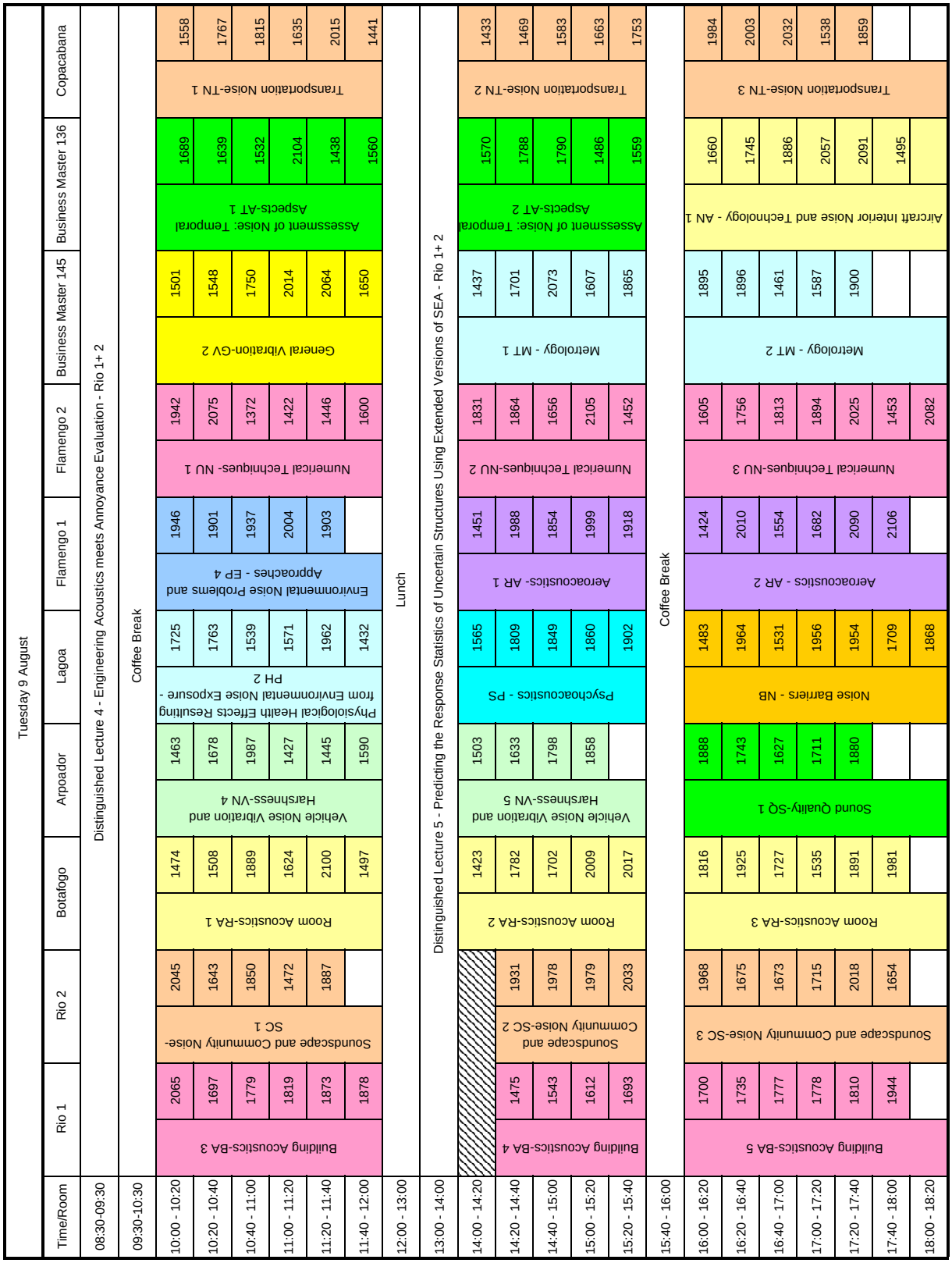
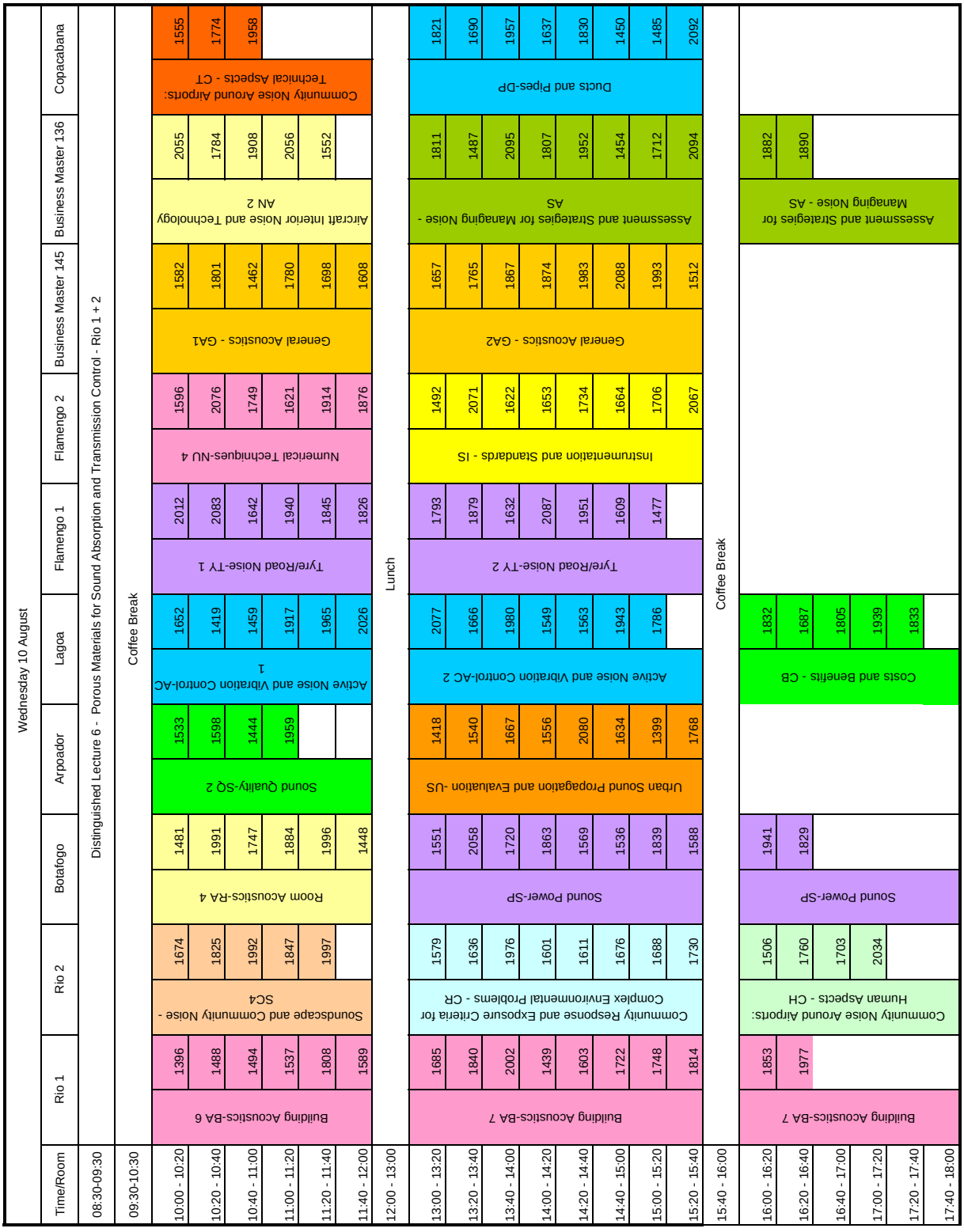
Monday 8 August 2005



Tuesday 9 August 2005



Wednesday 10 August 2005



Overview of papers by topic

Distinguished Lectures

Active Noise and Vibration Control (AC)

Aeroacoustics (AR)

Aircraft Interior Noise and Technology (AN)

Airport Noise (AP)

Assessment and Strategies for Managing Noise (AS)

Assessment of Noise: Temporal Aspects in the Psychological Evaluation of Single and Combined Noise Sources (AT)

Building Acoustics (BA)

Building Acoustics (BA) *continued*

Building Acoustics (BA) *continued*

Community Response and Exposure Criteria for Complex Environmental Situations (CR)

Community Noise Around Airports: Human Aspects (CH)

Community Noise Around Airports: Technical Aspects (CT)

Costs and Benefits (CB)

Ducts and Pipes (DP)

Environmental Noise Problems and Approaches (EP)

Environmental Noise Problems and Approaches (EP) *continued*

General Acoustics (GA)

General Vibration (GV)

General Vibration (GV) *continued*

Hearing Protectors (HP)

Instrumentation and Standards (IS)

Measurements in Room and Building Acoustics (MR)

Measurements in Room and Building Acoustics (MR) *continued*

Metrology (MT)

Noise Barriers (NB)

Noise Barriers (NB) *continued*

Noise Measurement Techniques (NT)

Numerical Techniques (NU)

Numerical Techniques (NU) *continued*

Outdoor Noise (ON)

Physiological Health Effects Resulting from Environmental Noise Exposure (PH)

Psychoacoustics (PS)

Responses to Changes in Noise (RC)

Room Acoustics (RA)

Room Acoustics (RA) *continued*

Sound Power (SP)

Sound Quality (SQ)

Soundscape and Community Noise (SC)

Soundscape and Community Noise (SC) *continued*

Transportation Noise (TN)

Tyre/Road Noise (TY)

Ultrasound (UL)

Urban Sound Propagation and Evaluation (US)

Urban Sound Propagation and Evaluation (US) *continued*

Vehicle Noise Vibration and Harshness (VN)

Vehicle Noise Vibration and Harshness (VN) *continued*

Vibration Isolation and Damping (VI)

National Hearing Conservation Association Meeting - NHCA Open House

Monday 8 August 2005, 12:00-13:00 h at SOFITEL - Room: Lagoa

Join us for a light lunch to learn about the National Hearing Conservation Association, whose mission is to prevent hearing loss due to noise and other environmental factors in all sectors of society, with a strong emphasis on occupational hearing conservation. NHCA leaders will be available to talk about NHCA, answer any questions you may have about the association and encourage you to join our international group. With us will be InterNoise 2005 distinguished lecturers John G. Casali, Ph.D., CPE, NHCA President-Elect, and Dr. Thais Morata, with NIOSH-USA/UTP-Brazil, as well as the one of the chairs of the InterNoise 2005 special session on hearing protection, Elliott H. Berger, M.S., INCE, Bd. Cert. who will also chair the ANSI WG11 committee on hearing protection. See the technical papers on hearing protection on page 54 and 85

Workshops

Two workshops will take place during Internoise 2005, both at COPACABANA PRAIA HOTEL, just over the street from SOFITEL. Easy access from SOFITEL through the Shopping Atlântica in the SOFITEL groundfloor, see the map provided on the inside back cover.

Workshop 1: Global Noise Policy

Monday 8 August 2005, 10:00-12:00 h and 14:00-18:00 h at COPACABANA PRAIA HOTEL, Room: Salão Nobre. For Internoise 2005 partipants only.

Chairs: William W. Lang and Tjeert ten Wolde

The second annual workshop on Global Noise Policy will be held in the morning and afternoon on 8 August 2005, on the opening day of the International Congress on Noise Control Engineering, Internoise 2005, in Rio de Janiero, Brazil. The purpose of the workshop is to discuss the latest developments in noise policy in the three areas of major interest: occupational noise, community noise, and consumer product noise. The discussions on community noise will include aviation/airport noise, surface transportation noise, industrial noise, and local citizens' concerns. Specialists from governments and from the private sector will focus on recent actions related to noise policy. In those areas where actions have been taken since the first workshop in 2004, the speakers will be asked to summarize the implementation of these policies in their areas of expertise. Following the presentations, there will be focused discussions among the presenters and members of the audience. The objective of the workshop is to bring the attendees up-to-date on the implementation of national noise policies that ultimately will lead to a global noise policy. The special focus for the 2005 workshop will be on the noise emissions of products and the impact of these emissions on international trade.

Workshop 2: Aircraft Noise Certification

Tuesday 9 August 2005, 08:20-12:00 h and 13:00-15:30 h at COPACABANA PRAIA HOTEL, Room: Salão Nobre

Arranged by: International Civil Aviation Organisation (CAEP-ICAO)

Chair: Alain Depitre, Head of Noise Certification Bureau, Direction Générale de l'Aviation Civile (DGAC), France

Speakers: Jane Hupe, Secretary of Committee on Aviation Environmental Protection (CAEP), International Civil Aviation Organization, (ICAO)

Pierre Lempereur, Senior Expert, Acoustics and Environment Airbus France/ICCAIA

Jean-Baptiste Rigaudias, Director Environmental Affairs, Air France/IATA

Mehmet Marsan, Noise Division, Office of Environment and Energy, FAA (US)

The ICAO noise certification workshop is being held in conjunction with the Internoise 2005 Congress which is a well known event in the field of aircraft noise. This workshop will provide a good opportunity for authorities of states located in South and Central America to get acquainted with the latest developments in aircraft noise certification. The meeting is aimed at those involved in or with specific interest in, aircraft noise certification activities. The environmental aspects of aviation, in particular aircraft noise, continue to attract the attention of both the aviation community and the general public. The first International Standards and Procedures for Aircraft Noise Certification were developed by ICAO in the early 1970s and they have evolved substantially since then. These noise Standards and Procedures are reflected in Annex 16 — Environmental Protection, Volume I — Aircraft Noise and the Environmental Technical Manual on the use of Procedures in the Noise Certification of Aircraft (Doc 9501). In February 2004, the sixth meeting of the Council's Committee on Aviation Environmental Protection (CAEP/6) made substantial recommendations in the area of aircraft noise certification and re-certification that have since been considered by the Council. Against this background, the Council has agreed that noise certification workshops should be conducted to assist state authorities. Their objectives will be to:

1. enhance state certificating authorities' awareness of the current Standards and Recommended Practices (SARPs) and associated guidance material related to aircraft noise certification and re-certification for transport aircraft (including subsonic jets and propeller-driven aeroplanes), helicopters and light propeller-driven aeroplanes;

2. promote harmonization of procedures for the noise certification and re-certification of aircraft; and

3. familiarize states authorities with the work of CAEP in this area, and provide information on the recommendations from CAEP/6, including:

    - new guidance on noise certification documentation;
    - re-certification within Annex 16, Volume I (for example from Chapter 2 to Chapter 3; from Chapter 2 to 4; and from Chapter 3 or 5 to Chapter 4), as well as from the Federal Aviation Administration's FAR 36, Stage 3 to Annex 16, Volume I, Chapter 4; and
    - provisions for thrust de-rate.

Workshop topics

A preliminary programme for the workshop follows and has been structured to provide:

1. a general understanding of aircraft noise certification and re-certification;

2. an explanation of ICAO's existing SARPs and guidance on the subject;

3. information on the most common difficulties encountered in the interpretation and implementation of existing provisions;

4. information on CAEP's future work programme related to this topic; and

5. identification of the principal factors that are likely to be of relevance in the years ahead.

Workshop format

The workshop is intended for those interested in noise certification and re-certification, and in particular for experts in charge of aircraft noise certification in national civil aviation administrations, as well as experts responsible for clearing airworthiness aspects before aircraft are included in the national aviation register.
Each topic and, where appropriate, each sub-topic will commence with one or more prepared presentations by speakers who are knowledgeable on the subject concerned. The opportunity will be provided for participants to comment or pose questions to the speakers.

Organisational arrangements

The working language will be English.

Experts nominated by their aviation authority and persons interested are entitled to attend the ICAO Noise Certification Workshop free of charge and should use the registration form, which will be provided at COPACABANA PRAIA HOTEL. Please note that participants wishing to attend other sessions of Internoise 2005 Congress, will need to register for that meeting and will be charged the congress fees. Registration forms for Internoise 2005 can be found at http://www.internoise2005.org.br/welcome.aspx

Further information

A copy of the programme for the workshop as well as other organisational arrangements such as registration and meeting documentation will be placed on the ICAO website www.icao.int in due course.

Agenda for Workshop 2: Aircraft Noise Certification

08:00-08:20	Opening Address	Jane Hupe, ICOA/CEAP; Alian Depitre, DGCA, France
08:20-08:40	Historic Perspective	Jane Hupe, ICOA/CEAP
08:40-09:30	Descrition of Annex 16: Chapters and appendices with more details on chapter 3	Alian Depitre, DGCA, France
09:30-10:00	Aircraft Noise Measurement Unit - EPNdB; Why work with this unit, technical description, equivalent procedures and the Environmental Technical Manual - ETM	Mehmet MARSAN, FAA, US
10:00-10:30	Coffee Break	
10:30-11:00	Aircraft Noise Measurement Unit - EPNdB; Why work with this unit, technical description, equivalent procedures and the Environmental Technical Manual - ETM	Mehmet Marsan, FAA, USA
11:00-11:30	Noise Certification Documentation; Roles and responsibilities	Alain Depitre, DGAC, France; Mehmet Marsan, FAA, USA
11:30-12:00	Harmonization	Mehmet Marsan, FAA, USA
12:00-13:30	Lunch	
13:30-14:00	Recertification	Alain Depitre, DGCA, France
14:00-14:20	The point of view of Aircraft Manufacturers	Pierre Lempereur, ICCAIA
14:20–14:40	The point of view of Airlines	Jean Rigaudias, IATA
14:40–15:15	New challenges	Jane Hupe, ICAO/CAEP
	Demonstration of the Noise Database	Alain Depitre, DGCA, France; Jane Hupe, ICAO/CAEP
15:15-15:30	Conclusion	Jane Hupe, ICAO/CAEP

Sunday 7 August 2005

Christ Statue - *Christo Redentor*

Short Courses

All short courses will be given on Sunday 7 August 2005, from 09:00 to 17:00. They are subject to an extra registration and fee.

09:00-17:00 h **Room:** Lagoa

Course 1: Sound Quality

Patricia Davies
Professor, Ray W. Herrick Labs, School of Mechanical Engineering, Purdue University, USA

Current Research Interests:
Perception-based Engineering (PBE) and Sound Quality (SQ), Modeling, System Identification and Simulation of Linear and Nonlinear Systems, Condition Monitoring of Machinery and Measurements and Signal Processing

This course will address aspects of: good practice in psycho-acoustical testing; analysis of test results; sound analysis and simulation; identification of perceptual attributes of sounds; sound analysis to predict perceptual attribute strengths and sound quality metrics; modeling the relationships between, perceptual attributes and perceived sound quality; global versus applications-oriented models of sound quality and annoyance; and connecting noise control approaches to sound quality evaluation. The course will include examples of practical applications of the techniques described; discussion of the role that different types of sound attributes play in different applications; and the strengths and short-comings of existing models to predict those attributes. Examples of applications include transportation, diesel engines, tractors, HVAC systems, and refrigerators. Participants are encouraged to bring examples of sound quality case histories.

09:00-17:00 h **Room:** Arpoador

Course 2 (in Portuguese): Successful Prevention of Hearing Loss at Work, Leisure and Home; Sucesso na Prevenção de Perdas Auditivas no Trabalho, Lazer e em Casa

Thais Morata
Ph.D.; National Institute for Occupational Safety and Health, USA

Dr. Thais Morata is an audiologist working in the area of hearing loss prevention since 1982. Her main area of interest is the prevention of auditory effects of combined exposure to noise and chemicals. Dr. Morata is a research fellow at the National Institute for Occupational Safety and Health, in Cincinnati, OH, USA. She collaborates with several international occupational health institutes in this area and teaches graduate courses at the Universidade Tuiuti do Paraná, in Curitiba, Brazil.

Successful Prevention of Hearing Loss in Work, Leisure and Home Environments Analysis of environmental and occupational noise exposure and the need for preventive initiatives. Presentation and discussion of existing international preventive programs. Update of the theoretical basis and best practices in hearing loss prevention. Analysis and development of strategies for epidemiological surveillance.

Análise da exposição à ruído ambiental e ocupacional e a necessidade de medidas preventivas. Apresentação e discussão de programas preventivos existentes a nível internacional. Atualização dos subsídios teóricos e práticos referentes a prevenção de perdas auditivas. Análise e desenvolvimento de estratégias de vigilância epidemiológica.

09:00-17:00 h **Room:** Botafogo

Course 3: Noise Control Materials

J.Stuart Bolton
Ray W. Herrick Labs, School of Mechanical Engineering, Purdue University, USA

Current Research Interests:
Active Noise Control, Effective Use of Noise Control Material, Measurement of Material Properties, Holographic Visualization of Sound Fields, Experimental Identification of Structure-Borne Noise Fields, Optimum Design of Centrifugal Fans and Outdoor Sound Propagation.

Short course on porous materials: Background and Definitions, Acoustical Characterization of Porous Materials and Standing Wave Tube Theory, Simple Theoretical Models for Porous Materials, Effective Use of Porous Materials, Demonstration of System Modeling Software and Comments on the Use of Porous Materials in the Automotive Industry, Modeling of Elastic Porous Media: Part 1 - Fundamental Theory, Modeling of Elastic Porous Media: Part 2 - Demonstration of Wave Propagation in Elastic Porous Media and Comments on Sound Absorption, Measurement of Mechanical Properties of Foam, and Special Purpose Measurements of Interest to the Automotive Industry, Modeling of Elastic Porous Media: Part 3 - Sound Transmission, Measurement of Transmission Loss by a Standing Wave Tube Method, SEA in Sound Package Design, Introduction to Finite Element Modeling of Elastic Porous Materials, Finite Element Modeling of Noise Control Materials and Software Demonstration, Wrap up, General Discussion and Question and Answer.

Opening Ceremony and Distinguished Lecture 1

17:30-19:30 h **Room:** Rio 1+2

Sustainable Development in an Urbanizing World.-The Noise Issue

Tor Kihlman,
professor em. Chalmers University of Technology, Sweden

Mr. Kihlman has worked on different aspects of noise issues. In the early 90, he developed the Swedish National Action Plan against Noise for the government. He also participated in the work to develop the European Noise Policy. At present, he is active in a Swedish research program, Soundscape Health Support.

Large city noise is considered by WHO to be the 3rd most hazardous pollution (air, water, noise). The effects of the noise are: sleep disturbance, speech interference, general annoyance, cardio-vascular effects. Adverse effects start at levels in the order of 45-50 dB. Currently, more than 50% of the world's population live in cities. In European cities, $L_{eq,24h}$ values outside windows frequently lie in the range 60 – 65 dB. These levels are caused by normal traffic flows of vehicles fulfilling noise emission demands. In many cities in other regions the situation is even worse, because of insufficient maintenance of roads and vehicles and common use of the horn and high levels of car radios. Reducing the adverse effects requires several actions of different kinds both by authorities and individuals. It is necessary to tackle the different sources. Demands on new vehicles must be stricter. Also, the traffic culture needs to be changed. But this is not sufficient. The possibilities to reduce the effects by appropriate urban planning must be explored. All this demands good governing.

Monday 8 August 2005

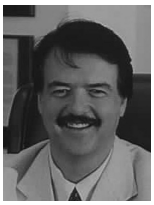
Sugar Loaf - *Pão de Açucar*

Distinguished Lecture 2

08:30-09:30 h **Room:** Rio 1+2

Advancements in Hearing Protection: Technology, Applications and Challenges for Performance Testing and Product Labeling

John G. Casali
Ph.D., Auditory Systems Laboratory at Virginia Tech, Blacksburg, Virginia, USA



Dr. John Casali is the Grado Professor of Industrial and Systems Engineering and Director of the Auditory Systems Laboratory at Virginia Tech in Blacksburg, Virginia. He is a Board-Certified Professional Ergonomist and Industrial Ergonomist and a Fellow of the Human Factors and Ergonomics Society and the Institute of Industrial Engineers. His university research has spanned over 60 separate projects and funded to a total of over U$5 million by a variety of companies, military branches, and government agencies. As a consultant, Dr. Casali has served over 50 companies in projects concerning acoustics and hearing protection, ergonomics, warning signal design, and litigation.

Augmented hearing protection devices (HPDs), as opposed to conventional devices which attenuate noise through static passive means, have been available for several decades and are continually being developed. These include HPDs which incorporate electronic means for noise cancellation or restoration of desirable sounds, nonlinear electronic networks or passive elements for adjusting attenuation as a function of ambient noise level, uniform attenuation devices with a flat attenuation curve, and adjustable devices which can be varied in their attenuation or other features. The intended benefits of augmented HPDs, some of which are realized in practice and others not, include more natural hearing for the user, improved speech communications and signal detection, reduced noise-induced annoyance, and provision of protection which is somewhat tailored for the user's needs, noise exposure, and/or job requirements. Despite these potential benefits, certain types of augmented HPDs cannot be properly marketed, or marketed at all, in the United States as hearing protection due to the fact that the EPA-promulgated requirements for HPD testing and labeling do not accommodate their special features, nor completely reflect their performance. This paper provides an overview of augmented HPDs that are currently available (circa mid-2004) and their general performance. Emphasis is placed on the testing needs for augmented HPDs, a critique of the appropriateness of current testing standards for their evaluation, and how their performance could be quantified by extant standards and/or other measurement techniques and protocols other than those currently mandated by the EPA.

Session AP1: Airport Noise

chairs:

Delia Dimitriu - *Romania*

Adriana Amarante - *Brazil*

10:00-12:00 **Room:** Flamengo 2

10:00-10:20

1509 _____ *invited*

IMPACT OF NOISE REGULATIONS ON CAPACITY OF GERMAN AIRPORTS

Jan Schumacher

Airbus, Hamburg, Germany

The existing noise regulations and operational restrictions at German airports will be described and explained (17 international, 14 regional and 5 smaller airports in Germany are affected). - Expected national noise legislation which is either already in progress or planned for the next 5 – 10 years will be presented and their impact on the capacity of German airports will be illustrated by examples - Directives of the European Union regarding the impact of noise in the vicinity of airports will be presented and their influence on airport capacity will be explained - Relevant ICAO regulations will be mentioned to identify possible additional operational restrictions - The resulting airport capacity reduction will be estimated and illustrated by examples - Ways to avoid further operational restrictions and limitations at airports will be proposed

10:20-10:40

1758 _____ *invited*

AIRPORT NOISE COMPUTATIONAL MODELS - USING AIRCRAFT TRAJECTORY DATA TO ASSESS APPROACH PROFILES INCLUDING NEW GENERATION CONTINUOUS DESCENT APPROACH

Vincent Mestre ⋆, John Gulding, John Paul Clarke, Eric Dinges

⋆ *Mestre Greve Associates, Laguna Niguel, USA*

Approach operations have historically received less attention than departures in community noise model systems. However, recent attention to the study of Continuous Descent Approaches both in the US and Europe have re-focused the research community on the approach noise modeling assumptions in the assessment tools available to the airport planner. These include the source noise definition as well as the general relationship between noise and aircraft performance that is central to modeling systems. Modeling approach noise performance is much more difficult than departure due to the uncertainty in approach trajectory resulting from air traffic control procedures and pilot technique. Existing noise model guidance does not provide a method to make the assessment tractable for the general user. Inaccuracies in the size of aircraft noise contours due to the uncertainties listed above will make the assessment of CDA's error prone for the decision planners who balance CDA's across a broad array of noise mitigation alternatives. In this paper we analyze radar data from two major airports in the US to determine the trajectory variation that is typical in operation, gain insight into the procedural constraints that drive this variation, and develop trajectory clusters that are representative of nominal operations. Results of the analysis indicate that there is a tendency to have average glide slopes slightly higher than the nominal 3 degrees, and that downwind approaches tend to have a higher glide slope than straight-in approaches. It is the intent that the result of this research be made available to the general user through input into guidance given in international noise modeling documents such as SAE-AIR-1845, European Civil Aviation Conference Document 29 and ICAO Circular 205.

10:40-11:00

1824 _____ *invited*

A NOVEL METHOD FOR THE ESTABLISHMENT OF NOISE CONTOURS AROUND AIRPORTS WITH RELATIVELY LOW TRAFFIC

Rita Markovits-Somogyi

CAA of Hungary, Budapest, Hungary

Being aware of the noise situation is one of the most important environmental tasks of an airport. That is why noise monitoring systems have been installed and are being operated at several airports. However, these systems cannot make predictions about the effect of a changing volume of traffic, or the introduction of a new departure/approach procedure. For this reason so called noise simulation softwares have been developed, with the help of which noise contours can be calculated, even before the changes take place. First this paper gives a broad outline of the most important noise calculation softwares (like Soundplan, Wölfel's IMMI, FAA's INM, NOISIM and PrADO's Noise Analysing Module) focusing on their use for aircraft noise. Examination of the above mentioned models shows that none of them has been developed with the purpose of giving a quick estimate of the noise situation. Whereas sometimes the need arises to predict noise in a less complicated – even if less accurate – way, like in the case of airports with relatively low traffic (less than 50 thousand movements/year), where the former noise simulation methods do not prove cost efficient. Therefore a new method to estimate noise contours has been developed, and it is described in the second part of this paper. The calculation method comprises a new idea, it uses continued fractions to establish the noise contours directly, instead of calculating the noise level in every point of

a grid. The first application of the method is capable of predicting the maximum noise levels, and the results show that there is a relatively good agreement between the calculated noise contours and the measured noise levels. Future work could include the verification of the method and also its extension to calculating equivalent noise contours, and number of people annoyed.

11:00-11:20

1834 _____ *invited*

MODELLING ANNOYANCE FROM AIRCRAFT NOISE USING A RANGE OF INDICES: LYON AND MANCHESTER AIRPORTS

Abigail Bristow ⋆, Richard Batley, Mark Wardman, Peter Hullah, Elisabeth Plachinski

⋆ *Loughborough University, Loughborough, UK*

Data on aircraft noise and annoyance levels were obtained for households in Manchester and Lyon as part of a study investigating the value of noise. Annoyance was assessed on a five point verbal scale consistent with international standards. Noise indices obtained included Leq, Lden, Ldn, NA65 and NA70. This data allowed us to look in some detail at levels of annoyance from aircraft noise and influences on levels of annoyance. In this paper we report: • The relative importance of aircraft noise amongst other factors impacting on quality of life • Annoyance from aircraft noise relative to other sources of noise • Reported disturbance of activities and other concerns with respect to aircraft noise • Variations in annoyance levels by time of day • The relationship between annoyance and perceived noise • Models using ordinal regression to explore the relationship between annoyance levels, noise indices and a range of other variables including socio-economic characteristics and contextual variables also self reported exposure to aircraft noise; perceived levels of noise and sensitivity to noise.

11:20-11:40

1881 _____ *invited*

INVESTIGATING EFFECTS OF SOUND SOURCE DIRECTIVITY ON THE ACCURACY OF AIRPORT NOISE PREDICTION

Hisashi Yoshioka⋆, Ichiro Yamada

⋆ *Aviation Environment Research Center A.E.I.F., Tokyo, Japan*

This paper discusses a result of field measurement regarding effects of sound source directivity on the accuracy of airport noise prediction. In a previous examination of the validity of a recently-developed noise model based on LAeq, the result of a comparison between calculations and measurements was fairly good at points under the straight flight path, but it was not good at points outside circular path segments. It was considered that the discrepancy might be ascribed to an inadequacy in the method of adjustment for the sound source directivity. Thus, another field measurement of aircraft noise and flight paths was carried out near a circular departure path at a domestic airport. Analysis was made to investigate effects of sound source directivity on the accuracy of noise prediction.

11:40-12:00

2096 _____ *invited*

INTERIOR NOISE MODELING FOR AIRPORT NOISE:A CONCEPTUAL ANALYSIS

Micah Downing⋆, B. Ikelheimer, G. Ehrlich

⋆ *Wyle Laboratories, Inc., Arlington, USA*

Noise simulation modelling is now feasible for assessing the noise impacts in airport communities since computational capabilities have increased. Noise simulation models, such as NMSim, provide accurate noise exposure calculations by including the ability to model the effects of terrain, barriers, weather, and aircraft directivity. The basic calculation consists of spectral time histories for specific locations or a grid of points from aircraft operations. These spectral time histories allow the calculation of more noise metrics than standard integrated metrics such as DNL. Moreover, interior noise levels can be estimated since the noise spectra and source-to-receiver geometry are known. This paper will describe an approach to calculate interior noise levels for specific locations as well as more general estimation of interior noise levels for standard housing around an airport.

Session EP1: Environmental Noise Problems and Approaches

chairs:

J.L. Bento Coelho - *Portugal*
Maria Luiza Carvalho - *Brazil*

10:00-12:00 **Room:** Flamengo 1

10:00-10:20

1885 *invited*

NOISE EVALUATION OF HYDROELECTRIC POWER PLANTS

Maria Luiza U. Carvalho ⋆, Leroy Wagner, Rodrigo Calixto, Cynthia Borges

⋆ *Furnas Centrais Elétricas S.A., Goiania, Brazil*

Even though experiments in environmental noise from Hydroelectric Power Plants show that external noise pollution is not a hazard to community noise levels, an evaluation on noise generated by them in Brazil is observed in this article. Noise was analyzed as to its sound pressure levels close to machinery. Power Plant selection was determined by similarity of type and age. The chosen ones have 3 to 4 Francis turbines each and their powerhouses are sheltered or underground. Because of the amount of machinery, such as turbines, air compressors and rotors associated to each generating unit, noise production is high. This makes the work environment unsuitable regarding occupational health. A noise map was made with an A-weighted sound level at 1.000 Hz. After that, a more specific analysis was made obtaining the equivalent continuous sound level (LAeq) in dB(A) from 125 Hz to 8.000 Hz. There is not a specific law regarding the noise limits of power plants or powerhouses in Brazil. One can find some reference to these kinds of limits in the occupational health field, more specifically in Law number 6.514 from 22/12/1977 and the regulating principles associated to work and health. This law discusses the time of exposure of workers to continual, intermittent and impact noises. In most cases studied in this paper the noise levels in the working place were excessive and the exposure time of personnel to these places should be that strictly necessary and the use of personal protection from hearing damage demanded. Nevertheless, it is important that a more efficient solution be established with a possible acoustic room treatment. Keywords: power plant, noise, occupational health

10:20-10:40

2043 *contributed*

NOISE MAPPING AND NOISE ABATEMENT PLANS IN LARGE CITIES IN PORTUGAL

J. L. Bento Coelho⋆, D. Alarcão

⋆ *CAPS - IST, Lisbon, Portugal*

Noise in cities has increased in the past decades, due to a growing urban development. With increasing population density, communities become noisier. Management and reduction or urban noise is then called for in effective urban environment plans. Noise community ordinances have been approved at national and local levels in various countries of the world. They usually establish noise limits for various activities and zones, according to the land uses, and define the basis of noise abatement strategies. The new European Directive 2002/49/EC on the assessment and management of environmental noise requires the drawing of noise maps of communities with more than 100,000 inhabitants and of areas near the major transport infrastructures for the assessment of noise outdoors. The Portuguese Noise Pollution Act of 2000 requires the local authorities to draw noise maps to be integrated in the Land Use Plans and to be used as a basis for noise reduction plans where the noise levels exceed maximum prescribed levels. Noise mapping in large urban areas presents methodological and financial hindrances due to both the technical complexity involved and to the amount of human and technical resources that are necessary. The project management of large scale noise mapping requires special care since several public and private entities must work together to provide accurate and detailed input data. Noise abatement plans must be based on reliable information and on strategies that take into account a vast number of technical, operational, and economical factors. The cost-benefit ratios of all solutions have to be considered. Case studies of large-scale noise mapping and of noise abatement plans drawn for various large cities and for areas around large suburban transport infrastructures are presented here. Problems are highlighted and discussed, especially those regarding the optimization of data quality and data management, the accuracy of the results and the benefits for the acoustical environment.

10:40-11:00

2035 *invited*

STATUS REPORT ON A NEW ASTM STANDARD GUIDE FOR MEASURING LARGE GAS TURBINE INLET AND EXHAUST SOUND PRESSURE LEVELS

Robert A. Putnam

Siemens Westinghouse, Orlando, USA

Currently under development by ASTM Committee E33 is a new standard guide for the measurement of

in-duct sound pressure levels from large gas turbines and fans. The author is the Chair of ASTM Task Group E33.08I developing this standard. Historically, the determination of in-duct sound power levels from large industrial fans and gas turbines has suffered from the lack of standardized methodologies. If the sound pressure level within the duct cannot be measured with reasonable reproducibility, then the sound power levels derived there-from will not be reliable. For instance, the highly turbulent, high temperature exhaust flow from large industrial gas turbines presents serious problems to the analyst attempting to quantify, with reasonable precision, the sound pressure levels, and thus the sound power levels, within the exhaust duct. These sound power levels are the analytical bases of the design of necessary attenuation for exhaust systems whether simple cycle exhaust stacks or combined cycle waster heat boilers. Standard methods for measuring sound levels can avoid cost penalties either from initial over design of attenuators or expensive retrofit of inadequate designs. This paper presents the background of the Task Group's work and outlines the essentials of the proposed methodology.

11:00-11:20

1719 _____ *contributed*

HOW TO EVALUATE THE QUALITY OF NOISE PREDICTION SOFTWARE

Wolfgang Probst

ACCON GmbH, Greifenberg, Germany

Noise prediction software of newest technology comprises plenty of powerful features and is able to handle largest file sizes. This makes it difficult for the user to control the correctness of results, because it is nearly impossible to do part of these complex calculations by hand. There are three types of errors and uncertainties, and it is important for the user of a software to know about these problems. Some of these errors are discussed and methods are presented to detect them.

11:20-11:40

1759 _____ *contributed*

USE OF GIS AND INTERACTIVE 3D TECHNOLOGY TO ENHANCE VISUALIZATION OF ACOUSTICAL ENVIRONMENT

Edmund Chu*, P.S. Ng, C.K. Lee, C.W. Law, Marcus Tang

* *Environ. Protection Department, Hong Kong, China*

Continuous public involvement is a critical element for a successful Environmental Impact Assessment (EIA) Process. However, it is more critical to have such information presented in such a way that is easily understood and digested by the general public. The traditional two dimensional presentation approach by means of tables, photos and numerical figures on maps would not be easily understood by the general public, especially for a project in a complex high-rise metropolitan like Hong Kong. This paper presents a pilot study on a 3-D presentation of noise impact assessment results using GIS and a new 3D visualization technology to enhance the public's understanding. This would provide a 3-D interactive virtual acoustical environment, through the Internet, for the public to walk and fly through the 3D space to grasp the noise information. The public may navigate the virtual space and appreciate the future noise environment of different road alignment options and different forms of measures instantly.

11:40-12:00

1897 _____ *contributed*

A NATIONAL PROJECT TO REDUCE HIGH SOUND LEVELS FROM MUSIC

Johanna Bengtsson

The National Board of Health and Welfare, Stockholm, Sweden

The highest recommended levels for leisure sounds in Sweden are 100 dB LAeq and 115 dB LAFmax. New regulations are under construction. The suggestion is a lower sound level for environments were children below 12 years are allowed. On a request from the Swedish government, the National Board of Health and Welfare investigated the use of the present regulations regarding high sound levels. In many restaurants and discotheques, the measured levels were higher than the recommended level. It was also found that young people often complained on too high sound levels and, a higher number of children then expected suffered from hearing damage and/or tinnitus. The main conclusion from that study was that the local environmental and health authorities need detailed guidelines on how to work with these questions. This is needed if it should be possible to listen to and enjoy music without the risk of damaging your hearing. Therefore, a national project will start. The aim is to improve environments with high sound levels from music. Such environments are e.g. concert halls, restaurants, movies and theatres. Both live and recorded music is included in the project. To date, 130 communities will be participating in the project. The project will be further discussed at the conference, together with information about the new regulations.

Session HP1: Hearing Protectors

chairs:

Elliott H. Berger - *USA*

Warwick H. Williams - *Australia*

10:00-11:20 **Room:** Lagoa

10:00-10:20

1617 _____ *invited*

PREFERRED METHODS FOR MEASURING HEARING PROTECTOR ATTENUATION

Elliott H. Berger

E-A-R / Aearo Company, Indianapolis, USA

There are numerous well-documented measurement methods available to evaluate hearing protector attenuation, however, some are flawed or difficult to implement and some can and have been misused with the erroneous results fostering misleading conclusions. This paper will examine the three most robust methods including the "gold standard" in hearing protector attenuation measurements, namely real-ear attenuation at threshold. It will be compared to the most useful alternatives such as microphone in real ear, including the use of probe microphones, imbedded microphones, and miniature microphones, and to measurements using acoustical test fixtures, also called blockheads. Examples of the latter include the ANSI- and ISO specified blockheads, KEMAR, and others. Illustrative data will be provided to guide the user in the application of such techniques and tools and to point out errors to avoid. None of the three methods is entirely "accurate," all being plagued by various experimental artifacts. However, REAT has been thoroughly "road tested" and standardized around the world, and has been shown to be the most accurate at estimating the performance for a defined group of subjects under a given set of conditions.

10:20-10:40

1704 _____ *invited*

A DIFFERENT PERSPECTIVE ON THE ANALYSIS OF HEARING PROTECTOR ATTENUATION TEST DATA AND IMPLICATIONS

Warwick H. Williams

National Acoustic Laboratories, Chatswood, Australia

A variation in the method of calculating the attenuation performance of hearing protectors can effectively reduce the number of standard deviations from seven (nine in the case of NRR) to one. The outcome is that there is a less complex error analysis and a much simpler statistical analysis. This analysis reveals a strong negative correlation between attenuation and standard deviation and appears comparable to any current single number rating such as NRR, SNR or SLC80. These results have important implications on the perceived performance of hearing protectors for the end user. The results also explain why, particularly in 'low' noise environments, hearing protector programs are not as successful as they should be.

10:40-11:00

1710 _____ *invited*

FIELD MEASUREMENTS OF HEARING PROTECTION DEVICE PERFORMANCE

William J. Murphy*, John Franks, Rickie Davis

**NIOSH, USA, Cincinnati, USA*

The National Institute for Occupational Safety and Health, Hearing Loss Prevention Team has conducted hearing protector real-ear attenuation at threshold measurements for 200 workers. Each worker's A-weighted noise exposure was known and the hearing protector attenuations were assessed several times during the course of a year. Initial assessments were restricted to 125, 500 and 2000 Hz one-third octave noiseband frequencies. Subsequent evaluations tested 125, 250, 500, 1000, 2000, 4000, and 8000 Hz noise bands. The attenuations from the reduced set of frequencies were used to predict the protected exposure level for each worker based upon the A-weighted noise exposure level and assuming a flat noise spectrum. From these estimates, additional counseling was provided to the workers with respect to the type of protector and technique(s) used to fit the hearing protection devices. This paper will report the attenuation data, unprotected and protected exposure levels for the workers, as well the differences between the labeled NRR and the noise reduction delivered by the devices tested in this study.

11:00-11:20

1718 _____ *invited*

PERFORMANCE OF EARMUFF PROTECTORS UNDER CONTROLLES HIGH AMPLITUDE IMPULSIVE NOISE

Erasmo F. Vergara *, Robert S. Birch, Samir N.Y. Gerges

**UFSC, Florianópolis, Brazil*

When submitted to continuous noise, hearing protectors, such as earplugs, earmuffs and their combination, are usually evaluated using the attenuation of amplitude in the frequency domain. This is obtained from the difference of sound pressure level with and without the hearing protector in place. On the other hand, for impulsive noise, parameters such as peak sound

pressure, rise time and decay time must also be investigated. This is because these physical characteristics of the impulse noise are most relevant to the study of potential damage to the human auditory system. This paper considers the acoustic performance of earmuff type hearing protectors when subject to impulsive noise and with respect to their basic physical characteristics (weight, volume, etc.). The analysis is based on experimental results obtained using a shock tube apparatus to assess the sound attenuation of various designs of earmuff protector undergoing a sound pulse in grazing incidence. Transient and frequency performance parameters of the hearing protector are defined in terms of the idealised Friedlander pulse as defined by a rise time, peak sound pressure and decay time. The results are presented in terms of the sound peak attenuation and the changes of the rise and decay times of the attenuated pulse.

Session MR1: Measurements in Room and Building Acoustics

chairs:

Michael Vorländer - *Germany*

Francisco Parentes - *Brazil*

10:00-12:00 **Room:** Botafogo

10:00-10:20

1691 _____ *invited*

SOUND PROPAGATION MEASUREMENT USING SWEPT-SINE SIGNAL

Fumiaki Satoh ⋆, Hirano Jin, Sakamoto Shinichi, Tachibana Hideki

⋆ *Chiba Institute of Technology, Narashino, Japan*

In the measurement of sound propagation outdoors, the synchronous averaging techniques using MLS signal or swept-sine signal can not be applied to reduce the influence of the background noise because of the time-variance of the sound field influenced by the meteorological conditions. Therefore, we have been investigating the method of measuring impulse response using swept-sine signals with a long duration time (up to 600 sec. per a octave band) to avoid the influence by wind and atmospheric turbulence and to get a high signal-to-ratio. In order to examine the applicability of this method to outdoor sound propagation measurement, numerical simulation, scale model experiment using a 1/40 wind tunnel and field measurement of sound reduction index of a building facade have been conducted. As a result, it has been found that the results obtained by the method using a long swept-sine signal and those obtained by the ordinary method using a stationary-random noise are in high correspondence. As another application, the measurement of sound propagation characteristic from a semi-underground road will be presented.

10:20-10:40

1602 _____ *invited*

SWEPT-SINE METHOD IMPROVES SIGNAL-TO-NOISE RATIO IN BUILDING ACOUSTIC APPLICATIONS

Igor Nikolic⋆, Ole-Herman Bjor, Svein Arne Nordby

⋆*Norsonic AS, Lierskogen, Norway*

The swept-sine method as defined in ISO/DIS 18233 greatly improves the obtained signal-to-noise ratio when measuring reverberation decay and airborne sound insulation. The paper describes experience during application of the new method for field measurements and compares the results with values obtained by classical methods as described in ISO 140-4: Field measurements of airborne sound insulation between rooms.

10:40-11:00

1671 _____ *invited*

LEVEL ADJUSTMENT FOR MULTI-CHANNEL IMPULSE RESPONSE MEASUREMENTS IN BUILDING ACOUSTICS

Paulo Massarani⋆, Marco Antonio Nabuco de Araujo, Rodolfo Venegas

⋆*Inmetro, Duque de Caxias, Brazil*

Methods that use deterministic excitation signals to estimate impulse responses, like MLS and sweep sine, are being used in building acoustics measurement to improve signal-to-noise ratios. The sound pressure levels of the impulse responses can not be associated directly to absolute values after the digital processing steps involved in the estimation. To measure building acoustics properties, normally it's necessary to account for level differences or rates of level change. This can be done after the impulse response integration. In many cases it's very convenient to use multi-channel measurement systems, collecting data at several points in a room for spatial averages, or in two rooms for sound isolation measurement. The differences between the channel sensitivities, including the microphone responses, have to be observed. Some procedures for channel adjustment are included in the ISO/DIS 18233, using sound calibrators or by doing comparative measurements with microphones placed close to the excitation source. This work presents experimental results for multi-channel level adjustment using sound calibrators and room measurements. The main purpose is to compare the results obtained by the adjustment methods.

11:00-11:20

1575 _____ *invited*

LOW-MID FREQUENCY MEASUREMENT OF SINGLE NUMBER PARAMETERS IN ROOM ACOUSTICS WITH MULTI-WAY DODECAHEDRON SPEAKERS

Ingo Witew*, Gottfried K. Behler

* *Institute of Technical Acoustics, Aachen University, Aachen, Germany*

Single number parameters are often used to describe the acoustic conditions in auditoria. ISO 3382 describes a procedure to conduct room acoustic measurements and defines quality requirements on the measurement equipment. This study deals with the influence of the source, namely dodecahedron speakers, on the measurement result. The characteristics of different loudspeakers in the same measurement condition will be presented. As it is expected that most dodecahedron speakers have a fairly good omni-directional radiation pattern for lower frequencies differences in the single number values are even more surprising. For this reason a special focus will be placed on the observed differences in mid and low frequencies. In this light the results of multi-way dodecahedron loudspeakers will be discussed in detail. The effects of different measurement procedures and different signal processing methods on the parameters will be shown.

11:20-11:40

1440 _____ *invited*

THE INFLUENCE OF SUSPENDED CEILING MOUNTING CONDITIONS ON MEASURED SOUND ABSORPTION COEFFICIENTS

Marcelo Godoy*, Sylvio R. Bistafa, Peter Barry

**Institute for Technological Research, São Paulo, Brazil*

The work presents the results of an investigation into the influence of mounting conditions on the measured sound absorption coefficients of a suspended ceiling specimen. A series of measurements and analyses were carried out using a fixed standard sample, varying independently different mounting parameters and introducing controlled leaks. The measurements were performed in a reverberation chamber using the methods of the ISO 354 (2003) standard. The mounting system chosen was the "type E-300" of the standard, and the test specimen consisted of fiberglass wool ceiling panels, covered with a plastic film on the exposed face. Some parameters effecting the calculation of the sound absorption coefficients were also taken into account. By considering the uncertanties involved in the experimental results, the contribution of each parameter on the measured sound absorption coefficients could be checked. Based on this work, some recommendations for improving the standard measurement procedures will be given.

11:40-12:00

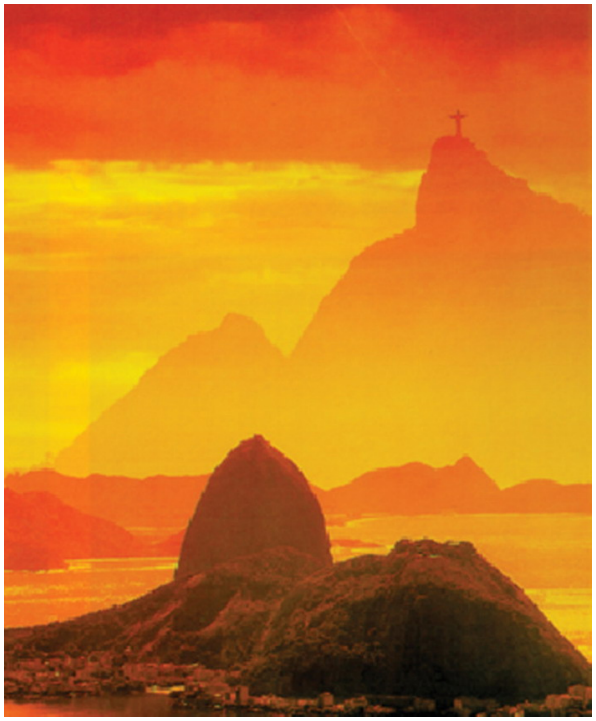
1479 _____ *invited*

APPLICATION OF BAYESIAN INFERENCE IN MEASUREMENTS OF DECAY TIMES IN ACOUSTICALLY COUPLED SPACES

Ning Xiang*, Mendel Kleiner, Paul Goggans

**Rensselaer Polytechnic Institute, USA, Troy, USA*

Acoustically coupled spaces have drawn increasing attention in architectural acoustics community. Measurements of multiple decay times in acoustically coupled spaces are of practical significance when studying and designing acoustics of the coupled spaces. Traditionally, however, identification of double- or multiple-sloped sound energy decay in room impulse response measurements has been considered very challenging. Previous works [Xiang and Goggans, J. Acoust. Soc. Am. 110, 1415-1424 (2001); 113, 2685-2697 (2003)] have applied Bayesian inference to cope with the demanding tasks in estimating number of decay modes and multiple decay times from Schroeder decay functions, evaluated from measured room impulse responses. This paper discusses recent development of efficient calculation of relevant decay parameters and incorporation of available information into model-based Bayesian formulism. We will show that Bayesian probability theory provides useful tools for the measurement of decay times. Implemented routines of Bayesian approaches will be demonstrated upon experimentally measured room impulse responses.



Session NT1: Noise Measurement Techniques

chairs:

Gilberto Fuchs - *Brazil*

Peter Wagstaff - *France*

10:00-12:00 **Room:** Rio 2

10:00-10:20

1505 *invited*

NEW SYSTEM FOR MONITORING EXPOSURE TO IMPULSIVE NOISE

Chucri A. Kardous*, William J. Murphy

* *U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, Cincinnati, Ohio, USA*

The U.S. National Institute for Occupational Safety and Health (NIOSH) developed a measurement and analysis system for accurately capturing and monitoring exposure to impulsive noise. The system consists of a Type 1, high intensity measurement microphone, a 24-bit data acquisition board with 96 kHz sampling rate, and a software tool that uses a graphical user interface (GUI) built in MATLAB to display the time domain waveform, frequency spectrum, and (1/1) and (1/3) octave band spectra of the captured impulse noise event. Additionally, parameters such as peak pressure level, equivalent average level, kurtosis, time duration, number of impulses, and temporal spacing between impulses are also calculated and displayed. An impulse detection routine was developed to aid in the location and analysis of impulsive events. Once the impulsive events have been identified, the program uses the three major damage risk criteria in use today (LeqA-8hr, MIL-STD 1474D, and Price/Kalb Auditory Hazard Units) to determine the limits for exposure to a particular impulsive noise event.

10:20-10:40

1455 *contributed*

IDENTIFICATION OF NOISE SOURCES USING GENETIC ALGORITHM

Maria Alzira Nunes*, Marcus Antônio Duarte

* *UFU, Uberlandia, Brasil*

Actually, the loss of hearing caused by long exposition to high noise levels is one of the most frequent causes of retirement in industry. Many laws have been passed in different countries to protect employees from dangerous noises. However the control of industrial noise is not an easy task. Generally, in most industries the production unit is complex due to the large number of machines and their lay-out in the building. To control industrial noise, the first step is to identify the sources of noise for later treatment. However, a difficulty encountered is that a machine may have various noise sources such as valves, jets, orifices. With technological advances and advanced techniques of programming, an optimization technique using the method known as Genetic Algorithm (GA) is proposed for identification of such sources. In this context, using the measured SPL(Sound Pressure Level) or IL (Intensity Level), the model to be optimized is constructed considering nondirectional point sources at a probable location and their possible SWL(Sound Power Level). In this way, the Genetic Algorithm technique ajusts the best model, having as project variables the SWL and source locations, such as to obtain the least mean square error between the measured SPL and the SPL obtained with the optimized model. Field results showed the applicability of this method.

10:40-11:00

1480 *contributed*

SOUND TRANSMISSION CHARACTERISTICS OF SANDWICH-PANELS WITH PORO-ELASTIC CORES

Kim Jeong-Woo*, J. Stuart Bolton

* *Ray W. Herrick Laboratories, Purdue University, West lafayette, USA*

A joint experimental and analytical investigation of the sound transmission loss (STL) and two-dimensional free wave propagation in two sandwich panels is presented here. An existing panel, a Nomex honeycomb sandwich panel, was studied in detail. For the purpose of understanding the typical behavior of sandwich panels, a composite structure comprising two aluminum sheets with a soft, poro-elastic foam core was also constructed and studied. The cores of both panels were modeled using an anisotropic poro-elastic material theory; it was used both to calculate the STL and to find the free wave propagation solutions. By analyzing the first anti-symmetric and symmetric modes of the panels, and their corresponding phase speeds, the panel coincidence frequencies could be identified. The behavior of the STL could then be clearly explained by matching with the free wave propagation solutions. The predictions for free wave characteristics were verified by comparing them with the measured free wave speeds for the first anti-symmetric mode and good agreement was obtained. The randomly incidence STL predictions also agreed well with measurement By performing a parameter study based both on the STL and free wave propagation speeds, the mass, stiffness and damping-controlled regions of the STL were identified. The effective structural factors that can be adjusted to improve STL performance were also identified.

11:00-11:20

1528 _____ *contributed*

ACOUSTIC INDOOR SIMULATION SOFTWARE: A CASE STUDY IN THE TEXTILE INDUSTRY

Pedro M. Arezes

University of Minho, Guimaraes, Portugal

Occupational noise exposure is one of the most important occupational health and safety problems in the textile industry. Due to some constraints, such as the lack of technical solutions and the high cost of some solutions, companies frequently adopt hearing protection devices as final solution. However, individual protection must be regarded as a temporary solution while other technical measures are adopted. The difficulty and costs involved on the implementation of technical and organizational solutions led to the need of some provisional tools. These should allow companies to have a first approach of the solutions' efficiency in order to decide what solutions should be considered and implemented. This paper describes a case study of the use of a particular acoustic indoor simulation software, and it aims at the analysis of the results' preview, considering the implementation of some technical and organizational measures. A simulation of the use of acoustical barriers and a new machinery layout was carried out. Considering the possible solutions several scenarios of noise exposure were analysed. From the obtained results it was possible to conclude that it is possible to preview with significant accuracy the noise pressure levels that workers will be exposed to after implementing some solutions. Therefore, it is possible to study what kind of materials and barrier dimensions are more efficient. Finally, it was possible to verify that this kind of software is a powerful tool in helping companies deciding the best solutions for the mitigation of the risk of occupational noise exposure.

11:20-11:40

1511 _____ *contributed*

ESTIMATION OF PARTIAL AREA SOUND POWER DATA WITH BEAMFORMING

Jørgen Hald

Brüel&Kjaer SVM A/S, Naerum, Denmark

Nearfield Acoustical Holography (NAH) provides accurate calibrated maps of any acoustical parameter near the source, in particular of sound intensity, from which partial area sound power data can be obtained. Beamforming, on the other hand, is basically a far-field measurement technique that estimates, how much of the pressure at the array position is incident from different directions. No calibrated source data are obtained, only maps showing the contributed pressure from different directions or positions on an assumed distant source plane. Beamforming is, however, being used more and more for general noise source identification, because measurements are fast and provide good resolution at the high frequencies. In such applications, calibrated source maps that can be compared with the output from intensity measurements or NAH are important. Beamformer arrays with uniform element spacing can be used at measurement distances down to around 0.6 times the array diameter, which means that the array will pick up the major part of the radiation from the source area under the array. The paper describes a simple method to scale the beamformed maps as sound intensity in such a way that area integration provides good estimates of partial area sound power data. The accuracy of the method is analyzed through numerical simulations and practical measurements.

11:40-12:00

1665 _____ *contributed*

THE USE OF NEAR FIELD ACOUSTICAL HOLOGRAPHY FOR LEAK DETECTION IN MINIATURE OBJECTS, SUCH AS HEARING AIDS

Gijsbert Dirks*, Svend Gade, Jørgen Hald

* *Brüel&Kjær Sound and Vibration A/S, Nærum, Denmark*

This paper presents how Near field Acoustical Holography (NAH) can be used to identify acoustical leaks on small electro-acoustic devices. As an example, the radiation from a defective hearing aid in the in the frequency range of 1 kHz – 10 kHz, exhibiting a spatial resolution of 3 mm, is shown. The performance of electro-acoustic devices such as hearing aids is in practical implementations severely limited by the amount of acoustical and mechanical feedback within the electro-acoustic system. During the design phase, parts need to be identified in the electro-acoustics systems assembly that causes acoustical leakage thus possibly creating an acoustical feedback path and resonances creating a mechanical feedback path. Spatial Transformation of Sound Fields, STSF proves to be a reliable and accurate solution to identify those parts in the assembled system.

Session PO1: Poster

09:30-12:00 **Room:** Copacabana

Active Noise and Vibration Control

1507 *poster*

ACTIVE CONTROL OF VIBRATION WITH EIGENVALUE PLACEMENT CONTROLLER

Janusz Kowal*, Jaroslaw Konieczny

* *Department of Process Control AGH-University of Science and Technology, Krakow, Poland*

Abstract The paper explores the potential applications of a controller designed in accordance with the eigenvalue placement rule. A 2DOF model representing a quartervehicle suspension is considered. This is only a theoretical model, however, and the dynamic properties of a active element are neglected. The study investigates how the variations of the gains matrix K elements should affect the dynamic behaviour of an active vibration control system. Active methods of vibration reduction receive a great deal of attention. Recently most researchers have explored actuators utilizing smart materials as they offer a vast potential of improving the energy balance and the dynamic behaviours of active vibration control systems. However, the dynamic properties of active vibration control systems are not dependent on the selection of actuators exclusively. The dynamic behaviour and hence the vibration isolation performance are largely dependent on the applied control unit. Control systems reported in literature include those utilizing PID, optimal controllers, robust, fuzzy logic controllers, sliding control approach and control systems supported by neural networks. The pole placement method enables the selection of natural frequencies and damping ratio, i.e. key parameters in any vibration reduction strategy. This paper provides the synthesis of a controller in accordance with the pole placement method.

1625 *poster*

REAL-TIME CONTROLLERS FOR A MR DAMPER IN A QUARTER CAR SUSPENSION – RESULTS OF LABORATORY TESTS

Bogdan Sapinski

AGH - University of Science and Technology, Cracow, Poland

The paper reports the results of experiments of real-time controllers for a magnetorheological (MR) damper in a quarter car suspension. Experiments were conducted in the open loop and feedback system configurations of the tested application under vibration excitations. The real-time controllers with on-off and continuously variable control schemes were developed in the integrated design and control environment of MATLAB/Simulink.

1910 *poster*

NULLSPACE-BASED SOUND FIELD CONTROL FOR BARGE-IN-FREE SPOKEN DIALOGUE INTERFACE

Shigeki Miyabe *, Saruwatari Hiroshi, Shikano Kiyohiro, Tatekura Yosuke

* *Nara Institute of Science and Technology, Ikoma-Shi, Japan*

This paper describes a new small-scale interface for a barge-in-free spoken dialogue interface combining a multi-channel sound field control and a microphone array, in which the interference produced by the spoken dialogue system (response sound) can be canceled out at the microphone points. In general, the speech recognition performance degrades when both the spoken dialogue system and the user speak simultaneously. An acoustic echo canceller is commonly used for eliminating the response sound, but the method has the inherent problem that the accurate filter adaptation is difficult in the barge-in situation. To reduce the response sound without filter adaptation, Multiple-Output and Multiple-No-Input (MOMNI) method using a sound field reproduction and a microphone array has been proposed by the authors. However the reproduction of the response sound fixes user's position and requires huge number of loudspeakers. To address the problem of MOMNI method, we propose a new filter design method to realize silence on the positions of microphone elements without reproducing the response sound on the user's particular position. First, singular value decomposition is utilized to provide vectors which span nullspace of the matrix of the room transfer functions among the loudspeakers and the microphones, and each nullspace vector is one of the filter candidate which can realize the silence at the microphone positions. Secondly the linear combination of the vectors closest to the delayed impulse yields the resultant filter coefficients corresponding to the nullspace while keeping better sound qualities. The relaxation of the strict reproduction of the response sound reduces the number of loudspeakers with stable control, and allows user's move. From the result of the response-sound-elimination experiments, it is ascertained that the proposed method is more robust against fluctuation of room transfer functions than the conventional methods even when the number of the loudspeakers is small.

1913 _____ *poster*

AN ACTIVE SYSTEM FOR NOISE CONTROL USING DIGITAL FILTERING

Andrzej Golas ⋆, Wojciech Ciesielka, Ryszard Olszewski, Ireneusz Czajka

⋆ *AGH University of Science and Technology, Krakow, Poland*

Any acoustical system can be treated as technical control system in which we can distinguish input, state and output variables.Traditional methods of sound control are connected with passive methods.Active methods of control of acoustical field parameters are connected with an ingeration into the sound field structure with additional sound sources.It is the problem of inverse exercise.It means, how to find the distribution of sound sources with controlled dynamical parameters (changable directional characteristics and phase characteristics) to obtain an expected sound field distribution.The construction of the system is connected with solving many partial problems as the creation of sound field model including phases relations, creation of control algorithms according to accepted criterias of sound distribution in investigated space and the construction of the real set of control.In the paper results of investigations of the team cunducted by the Author in the area of active sound reduction and active control of sound field parameters distribution are presented.Particularly the paper presents an application of finite elements and boundary elemenths method for active sound control by estimation of pulse response basing on calculated static characcteristics. Also an adaptive system for noise control is presented. The main part of the system is a finite impulse response (FIR) digital filtering.The theory of optimal filtering was also employed for design of multipoint sound source with changeble in time directional characterisics.The complex system of sound control which realize expected criteria is shown.

Aeroacoustics

1407 _____ *poster*

QUADRIPOLE SOURCE MOVING NEAR AN INTERFACE WITH VELOCITY DESCONTINUITY

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We study the sound field produced by a quadripole source moving along the x-axis, near the interface between two flows, where one of them is in rest and the other one has velocity equal to that of the source. This approach is intended to provide information about the amplification and the refraction caused by the passage through the interface.

Aircraft Interior Noise and Technology

1421 _____ *poster*

STUDY OF THE STRUCTURAL-ACOUSTIC INTERACTION IN AN UNIFORM CYLINDER SHELL STRUCTURE

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In the last years it has been increasing the researcher's interest, contemplated by the great number of publications, dedicated to the active control of noise, in structures as aeronautics and vehicular. In that sense the study of the interaction between structures and acoustic fields is of fundamental importance in the understanding and the application of the technique of active control. This work presents a study of the coupling between structures and acoustic fields, applied in a structure of uniform cylindrical shell type. The ANSYS is used to obtaining the natural frequencies and the acoustic and structural modes. It is shown that the structural and acoustic modes act in different frequencies, that the number of modes of structural vibration is larger than the number of acoustic modes and that the natural frequencies of a structure don't increase with the increase of the modal indexes. Key Words: Fluid-structural interaction, acoustics, shells, mechanical vibrations

Airport Noise

1841 _____ *poster*

EFFECT OF NOISE REDUCTION TECHNOLOGIES AND OPERATIONAL PROCEDURES ON EXTERNAL COST AROUND A GENERIC AIRPORT

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Recovering from the recent crisis, worldwide air traffic is expected to grow steadily the next decades. In this context, ongoing consolidated research from industry, institutions and universities is increasingly focussing on the reduction of adverse environmental effects like noise and pollutant emissions (in this study mainly aircraft noise was regarded). In order to support a sustainable development of the aviation industry, it is necessary to evaluate the long-term overall impact of noise reduction technology and operational noise abatement improvements on society, airports, aircraft operators and manufacturers. An important part of this process is to analyse the effect on external costs particularly with regard to current attempts of EU authorities and

national governments to internalize these cost according to the "polluter pays principle". For this reason, the detailed evaluation of the noise reduction potential of different technologies (chevron nozzle, scarfed inlet etc.) and operational procedures (CDA, LPLDA) in terms of total, aircraft specific (marginal) external cost savings is gaining in importance. It is especially interesting to make transparent what effects come from an aircraft manufacturer investment in the development and integration of new technologies and noise abatement measurements. The developed methodology is a combination of noise contour simulations and external cost calculations. The used method of calculating external costs of aircraft noise includes economic state-of-the art valuation approaches like hedonic pricing, costs of illness and restricted land use. For this purpose, several studies were conducted with the help of an Integrated Noise Modelling tool of a generic airport whose layout and population distribution was based on Frankfurt airport for the first sensitivity analysis. Different fleet mixes, noise reduction technologies, operational procedures and market penetration for the current situation and for 2022 predicted by means of the Airbus Global Market Forecast have been examined. The results have been validated with data provided by German airport authorities, recent noise valuation studies from other parties and comparative trials at 14 international airports.

Building Acoustics

1530 _____ *poster*

APPLICATION TO THE TOWN OF REGGIO CALABRIA OF AN ANALYSIS METHOD AIMED AT CHARACTERIZING BUILDING ELEMENTS WITH REFERENCE TO OUTDOOR NOISE IN DIFFERENT ACOUSTIC ZONES

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The paper is related to acoustic comfort in indoor environments and is based on an analysis method aimed at the optimisation of choices concerning building materials and components with reference to their performances in the different acoustic zones provided for by Italian law. In particular the method relates indoor noise levels with the acoustic features of indoor environments, their geometric parameters (in terms of glazed/opaque ratio and altitude) and acoustic spectra characteristic of outdoor noise in different acoustic zones of given cities. Through the paper an application to two towns of different sizes, located in Southern Italy, is described, aimed at obtaining friendly maps pointing out the building materials to be used in different zones, at different floors, in order to guarantee indoor comfort levels. Further maps show the present situation of the building yard in the two cities, pointing out areas in which building types show to be not suitable for assuring given indoor levels.

1658 _____ *poster*

EVALUATION OF RESIDENCIAL SOUND INSULATION CRITERIA FOR BRAZIL

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The lack of Brazilian rules about sound insulation in buildings brings difficulty the evaluation of the components and constructive systems insulation. Nowadays, a residential building performance code have been developed in Brazil (CB.02:136.01.004), which considers the sound insulation of components and constructive systems among other items. However this code project are not directed related with NBR 10151 and NBR 10152 Brazilian standards yet. It must be mentioned that these codes are in reviewing process and that is necessary to get them compatible to the CB.02:136.01.004. This work also compare the CB-02-136.01.004 with the related codes from other countries, which suggests improved sound insulation index to be used in Brazil.

1680 _____ *poster*

FIELD MEASUREMENT FOR IMPACT SOUND INSULATION OF FLOORS OF MIDDLE SIZE APARTMENT

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Impact noise insulation performance of floating floor is evaluated for several apartment houses. Insulation performance for light sound is measured by the measurement method of ISO 140-7 using standard light impact source generator and that for heavy impact sound b the Korea Industry Standard which is a revision of ISO 772-2 which addresses the rating of floor impact sound insulation for impact source in buildings and of building elements. It is found that the insulation rating for light impact sound is satisfied by the floating floor which gives less than the rating critical of 58dB but that for the heavy impact sound shows greater than the rating critical of 50dB

1742 _____ *poster*

E.V.A (ETHYLENE-VINYL ACETATE COPOLYMERS) RESIDUES FOR IMPACT NOISE INSULATION IN BUILDINGS

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The present research seeks an alternative to the recycling of solid residues derived from shoe factories, specially ethylene-vinyl acetate copolymers employed in the manufacturing of soles and inner soles. The possibility of using grained E.V.A. in impact noise insulation in buildings was analyzed. The system of floating floor was used, with an intermediate layer between the structure and the floor finish, made up of elastic material in order to minimize the effect of impact noise. Plates molded with E.V.A. were lab tested, and these had several kinds of thickness and compositions. Results were compared aiming to determine the composition which offered the best result for impact noise insulation in buildings.

1851 _____ *poster*

ARCHITECTURAL ACOUSTICS AND PRESERVATION, A FEASIBLE PROJECT FOR SCHOOLS OF MUSIC

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This work aims at establishing acoustic parameters for the architectural interventions in music schools located in buildings with preservation interest. The focus of this work is to provide a solution to a contradiction between preservation demands and acoustic needs. Although seemingly contradictory subjects, they are complementary since preservation is only possible with the adjustment of monuments to the demands of modern society. Lack of acoustic comfort may compromise the use of monuments and, therefore, the effectiveness of the conservation actions. This may sometimes be due to general phenomena, e.g. urban noise, or due to some specific phenomenon, such as the changes in the programmatic needs of music schools. Therefore, acoustic planning in the conservation actions should be one of the initial guidelines. Restoration restrictions such as façade unalterableness and the respect for the original materials, most of all, hinder the actions of acoustic treatment. Thus, a detailed survey of any buildings acoustic situation, as well as the identification of its deficiencies and acoustic potentialities is paramount. It is also essential to evaluate the users´ needs, and research the records of the building for classification as heritage in order to issue a value judgment that will later on be fundamental when the time comes to determine priorities in the intervention process. The intervention parameters are established based on the gathered data, the bibliographical revision, the existing legislation, and the recommendations to be found in Brazilian Rule 10152 and in the International Restoration Principles.

1872 _____ *poster*

APPRAISAL OF KEY INFLUENTIAL FACTORS ON FLOOR IMPACT SOUND ISOLATION PERFORMANCE IN A FLOOR IMPACT SOUND TEST BUILDING

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Floor impact sound occurring due to foot steps, falling objects, furniture movement etc. in common residences causes great unpleasantness to the household in the floor below. The floor impact sound pressure level appears differently depending on the object that is making the impact, basic floor structure, and the finishing material. For this study, a test building to enable the floor impact sound test was constructed, and the floor slab thickness, resilient materials, ceiling & wall composition methods influencing the level of floor impact sound were measured & appraised. The measurement results revealed that the increase in thickness of the slab had effects on both the light weight impact sound and heavy weight impact sound, and resilient materials installation, ceiling & wall treatment methods showed to be more effective on light weight impact sound than heavy weight impact sound. The reduction effects of ceiling & wall treatment methods were greatest when light weight impact sound was at 125Hz, 250Hz.

2059 _____ *poster*

OPEN SPACE ACOUSTIC PROJECT FOR ENTERTAINMENT AREAS: A CASE STUDY OF MAXI PLACE

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The present work aims at presenting an acoustic project, with solutions for control of the emission of noise originating from live music concerts, in Maxi Place central court. The venue is constituted of a commercial area that includes restaurants, bars, stores and nightclub in the city of Vitória in the state of Espírito Santo. After the opening of the venue with the use of the stage for concerts the surrounding community was affected by sound levels above the limit allowed by resolution no. 10/98, of Municipal Council of Environment. The project had as a condition the respect and harmonization of the original architectural project guidelines. The guidelines proposal seeks a central patio with a retractable covering that would be treated in such a way as to make performance of the concert, satisfying the acoustic conditions and protecting the listeners in case of rain. At the same time, in days without per-

formances, the atmosphere could be used as a meeting point and coexistence among the customers that patronize the bars and restaurants, seeking comfortable conditions and well-being, in a wide open space.

Community Response and Exposure Criteria

2013 _____ *poster*

THE NOISE DISTURBS IMPACTS ON A TOWN IN BRAZIL: COMMUNITY NOISE RESULTS

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The object of the paper is to present a survey of formal complaints concerning noise in the city of Sao Jose dos Campos, where a major part of population lives in urban area. The Municipal City hall attends the complaints of the population. This study shows that the number of complaints of the population disturbed by noise is increasing annually but most of the noise problems are caused by authorized activity. In this work the results of more than one hundred measurements carried out in the last two years are analyzed, along with a critical study of the methodology used for the measurement of noise.

Ducts and Pipes

1504 _____ *poster*

APPLICATION OF THE FEM TO PREDICTING ACOUSTIC ATTENUATION PERFORMANCE OF CIRCULAR EXPANSION CHAMBERS WITH IRROTATIONAL MEAN FLOW

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The finite element method (FEM) is applied to predict the acoustic performance of circular expansion chambers with irrotational mean flow. In order to evaluate both the acoustic and mean flow variables, a FEM software was developed. The formulation of the FEM is derived for the axisymmetric condition, being valid for incompressible mean flows. Predicted values of transmission loss of different expansion chambers configurations without and with mean flow are compared. In addiction, it is compared with plane wave analytical solutions. The presence of extended inlet/outlet ducts as well as the presence of a rigid baffle in the chamber and the effect of the mean flow are investigated. Some of these effects are shown to modify the acoustic behavior drastically, suggesting potential means to improve the acoustic attenuation performance.

General Acoustics

1502 _____ *poster*

RESONANCE EFFECT OF NANOFIBROUS LAYER ON SOUND ABSORPTION

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This paper deals with the acoustic behavior of a flexible porous material with resonant nanofibrous layer. The resonance effect of nanofibrous layer has been studied. The material formed from nanofibrous layer has been evaluated in comparison with the nanofibrous layer damped by porous nonwovens. Both materials are located in different distance from the wall. The resonance frequency is given by nanofibrous layer characteristics. The sound absorption coefficient increases with the distance of resonant layers from the wall and porous material using.

1705 _____ *poster*

A TEST SIGNAL ROBUST AGAINST BACKGROUND NOISE IN THE MEASUREMENT OF ACOUSTIC IMPULSE RESPONSES : WARPED-TSP

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We propose a new signal to improve the accuracy in the measurement of acoustic impulse responses. Linear TSP (Time-Stretched Pulses) signals have been widely used for the acoustic measurements. It is known as a useful signal robust to time-varying acoustic environments due to the concentration of energy as a chirp signal. It is, however, the case that it requires multiple repetition particularly in low SNR conditions since the enegy destribution is flat while the energy of ambient noise tends to concentrate in low frequency regions. The multiple measurements preclude the merit of the robustness to time-varying environments. Recently, a "log-TSP" signal was defined on the logarithmic time-axis to improve the tolerance to noise and harmonic distortion. It, however, reduces relative SNR in high frequency region. It is desirable to develop a signal to introduce the merits of both linear-TSP and log-TSP signals. We propose a new TSP signal, referred to as 'warped-TSP', which combines two signals gradually in a transitional frequency region. The warped-TSP enables us to choose an optimal parameter for the transition in accordance with the spectral distribution of noise in the environment under measurement. In this paper, we describe the warped-TSP in terms of the design, principle and effectiviness. We describe the

definition and the relationship between the parameter and spectral distribution. We show the principle for robustness to background noise and haramonic distortion, and a method for optimal choice of the parameters using simple measurement and calculation. We show the results on a series of measurement tests under different environments. It is clearly demonstrated that the warped-TSP performs better than conventional linear-TSP and log-TSP. Since the definition of warped-TSP is simple, it is possible to replace conventional TSPs without additional computational cost.

1599 _____ *poster*

NOISE REDUCTION OF THE 154 KV TRANSFORMER

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In order to effectively cope with the trend of increasing demand for electrical power, it is essential to install the substation in the proximity of the urban area for its stable supply. However, the radiated noise from a transformer, a main noise source in a substation, may lead to a serious environmental problem and complaint of residents because of its high noise level. In general, the transformer noise results from the broadband ventilation system noise and the mechanical vibration due to the core's magnetostriction and winding's electromagnetic force. In a fluid-insulated transformer, the mechanical vibration is transmitted to the tank wall through the structural supports of the core and coil assemblies and through liquid. In this paper, to identify the dynamic characteristics of 154kV transformer, a series of noise and vibration measurement and FE structure modeling were firstly carried out. And then, a variety of structural modifications such as plate reinforcement, the alteration of the tank wall thickness and the stiffener spacing, and attachment of dynamic absorber have been proposed and confirmed using the vibro-acoustic program, SYSNOISE. From the results, it was found out that the transformer noise was dominated by the vibration of tank wall and that the sound power level of transformer could be reduced considerably by the modification of the stiffener spacing and the adaptation of the damping material only.

2047 _____ *poster*

USE OF DISSIPATIVE SILENCERS FOR FAN NOISE CONTROL

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Axial and centrifugal fans are very used in industries in general. These equipments have great applicability in the product development as well as ambient comfort. Among the operational problems of fans, the noise arises as a common source. However, fan noise is not an acoustic problem hard to be solved. The fundamental approach is the utilization of absorptive, parallel, or circular baffle-type silencer. The features of this type of silencer are good high-frequency attenuation and minimal aerodynamic pressure loss. In this context, this work presents a review of the common noise sources in fans and the procedures to noise attenuation. Finally, an application case is presented to illustrate the use of dissipative silencer.

1726 _____ *poster*

THE EFFECT OF SIMULATED ENVIRONMENTAL CONDITIONS ON THE DISTINCTIVE FEATURES OF THE ACOUSTIC SIGNAL ACCOMPANYING THE CORONA PROCESS IN LABORATORY CONDITIONS

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The sound accompanying the corona noise can be easily recorded and its analysis, making use of the contemporary signal processing techniques and artificial intelligence (AI) methods, may be the source of information concerning the line damages, which are very difficult to detect and assess by other methods. The essence of the problem is the fact that useful information about the power line damages is hidden in the structure of the analyzed signal and has to be extracted, in which process the AI techniques applied by the authors can be very helpful. In addition to separation of the useful signal the AI techniques can be used for recognizing whether the signal source can be attributed to a given type of line damage. As has been shown in previous papers some distinctive features of such phenomena can be extracted in laboratory conditions. However it has been found that in long-term studies the observed recognizability of these features was lower in comparison with studies carried out in a short time period e.g. in one day. One of possible reasons of that result can be the effect of environmental conditions on the distinctive features of the signal. The present study has been carried out on a conductor located in a climatic chamber, where the effect of temperature and air humidity could be studied on the properties of the distinctive features of acoustic signal accompanying the corona process in its various stages The work contains the results of the study and their discussion. The presented results have shown that in the wide range of environmental parameters in real world conditions, the properties of the distinctive features did not exhibit considerable changes, what definitely supports the opinion that these features can used as a basis for the diagnostic procedure assessing the technical condition of power lines.

1797 *poster*

APPLICATION OF THE AUTOMATIC ACOUSTIC PATTERN UNDERSTANDING METHOD TO IDENTIFICATION OF ACOUSTIC EVENTS

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Noise monitoring, as a solution for periodic or continuous monitoring of acoustic climate in a selected area, is usually based on well-known and standardized research procedures. However in some cases the bare noise level measurement and the determination of its principal temporal and spectral parameters turns out to be inadequate. The more and more strict regulations concerning the allowed parameters of acoustic climate (in particular in the airport vicinities) and the requirement to identify not only the mere fact of breaking the noise standards allowed by law but also the trespasser and the exact circumstances of the event direct the noise supervision towards the application of more advanced methods of signal analysis, related to the automated acquisition of knowledge required for understanding the acoustic phenomena taking place in the area under supervision. Because the proposition of automatic understanding of acoustic signals (not to be confused with their automated recognition) presents a new concept, introduced in the present work, some additional explanations seem to be necessary. In the contemporary diagnostic practice the acoustic climate is being monitored by making use of the identified diagnostic relations between the supervised symptom and its actual condition. The concept of "diagnostic relations" is context dependent, and additional difficulties in the process of its specification arise from the existing measurement limitations and the interference signals distorting the result of the measurement itself. The problem leads to considerable technical and interpretative difficulties. In the approach proposed in the present work the authors strive to enhance the assessment of the meaning connected with a specific type of measurements, with particular stress on the semantic analysis and cognitive approach. In all the tasks in which the standard methods of acoustic signal processing and classification, routinely used in diagnosis and classification, totally fail, new methods for signal analysis and interpretation are necessary, like the ones proposed in the present work, which are nonstandard, more refined and oriented towards the reasoning about the actual acoustic processes, not only the signal description The problems considered in the present paper will be discussed in the context of aviation noise monitoring, where it is necessary to identify the acoustic events registered by the system, because in the airport area there are many transportation routes with intense road or railway traffic. In the present systems the process of identification of acoustic events related to the airport operation is aided by a connection between the noise monitoring station and the airport's radar stations. Because of the communication problems encountered in such a system it would be advisable to equip the monitoring stations with tools capable of independent recognition and classification of the monitored noise sources. The application for that purpose the artificial intelligence methods and in particular the neural network techniques, allows the extraction of aerial noise and even recognition of individual types of air vehicles and specific semantic connotation of acoustic events subject to automatic interpretation analysis.

General Vibration

2062 *poster*

DYNAMIC OF THIN PLATES WITH DIFFERENT BOUNDARY CONDITIONS

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Several techniques are used to study the frequency response of plates, however, they performed to the limit of all side simply supports. This paper presents several combinations of simply supported (S), clamped (C) and free (F) edges in thin rectangular plate through analytical analysis and it is obtained the effect of boundary conditions in the finite plates. Several combinations are shown in this work, as SSSS, SSSC, SSSF, SSCC, SSFF and SSFC and it can be extended to other cases. Therefore, this analysis concerned with appendage in the form of dynamic response of plates with random excitation and by classical Kirchoff's theory. Numerical calculations are used to check the analytical results and the predicted resonance frequencies curves and mode shape are compared against the Finite Element Method (FEM) and a good agreement has been found.

1799 *poster*

DYNAMIC ANALYSIS OF A NEW PIEZOELECTRIC FLEXTENSIONAL ACTUATOR USING THE J1-J4 OPTICAL INTERFEROMETRIC METHOD

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Piezoelectric actuators are widely used in positioning systems which demand high resolution such as scanning microscopy, fast mirror scanners, vibration cancellation, cell manipulation, etc. In this work a piezoelectric flextensional actuator (PFA), designed with the topology optimization method, is experimentally characterized by the measurement of its nanometric displacements using a Michelson interferometer. Because this detection process is non-linear, adequate techniques must be applied to obtain a linear relationship between an output electrical signal and the induced optical phase shift. Ideally, the bias phase

shift in the interferometer should remain constant, but in practice it suffers from fading. The J1-J4 spectral analysis method provides a linear and direct measurement of dynamic phase shift in a no-feedback and no-phase bias optical homodyne interferometer. PFA application such as micromanipulation in biotechnology demands fast and precise movements. So, in order to operate with arbitrary control signals the PFA must have frequency bandwidth of several kHz. However as the natural frequencies of the PFA are low, unwanted dynamics of the structure are often a problem, especially for scanning motion, but also if trajectories have to be followed with high velocities, because of the tracking error phenomenon. So the PFA must be designed in such a manner that the first mechanical resonance occurs far beyond this band. Thus it is important to know all the PFA resonance frequencies. In this work the linearity and frequency response of the PFA are evaluated up to 50 kHz using optical interferometry and the J1-J4 method.

Instrumentation and Standards

1613 *poster*

SOUND LEVEL METER'S CALIBRATION USING A 24BITS AD/DA CONVERTER

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In this paper will be presented a sound level meter's calibration system using a 24bits AD/DA converter. A software built on Labview's National Instruments language was developed for creating IEC 60651 signals. This software generates pure tones arrays for verification of A, C and Flat frequency weightings, besides signals for RMS verification by crest factor method, linearity level, fast and slow time weightings. These signals were built on 44.1kHz sampling rate with an effective dynamic range more than 100dB, which is good enough for linearity level calibration. It was used labview´s drivers, developed on C language, that makes able Hammerfall DSP Multiface sound card being controlled for outputting standard signals. All measurements were performed on class 0 and class 1 sound level meters. Generation system was calibrated by means other labview software that uses a Hewlett Packard 3458A multimeter which is the laboratory standard for AC voltage and total harmonic distortion (THD) measurements, and a HP53132a universal counter for frequency measurements. Finally it will be described software steps and will be presented advantages of using such calibration system.

Measurements in Room and Building Acoustics

1470 *poster*

INFLUENCE OF THE MOUNTING METHODS OF BAFFLES IN REVERBERATION ROOM ON THEIR SOUND ABSORPTION

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In the paper the measurement problems of sound absorption of space absorbers such as baffles, are discussed. The sound absorption coefficient of space absorbers suspended as a configuration of objects, depends on their mounting method during the test in a reverberation room. In updated second edition of standard ISO 354:2003 new type J mounting for rectangular unit sound absorber pads or baffles is recommended. The way in which the sound absorption properties are determined raises a great deal of controversy. The paper presents some of the measurement results of sound absorption of baffles, for different methods of their installation in the reverberation room. The influence of baffle arrangement(configuration, density) and the location of the absorbers in reverberation room are discussed.

1610 *poster*

SOUND ABSORPTION PROPERTIES OF SUSTAINABLE FIBROUS MATERIALS IN AN ENHANCED REVERBERATION ROOM

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In this paper, the measurement of sound absorption coefficient of novel sustainable fibrous materials is investigated. Nowadays the use of such materials is becoming wider for various applications, being ecological, biodegradable and renewable: they differ from traditional fibrous materials, as rock or glass wool, for their very low toxicity and polluting effects. These materials can be used in many ways: noise mitigation and building acoustic correction are surely among the most important. Sound absorbing layers made of natural fibres and of recycled raw materials have been tested in the reverberation room of the Acoustics Laboratory of the University of Perugia according to ISO 354 standard, in order to quantify their sound absorption properties and to make a comparison with traditional fibrous sound absorbers. An optimization of the reverberation room characteristics has been also carried out. Good sound field diffusivity inside the room is a fundamental requirement for the measurement accuracy. Among the parameters that mainly affect room diffusivity are the room shape and the sample disposition inside the room. In order to obtain accurate values of

the sound absorption coefficient, specific actions were adopted. Test specimens were placed on the floor with edges nonparallel to the room walls. A partial closing of the lower room corners with absorbing and reflecting diffusers and suspended plane diffusers were also tested, obtaining a significant improvement of the results. The measured performance of the tested materials seems to be fully comparable with that of mineral wool fibres: because of their low impacts on the environment and the human health they can be seen as a valid alternative to conventional materials.

1733 _____ *poster*

ACOUSTIC CONDITIONS OF SCHOOL CLASSROOMS IN THE DISTRITO FEDERAL: BACKGROUND NOISE AND REVERBERATION TIME

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Among the several aggression manifestations to the environment, there is one that brings many consequences for the human health. The sound pollution is one form of environmental contamination that has been growing in the big cities. In Distrito Federal (DF, Brazil), as in other big centers, the urban traffic is one of the main causers of the high noise levels in environments. The purpose of the present paper is to discuss the results of a series of investigations regarding the performance of classrooms concerning the acoustic comfort conditions in the public and private schools. In classrooms of ten schools in DF, the reverberation time (RT60) and background noise, Leq(A), were evaluated during the year of 2003 and 2004. The background noise was measured during vacation time and yet during the normal period of classes. Noticed that, in the vacation time, half of the researched schools were being contaminated with noise from aircrafts, road traffic, trucks, advertising cars, motorcycles, buses and others. The buildings are bad located in the city and exposed to levels that are above of the recommended for the norms. In the normal period of classes, all the schools searched presented noise levels very above the recommended. The results show a critic situation indicating the urgent need of actions with the objective of mitigating this serious kind of pollution. Regarding the reverberation time, the investigations showed a serious problem: only one of the analyzed schools presented compatible results with the legal rules. The research showed that the conditions of almost all the evaluated rooms can not be considered acoustically appropriate. In a classroom, the communication between teacher and students is damaged by the inadequate acoustic conditions, poor communication will make the learning process more difficult.

Metrology

1516 _____ *poster*

THE EVALUATION OF UNCERTAINTY IN URBAN TRAFFIC NOISE MEASUREMENT ACCORDING TO THE ISO "GUIDE"

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The urban traffic noise is generally characterized by non – stationary features, for this reason the values of LAeq it produces can show, especially when calculated for not sufficiently wide time intervals, even large variations. This can produce an amount of uncertainty in the results that becomes critical if the measurement results must be compared with the limits imposed by laws or regulations. The ISO "Guide to Express Uncertainty in the Measurements" gives a general conventional method to treat and express uncertainties in measurements regardless of their nature, therefore uncertainties in acoustical measurements should be treated according to what stated in the Guide as well. In this work the evaluation and the expression of uncertainty associated to urban traffic noise measurements, under different traffic conditions and according to Guide, have been analysed; in particular the problem arising from the use of pressure levels instead of linear physical quantities has been studied showing that care must be taken in this case in handling and interpreting data uncertainties. In particular it has been shown that a treatment based on a "classical" definition of standard deviation is generally meaningless and a new suitable formalism should be applied to data in order to give usable results.

1926 _____ *poster*

SOURCES OF UNCERTAINTY IN SOUND LEVEL METER CALIBRATION

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With the expansion of the Brazilian Network Accreditation (RBC) in electroacoustics area there is a need for guidelines on uncertainty budget elaboration for sound level meter´s calibration. The measurement expanded uncertainty stated on calibration certificate issued by Inmetro´s Electroacustics Laboratory is 0,2dB. This task have been done using two different equipment: sinusoidal signal HP33120a and standardised IEC 60651 signal Hentschel SK 148 generators. Although some secondary laboratories does not have these generators, these talk will only have guidance direction. The aim of this paper is deeply detail the type B standard uncertainty components, decreasing then the stated measurement uncertainty, besides helping calibration laboratories that request accreditation. There will be evaluate

1927 _____ *poster*

ANALYSIS OF UNCERTAINTY IN THE INVESTIGATION OF SOUND LEVEL METERS

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The paper describes a procedure, elaborated for calculation of uncertainty in the determination of frequency characteristics of free-field response for measurement microphones and sound level meters. The procedure has been elaborated on the basis of a mathematical model of the measurement, according to the methodology elaborated in the Chair of Mechanics and Vibroacoustics. On the basis of the elaborated calculation model individual uncertainty components have been determined for the carried out measurements, their individual contributions to the combined standard uncertainty have been discussed and an example of uncertainty budget, prepared for a selected sound level meter, has been presented.

Psychoacoustics

1648 _____ *poster*

INFLUENCE OF NOISE ON SPONTANEOUS CONTRACTIONS OF TENSOR TYMPANI MUSCLE OF GUINEA PIG

Ernst Jurgen Haberland*, Hans Neumann

* *University of Halle, Halle (Saale), Germany*

High intensity noise influences spontaneous contractions of tensor tympani muscle. These contractions may occur in experiments with guinea pigs in Ketamin aneasthesia. The frequency ranges from single events to respiration sequence. More or less phases of contraction and respiration are connected. In this preliminary study contractions of tensor tympani muscle were indirectly detected by pressure measurements in 8 guinea pigs. The measurements were performed (1) fluid coupled in the perilymphatic system and (2) air coupled in the sealed volume of external auditory canal. Electromyogram was registered simultaneously from the muscle surface. Contractions were quantified by its frequency and duration. Influence of pulses of white noise (4 animals, 116 dB SPL, duration 2 s) and slow fluctuations of stationary perilymphatic pressure (about 10 Pa/s) caused by injection and aspiration of perilymph were investigated. Mean value of the contraction frequency is 29,5±11,5 min^{-1} and half-peak width is 350±100 ms. White noise of 116 dB SPL depresses the release of contractions. After noise exposure the duration of the next contraction is distinct longer than the previous and following regular contractions. The contraction frequency is modulated by pressure fluctuation velocity and the value of stationary perilymphatic pressure. The stationary perilymphatic pressure is influenced with a very small pressure reduction by noise. The observations have shown that noise of high intensity as well as perilymphatic pressure fluctuations modulate the activity of tensor tympani muscle. For noise processing in animals are discussed both, the possibilities of acoustic signal processing and mediation via intracochlear pressure receptors in the perilymphatic fluid balance system. Spontaneous contractions of tensor tympani muscle, which occur in human too, may have significant importance for the convective transport function of perilymph.

1953 _____ *poster*

CENTRALITY OF SOUNDS IN THE PRODUCTION OF SENSE: CONTRIBUTION TO A POLITICS OF PREVENTION OF HEARING LOSS IN THE WORK UNDER NOISE

Marisa Klemenc

UNICEUMA, São Luis, Brasil

This research pertains to the area of Audiology and Occupational Health, although it makes extensive use of the knowledge of Social Psychology theories and methods for the analysis of the data. It's aim is to contribute to the development of procedures related to the preservation of health, specially with regards to the health of workers exposed to the noise in the work environment. This research stems from the author's experience in the area from the ensuing concern with the lack of motivation for participation in existing health promotion actions. Focus Groups were conducted with the clientele of Public Health Service specialized in Occupational Health with the objective of understanding the role of sounds in the production of meaning in everyday life. The basic assumption was that only through a better understanding of the meaning ascribed to sounds would it be possible to contribute to the advancement of health promotion actions more attuned to the worker's perceptions and, hence, more able to promote motivation for participation in actions geared to create better work environments. The various analyses lead us to conclude that the people, in general, have a very complex perception of the sounds they encounter in their daily life; a variety of sounds that also provide us with information as to the mode of life in modern societies. People seem to have empirical knowledge about sounds that is compatible with the scientific knowledge about the effects of sounds for health in general, as well as more specifically for auditive health. They employ a rich vocabulary for talking about sounds, although very different from the technical vocabulary that is used for health promotion in this area. The research shows that sounds do not exist in isolation. All references to sounds is situation specific. Thus, the perception about the various sounds is associated to the context in which they occur and, therefore, might be very specific to the different social groups. It is concluded that the proposals for the

preservation of audition in work should be compatible with the workers perception of the centrality of sounds in their lives. They should take into account the live context of workers, given that the work environment is part of live, and noise - as well as noise induced hearing loss - acquires its meaning in the context in which it occurs.

Transportation Noise

1515 _____ *poster*

THE AUTOMATIC IDENTIFICATION OF EXTRANEOUS NOISE EVENTS IN ENVIRONMENTAL ACOUSTIC MEASUREMENTS OF ROAD AND RAILWAY TRAFFIC NOISE, BY MEANS OF SIMULTANEOUS TIME – FREQUENCY AND STATISTICAL ANALYSIS

Luigi Maxmilian Caligiuri

University of Calabria, Arcavacata di Rende, Italy

The identification of extraneous noise events in environmental acoustic measurements is often a critical problem especially for noise generated by mobile sources as road, railway and aircraft traffic. In these cases, when the operator doesn't attend to measurements, we should dispose a methodology able to separate extraneous noise events and, on the other hand, to clearly identify the events associated to specific sources whose noise we'd like to evaluate. In this paper a simultaneous analysis of LAFast(t) profile, statistical levels Ln and 1/3 of octave spectrum has been presented and applied to road and railway traffic noise measurements. In particular, for each analysed event, the duration, the maximum sound pressure level, the symmetry and the permanence of LAFast(t) above a threshold have been considered. In addition, the 1/3 of octave spectrogram and the profile of "running" Ln associated to event have been used to confirm the interpretation of data. The results show that, for an appropriate choice of analysis parameters, the methodology is able to automatically recognize typical and atypical noise events with a good level of sensitivity and specificness in road and railway traffic noise measurements.

1517 _____ *poster*

THE EUROPEAN OFFICIAL COMPUTATION METHOD FOR ROAD TRAFFIC NOISE XP S31-33: A STUDY OF ACCURACY OF THE CALCULATED LAEQ VALUES WITH RESPECT TO INPUT PARAMETERS AND COMPARISON WITH EXPERIMENTAL DATA

Luigi Maxmilian Caligiuri

University of Calabria, Arcavacata di Rende, Italy

The European Directive 613/2003/EC recommends, as interim official computation method for road traffic noise in the EU countries, a model based on the French standard XP S31-33. This model calculates the LAeq values using, as input data, different parameters related to traffic features (mainly average speed, volume, read and vehicle type), geometrical configuration of site and meteorological data. The reliability of model results strongly depends on the accuracy associated to the specification of input quantities. In this paper, the effect of the variation in such parameters on the estimated LAeq values has been studied, comparing the results with the LAeq measured for different road traffic configuration in an urban context.

1724 _____ *poster*

PREDICTION AND EVALUATION OF NOISE POLLUTION CAUSED BY A ROADS NETWORK

Francesco Asdrubali*, Carlo Costantini

* *Universita di Perugia , Arcavacata di Rende, Italy*

According to OECD, at least 20% of the European Union population (around 80 million of people) is exposed in daytime to traffic noise, whose level exceeds the limits of 65 dB(A); traffic represents today the main source of noise in most European countries. Italian laws are very concerned about noise pollution; in particular law no. 447/95 states the obligation - for companies which run public transport services and for those which run road infrastructures - to carry out noise evaluation and reduction plans. In this context, the local government of the zone of Perugia and the Department of Industrial Engineering of the University of Perugia have started a cooperation aimed at predicting, evaluating and reducing traffic noise in the whole network of the zone (about 2,800 km). The large extension of the network made necessary the use of a simulation code; a commercial code was used to study the acoustical climate produced by the road infrastructures in a conventional "impact corridor". The code needs traffic flow data as input and is able to produce 3-D noise maps as well as developing the costs-benefits analysis of the mitigation interventions. The calibration of the code was made by comparing a significant number of noise measurements with the predicted data. Results were satisfactory in most cases, though corrections regarding traffic flow coefficients had to be introduced into the code. The final accuracy of simulations obtained is about 0.5 dB(A).

1737 *poster*

MATHEMATICIAN MODELS FOR NOISES EMITTED BY THE VEHICLES TRAFFIC IN DISTRITO FEDERAL, BRAZIL

Armando de M. Maroja ⋆, Demutiey R. de Sousa, Sérgio Luiz Garavelli

⋆ *Universidade Católica de Brasília - UCB, Brasília, Brazil*

Accelerated urbanization processes combined with the significant growth of the vehicles fleet in circulation have produced profound changes in the structure of the Brazilian cities. The urban traffic is one of the main sources of noises observed in a city. All the instruments that assist in the planning and management of this problem are important to reach a better condition of urban life. In Distrito Federal (DF) is observed one of the largest relation of cars x inhabitants of Brazil. This fact has been causing, besides the slowness of the traffic, noises levels very above the legislation. The noises prediction models represent a powerful tool for the planning and the control of the noises in an acoustically contaminated city. In the main avenues of DF, were measured simultaneously the sound levels pressure, the vehicles flow and the traffic composition. Based these information it was performed a statistical study for the development of a mathematical road traffic noise prediction model. The measured level has been compared with the calculated ones obtained from the mathematical model and the other models such as the German Standard RLS 90. The differences among values obtained from mathematic model and the measured did not exceed 2.0 dB(A), showing the validity and precision of the model. The noises levels were examined and it was confirmed that people living or working in these areas are exposed to noise levels beyond the legislated norms. This model is going to subsidize the managers and Legislators in the implementation and administration the programs of sound pollution, assist in the planning of new roads and modifications of the existing ones with objective of improving the quality of life of the population in DF.

1755 *poster*

THE ACOUSTIC CONTAMINATION IN THE PUBLIC TRANSPORTATION OF GOIÂNIA, BRAZIL

Marcos Santos da Silva⋆, Sérgio Luiz Garavelli

⋆ *Faculdades Alves Faria – ALFA e Universidade Paulista – UNIP, Brazil*

The great urban centers, where the majority of the population lives, suffers with the increase of problems caused by concentration of people. The necessity of locomotion to cover great distances brought the necessity of public transport. However they criticize points like temperature, the size, the lack of hygiene and, also the distress caused by the noise. The objective of this research to quantify the noise levels that users and drivers of public transport in the city of Goiânia are exposed to. In order to quantify it, the adopted parameter was Leq(A), the equivalent sound level pressure, which was evaluated with the sound pressure meters MSL-1352 of MINIPA, according to the norms established by the Brazilian Association of Technical Norms. They were performed 280 measures in front and in the middle of the bus which act in the system of collective transport performing a total of 64 mensurations hours, in the seven regions of the city: Northwest, East, North, West, Southwest, Expansion south and Center, and the two big axises that cross the city, East/West and North/South. The data were collected in from May to October in 2003. The used equipments were the level meters of sound pressure mark Minipa – model MSL-1351A, with wind protectors. Inside the bus the noises levels varied from 80.0 to 87.6 dB(A), for the measures performed in front and from 77.0 to 82.6 dB(A), for performed in the middle, these elevated levels of acoustics contamination indicate that urgent legal actions need to be adopted to mitigate this serious problem observed in the public transport of the city of Goiânia.

Ultrasound

1447 *poster*

CODED PULSE VERSUS SHORT PULSE EXCITATION SIGNALS FOR ULTRASONIC TRANSDUCER CALIBRATION

Rodrigo Costa-Félix⋆, João Machado

⋆ *Inmetro, Duque de Caxias, Brazil*

Short pulses are often used as excitation signals to calibrate ultrasonic transducers, usually 1 or 2 cycles in the nominal resonance frequency of the device. They are used as if they were impulses, so that the response achieved with such excitation signals are similar to impulse responses. However, any time signal longer than an impulse leads to a distortion in the spectrum, narrowing its bandwidth. On the other hand, a Coded Excitation Pulse (CEP), similar to a conventional linear frequency modulated chirp but with slightly distinct theoretical approach in its development, can suppress those distortions. After proper decoding, the response achieved with a CEP is an exact digital impulse response. A comparison of both excitation signals (short pulse and CEP) was performed, and arguments to consubstantiate the use of the second one are experimentally validated. This paper presents the results to be compared, pointing out the advantages of CEP against Short Pulses as excitation signal, and therefore reinforcing previous works' findings.

1561 *poster*

THERMODYNAMIC RESPONSE OF AN ULTRASONIC DENSITOMETER

Ricardo Higuti ⋆, Bruno Galindo, Cláudio Kitano, Flávio Buiochi, Julio Adamowski

⋆ *Unesp - Ilha Solteira, Ilha Solteira, Brazil*

An ultrasonic densitometer is experimentally characterized as a function of temperature. The measurement of propagation velocity and density of several liquids is performed in the 15 to 40°C temperature range. Results are compared to tabulated values in the case of distilled water, showing accuracy of 0.07% for the propagation velocity. Density values are compared to those obtained with a pycnometer, showing 0.2% accuracy in density measurement for stabilized temperature and 0.4% under thermal gradient conditions.

Vehicle Noise Vibration and Harshness

1638 *poster*

EQUIVALENT MODEL FOR TRANSMISSION LOSS OF A SANDWICH PLATE WITH POROELASTIC CORE

Márcio Calçada⋆, Samir N.Y. Gerges, Washington de Lima

⋆ *UFSC - LVA, Florianópolis, Brazil*

There are various types of noise control materials commercially available. These materials should be specified correctly in order to achieve a high acoustic performance for a particular application. In the case of a multilayered plate, most analytical methods assume that the plate is laterally infinite, and hence, they do not take into consideration the boundary effects, resulting in poor predictions within low frequency ranges. In this study the sound transmission loss of a sandwich panel with a poroelastic core was investigated. Classical plate theory hypotheses are assumed for the displacement field of the panel and Biot constitutive equations are used to model the poroelastic core. A simple equivalent model based on finite thin plate theory and equivalent constants is presented. Results of the sound transmission loss of this model are compared with results published in the literature.

1973 *poster*

OBJECTIVE AND SUBJECTIVE NOISE ASSESSMENT OF HYDRAULIC POWER STEERING SYSTEMS

Erasmo F. Vergara⋆, Samir N.Y. Gerges, Evandro C. Cerqueira, Leonardo Lessa

⋆ *UFSC, Florianópolis, Brazil*

The frequencies of moan and whine noises are directly related to the operation of Hydraulic Power Steering (HPS) systems. These noises are dependent on the rotation and charge of the hydraulic pump. Moan noise appears in the idle condition (slow rotation) and whine noise is produced at faster rotations. Moan and whine noises are associated with and characterized by the Vane Passing Frequency (VPF) which is related to the fundamental frequency and its harmonics. In this study moan and whine noises are investigated experimentally to evaluate the vibro-acoustic performance of HPS pumps, manufactured in melted iron and aluminium and installed in a vehicle and in a test stand. In the vehicle, simultaneous measurements were made of acceleration in the pump carcass and sound pressure inside the cabin along with bi-aural recording for the calculation of psycho-acoustic metrics. In the test stand, the dynamic hydraulic pressure at the pump output and the acceleration in the pump carcass were measured simultaneously. Moan and whine noises were simulated in the test stand applying a static hydraulic pressure of 30 Bar, and two pump rotations of 1000 and 2000 rpm. The results obtained for the measurements in terms of objective metrics, in a vehicle and in the test stand, were analysed and compared with the subjective evaluation of the same pumps installed in a vehicle, through the classification given by trained listeners.

Vibration Isolation and Damping

1385 *poster*

A FIELD MEASUREMENT OF TRAFFIC GROUND VIBRATION AROUND ELEVATED BRIDGE

Yasuyuki Nabeshima⋆, Hayakawa Kiyoshi, Kawabata Nobuyuki

⋆ *Osaka University, Civil Engineering, Suita, Japan*

In the urban area, to solve or reduce the traffic congestions, many elevated roads or elevated bridges are constructed. However, it is newly recognized that running vehicles vibrate the elevated roads and bridges, and they caused ground vibration. The propagation of ground vibration caused by elevated roads and bridges are not fully elucidated and it is necessary to make clear to solve this problem. In this paper, velocity components and ground vibration levels around an elevated bridge in Osaka were measured by using a potable type

of seismometer and vibration level meters. The ground vibration of an elevated bridge due to running vehicles and propagation of ground vibration from an elevated bridge are discussed. Especially, the amplification of ground vibration during a heavy vehicle passed through the elevated bridge is discussed. Consequently, elevated bridge vibrated the ground after heavy vehicles passed and its ground vibration with about 5 Hz frequency amplified at the house.

Session RC: Responses to Changes in Noise

chairs:

Lex A. Brown - *Australia*

Irene Van Kamp - *Netherlands*

10:00-11:20 **Room:** Rio 1

10:20-10:40

1855 _____ *contributed*

CHANGES IN THE ACOUSTICAL ENVIRONMENT ARISING FROM NEW RAILWAY INFRASTRUCTURE: A CASE STUDY OF HONG KONG

Wai-Hong Au*, Kin-Che Lam, Wing-Chi Hui

**Department of Geography and Resource Management, The Chinese University of Hong Kong, Hong Kong, China*

The operation of a new railway changes the acoustical environment not only through the introduction of a new noise source but also through consequential changes in the traffic mode and patter. This study investigates such changes to a community brought about by the new Ma On Shan Rail in Hong Kong. The study identified changes in the use of private and public transport as well as the routes and frequencies of bus and mini-bus operations. These traffic changes have resulted in changes in the acoustical environment over the new town. At the same time, the new rail system has created some noise impacts on residential units located adjacent to the railway. The acoustical changes have been determined by noise mapping with which the spatial pattern of acoustical changes, both in terms of noise intensity and source can be delineated. The information so obtained can also be used to assess possible human annoyance reactions based on increase or decrease in the noise level and changes in the source of traffic noise. Some preliminary findings of a human response survey of the new railway will be presented.

10:40-11:00

1781 _____ *contributed*

DEFINING A STEP CHANGE OF AIRCRAFT NOISE IN RESIDENTIAL AREAS

Rainer Guski

Ruhr-Universität Bochum, Bochum, Germany

Aircraft noise is characterized by intermittent noise events which vary in number and level from day to day, from one season to another, and usually show a gradual increase of the number of flights and a gradual decrease of the LAeq from year to year. Since a real or expected step change in aircraft noise often causes strong change reactions in residential areas, which cannot be predicted by studies in steady-state conditions, it is necessary to distinguish between gradual and step changes in aircraft noise. The paper discusses definitions of step changes from the perspective of residents with respect to (1) statistical considerations, (2) the time history of changes, (3) the mean LAeq for day or night, (4) the total number of aircraft operations during the warm season, and (5) the distribution of aircraft operations during the day (6-22 h) or night (22-06 h). It is concluded that a significant step change in aircraft noise can occur even in situations with no overall change in noise levels - simply by changing the distribution of flights between day and night, or within daytime or nighttime hours.

11:00-11:20

1436 _____ *contributed*

TOWARDS A DESIGN FOR STUDIES OF RESPONSE TO A CHANGE IN NOISE EXPOSURE

Lex A. Brown*, Irene Van Kamp

* *Faculty of Environmental Sciences, Griffith University, Brisbane, Australia*

Most information on the relationship between transport noise exposure and subjective reaction (annoyance/dissatisfaction) comes from steady state surveys at sites where there have not been step-, or sudden changes in noise exposure. Environmental appraisals often need to assess the effects of such step-changes in exposure and there is growing evidence that when noise exposure is changed, annoyance-ratings may change more than would be predicted from steady state relationships. Research into human response to step-change in exposure has not been conclusive, but we cannot discount the possibility, based on the frequency of such reports in the literature that: 1. Responses to change may demonstrate an overreaction compared to responses predicted from steady-state data. 2. The magnitude of the excess response to change may be persistent over time (meaning: no adaptation). Many studies of step-changes in exposure have been reported, and in many, too, explanations are put forward with respect to the various observations. There also have

been five reviews of subsets of these studies and explanations, though a common feature of these is that none of them have been reported and tested in the mainstream literature. We suggest that this lack of exposure has been an impediment to the development and testing of theory, and explanation, of response to change. Further, reports of individual change studies often lack essential data, and are rarely comparable in terms of method, design and context. This paper briefly explores the various explanations for the phenomenon of a long-term overreaction to change. The conclusion is that there is no accepted view on the mechanism by which annoyance changes in response to a change in exposure, and that the existing studies provide inadequate data on which to develop this understanding. A model on which to design future studies of response to step-changes in transportation noise is proposed.

Session UL1: Ultrasound

chairs:

Flávio Buiochi - *Brazil*

Rodrigo Costa-Félix - *Brazil*

10:00-12:00 **Room:** Business Master 136

10:00-10:20

1713 _____ *invited*

TOWARD 100 MHZ FRONTIER: ACOUSTO-OPTIC METHODS AND FIBER OPTIC SENSORS IN ULTRASOUND METROLOGY

Peter A. Lewin⋆, S. Umchid, Andrew Berger, C. Mu, A. Daryoush, M. El-Sherif

⋆ *Drexel University, Philadelphia, USA*

An increasing number of ultrasound diagnostic systems employ harmonic imaging, and center frequencies as high as 15 MHz are now commonly used in clinical practice. However, currently available measurement tools are not fully adequate to characterize the acoustic output of such nonlinear systems, partly due to the limited knowledge of the frequency responses of the available piezoelectric hydrophone probes beyond 20 MHz, and partly because the physical dimensions of those probes are introducing spatial averaging error. This paper describes the development, implementation and verification of acousto-optic calibration methods in the frequency range up to 100 MHz. As no primary calibration procedures were available beyond approximately 70 MHz, the acoustic method employed a semi-empirical approach that could predict pressure-time waveform at the considered point in the field and the waveform's associated spectrum was used to obtain end-of-cable sensitivity in terms of V/Pa for different PVDF polymer hydrophone probes, including needle and membrane designs with nominal diameters ranging from 50 to 500 micrometers. To verify the results of these calibrations the measurements were repeated employing fiber optic sensors having a diameter on the order of ten micrometers and the overall calibration uncertainty was estimated to be +/-2dB at 100 MHz. Preliminary data obtained using 7 μm diameter fiber optic sensors indicate that once fully developed and optimized, such sensors would provide an alternative to using now ubiquitous PVDF hydrophones without a need to account for spatial averaging. The fiber optic sensors could also meet the challenges posed by high intensity focused ultrasound (HIFU) and other therapeutic applications.

10:20-10:40

1842 _____ *invited*

ON THE GEOMETRICAL DESIGN OF SEGMENTED ANNULAR ARRAYS

Oscar Martínez ⋆, Gregorio Godoy, Montse Parrilla, Alberto Ibañez, Luis Gomez-Ullate

⋆ *IAI (CSIC), Arganda del Rey, Spain*

Segmented annular arrays (SAA) can be a good option to generate 3-D ultrasonic images. Designing this kind of aperture involves a variety of geometrical parameters that are decisive for the quality of the image. For instance, it is possible to use regular or non-regular SAA configurations in which the number of annuli and the elements per annulus can be varied. The objective of this work is to analyse these configurations in order to define the most important design parameters. In this sense, our study will be centered in several points: the alignment between rings, the array size and the elements' aspect ratio. The evaluation of these parameters is focused in obtaining the best trade-off between the number of elements and the image quality. The arrays under analysis are equivalent in the sense that their size, number of active elements and active areas are similar and that they emit the same ultrasonic pulse. In order to achive a clear analysis of the grating lobes, the array factor approach, which considers the array formed by vibrating points, is applied.

10:40-11:00

1934 _____ *invited*

SPECKLE IN ACOUSTICAL IMAGES: ARTEFACT OR NOISE?

Eduardo Tavares Costa⋆, Ricardo Dantas

⋆*CEB/UNICAMP, Campinas, Brazil*

Speckle, although usually characterised as random noise, is a determinist artefact that affects all kinds of signals that use coherent sources, such as acoustical waves (sound and ultrasound), laser or radar. In the context of ultrasound for non-destructive testing, speckle is responsible for a severe signal degradation

leading to misdetection of the material inner structures, like flaws or microbubbles. On the other hand, in medical imaging, the presence of speckle may create a substantial level of subjectivity in the diagnostic. Many methods of speckle reduction are based on the premise that the speckle presence in a signal or image depends on the density of the acoustic scatterers randomly distributed in the material or tissue being investigated. On the contrary, in this paper we want to show that the signal-to-noise ratio of any signal or image corrupted by speckle does not change with scatterer density. Additionally, even a regular grid of scatterers may give rise to an acoustic signal that is corrupted by speckle with a random pattern. We will present results showing that the speckle presence is independent on the scatterer density or on any special distribution. We believe that the proper identification of speckle and its distinguishing from other kinds of noise and artefacts can help the characterisation of materials and may improve the performance of speckle reduction methods.

11:00-11:20

2072 _____ *invited*

METHODS FOR THE PHASE CALIBRATION OF HYDROPHONES

Christian Koch*, V. Wilkens

* *Sound Department, Physikalisch-Technische Bundesanstalt, Braunschweig, Germany*

To date, primary and secondary hydrophone calibration techniques provide the amplitude of the hydrophone sensitivity of internal standards or for a calibration service. In many applications precise and reliable measurements are, however, impeded by the non-ideal transfer characteristic of the hydrophone, and deconvolution procedures are necessary for data correction, which requires the complex sensitivity of the hydrophone being determined. Three generally different methods are presented providing the complex hydrophone sensitivity. Two techniques are based on the principles of time-delay spectrometry (TDS). In the first technique heterodyning is used to ensure a fixed phase relation between transmitting and receiving voltage at the ports of a network analyser. The second method separates unwanted signals from the measurement information in the time domain using a fast-Fourier transform (FFT). TDS is, however, a substitution technique that needs a suitable 'absolute' standard. Thus, an alternative third method applies nonlinearly distorted, focused ultrasound pulses to the hydrophones also providing a comparison of phase responses. With the help of this technique, an optical multilayer hydrophone showing an extremely flat amplitude and phase response could be exploited as a phase reference. Transfer standard devices were calibrated for application by TDS since the pulse technique is limited to small diameter hydrophones. To show the performance of the methods, a bilaminar hydrophone with a PVDF layer thickness of 25 μm was investigated by TDS with a coplanar and a bilaminar hydrophone serving as reference and transfer standard device, respectively. The amplitude and phase values measured in the frequency range from 1 to 20 MHz agree well with results obtained by the conventional TDS technique and interferometry (amplitude) and with a theoretical hydrophone model (amplitude and phase). A needle-type hydrophone with a sensor diameter of 200 μm was calibrated by TDS and the pulse technique in the frequency range from 1 to 50 MHz (70 MHz) and excellent agreement between the results was obtained.

11:20-11:40

2074 _____ *invited*

OVERVIEW OF NPL'S MEDICAL ULTRASOUND CAPABILITIES

Bajram Zeqiri

National Physical Laboratory, Teddington, UK

The need to determine the acoustic output of medical ultrasonic equipment has been primarily driven through safety concerns, particularly within applications such as obstetrics, where the developing foetus is exposed. The Medical Ultrasound Group was established at NPL over twenty-five years ago, in order to develop, maintain and disseminate primary standards for the measurement of key acoustical quantities such as ultrasonic power and acoustic pressure. The aim of this presentation will be to provide a snapshot of its current capabilities. This will include a description of the key mechanisms by which measurement standards are disseminated to the user community, through its Measurement Services providing traceability to both Hospitals and Industry, as well as an on-going R&D programme to develop the new and improved measurement methods increasingly required by the user community. A number of areas will be touched upon during the presentation. The hydrophone represents the pivotal measurement device by which users determine the absolute properties of the ultrasonic field emitted by from transducers. The primary standard for the calibration of these devices at NPL is an optical interferometer, which is used to determine the acoustic displacement (typically of the order of nm) generated by a propagating burst of ultrasound. Under certain conditions, this displacement may be related to the acoustic pressure at a point. Positioning a hydrophone at that identical point and determining its output voltage, is used to calibrate the device. A more rapid method, suitable for calibrating customer devices, is used to disseminate the standard to the user community. A suite of techniques are available, providing calibrations in the range 0.2 to 50 MHz, at various frequency resolutions, as well as the calibration of hydrophone phase response over a more limited frequency range. The primary standard method for determining ultrasonic output power lies in the measurement of radiation force experience by a special target which intercepts the acoustic beam. NPL has developed a number of radiation force balances,

enabling power to be determined within the range 1 mW to 20 W, at frequencies in the range 1 to 15 MHz. These facilities are used to determine output power of medical ultrasonic transducers or to calibrate customer power balances, particularly those used to characterise physiotherapy-level devices. A key feature of the work at NPL has been the development of specialist measurement instrumentation, initially developed in support of the NPL core standardisation programme, but now made available to the wider community. A handful of these systems will be briefly described: the Ultrasound Beam Calibrator; Check Source and Thermal Test Objects. Some of these developments has been through collaboration with industry and NPL and the UK hydrophone manufacturer Precision Acoustics are currently collaborating to develop a novel power meter which should be suitable for application directly at the physiotherapist level. The principle of operation of the device, and early results will be presented. The continued support of the standards programme at NPL by the National Measurement System Policy Directorate (NMSD) of the UK Department of Trade of Industry, is acknowledged by the author.

11:40-12:00

1856 _____ *contributed*

ACOUSTIC SPEED PROFILING OF A SCATTERING MEDIUM: EXPERIMENTAL RESULTS

Marissa Anabel Rivera Cardona ⋆, Fernando Reiszel Pereira, Wagner Coelho de Albuquerque Pereira, João Carlos Machado

⋆ *INMETRO, Rio de Janeiro, Brazil*

During the last decades many investigations were conducted to provide quantitative ultrasonic characterization, such as wave propagation speed (WPS), as well as attenuation and backscattering coefficients of the irradiated medium. Knowledge of these parameters, besides providing a better description of the medium, would indeed improve image quality. This work presents preliminary results of a method developed to obtain the WPS profile along the penetration depth of an ultrasound pulsed wave transmitted through a single scattering medium. The method was tested using a phantom specifically designed for this purpose with a WPS profile increasing linearly with depth and the experimental result of the estimated profile presents a RMS error of 5.5%.

Session VN1: Vehicle Noise Vibration and Harshness

chairs:

Helcio Onusic - *Brazil*

Takeshi Abe - *USA*

10:00-12:00 **Room:** Arpoador

10:00-10:20

1770 _____ *invited*

THE STORY OF FORD MOTOR COMPANY AEC SPIN-TORSIONAL TEST FACILITY: DEVELOPMENT AND IMPACT

Takeshi Abe ⋆, Ming-Te Cheng, Liqun Na, Chris Nouhan

⋆ *Ford Motor Company, Ann Arbor, USA*

The Ford Motor Company AEC Spin-Torsional cell has been in operation since 1999 (ref. SAE papers). The state-of-the art test facility integrates five dynamometers system and a high frequency hydraulic actuator with closed-loop control system. The input module ("Virtual Engine") is a high-speed AC dynamometer coupled with hydraulic actuator system to simulate different engine torque fluctuation. And the four AC absorbing dynamometers function as a precision 4WD/AWD chassis dynamometer During the past five years, many technical developments have been birth out from this facility such as driveshaft breathing mode visualization, transmission gear rattle rig simulation, gear whine rig simulation, driveline clunk rig simulation, system/sub-system NVH target cascading... This facility also provides numerous NVH problem resolutions for Ford product development. This paper overviews the technical capabilities of the facility, the development of new technologies and its impact to the Ford products.

10:20-10:40

1456 _____ *contributed*

INTERIOR NOISE OF VEHICLES: THE CORRELATION OF ARTICULATION INDEX (AI) WITH SPEECH INTERFERENCE LEVEL (SIL) / PREFERRED SPEECH INTERFERENCE LEVEL (PSIL)

Helcio Onusic⋆, Edgar Baptista, Marcelo Hage

⋆ *Physics Institute - University of São Paulo, São Paulo, Brazil*

The Articulation Index (AI) was originally a criterion to characterize the influence of parasite noise on the Intelligibility of a conversation in the design of speech communication systems. Introduced in the automobile acoustics, it is more and more commonly

used by vehicle manufacturers to estimate the middle and high frequency content of spectra noise inside various types of vehicles driven under several running conditions. The correlation with Speech Intelligibility, measured through subjective measurements is well known. Presently we have more sophisticated parameters like STI, RASTI, SII directed mainly to architectural acoustics and sometimes used in vehicle acoustics. They require specific hardwares and softwares and are more complicated to deal with and often are called machine measures of Speech Intelligibility. On the other side, a simplified way to estimate Speech Intelligibility was proposed by Beranek in the fifties, introducing Speech Interference Level (SIL). Later a new version named Preferred Speech Interference Level (PSIL) was developed. They are calculated using measurements of sound pressure levels in octave bands above 500 Hz. This work uses a set of passenger cars and a set of commercial vehicles to study the correlation of these parameters regarding internal noise. Besides the usual definitions, we propose new approaches for SIL and PSIL, introducing some frequency weightings similar to those existing in the calculation of AI in third octave bands. We apply to the experimental data a least-squares curve fitting by straight lines. The results observed through graphics show the degree of linear correlation for the separated sets and also for all the data jointed together. For some parameters we obtain a high degree of linear correlation in such way we expect simplifications and facilities in the estimation of Speech Intelligibility inside vehicles. We can see that using sound pressure levels in octave bands from 1kHz to 4kHz we are able to have a picture of Speech Intelligibility , and due to this simplicity we also recommend them for quality control.

10:40-11:00

1773 _____ *contributed*

VEHICLE CLUNK: PHENOMENA, RESOLUTION AND RIG TEST DEVELOPMENT

Ming-Te Cheng ⋆, Liqun Na, Takeshi Abe, Chris Nouhan

⋆ *Ford Motor Company, Ann Arbor, USA*

The vehicle clunk is a customer perceived vehicle transient response due to the drivetrain torque reversal event. The driveline clunk usually imposed an adverse effect to the perceived vehicle quality. In this paper, two case studies, which have different root causes, are presented to discuss the clunk phenomena, the energy transfer paths and the resolutions for driveline clunk issues. The second part of this paper then focus on the development of the rig based clunk simulation in Ford AEC Spin-Torsional cell.

11:00-11:20

1818 _____ *contributed*

NUMERICAL AND EXPERIMENTAL VALIDATION OF THE HYBRID FE-SEA METHOD

Phil Shorter⋆, Vincent Cotoni, Robin S. Langley

⋆*ESI Group, Bloomfield Hills, USA*

A number of advances have been made recently in the development of a Hybrid method for rigorously coupling deterministic and statistical descriptions of the dynamics of a vibro-acoustic system. The method provides an efficient way to describe the response of a complex vibro-acoustic system across a broad frequency range. This paper provides an overview of various numerical and experimental validation studies that have been performed using the method.

11:20-11:40

1986 _____ *contributed*

NUMERICAL SIMULATION OF AIR INTAKE SYSTEM ORIFICE NOISE USING 1D MODELING

Fabio R. Arruda⋆, Paulo Zavala

⋆*Ford Motor Company, Salvador, Brazil*

The pass by noise is a metric tracked during the development of a new vehicle or during changes in the baseline production model. The pass by noise needs to meet legal requirements and customer satisfaction. The main sources for pass by noise are exhaust orifice noise, air intake system orifice noise, power train radiated noise and tire noise. During the implementation of a new engine in a new model year, the pass by noise test identified that the air intake system orifice was the main sound source. To reduce the peak noise in the air intake system a quarter wave resonator was select due its optimal use of available space in the engine compartment. The intake orifice noise analysis was carried out using a 1D engine model. The model was updated with air intake system and engine data such as, compression ratio, burn duration and delay, cylinder head flow coefficient and camshaft profile. The analyses were done from 1000 rpm to 6500 rpm in steps of 125 rpm. The results show a significant reduction in the sound pressure level in the 4th and 6th engine orders. The implementation of the proposed quarter-wave resonator decreased also, as it was afterwards confirmed by physical testing, the overall pass-by noise levels, resulting in a quieter vehicle.

11:40-12:00

2048 _____ *contributed*

THE CORRELATION OF THE PERFORMANCE OF THE DUCT LINING MATERIALS WITH THEIR NORMAL INCIDENCE PROPERTIES

Jeong-Woo Kim ⋆, Taewook Yoo, J. Stuart Bolton, Jonathan H. Alexander

⋆ *Ray W. Herrick Laboratories, Purdue University, West Lafayette, USA*

In certain geometries, automotive door panel linings, for example, noise control materials may act more nearly as duct or channel linings rather than as normal incidence barriers or absorbers. However, noise control materials are frequently characterized primarily in terms of normal incidence properties such as the absorption coefficient. It was of interest here to establish whether there was a close relationship between the normal incidence properties of a sound absorbing material and its performance in a duct lining application. Thus, the performance of two different duct lining arrangements was considered. It was arranged that both treatments had approximately the same normal incidence absorption coefficients. In one case, a relatively deep layer of fibrous material filled the channel; in the other case, a thinner layer of material faced by a resistive membrane partially filled the channel. The masses per unit area of the two treatments were approximately the same. Both treatments were modeled in two dimensions by using a full poro-elastic theory in combination with appropriate boundary conditions. By substituting an assumed propagating solution into those boundary conditions, a homogeneous matrix equation results. By finding the conditions under which the determinant of the coefficient matrix is zero, it is possible to solve for the free wave propagation characteristics in the channel, and thus the sound attenuation per unit length. Corresponding experimental measurements were conducted by using a modified four-microphone standing wave tube to verify the theoretical models. Good agreement was found between the measured and predicted results. In addition, both experimental and theoretical results showed that the treatment completely filling the duct gave significantly greater attenuation rates along the duct than the thinner treatment with a resistive facing. Thus, it is concluded that normal incidence absorption does not correlate well with the performance of an absorbing material in duct lining applications.

Session VI1: Vibration Isolation and Damping

chairs:

Balakrishna Thanedar - *USA*

Luvercy Azevedo - *Brazil*

10:00-11:40 **Room:** Business Master 145

10:00-10:20

1557 _____ *contributed*

DESIGN CRITERIA FOR THE VIBRATION ISOLATION OF A MARINE DIESEL GENERATOR SET

Lee Donchool⋆, M. Brennam, B. Mace

⋆*Mokpo National Maritime University, Mokpo, Korea*

The resilient mounts of a diesel engine installed onboard a ship should be designed for both static and dynamic loads. If possible, the resonance frequencies of the six rigid body modes of the installation and the flexible modes of the engine support structure should not lie within the engine operation range. In this paper a design criterion is proposed to evaluate an isolation system which involves the summation of dynamic forces transmitted through the resilient mounts and elastic potential energy index stored in the mounts. A case study is also presented in which a diesel engine generator, which had an elastic foundation and was mounted in a 5500 TEU container vessel, was studied both theoretically and experimentally. The theoretical analysis of the test model was performed by using a single mass 6 degree of freedom system. Actual measurements of mechanical vibration of the engine and its foundation onboard were carried out, which showed the importance of including the flexibility of the engine support structure in the model.

10:20-10:40

1594 _____ *contributed*

FIELD MEASUREMENT AND ITS ANALYSIS OF "HYBRID VIBRATION ISOLATION WALL" USING GAS CUSHIONS

Hitoshi Kanda ⋆, Ishii Hirotoshi, Yoshioka Osamu, Hioki Kazuaki

⋆ *Central Japan Railway Co., Komaki, Japan*

Ground vibration induced by traffic, such as roads, highways and railroads may cause nuisance to nearby inhabitants and buildings. These problems have recently increased especially in urban areas as higher environmental quality is required. Although many efforts have been made to mitigate the ground vibration, it can be said that more powerful measures are inevitable.

In this paper, a three-layered "hybrid type" vibration isolation wall using gas cushions was developed. The basic idea of the gas cushions was originally presented by Dr. Massarsch in Sweden. The authors developed here the new specifications of the vibration wall including the gas cushions by considering the safety of adjacent buildings in narrow construction sites. This hybrid wall consists of three components; steel sheet piles, soil cement wall and gas cushions. The main purpose of the sheet piles and soil cement wall is the protection of existing structures against the deformation of nearby ground when the wall is built and/or if the gas cushion fails in future. In order to confirm the vibration isolation performance of this hybrid wall, field experiments were conducted. In the test site, a real size hybrid wall was constructed with 8 meters depth, 0.5 meters width and 10 meters length. The ground vibration was measured before and after the construction work at the same points generated by an oscillator. Ground deformation was also measured when the wall is built and when some cushions burst. Numerical simulations were also performed by using the field data to clarify the basic characteristics of this vibration isolation wall. This paper describes the field data and its analytical result. It becomes clear that the hybrid wall is as effective as open trenches especially in lower frequencies, such as 5 to 10 hertz. Based on the findings, vibration isolation effects are widely discussed.

10:40-11:00

1435 _____ *contributed*

PUR BASED WASTE UTILIZATION IN TECHNICAL ACOUSTICS

Martin Vašina⋆, Barbora Lapcíková, Lubomír Lapcík jr., Kirill Horoshenkov, David Hughes

⋆ *Tomas Bata University in Zlín, Zlín, Czech Republic*

There is a lot of waste in industrial production. One of possibilities of the waste materials utilization is their application for the noise and vibration damping. The paper deals with experimental determination of sound absorption coefficient, complex modulus of elasticity, loss factor and transfer function of the soft polyurethane (PUR) composite matrix based samples. The PUR samples were produced with different thickness and different amount of bonding agent. Measurement of the sound absorption coefficient was carried out on B&K 2034 analyzer with Kundt´s tube. The complex modulus of elasticity, the loss factor and the trasfer function were determined on B&K 2034 analyzer with vibrator.

11:00-11:20

1489 _____ *contributed*

ON THE POISSON'S LOSS FACTOR OF RUBBERY MATERIALS

Tamas Pritz

Acoustics Laboratory, Szikkti Labs, Budapest, Hungary

There are a number of acoustical and vibration applications of rubbery materials, which require the knowledge of the complex Poisson's ratio. The ratio of the imaginary part to the real part of the complex Poisson's ratio is referred to as Poisson's loss factor.The magnitude of the Poisson's loss factor is investigated in this paper for homogeneous, isotropic solid viscoelastic materials with special respect to rubbers and other elastomers. The theoretical relation between the Poisson's loss factor and the modulus loss factors (bulk and shear)is derived.It is shown that the magnitude of the Poisson's loss factor is proportional to the difference between the shear and bulk loss factors, and depends on the dynamic Poisson's ratio too. In addition, it is shown that the Poisson's loss factor of rubbery materials can be calculated with a good accuracy from knowledge of only the shear loss factor and the dynamic Poisson's ratio. The magnitudes of the Poisson's loss factor experienced for a styrene-butadiene rubber are presented and compared with theoretical predictions.

11:20-11:40

1546 _____ *contributed*

MULTI-MODAL PASSIVE VIBRATION SUPPRESSION BY USING SHUNTED PIEZOELECTRICS

Felipe A.C. Viana⋆, Danuza C. Santana, Domingos A. Rade, Valder Steffen jr.

⋆ *Federal University of Uberlândia, Uberlândia, Brazil*

A piezoelectric element bonded to a mechanical structure and connected to a shunt circuit forms a system that can be designed in such a way that passive vibration damping is added to the system. Due to the piezoelectric effect, a part of vibration energy is transformed into electrical energy and is dissipated. Therefore, by using a convenient electrical circuit, it is possible to dissipate strain energy and, as a consequence, vibration is suppressed through the introduced passive damping. From the electrical point of view, the piezoelectric behaves like a capacitor plus a controlled voltage source and, the shunt circuit, commonly formed by an RL network, is tuned to dissipate the electrical energy preferentially in a given frequency band. It is important to know that frequently, large inductances are required, leading to the necessity of using synthetic inductors. From the mechanical point of view, the vibration energy can be attenuated in a single mode, or in multiple modes, according to the design of the damping device. This paper presents a design methodology for multi-modal vibration sup-

pression systems. It is made a brief review of shunted piezoelectric materials and their coupling to mechanical structures. Thus, the studies of resonant circuit shunting for the single mode and multi mode cases are performed. In this point, a design methodology for the multi-modal case is introduced, by taking into account the frequency band, the considered mode shapes and the piezo devices influence. By using a suitable optimization strategy a realistic multi-modal damping device is obtained. The synthetic inductor topology is presented together with its basic equations and practical implementation aspects. Finally, experimental results are reported, illustrating the success of optimal design for passive damped applications of mechanical and mechatronic systems.

Distinguished Lecture 3

13:00-14:00 h **Room:** Rio 1+2

Health Effects of Noise Interactions at Work, Leisure and Home

Thais Morata
Ph.D.; National Institute for Occupational Safety and Health, USA

Dr. Thais Morata is an audiologist who has worked in the area of hearing loss prevention since 1982. Her main area of interest is the prevention of auditory effects of combined exposure to noise and chemicals. Dr. Morata is a research fellow at the National Institute for Occupational Safety and Health, Cincinnati, OH, USA. She collaborates with several international occupational health institutes in this area and teaches graduate courses at the Universidade Tuiuti do Paraná, in Curitiba, Brazil.

In life we are exposed to numerous chemical, physical, and biological agents, that along with our individual characteristics and habits affect our health and well being. Understanding the influence of factors that affect our health can have an impact not only on individual, but on society's decisions, and determine changes to improve lives and preserve the environment. However, understanding the influence of this collection of factors is a difficult challenge. Noise is one environmental agent that has an impact on health and well-being. High noise levels can cause irreversible damage to hearing. Lower noise levels, can cause annoyance, sleep disturbance, and lead to cardiovascular, immunological, and psychological effects in children and adults. Combination of noise exposures and other agents can produce greater health effects than noise acting alone. For example, hearing losses from noise and chemicals can be more common and more severe than hearing losses from only one of these agents. The new European Community (EC) directive on noise (2003/10 EC noise) requires that the interaction between noise and ototoxic chemicals be taken into account in the risk assessment of exposed populations. Combination of noise and other pollutants is also being shown to cause further deterioration in non-auditory health effects. This presentation considers the effects of noise in conjunction with air pollution, chemicals, vibration, and heat and examines research needs and approaches to improve protection of hearing of populations at risk.

Session AP2: Airport Noise

chairs:

Delia Dimitriu - *Romania*

Jan Schumacher - *Germany*

14:00-15:40 **Room:** Flamengo 2

14:00-14:20

1425 _____ *contributed*

EVALUATION OF THE NOISE POLLUTION AROUND THE ITALIAN AIRPORTS

Massimo Coppi*, Andrea De Lieto Vollaro, Roberto De Lieto Vollaro, Andrea Vallati, Andrea Venditti

* *University of Rome, Rome, Italy*

This paper describes the work of the research group IAA (Acoustic Airport Pollution). In the last years the group has studied the aircraft noise problems through contracts with Institutional Corporate Office (Ministry of the Environment) and Private Office (ISPESL Institute to prevention and safety on the job). The actual noise descriptors proposed by the Italian and European standard and the real correlation with the human response to aircraft noise are examined. The development of a filing and management system of the environmental measurement is proposed. In this paper the procedures used for characterizing the aircraft noise in a zone neighbouring the airport are illustrated. It's been able to verify that aircraft noise is characterized by the presence of frequencies that influence the receptivity of the human ear. The presence of this frequency has allowed us to affirm that the aircraft noise descriptors must depend from a factor that represents the frequency analysis in the over fly. Therefore it's studied the potentialities of the system of data handling produced by the research group. Through the various phases of filing and management of the dates this important tool of analysis allows checking fast and satisfactory environmental situations in the Italian airports. The flexibility of this tool will allow the environment future data management in according to various European directives.

14:20-14:40

1467 _____ *contributed*

AN INTEGRATED INDEX FOR AIRPORT NOISE

Federico Rossi*, Andrea Nicolini, Mirko Filipponi

* *Universita di Perugia , Italy*

Italian and European legislations propose airport noise indicators based on acoustic climate in the round airport areas and noise exposed population density. Italian Environmental Minister Decree of 20th May 1999 defines an index for airport classification; furthermore, an European proposal concerning a new aircraft noise indicator is being discussed. These indicators are not suitable to evaluate airport "acoustic impact"-"strategic importance" ratio; in fact, transport and logistic airport characteristics are not taken into account. In this paper, an integrated airport noise index is proposed. The new index takes into account the previous indicators parameters but also airport characteristics such traffic data, logistic and connection structures and the airport strategic importance. The proposed indicator may be very useful for airport managing; at last, some Italian airports cases have been analyzed in order to test the proposed index.

14:40-15:00

1738 _____ *contributed*

MEASURED AND PREDICTED NOISE LEVELS IN SURROUNDINGS OF THE "JORGE CHAVEZ" INTERNATIONAL AIRPORT IN LIMA, PERU

Jorge Moreno*, Carlos Jimenez, Celso Llimpe, Richard Rivera, Raul Medina

* *Pontificia Universidad Católica del Perú, Lima, Perú*

In this paper the noise assessment for the "Jorge Chavez" International Airport of the city of Lima is presented. An algorithm as well as measuring set-up were specially prepared for this study and both will be discussed. The algorithm proved to be effective enough in discriminating both aircraft noise and background noise. The city of Lima is particularly noisy and therefore often aircraft noise is smeared with traffic noise. A map was prepared based on information supply by the airport administration; good agreement was found when the predicted levels were compared with the levels measured on ground. This study is the first complete study of this kind in Lima for aircraft noise.

15:00-15:20

1846 _____ *contributed*

AIRCRAFT NOISE DEPRECIATION NEAR ORLY AIRPORT : A NEW EFFECT NOT REALLY LINKED WITH NOISE INTENSITY

Guillaume Faburel

University Paris 12, Créteil, France

The impacts of the aircraft noise on the populations (health, annoyance...) and the nearby airports places (property values depreciation, social polarizations, urban evolutions) become an important stake for airports and authorities. Number of airport debates turns to this problem, and the European directive of June 2002 should strengthen this tendency (noise exposure maps, in the perspective of located actions plan). Here, the houses property values depreciation focus more and more the attention of the local residents and the authorities. The paper proposed wishes to report an

econometric valuation led near the airport of Orly (2nd French airport), from more than 600 property values stemming from real transaction intervened between 1995 and 2003. With no surprise according to the important literature on this topic, there is a depreciation caused by the aircraft noise, all else equal, in at least three of eight municipalities of the sample (amounts in euro are given to it, by municipality and by average flat). But, what is more newly is that this depreciation assessed thanks to econometric models is growing since 1995, although the noise exposure remains stable because the cap slots at Orly Airport since this date. Lastly, this depreciation measured seems to attract certain categories of population, taking part into a social segregation process in the localities appeared thanks to statistical runs (low income and younger households are growing). It confirms what land economics has already proved, but less demonstrated in environmental field : the households arbitrate according to a sensibility, sensibility not "totally" linked acoustical intensity (same demonstration in psycho-acoustics field for annoyance). So, it indicates that authorities should supplement their decision support tool with economic and psycho sociological assessment on aircraft noise, to better understand households reaction to noise exposure, and perhaps make other decisions, more related with places and living.

15:20-15:40

1866 _____ *contributed*

SYNTHESIS OF AIRCRAFT FLYOVER NOISE

Karl Janssens ⋆, Antonio Vecchio, Herman Van der Auweraer, Filip Deblauwe

⋆ *LMS International, Leuven, Belgium*

Noise pollution from air traffic is a major environmental problem affecting many citizens. Aircraft flyover noise represents an extremely complex auditory scenario. Noise annoyance is not only dependent on sound exposure levels. There are also many other acoustic and psycho-acoustic factors (spectral content, time modulations, sharpness, tonality,...) that play an important role. This paper presents a model-based sound synthesis approach which takes these factors into consideration. The sound synthesis approach is interesting for a number of reasons: (1) it allows to study and assess aircraft noise annoyance in relation to the various acoustic and psycho-acoustic characteristics of the sound, (2) it helps to understand sound quality differences among various types of aircrafts in both landing and take-off conditions and (3) it forms an excellent basis for target sound design. The presented research is one of our major activities in the EU-project SEFA (Sound Engineering for Aircraft; coordinator: Dornier GmbH, Germany) which aims at developing technology design criteria to make aircrafts more acceptable from a noise signature point of view. The synthesis of aircraft flyover noise is based on a sound synthesis model that is identified from sound recordings near the ground. A sound synthesis model is a compact and sound-quality-accurate model consisting of Doppler shifted tonal components and of third octave noise bands to characterize the broadband noise. The reflection characteristics of the ground and the time-delay between the direct incident and reflected sound are taken into consideration to characterize the typical ground-interference pattern in the sounds. The sound synthesis approach was applied to a large database of aircraft sound recordings, covering various types of aircrafts in landing and take-off conditions. The flyover noise synthesis results were validated with a number of listening tests. Impressive results were achieved.

Session BA1: Building Acoustics

chairs:

Elvira B. Viveiros - *Brazil*

Peter Barry - *Brazil*

14:20-15:40 **Room:** Rio 1

14:20-14:40

1580 _____ *invited*

PREDICTION OF THE STRUCTURE-BORNE SOUND POWER FROM MACHINES IN BUILDINGS BY MEANS OF A RECEPTION PLATE METHOD

Barry M. Gibbs⋆, Ning Qi, Moritz Spaeh, H. Fischer

⋆ *University of Liverpool, Liverpool, UK*

Unlike for airborne sound sources, there are not presently available methods of predicting the sound pressure levels resulting from mechanical services machinery in buildings. This is because much of the sound generated by the vibrating components transmits as structure-borne sound before radiating into the other rooms. In addition, there is not yet available a laboratory test method which provides appropriate input data for predictive models. A laboratory reception plate method is described, where the mobility of the reception plate approximates that of real concrete floors. The method yields a single value for structure-borne source strength from the bending energy of the excited attached plate. The challenge is then to relate the laboratory reception plate power to that generated by the tested machine in the installed condition. In both the laboratory case and in the installed condition, the receiving plates are of low modal density and corrections are required for the variation in mobility, with frequency, at low frequencies. A reception plate has been modelled as a plate with free edges, to give the mobilities at any position of machine for the three out-of-plane components of excitation (perpendicular force and two moments). Similarly, a building floor

has been modelled as a simply supported plate. The structure-borne powers have been calculated for a range of sources, including fans, electric motors and domestic appliances. The work aims to establish a relationship between the laboratory reception plate estimates of structure-borne power and the installed power.

14:40-15:00

1728 _____ *contributed*

THE INTERFERENCE OF INTRUSIVE EXTERNAL NOISE AND THE NEED FOR APPROPRIATE LEGISLATION AND DECREES TO PROMOTE ACOUSTICAL QUALITY IN SCHOOLS

Maria Lucia Oiticica ⋆, Ivan Lamenha, Luiz Bueno Silva

⋆ *Universidade Federal da Paraíba - UFPB, Maceió, Brazil*

Low acoustical quality in classrooms is a problem that has been amply discussed in recent years. This topic, oftentimes overlooked in the architectural outline of schools, has been brought to the forefront in view of its effects upon the students' learning experience. Thus the need for greater awareness of this problem on the part of the educational sector. The importance of this paper is in providing valuable information to those involved in education, so that future changes in school buildings might improve the acoustical character of the classrooms and that the information concerning the level of sound pressure in classrooms become a fundamental criterium in the designing of the architectural project. The aim was to measure the levels of background equivalent sound pressure (Leq) in public elementary and junior high schools in the city of Maceió-Alagoas-Brazil, mapping the situation of these schools within the acoustical environment. The results of this survey attest the precariousness of the acoustical quality in schools. It is therefore of utmost urgency the enforcement of the law no. 6,938/81, which determines that State governments be responsible for the drawing up and implementation of regulations additional to those specified by the National Environmental Council – CONAMA. Scientific and technological support must be sought to define the standards, decrees, and legislation for the attainment of acoustical quality in the school environment. The upside of all this shall be the improvement in scholastic achievement.

15:00-15:20

1729 _____ *contributed*

ASSESSMENT OF ACOUSTICAL QUALITY IN A PUBLIC SCHOOL BUILDING – CASE REPORT

Maria Lucia Oiticica⋆, Mariana Bezerra Moura, Luiz Bueno Silva

⋆ *Universidade Federal da Paraíba - UFPB, Maceió, Brazil*

Noise pollution in urban areas is increasingly a problem of great magnitude. Unpleasant noise in buildings may be caused by many a source, such as vehicle traffic, air conditioners and ceiling fans, and poor sound isolation. In designing and building schools, architects and engineers have given little thought to the acoustical character of the space, despite its being of great importance to the type of activity done there. Acoustical quality in these spaces can be attained when high magnitude indoor noise and/or improvements in reverberation time become relevant towards enhancing the learning experience. Accordingly, this paper assesses the acoustic condition of a classroom. One such classroom was singled out in a public school in Maceió-Alagoas-Brazil, and the goal was to investigate all the factors that might interfere with its acoustical quality. The following were looked into: reverberation in the classroom, measurement of the relationship between the level of Signal/Noise in the classroom and the intelligibility index inside the classroom. Owing to these variables, the need for a greater regard for acoustical quality inside the classrooms has thus been warranted. The ultimate goal is to make communication between teachers and pupils better.

15:20-15:40

1971 _____ *contributed*

ACOUSTICAL QUALITY OF EDUCATIONAL BUILDINGS – THE ACOUSTICS OF MODULAR CLASSROOMS

Paulo H.T. Zannin⋆, Carmem P. Loro

⋆ *Universidade Federal do Paraná, Curitiba, Brazil*

The acoustical quality of a standard classroom in a public school has been evaluated. This standard is defined as a central circulation aisle with two classrooms on each side, with a total of four classrooms per edification. The measured reverberation times (RT) of the 4 classrooms for a frequency of 500 Hz were: 1.65s (empty classroom); 1.15s (20 students in the room); and 0.76s (40 students). According to WHO recommendations, the ideal RT in classrooms should be around 0.6 s. DIN 18041 establishes an RT between 0.8 and 1.0 s, to allow for adequate intelligibility. Background noise in an empty room was 63.3 dB(A), above the limit established by the Brazilian standard for acoustic comfort, which is 40 dB(A).

Session EP2: Environmental Noise Problems and Approaches

chairs:

Maria Luiza Carvalho - *Brazil*
Paulo H.T. Zannin - *Brazil*

14:00-15:40 **Room:** Flamengo 1

14:00-14:20

1716 _____ *contributed*

NOISE REGULATIONS AGAINST THE HUMAN NATURE?

Fernando J. Elizondo-Garza

UANL-FIME, MEXICO, San Nicolas, Mexico

The discussion around the concept of the addiction to noise has evidenced the importance of noise for the human being and explains why in some cases the regulations fail to control the noise in cities. In this presentation the different conscious and unconscious uses of noise, from simple habits up to possible addictions will be analyzed. Also discussed are the implications of establishing regulations against human nature as well as the importance of the acoustic design and the education to manage the noise instead of just trying to ban the noise in some social circumstances.

14:20-14:40

1518 _____ *contributed*

FIRST PROPOSAL OF A METHODOLOGY FOR A PREVENTIVE ASSESSMENT OF THE ACOUSTIC IMPACT OF ADVANCED LANDFILLS

Vincenzo Franzitta ⋆, Maria La Gennusa, Gianluca Scaccianoce

⋆*DREAM - Università degli Studi di Palermo, Palermo, Italy*

In this paper, the results of a preliminary study on the environmental noise pollution of a technologically advanced landfill to be realized in Sicily (Italy) are presented. The investigation has been carried out analysing, at the beginning, a simulating model suggested by the European Community. The method makes reference to the ISO 9613-2:1996 standard, which suggests a general method of calculation to assess the attenuation of sound during propagation outdoors. The simulation has pointed out the troubles in carrying out the noise pollution assessment of an advanced landfill, where several and different kinds of sound sources are present at the same time; it isn't always possible, for example, to find in scientific literature the spectra of all different sound. In this respect, the paper intends to provide an useful subject for discussion in order to achieve guidelines to be used in the assessment of acoustic impact of typical processes which occur in advanced landfills. Finally, an "area sound source", which characterizes the landfill, is defined, in order to carry out an acoustic impact assessment in a more fast and simple manner.

14:40-15:00

2103 _____ *contributed*

REDUCING NOISE FROM AN OIL REFINERY CAT CRACKER

David Rawlinson⋆, Javier Alberola, Phil Joseph

⋆*ISVR, University of Southampton, Southhampton, UK*

This paper concerns the noise from a Cat Cracker exhaust stack, used for the purpose of converting heavy oil into gasoline products. Following the upgrading of the Cat Cracker, there were persistent community complaints of an irregularly varying noise that sounded like an "overflying jet aircraft". This paper describes a detailed study of the Cat Cracker noise involving: field tests on-plant and in the community; scale model tests in the laboratory; theoretical predictions using thin aerofoil unsteady aerodynamic theory; and a study of atmospheric propagation effects using the Parabolic Equation method. The objective of the study was to i) identify methods of reducing the noise levels, and ii) establish the cause of the irregularity of the noise level in the community. The laboratory tests used a ? scale model to explore qualitatively the nature of any potential interaction between the two principal elements in the stack. The study concluded that the cause of the noise was an interaction between the turbulent flow from a valve and a Multi-Holed Orifice (MHO) downstream of the valve. The irregular variations in the noise where predicted to be atmospheric effects. Following the investigation the valve and the MHO were subsequently replaced by three MHO's in series which gave a reduction in noise levels at the stack tip of up to 14dB. Noise measurements in the community demonstrated a similar level of noise reduction. In some weather conditions the Cat Cracker noise can still be heard, albeit at a much reduced level. Work is continuing to reduce the noise even further.

15:00-15:20

1458 _____ *contributed*

ENVIRONMENTAL NOISE FROM MODERNIZED HOT-WATER BOILERS IN MOSCOW

Vladimir Tupov

MPEI, Moscow, Russia

Environmental noise from modernized power stations is important problem for large cities, including for Moscow. More powerful and frequently noisier equip-

ment is established instead of the old power equipment. The territory of power stations is near to residential areas. There are 14 large power stations, 64 district heat power stations and some hundred small boilers near residential areas. Considered different types of power stations: from large up to small stations. Requirements noise sanitary norms to power stations are discussed. Noise characteristics of the equipment depending on capacity of the equipment for various distances from power stations are resulted. The complex of actions necessary for maintenance noise sanitary norms is considered. The realized experience is shown.

15:20-15:40

1692 _____ *contributed*

ATTENUATION METHODS OF THE NOISE GENERATED BY THE ELECTRICAL TRANSFORMERS

Vasile Bacria*, Constantin Barbulescu

* *Mechanical Engineering Faculty, "POLITEHNICA" UNIVERSITY OF TIMISOARA, Timisoara, Romania*

The electrical transformers produce noise, which affects man's life and health. In the paper are analyzed the sources and the causes of the noise from the electrical transformers, the nocive effects and its admissible levels. It is investigating the way of the noise propagation. It is presenting the measurements methods and processing of the measurement results. In the same time, are established the attenuation methods.

Session HP2: Hearing Protectors

chairs:

Elliott H. Berger - *USA*

Warwick H. Williams - *Australia*

14:00-15:40 **Room:** Lagoa

14:00-14:20

1852 _____ *invited*

LOUDNESS MATCHING IN BONE/TISSUE CONDUCTED NOISE

Richard L. McKinley *, Alexander Kordik, Armand Dancer

* *US Air Force Research Laboratory, Wright-Patterson Air Force Base, USA*

Noise from current and new high performance fighter aircraft can be up to 150 dB at ground crew personnel locations 50 feet from the aircraft. In order to protect personnel adequately from the risk of hearing loss, a hearing protector providing approximately 50 dB of attenuation is required. Emerging hearing protection technologies employing custom molded deep insert earplugs combined with an effective earmuff can provide 42 dB in a passive attenuation mode and 47 dB combined passive and active attenuation if the contribution of bone conducted noise is neglected. However, bone/tissue conduction begins to be the primary noise source at hearing protection attenuations of air conducted noise above 40-45 dB at 2 kHz, Berger[1], Nixon[6]. Clearly, bone conducted noise is an issue with the high performance hearing protection required for these very high noise levels and exposures. This paper describes the first of three studies to investigate the potential hearing damage risk due to bone/tissue conducted noise. This first study was an investigation of the relation between loudness judgements of air conducted stimuli and bone/tissue conducted stimuli. Data and discussion from this study will be presented along with the design for a temporary threshold shift (TTS) study using bone/tissue conducted noise.

14:20-14:40

1837 _____ *invited*

NEW DIRECTIONS FOR CUSTOM EARPLUGS

John A. Hall *, Frank Mobley, Richard L. McKinley, Paul Schley

* *U.S. Air Force, Wright-Patterson, USA*

Three years ago the U.S Department of Defense chartered Defense Technology Objective (DTO) HS-33: Improved Aviation Personal Hearing Protection. This DTO is a joint effort encompassing all branches of the U.S. military. Several areas of study are underway under the DTO portfolio, including realizing what attenuation and communications intelligibility performance may be obtained via deep insertion custom molded earplugs. Currently, the U.S. Air Force and the U.S. Navy are implementing operational trials of such earpieces as solid passive earplugs, as communications earplugs, and as active noise reduction (ANR) earplugs. This paper will highlight research and operational data on such parameters and discuss relevance as an option for high noise aerospace operations.

14:40-15:00

1909 _____ *contributed*

ASSESSMENT OF USER VARIATION FOR ACTIVE NOISE REDUCTION EARPLUGS

Andre Goldstein*, William Saunders, Mike Vaudrey

* *Adaptive Technologies Inc., Blacksburg, USA*

Recent advances in personal active noise reduction technologies have led to the integration of ANR with deep-insert custom earplugs. Although some of the original work on ANR earplugs was completed over ten years ago, certain technical obstacles and marketability considerations for ANR earplugs apparently led to

a pause in their technology development. Now, there is renewed interest, primarily because of the need for improved overall attenuation in extremely hazardous noise fields. Recent work presented by the authors showed that ANR earplugs could offer improvements in ANR bandwidth, particularly in regards to the noise reduction bandwidth that is expected at a user's tympanic membrane. This opportunity relies on certain design features for ANR earplugs and one aspect of the design approach is discussed here. It is well known that feedback control robustness depends on the characteristics of the plant and its loop transfer function properties. Closed-loop performance and stability robustness for ANR earplug loop transfer functions are managed through the use of custom earplugs that improve the possibility of deep and consistent insertions. However, even with custom deep-insert earplugs, the characteristics of the control plant can vary from user to user. Plant variation among users can be significant and is resultant from different occluded space dimensions, as well as different eardrum impedances. In this work, systems analysis and acoustic modeling techniques are presented to investigate the variation of plant parameters and how it can impact active control performance and stability robustness. The simulation results are supported by experimental measurements of ANR performance for different user's ears.

15:00-15:20

1490 _____ *contributed*

HUMAN BODY CONDUCTION SENSITIVITY IN A SOUND FIELD

Stefan Stenfelt*, Sabine Reinfeldt

**Chalmers University of Technology, Göteborg, Sweden*

When a person is situated in a sound field, the sound is transmitted to the hearing end organ by two routes: the air conduction (AC) path and the body conduction (BC) path (also termed bone conduction). The AC path is reported to be 40 to 70 dB more sensitive than the BC path for a sound field. Hence, normally, a person's sound perception is dominated by the AC path. The BC transmission limits ordinary hearing protectors: these normally attenuate the sound transmission of the AC path. Thus, when high attenuation of the AC path is achieved (e.g. by hearing protectors) sound transmission through the BC path dominates. Although reported in the literature, there are still some uncertainties regarding the sensitivity for BC transmission of airborne sound. Further, by removing (or attenuating) the AC path the BC path generally alters. This means that even though hearing protectors attenuates the AC path, it does not give a true estimate of the differences between AC and BC transmission. Therefore, the sensitivity of BC transmission from a sound field was estimated using different approaches. The sound pressure at the TM, measured by a probe microphone, and subjective hearing threshold change was compared for several attenuation devices to estimate the AC - BC transmission difference. The occlusion effect was measured and the results were compensated accordingly. Earmuffs and earplugs were used to attenuate the AC path. The result showed the AC transmission to be 40 to 60 dB more efficient than BC transmission for sound field stimulation

15:20-15:40

1529 _____ *contributed*

INDIVIDUAL NOISE EXPOSURE IN SHOOTING SITES

Pedro M. Arezes*, Cristina Macedo

**University of Minho, Guimarães, Portugal*

Personal noise exposure has become a health problem and is no more restricted to occupational environments. Modern lifestyle originates new noise exposure situations. Therefore, there is a growing number of people exposed to noise outside their working environments, namely in recreational or leisure activities. A typical example of that is the use of fireguns with recreational or practice purposes. This use has becomes very popular amongst police agents and other people, namely those with sport purposes. Previous studies have shown that, unlike occupational environments, the management of the shooting sites do not have any kind of structured strategy to mitigate noise exposure and rarely considers any solutions beyond the use of HPDs (Hearing Protection Devices). Besides, noise exposure in these sites has specific characteristics, such as the short duration and the high impulsive characteristics of noise. The main aim of this study is to analyse the noise exposure characteristics of these sites and exposure, such as the frequency and duration of shooting practice and, consequently, to evaluate the risk of hearing loss development of the users. Additionally, it was analysed the main actions carried out to mitigate noise exposure in shooting sites as well as the characterisation of the type and adequacy of the Hearing Protection Devices used by shooters. From the obtained results, it was possible to verify that high impulsive noise exposure is very significant amongst shooting sites users. Furthermore, this type of exposure could have serious implications in what concerns the hearing preservation of the shooting sites users and employees due to the high impulsive characteristics of noise. Concerning the individual protection, results obtained show that the most frequent HPDs used are, in almost situations, suitable for users' protection against high impulsive noise levels.

Session MR2: Measurements in Room and Building Acoustics

chairs:

Michael Vorländer - *Germany*

Swen Müller - *Brazil*

14:00-15:40 **Room:** Botafogo

14:00-14:20

2063 *contributed*

ON THE INFLUENCE OF THE MOVABLE ROOF ON THE ACOUSTICAL QUALITY OF SÃO PAULO HALL

Lenine Vasconcelos*, Roberto A. Tenenbaum

* *UFRJ, Rio de Janeiro, Brazil*

This work addresses the acoustical quality of Sala São Paulo hall, which has, as one of its main features, a mobile roof. Impulse responses for one source position and around ten microphones or dummy head positions, using the sweep sine technique, were obtained, for each of the seven roof configurations tested. The measurements results were then used to compute the main room acoustical parameters, following the ISO 3382:1997 standard, for each octave band between 63 Hz and 8 kHz. It is shown the spatial average and standard deviation of these data, as a function of the frequency. It is also presented the influence of the roof configurations on the obtained acoustical parameters, with the main conclusion that the mobile roof is quite efficient to "tune" the hall. Also, some comparisons were made among the Sala São Paulo hall and the very best halls in the world (ranked as A+ by L. Beranek, 1966). Some aspects involving the main musical periods characteristics (baroque, classical, romantic and modern) and the chosen roof configurations are also discussed. It is concluded that the musicians' choices are quite good and we hope that this research can even improve it.

14:20-14:40

1947 *contributed*

CHARACTERIZATION OF THE ACOUSTICS QUALITY OF BASILICA MENOR NOSSA SENHORA DA GLÓRIA CATHEDRAL

Daniela M. Moreno *, Letícia Dos Reis, Irene Mendonça, Paulo Soares, Nicolas Isnard

* *Universidade Estadual de Maringá/Departamento de Engenharia Civil, Maringá, Brazil*

This present article has a main objective to analyze the acoustics quality that exists in the Basílica Menor Nossa Senhora da Glória Cathedral, located in Maringá, northwest city of Paraná State, Brazil. This is considered the tenth tallest monument in the word and the tallest one in Latin-America. Church with singular design it show an atypical geometry to this kind of use, requiring specific studies to determine its acoustics quality. The process has been started with the acquisition of sound waves reverberation in representative points inside the church. In data acquisition was used a sound pressure level meter, model SdB+ from 01dB Company. This set was linked to a computer where database was recorded by dBTrig32 software. Afterwards this same database was processed by dBTrait32 software both from 01dB Company. Through the sound system of the church, there two kinds of sound wave were emitted: pink noise and a group of sound signals at the frequency bands 125Hz, 250Hz, 500Hz, 1000Hz, 2000Hz and 4000Hz. The pink noise enable to build a map of sound distribution in the church nave. With the group of sound signals of the frequency band it was possible to get a diagnostic of reverberation time (TR) and an analysis early decay time (EDT). To obtain an effective evaluation of church acoustics quality it was used some parameters like early decay time (EDT), reverberation time (TR) and bass ratio (BR). The analysis of this parameters enable the rehabilitation of its acoustics quality, specially related to the correction of sound focalization, determining good places to use absorber covering materials, and determining and positioning reflective and diffusive surfaces.

14:40-15:00

1640 *contributed*

ACOUSTIC CONDITIONING OF THE PALÁCIO DA JUSTIÇA DO ESTADO DO RIO GRANDE DO SUL IN PORTO ALEGRE , RS, BRAZIL

Flavio Simões*, Diego Oliveira

* *UniRitter, Porto Alegre, Brazil*

The PALÁCIO DA JUSTIÇA DO ESTADO DO RIO GRANDE DO SUL was building in the years 50/60, by the architect C. M. Fayet and partner. In the year 2002, the "Palácio" was totally refurbished by Fayet, who call us to develop the Acoustic Design of the Auditorium, which in the new concept will have two functions: A- Auditorium, with 1.573 m^3, 214 places; B- TV Studio for the Justice Channel, with 822 m^3, 60 places, resulting from the use of a acoustic panel from HUFCOR, to reduce its volume and places. In the acoustic study, initially we measured the Background Noise and Reverberation Time. A digital model was built using acoustic simulation software AcustaCadd (IUCC), applying the values of the measurements. Then was analyzed Reverberation Time, Intelligibility of the Word and Geometric Acoustics. With the results was developed the Project of Acoustic Conditioning, increasing the absorption with the installation of black panels of glass wool in the ceiling (50 mm, 40 Kg/m^3, ISOVER). A special care was taken to change

the minimum possible the architectural characteristics of the room, because it is a construction of historical importance. In this paper we show the initial, the estimated and the final values of the Reverberation Time and Intelligibility of the Word, and how we access this results. (UniRitter, Brazil; IUCC-US, Spain).

15:00-15:20

1739 _____ *contributed*

ACOUSTIC POTENTIAL OF CALABASH RESIDUE AS SOUND ABSORPTION ALTERNATIVE MATERIAL

Jorge L. Pizzutti dos Santos ⋆, Marco Aurélio de Oliveira, Getúlio Picada

⋆ *Universidade Federal de Santa Maria - Laboratório de Termo-acústica, Santa Maria, Brazil*

This paper aims to give some scientific information on calabashes used as sound absortion alternative material. For two decades the need for concert halls with adequate acoustic quality has been increasing in Brazil. Therefore, modern buildings have been built in our country according to adequate standers. Nevertheless, the cost of the necessary acoustic materials in current use is prohibitive. In order to reduce building budgets, researches have been done by the acoustic lab from UFSM since 1986. The present research aims to find out whether residue material derived from calabash industries in our state can work properly as sound absorvent material at a low cost.The evaluation of the sound absortion coefficient for these materials was obtained using sophisticated sound measuring equipment employing the frequency range from 100 Hz to 4.000 Hz. In order to get the best performance, the material was installed in at least 11 ways and a math model was used to describe the phenomenon. The obtained results indicated tha the researched material behaved as a Helmoltz resonator. This research has provided scientific information on how calabash residue can be used as a sound absortion alternative material.

15:20-15:40

1522 _____ *contributed*

STUDY OF THE ACOUSTIC POTENTIALITY OF "PET"' TYPE BOTTLES AS SONOROUS ABSORBENT

Minéia Johann Scherer ⋆, Jorge Luiz Pizzutti dos Santos

⋆ *Universidade Federal de Santa Maria, Santa Maria, Brazil*

From some years, several researches have been done about the possible uses of alternatives or low cost recyclable materials in building. Many of these studies aim aplications in architectural acoustic, having special emphasizing researches about acoustic absorbent materials, in other words, that which have potential to be used in the correction of the reverberation time of indoor environments. It is known that the acoustic adequacy of a place for determined task depends on the environment dimensions and the sonorous absorption capacity of the surfaces and objects that compounds it. However, the absorption of each material depends on the frequency of the incident wave, since the medium and high frequencies are easily absorbed by spongy or fibrous materials. Nevertheless the low frequencies need mechanical devices for absorption, as the Helmoltz resonators. Thus, this work has the objective to investigate the behavior as acoustic absorbent of "pet" type bottles with capacity of 2 liters, tested entire and cutted at about 25 cm from the base and the last quoted were tested with the opening cavity position up and down. It consists on a material easily found in big quantity, recyclable, of low cost and with creativity it can offer interesting aesthetic properties. The procedure of mensuration of the sonourous absorption coefficient follows the recommendations of the international standard ISO 354, thus the essay was done in reverberation chamber of the thermo-acoustic laboratory of UFSM. Based on the results, we verify that the type "pet" bottles has high potential as sonorous absorbent, responding with efficiency in all frequencies, according with the used composition, either entire or cutted bottles.

Session NT2: Noise Measurement Techniques

chairs:

Gilberto Fuchs - *Brazil*

Peter Wagstaff - *France*

14:20-15:40 **Room:** Rio 2

14:20-14:40

1686 _____ *contributed*

NEAR FIELD ACOUSTIC HOLOGRAPHY BASED ON AN ARRAY OF PARTICLE VELOCITY SENSORS

Finn Jacobsen⋆, Yang Liu

⋆ *Technical University of Denmark, Kgs. Lyngby, Denmark*

Near field acoustic holography makes it possible to reconstruct three-dimensional sound fields from data measured in a plane close to a source. The usual method involves measuring the sound pressure in a plane with a microphone array. An alternative method that involves measuring the normal component of the particle velocity has hitherto not been feasible. However, a particle velocity transducer called the Microflown has recently become available. Thus the pur-

pose of this investigation is to compare the performance of velocity-based holography with conventional pressure-based holography. Simulations show that the normal component of the particle velocity decays faster towards the edges of the measurement plane than the sound pressure. This is an advantage because less spatial filtering is needed. On the other hand there will usually be higher spatial frequency components in the particle velocity than in the pressure in the same plane, and thus a finer spatial sampling of the velocity is required. If aliasing is avoided there is no appreciable difference between the quality of predictions of the pressure based on knowledge of the pressure in the measurement plane and predictions of the particle velocity based on knowledge of this quantity in the measurement plane. However, when the particle velocity is predicted close to the source on the basis of the pressure in a plane further away, higher spatial frequency components corresponding to evanescent modes are not only amplified by the distance, but also by the wavenumber in z-direction, and thus there is a danger of aliasing. By contrast, when the pressure is predicted close to the source on the basis of the particle velocity in a plane further away, higher spatial frequency components are reduced. Thus all in all a velocity array will generally perform better. These findings have been confirmed by an experimental study in which the particle velocity was measured using an array of Microflown p-u sound intensity probes.

14:40-15:00

1923 _____ *contributed*

PERSPECTIVES OF THE ACOUSTIC CAMERA

Dirk Doebler⋆, Gunnar Heilmann

⋆ *GFAI, Berlin, Germany*

The "acoustic camera" is a measurement tool which joined the field of acoustics a few years ago. This technology analyses the actual sound scene, which consists of a superposition of different sound sources, into a visual sound map. The basic principle relies on accurate calculation of the specific runtime delays of acoustic sound emissions radiating from several sources to the individual microphones of an array. An acoustic map of the local sound pressure distribution at a given distance will be calculated using the acoustic data of all simultaneously recorded microphone channels. The sound pressure level is displayed by color coding, similar to popular thermal imaging. Automatic overlay of optical image and acoustic map gives rapid answers about locations of dominating sound sources. Today's IT–technology allowed scientists at the "society for the promotion of applied computer sciences" in Berlin, Germany, to create one of the first practical, everyday use systems for mobile and interactive applications in sound source imaging. The technology is designed to be simple, robust and flexible to be applied in diverse acoustic environments. Our paper presents the newly developed mapping of moving sources, including video overlay and the necessary measurement technics. Problems concerning the synchronisation of optical and acoustical movie will be discussed. The second topic of the presentation is the three-dimensional mapping of acoustic sources onto a 3d-model of a measurement object. The simple mapping of a virtual plane at a fixed distance is now replaced by different measurement distances to individual points at the 3d-model surface. A complete 3d-mapping of interior rooms depends on omnidirectional, non-planar arrays. Such mappings can be useful inside cars, where CAD-models of the driver's cabin are readily available very often. Possible applications, physical restrictions and future perspectives of this new technology will be pointed out.

15:00-15:20

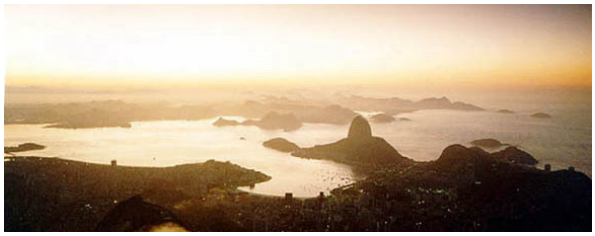
1510 _____ *contributed*

MEASURING THE ABSORPTION COEFFICIENT OF PANELS AT OBLIQUE INCIDENCE BY USING INVERSE FILTERED MLS SIGNALS

Pedro Cobo ⋆, Maria Cuesta, Jaime Pfretzschner, Alejandro Fernandez, Alain Schmitt, Manuel Siguero

⋆ *Instituto de Acústica. CSIC., Madrid, Spain*

This paper describes a method to measure the absorption coefficient of a panel at oblique incidence by a new procedure which combines the Adrienne method (MLS signals with the subtraction technique) with the inverse filter of the electroacoustic system response. This allows to radiate shorter pulses which discriminate better between the different events usually measured in situ (direct, reflected, diffracted, etc.). Therefore, the windows that select the direct and reflected events from the measured trace, which are then used to calculate the absorption coefficient, can be better set up. This in turn optimizes the frequency bandwidth of interest. The method has been validated by applying it to a microperforated panel (MPP) in the anechoic room of the Institute of Acoustics (Madrid). The absorber consists of a (2.44 m x 2.44 m x 1 mm) steel panel properly perforated to provide a suitable absorption bandwidth in front of a wooden panel of (2.44 m x 2.44 m x 2 cm) with an air gap 5 cm wide in between. The inverse filter of the electroacoustic response has been designed so that the radiated pulse has a zero-phase cosine-magnitude spectrum. Experimental absorption curves agree with the predicted ones.



15:20-15:40

1924 _____ *contributed*

THE EXPERIMENTAL RESULTS OF NAH METHOD WITH EXTRA SPATIAL SPECTRUMS

Masao Nagamatsu

Hokkaido Institute of Technology, Teine, Sapporo, Japan

I have proposed a converted NAH method which uses extra spectrums in spatial domain calculation. This method can overcome the limitation of NAH method about measurement pitch. By using this method, measurement pitch of NAH can be set longer than half wave length of sound wave. This is quite efficient in NAH measurement in high frequency. In previous years, I have proposed this method theoretically, and have verified this method in numerical simulations. In this paper, some experimental results of this method and the equipments used for measurement of this method are presented. The experimentations are performed with one or two speakers. By these experimentations, almost same images are aquired from original and converted NAH methods. But in 10kHz measurement, the converted method can accomplish measurement in about 20 minutes, compared with the original method takes few hours for measurement. As a result, the usability of proposing converted method in high frequency is verified in experimentations, and is now same level as it of acoustic intensity method.

Session PO2: Poster

14:00-16:00	**Room:** Copacabana

Assessment and Strategies for Managing Noise

1721 _____ *poster*

ASSESSING THE QUALITY OF URBAN SOUND ENVIRONMENT: COMPLEMENTARITY BETWEEN NOISE MONITORING SYSTEM, NOISE MAPPING AND PERCEPTION SURVEY, THE STAKES FOR THE INFORMATION TO THE PUBLIC

Bruno M. Vincent⋆, Jacques Lambert

⋆*Acoucite, Lyon, France*

Greater Lyon, Acoucité and INRETS are partners in several major projects aiming at promoting the integration of the sound dimension in urban planning. The European GIpSyNOISE project (mapping tool meeting the objectives of the European Directive of June, 2002) as well as the development of a permanent noise monitoring network in the city of Lyon (France), address this issue. One of the main concerns is to make these notions, these methods and the results they provide, comprehensible by the general public. This paper reports the connection between these various complementary tools (measures and noise mapping). The institutional approach, which prevailed in their application, is also developed. Effectively, all the methods of environmental diagnosis need important work prior to partnerships between the various local organizations that hold the information necessary to make the diagnosis, with those in charge of its realization, then with those in charge of the implementation of the action plans and finally with those competent in broadcasting the information. This paper addresses the issue of the complementarity between noise measurement and noise mapping which are two indissociable approaches for carrying out of a noise diagnosis, particularly when this diagnosis is expected to be presented to the public and used by multiple actors from different scientific and technical backgrounds. An analysis of the data collected up to know (permanent noise measurement and noise mapping, crossed with social survey data) clearly shows the benefits from these complementary approaches: each method provides complementary information. Finally this paper addresses the ways of informing the public, as well as the connection between the various actors involved in the management of a same urban area, from the experience gained relating to Greater Lyon and strengthened by the European partnerships within the frame of the GIpSyNOISE project.

1875 _____ *poster*

NOISE IN INCUBATOR: CONCERN TO THE NEONATAL TEAM

Milena D.O. Rodarte ⋆, Carmen Gracinda Silvan Scochi, Nelma Ellen Zamberlan, Sueli Mutsumi Tsukuda Ichisato

⋆ *Escola de Enfermagem de Ribeirão Preto/USP, Ribeirão Preto, Brazil*

At neonatal units, infants are exposed to countless environmental noise sources. The harmful effects of environmental noise and the possibility of hearing damage in premature and high-risk infants, which affect their development process and quality of life, justify the importance of measuring and reducing noise levels at neonatal units. In this sense, noise inside the incubator is particularly relevant, since this is a basic equipment in neonatal caregiving, which may produce intense noise as a result of the engine and during incubator handling. Aim. Quantify continuous and impact noise levels in incubators at neonatal intensive and intermediary care units of a school hospital in the interior of São Paulo State, Brazil. Design/methods. A structured observational study was carried out with 23 incubators, which were divided into 4 groups according

to their model. Measurements were collected without (continuous noise) and with (impact noise) incubator handling, in the careful and careless modes. Findings. The continuous noise level ranged from 44.0 to 57.0 dB/A. The highest SPL were recorded in group B, followed by groups A, D and C. An important increase in these levels occurred when the incubator alarm went off. All handling situations caused intense noise levels, ranging from 66.7 to 96.8dB/A in the careful mode and from 73.2 to 100.6 dB/A for careless handling. Conclusion. Even without a specific standard for impact noise levels inside the incubator, it can be affirmed that the noise produced in different handling situations are really intense, even in those groups with lower SPL. In combination with shorter usage time, careful handling is efficient to reduce the noise produced while handling incubators. This reveals the importance of permanent education for the neonatal team, dealing with ambient noise and incubator handling and control. Keywords: Noise, Noise Measurement, Speech, Language and Hearing Sciences, Audiology, Neonatal Nursing.

1904 _____ *poster*

MANAGEMENT OF ENVIRONMENTAL NOISE ON CRACOW BASED EXAMPLE – CREATING INFORMATION LAYERS

Wojciech Ciesielka*, Andrzej Golas, Jan Adamczyk

* *AGH University of Science and Technology, Krakow, Poland*

Aim of this article is describing management of environmental noise system. The main part of the system are information layers, which have been made on the base of SoundPlan, Integrated Noise Model and GRASS programs. The layers present maps of noise emitted by: road traffic, rail traffic, industrial activity sites and airport Cracow – Balice. The strategic noise maps were performed according to claims on Directive of the European Parliament and of the Council of the European Union and National Law Acts. System is working on available measurement data. Many groups of experts are working on noise controll. There is impossible to eliminate environmental noise so it is necessary to make appropriate decisions. Aim of those decisions is to reduce number of noise exposed people. When decisions are made, the problem is to get right information about sources, levels of each source, number of people living in given area, results of noise protection works. Every civil severant should have access to those information, especially when hist decisions could affect acoustical climate. From other side, law makes duty to serve noise pollution information to everybody (espcially in internet). This article describe such system which consists of two parts: datebase and presentation.

2042 _____ *poster*

ESTIMATION OF L_{DEN} ACCORDING TO TYPE OF STREETS AND LAND USE

Santiago Jimenez *, Teresa Pamies, Angel Sanchez, Ramon Capdevila

* *LEAM-UPC, Terrassa, Spain*

The European directive on the assessment and management of environmental noise, lay down some assessment methods shared by all the countries that make up the EU. It also fixes a number of noise indicators that will have to be taken into account when drawing noise maps and when planning acoustic zones. This paper presents a comparative analysis of the noise indicators Lden, Level (day – evening - night) Lday and Lnight stated by those directives. Experimental work has been done in different cities of Catalonia (Spain) to investigate the importance of the type of street (access roads, distribution roads, neighbourhood streets, pedestrian streets and streets with leisure activities) and use of the ground, (residential, shopping, industrial areas and zones de leisure). The work has been carried out during the period of winter, standard climate conditions, and it is based on long period measurements. Results show that values of Lnight and Levening can be easily calculated from Lday values considering type of streets and use of the ground with errors less than 1 dBA with only few measurements for each tipology of street/ground use. Differences between Lday and Lnight are between 3 dBA for streets with intensive traffic and around 10 dBA for neighbourhood streets.

Community Noise Around Airports: Technical Aspects

1783 _____ *poster*

CALCULATION OF NOISE VALUES AT ADDRESSES AROUND TWO REGIONAL AIRPORTS FROM RADAR DATA

Elisabeth Plachinski *, Peter H.C. Hullah, Abigail Bristow, Mark Wardman

* *EUROCONTROL Experimental Centre, Bretigny sur Orge, France*

The "Attitudes to Aircraft Annoyance Around Airports" (5A) pilot study used focus groups and written surveys to investigate aspects of living in the area around airports and to better understand the annoyance felt by such residents at a European level. This exploratory study focused on aircraft noise impact as a key source of annoyance around three airports: Manchester International Airport, Lyon Saint-Exupéry and Bucharest and attempted to identify the importance of noise in relation to other aspects. The questionnaire was designed using stated preference techniques offering a series of hypothetical choices related

to changes in frequencies of aircraft movements, during different periods of the day thereby allowing a monetary valuation to be made of one aircraft movement. In order to analyse the annoyance as a function of noise, rather than movements, it was necessary to reliably model noise data for the current situation and for each option in the Stated Preference experiments at each respondent's address. The EUROCONTROL Experimental Centre's ENHANCE tool and the Integrated Noise Model enables aircraft noise to be modelled based on actual recorded radar data. Respondents'attitude could be directly correlated to the noise created by real aircraft events at the place where the respondent experienced them. This did not prove to be possible for Bucharest due to a lack of reliable cartography. The present paper explains the use of the ENHANCE tool in this context and the methods used to determine the values of different indices for each respondent, for all hypotheses, to reach informed conclusions about personal preferences and values concerning the perception of aircraft noise and a valuation of noise and annoyance.

Environmental Noise Problems and Approaches

1544 _____ *poster*

STRATEGIC NOISE MAPPING EXPERIENCES IN HUNGARY

Maria Bite*, Istvan Dombi, Pal Bite

**Institute for Transport Sciences, Budapest, Hungary*

Strategic noise mapping experiences in Hungary The aim of this paper is to present experiences gathered during strategic noise mapping work in Hungary according to directive 49/2002 EC. The work consisted of two large scale noise mapping work of urban, motorway and railway areas. Examples include part noise maps of Budapest, 90km motorway and 15 km railway noise maps. During the work we faced the following difficulties: In situations with existing low height noise abatement, and small one storey houses the noise map gives a bad estimation of the present situation. In Hungary on the country side large percent of the residential buildings are one storey buildings. The error is due to the calculation height of 4 m. In some special cases an extra vertical noise map should be added to the action plan, the aim of this vertical map is to differentiate between the different façade noise levels. In this presentation we show examples, for noise maps along motorways and railways where noise reduction action planning without an accurate vertical map would suggest bad and unnecessary cost effective abatement measures. Another discussion point in this paper is, similar to the average meteorological value over a year, to calculate the inhabitants of recreational areas with an average value.

1877 _____ *poster*

METHODOLOGY FOR THE NOISE ENVIRONMENTAL IMPACT ASSESSMENT FROM BUILDING CONSTRUCTION IN URBAN AREAS

Stella Maris Melazzi Andrade*, Jules Ghislain Slama, José Paulo Soares de Azevedo

**L.H.C./COPPE, Federal University of Rio de Janeiro, Rio de Janeiro, Brazil*

This work aims at proposing a methodology for the assessment of noise environmental impact of civil construction, that includes: the aspects of the physical evironmental; the characterization of the construction; the definition of the work planning; the list of noise-significant services; the list of equipments in each stage of execution; their noise levels and utilization times; the noise level in the environment; the accoustic norms; a model of provision accoustics. The model developed for provision accoustics takes into account: the estimated levels of noise exposure of the equipments by using services compositions for equipment operation time; some elements interfering in the emission, propagation and reception of noise; negative effects of noise on human hearing; the kind of construction and stage; the constructing method. The theoretical grounds come from the main accoustic parameters, environmental legislation, the Fuzzy specialist system, and from the knowledge of constructing techniques. The proposed methodology considers the environmental noise planning allowing the mitigation of the noise prior to the assessment and constitutes a tool for the assessment of the environmental noise impact in the stage of installation of the construction as per the Brazilian Resolution - CONAMA 001/ 1986.

2021 _____ *poster*

INFLUENCE OF TOURISTS ON ENVIRONMENTAL NOISE OF A SMALL CITY (CASTRO, CHILE)

Enrique Suárez*, Pedro Antillanca

**UACh, Valdivia, Chile*

Noise caused by the traffic and industrial and recreational activities, is a big environmental problem in the world. Environmental noise generates an important people's annoyance. A noise map is a tool that gives visual information of the acoustic environment of a geographic area (district, town, region, country), in particular time. Castro is a small touristic city, located at the Lake's District in Chiloé Island, in the South of Chile. At the summer time its population is doubled by the presence of national and foreign tourists. It is of major interest to study how this fact affects to the environmental sound, and how it changes with population and traffic increase. The methodology used in the study is mixed, grid and road. The grid used was of 200x200 (m), with 39 points distributed on city. The temporary representativeness of the samples considered the yearly situation at two seasons: low (Winter)

and high (Summer). The weekly cycle was used as a basic unit of study, for similar days (Monday to Thursday) and different days (Friday, Saturday and Sunday). The cycle of the day was divided into 6 periods. The descriptor studied was LAeq, Lmin, Lmax, Lden, etc. The measurements were made during November of 2004 and February of 2005. Urban analysis between noise level and its characteristics are presented: traffic, influence of heavy vehicles (trucks) of fish companies and others (periods at night). The influence of the touristic population during the summer season was studied.

2101 _____ *poster*

ASSESSMENT OF BINAURAL EFFECTS ON INSTANTANEOUS NOISE ANNOYANCE ESTIMATION

Jaehwan Kim⋆, Lim Changwoo, Hong Jiyoung, Jung Wontae, Lee Soogab

⋆ *School of mechanical and aerospace engineering in Seoul National University, Seoul, Korea (Republic of)*

Human beings fundamentally hear sound through both ears, referred as binaural hearing. Most indices of transportation noise for measuring subjective responses such as an annoyance are, however, based on measurement using a microphone. Binaural signal, measured by 'head and torso simulator', is different from monaural signal, measured by a microphone, because it includes more information of physical phenomena like acoustical reflection and diffraction. Consequently, subjective responses to monaural and binaural signals would be discriminated. In order to identify this fact, events of transportation were measured using torso simulator and a microphone at the same site and time. Stimuli which were obtained through signal processing of measured noise events have been presented to subjects in simulated environment. This paper shows their difference through laboratory experiments.

1916 _____ *poster*

POLITICS AND ENVIRONMENTAL NOISE

Theodorus Welkers

Ministry of Housing, Spatial Planning and the Environment, Den Haag, Netherlands

Environmental Noise management is a political item. There is no discussion about the impact of environmental noise on health or annoyance. Millions of people suffer each day under too high noise levels produced by traffic and industry. Technical solutions are available for most situations. In The Netherlands research (related to The Innovation Program on Noise) has been done on silent porous road-surface, silent tires, rail dampers and better break systems for trains. Most of source-oriented measures are cost effective, mainly by saving money on building no or lower barriers. Politics should take a step and decide to invest in source-oriented solutions to give an impulse to implement technical solutions. Another point reflects instruments like standards and test procedures. The instruments should be properly. At this moment e.g. standards for tires are much too high. There is no incentive to introduce silent tires. The trigger for the EU or UN/ECE working parties is mainly harmonization. No one is responsible on a political level for the level of the standards of the noise emission in Directives. Politics should take the responsibility. Industry and Road Maintenance should be challenged by adequate standards and test procedures to develop and implement silent techniques. This method has been proven in the EU with Euro IV for lorries regarding to air quality. Proper standards will provide money and for all a better quality of living. The conclusions of Dutch Presidency of the EU during the second half of 2004 pointed already in this direction.

Noise Barriers

1500 _____ *poster*

ANALYSIS AND ERROR INVESTIGATION USING DUHAMEL'S EFFICIENT CALCULATION OF SOUND FIELD PRODUCED BY MOVING SOURCE

Hirofumi Nakajima⋆, Hideo Tsuru, Seigo Ogata

⋆ *Nittobo Acoustic Engineering Col., Ltd., Sumida-ku, Japan*

The integral transform from 2D sound field analysis results to 3D proposed by D. Duhamel has been applied to efficient estimations of the noise barrier. The transform can be achieved by Fourier one. An analysis using the transform can be used for a moving sound source. However, a practical calculation method and the numerical error of the results are not clearly expressed. In this paper, the practical calculation method and numerical error analysis derived from theoretical investigation are described. Also, a suppression method of numerical error generated by the sampling process is described, and its effect is clarified. Finally, the investigated numerical errors are verified by comparing them with numerical errors given by practical calculations. In the appendix, the difference between pressure and velocity potential, which are misunderstood in Duhamel's paper, is given.

2016 _____ *poster*

LIGHT-CONCRETE WITH LEATHER IN NOISE CONTROL

Iraides Baffa

UNIFRAN, Ribeirão Preto, Brazil

Light-concrete with leather waste is being developed to use in masonry and panels. This study is a contribution to assess the capability of this composite material in noise control or insulation. The leather residues

used in this work are small pieces of the final production of shoes and others artifacts. Some tests have been made to specify its physical properties and possible applications. The production of leather shoes in Brazil generates hundreds of tons in solid waste every day that need to be recycled. The leather waste from shoe's production is a material chemically treated to be stable and durable in many situations to improve the quality of the shoes. A light-concrete with this kind of leather is a composite material using more than 50% of chopped leather in relation to cement weight to be lighter. The use of additional materials depends of the strength desired. This paper presents some aspects of the light-concrete with chopped leather residues to use in fillings of slabs or walls, plates and blocks, indicating a possible application for these industrial residues in order to relieve the impact in the environment. Blocks of leather light concrete with different leather concentrations were produced and the attenuation of sound was measured as a function of frequency. A loudspeaker was positioned in one of the chambers and the sound intensity measured outside. Comparisons with the standard pure concrete block shows that there is an increase in attenuation from 11 dB to 25 dB, depending on the frequency and leather concentration. These results stimulated to build a small scale enclosure to measure other sound propagation properties to ascertain the possible use of this material in large scale. Work supported by: Universidade de Franca, Franca, SP, Brazil and FUNDANESP

2041 _____ *poster*

SPATIAL ACCURACY OF THE RAY METHOD IN PREDICTING INSERTION LOSS OF A BARRIER ON A REFLECTING GROUND

Daniel Ferreira de Panta Pazos*, Ricardo E. Musafir, Eldad Avital

**COPPE, Rio de Janeiro, Brazil*

The objective of this work is to evaluate the precision of the spatial location of insertion loss maxima and minima for the case of an acoustic barrier on a reflecting ground, calculated by the ray approach. The traditional Kurze-Anderson formula is applied to each one of the four propagation paths connecting source and observer and the interference between the rays is considered. The sound pressure and insertion loss fields given by the described method are compared to those obtained by the Boundary Element Method, considering pure tones. Good agreement in the spatial interference patterns between the results of both methods is obtained, with small deviations in location of maxima and minima up to about half wavelength, supporting the accuracy of the ray method.

Noise Measurement Techniques

1378 _____ *poster*

IN-SITU MEASUREMENT OF SOUND ABSORPTION COEFFICIENT OF TEST TRACKS - AN ALTERNATIVE METHOD FOR ISO 10844 QUALIFICATION

Gilberto Fuchs*, Cintia Lopes de Oliveira, Vânia Luzia Láo

**GROM Acústica & Automação, Rio de Janeiro, Brazil*

The international standard ISO 10844/1994 "Acoustics - Specification of test tracks for the purpose of measuring noise emitted by road vehicles" specifies the materials, design, construction and properties of a test surface in order to minimize variations in vehicle noise measurements. The referred standard recommends a maximum sound absorption coefficient for the test track pavement to be calculated from measurements performed with an impedance tube according to ISO 10534-1. The proposed method eliminates the necessity of sample removal for laboratory testing and utilizes the ISO 10543-2 as the reference standard for the impedance tube measurement. Several tests were performed with in-situ measurements and the results compared with ones obtained from the removed samples of the pavement at the precise location of the field tests. Different types of pavements are also studied. The results are presented and discussed, with the purpose to set basis for a new, faster and less expensive way of measuring the of sound absorption coefficient of test tracks.

Outdoor Noise

1754 _____ *poster*

EVALUATION AND ANALYSIS OF THE ENVIRONMENTAL NOISE DUE TO THE RELIGIOUS TEMPLES IN GOIÂNIA, BRAZIL

Séver Marcos Leal Alves*, Sérgio L. Garavelli

**Universidade Estadual de Goiás – UEGO, Brazil*

The acoustics contamination of the big cities has been provoking deterioration in quality of life of their inhabitants. This study was analyzed and quantified the equivalent levels sound pressure (Leq), emitted by 42 religious temples, and the background noise in its neighborhood. The used equipments were the sound level meters; MINIPA - model MSL-1352A, with tripods and protecting of wind, with the acoustic calibrator. The measures were performed outside the limits of the property once that the main focus of the research were the noise external, in other words, noises which extrapolate the limits of the installation of the temples and are

captivated by the neighborhood. The data were always collected on Sunday after the 19 hours, without users knowledge of the temples and following the recommendations of the Brazilian Association of Technical Rules. It was observed an accentuated growth of the number of religious temples that, in a disordered way, are occupying the urban space. This research showed that in 76% of the cases the levels of noises were above the limits established by the federal legislation, in 100% of the measures performed of the background noise, also were observed values above the recommending by the in force rules. As main conclusion can stand out that the city of Goiânia is suffering the acoustics contamination due to the noises generated by the religious temples and that measures of environmental control aiming the control of the noises are indicate to be adopted in this city.

Physiological Health Effects Resulting from Environmental Noise Exposure

1970 *poster*

HEARING LOSS, LEISURE AND OTOTOXIC SUBSTANCES

Rogério Regazzi ⋆, Kerly Servilieri, Elza Sartorelli, Diogo Kenupp, Leonardo Bernardes Lima, Victor Hirata Alexandre, Edélcio Sardano, Ricardo Dias Rego

⋆ *Gavea Sensors, Rio de Janeiro, Brazil*

Audio deficiency can be a consequence of exposures to noises and/or ototoxic agents. Noise is the main cause of hearing disorders in adults. Audio deficiency affects physical and mental well-being. Daily, the people are exposed to noise in their environment of work and leisure, while they use ototoxic medicines. The objective of this work is to verify the sound pressure level in night clubs, and in samba school*, to analyze the risks of potential hearing damages. Through the noise dosimeter, measurements were made in night clubs and in samba school*. It was detected that level of higher noise that above the threshold limit values (TLV). For example, the average noise at the samba school* reached 115 dB(A) during 31 minutes. It is alarming! According to the regulations of the Ministry of Labor and Job (MTE - Ministério do Trabalho e Emprego) and of the Social Security (Ministério da Previdência e Assistência Social - MPAS), exposures larger then 85 dB(A) during 8 hours per day (dose larger 100%) is considered unhealthy and higher than 115 dB(A) can cause imminent injury. The levels of noise presented were high enough to cause hearing damages. This has a big impact on the occupational health. This work is relating a possible hearing loss due to the increase of susceptibility to noise of individuals exposed to ototoxic substances found in pollutants and medicines. These provoke the complaints of audition loss, tinnitus and vertigo. * Samba school – "Escola de Samba" – Group of samba music and dancing that parades in Brazilian carnival.

Room Acoustics

2019 *poster*

OPTIMIZED BASS-TRAPPING RESONATORS FOR CONTROL ROOMS: A PRELIMINARY STUDY

Octávio Inácio⋆, José Antunes

⋆ *Musical Acoustics Laboratory, Escola Superior de Música e das Artes do Espectáculo do Instituto Politécnico do Porto, Porto, Portugal*

All small rooms, such as the ones specifically designed for amplified music listening like control rooms in recording studios, face the well-known problem of low-frequency over-enhancement by acoustic modes. For decades, several methods and devices have been developed to tackle this problem, some with more efficiency than others. Either by the use of Helmoltz resonators, membrane panels or tube-traps, among others, bass control devices (resonators) have typically been focused on a central frequency of maximum sound absorption usually spread over a determined bandwidth, depending on the system damping. Although it is possible to control more than one acoustic mode with a single damped resonator by adding porous materials in its construction, this is usually accomplished at the cost of a less efficient absorption. The number of controlled acoustic modes depends on the central frequency chosen, on the modal density in that frequency range, and damping. In this paper we conjecture that the efficiency of such resonators may be significantly improved if, instead of using basic Helmholtz or cylindrical tube devices, more complex shape-optimized resonators are used, in order to cope with a larger number of undesirable acoustic modes. We apply optimization techniques recently developed in our previous work, in order to obtain the optimal shapes for such devices that resonate at a design set of acoustic eigenvalues, within imposed physical and/or geometrical constraints. Finite element models were implemented and coupled with optimization techniques in order to achieve this goal. We illustrate the proposed approach with several examples of resonator shapes and different design sets of absorption frequencies.

Sound Power

1795 _____ *poster*

SOUND POWER CERTIFICATION OF A DODECAHEDRON SHAPED SOUND SOURCE

Gilberto Fuchs de Jesus ⋆, Rodolfo Venegas, Marco Nabuco, Paulo Massarani

⋆ *GROM Acústica&Automação, Rio de Janeiro, Brazil*

Reference sound sources must be stable, omnidirectional and shall present a frequency spectrum as flat as possible, within standardized limits. The reference sound sources most used on acoustic measurements are constructed as centrifugal fans that generate aerodynamic broadband noise. These sound sources are very stable due to mechanical and electrical inertia which guarantee an almost invariable rotation speed during their operation. They can be operated for long periods of time with minimum modification on their output sound power. Nevertheless, due to constructive limitations, the sound power level of aerodynamic sources is limited to approximately 95 dB(A). Even though this sound power level is enough for many laboratory and field applications, some tests require more sound power injection in reverberation rooms or on field measurements. Performance and endurance tests of electronic devices, when submitted to high sound pressure levels, and in situ sound isolation between partitions are two common examples of acoustic tests in which usual reference sound sources do not generate enough acoustic power. This paper describes a test set-up and presents some measurement results of electro-dynamic sound sources with dodecahedral shape tested in a reverberation room. The data can be used as a possible standardized procedure to evaluate this kind of sound source. Some endurance and repeatability investigation data are also presented as part of the validation tests for a 100% Brazilian made dodecahedron.

Sound Quality

1935 _____ *poster*

DIFFERENCES IN INFLUENCE OF LOUDNESS ON SENSE OF PLEASANTNESS

Robert Jurc⋆, Ondrej Jiricek

⋆ *CTU, Faculty of Electrical Engineering, Department of Physic, Prague, Czech Republic*

The auditory characteristic "pleasantness" was evaluated in two subjective tests of vacuum cleaners and computer fans. The results of subjective tests indicate that the influence of psychoacoustics metrics on the evaluation of auditory characteristics (in this paper, pleasantness) is specific for each sound of the tested device. Therefore, the loudness averaged spectra were obtained and then were compared. The aim of this paper is to determine the relationship between values of loudness in critical bands and the judged characteristic pleasantness of the evaluated sounds. The influence of loudness in the critical bands on the evaluation of pleasantness is dissimilar for the tested device sounds of the vacuum cleaner and the computer fan. These differences indicate the specific features of each product's sound.

1764 _____ *poster*

IMPROVING VEHICLE AUDIO SYSTEM PERFORMANCE THROUGH SUBJECTIVE AND OBJECTIVE EVALUATIONS

Fabio Guilherme Ferraz⋆, Marco Castro, Belisário N. Huallpa, Valdinei Sczibor, Herbert A. Gerevini

⋆ *Ford Motor Company do Brasil, Tatuí, Brasil*

Vehicle audio system performance is an important attribute for final costumers. In this sense, its evaluation is an important aspect for selecting the design and validation process for automobile manufacturers. Usually the vehicle audio system performance is evaluated only by subjective judgment. However the design requirements demands objective measurements to set targets, establish benchmarking and apply refinements to the design. Thus, in order to evaluate and improve sound system performance, it have been established a subjective evaluation process through of a drive in order to reproduce and analyze customer perception in a more reliable way. To support this information, objective evaluations have been used based on total harmonical distortion (THD) and normalized frequency response (NFR) methods, which have been shown as straight and fast objective tools. In order to reinforce the objective evaluations, qualitative time-frequency spectrogram have been used.

Urban Sound Propagation and Evaluation

1568 _____ *poster*

SOUND PROPAGATION MODEL FOR A REAL TIME WEB PUBLICATION

Stéphane Bloquet ⋆, Benoît Plassat, Laurent Faiget, Christine Aujard

⋆ *01dB-Metravib, Limonest Cedex, France*

Sound mapping calculation is based on a sound propagation model. The aim of this model is to quantify the mean sound pressure level integrated during a long period. Each kind of acoustical source type (road, industry, railway, aircraft) propose their proper method for sound level calculation. Several influences of the propagation's actors are included in these models con-

sidering their relative importance: atmosphere attenuation, wind effect, temperature gradient, topography... A model has been developed to predict the sound field using a real time processing. The study is focused on a simple case of a road where the sound field is measured at each extremity. From these two measurements, the method tries to combine acoustic propagation in specific region and probabilistic approach in large zone. Based on a Geographic Information System (GIS), several parameters of influence are taken into account to map the sound field. A standalone system of acoustic monitoring called Oper@ has been installed on pilot site. 5 measurements are realised simultaneously in a pilot site and are available for treatment. It permits to validate the proposed model. The aim of the study is to be able to publish on internet, real time acoustic map.

Session UL2: Ultrasound

chairs:

Flávio Buiochi - *Brazil*

Rodrigo Costa-Félix - *Brazil*

14:00-15:20 **Room:** Business Master 136

14:00-14:20

1541 _____ *contributed*

ESTIMATING PERIODICITY OF IN-VITRO HUMAN TRABECULAR BONE BY TWO DIFFERENT METHODS

Armel Lié Bakita ⋆, Wagner C.A. Pereira, Pascal Laugier

⋆ *UFRJ, Rio de Janeiro, Brazil*

Mean scatterer spacing (MSS) is a parameter that can be used to estimate the periodicity of biological tissues from ultrasound (US) signals. The present study compares the performances of 2 methods (Singular Spectrum Analysis - SSA and Spectral Autocorrelation – SAC) to estimate the MSS of in vitro human cancellous bone specimens. SSA proposes the previous separation of the periodic components of the US signal to be analyzed, while SAC generates a matrix in the frequency domain where the periodicity is related to off-diagonal peaks. In both methods, periodicity is obtained from the frequency corresponding to the spectral peak. Initial investigation was done using US pulse-echo signals from two wire-phantoms with spacing of 0.8 mm and 1.2 mm. The corresponding MSS values obtained were 0.77 mm and 1.10 mm for SAC and 0.79 mm and 0.97mm for SSA, respectively. In the next step, US signals were obtained from 24 cylinders of human trabecular bone, whose MSS values ranged from 1.07 mm to 1.63 mm as measured by synchrotron microtomography. From the signals of human cancellous bone, the correlation R2 = 0.71 and R2 = 0.69 were obtained for SAC and SSA as compared to the microtomography measures. These values indicate that both methods have potential to estimate periodicity in trabecular bones. When comparing the estimates SAC x SSA, it was obtained R2 = 0.92, which would in principle suggest that both methods are equivalent. Nevertheless, because of the limited number of specimens, we can say that the on average they tend to estimate values of the same order.

14:20-14:40

1584 _____ *contributed*

DEVELOPMENT OF A TWO DIMENSIONAL ARRAY ULTRASOUND TRANSDUCER FOR DOPPLER APPLICATIONS

Elaine Belassiano⋆, Marco Von Krüger

⋆ *COPPE / UFRJ, Rio de Janeiro, Brazil*

The ongoing research describes the development of a 2D phased array transducer to be used in a Doppler ultrasound tracking instrument for cerebral long term blood flow velocity monitoring. The simplest design for such a device consists of a nine-element array arranged as square of three by three elements, emitting with the central one and receiving with the eight peripherical elements, deflecting the beam on reception. Three prototypes were built and the basic procedures for constructing de 2D array transducer have been established. Problems regarding electrical connections to the elements turned out to be the main obstacle. The third prototype was able to produce a deflection of ±3mm which exceeds the requirement for the intended application, that is, the long term blood flow velocity monitoring in the middle cerebral artery.

14:40-15:00

1751 _____ *contributed*

REALIZATION OF NATIONAL ULTRASONIC POWER STANDARD

Baki Karaböce⋆, Enver Sadikoglu, Eyüp Bilgiç

⋆ *TÜBITAK UME, Gebze, Türkiye*

The ultrasonic power emitted by an ultrasonic transducer is the main measurand characterizing the strength of ultrasonic field. Extensive usage of ultrasound in medical applications puts forward requirements for the traceable ultrasonic power measurements. This traceability is provided through a calibration of therapy and diagnostical devices against national and international measurement standards. Operating frequency and power range of medical devices bring a frame for the national standard to be established which constitutes the top of metrological hierarchy and serves as a reference standard for ultrasonic power measurements and calibrations. Based on this frame national standard for ultrasonic power measurements covering

frequency range from 1 MHz to 10 MHz and power scale 100 mW – 20 W has been established at TÜBITAK Ulusal Metroloji Enstitüsü (UME). Standard is realized by means of radiation force balance in accordance with the recommendations of International Electrotechnical Commission (IEC) 61161 standard. Technical details of realized ultrasonic power standard, uncertainty evaluation and degree of its equivalence with the standards of other countries are presented in the paper.

15:00-15:20

1752 _____ *contributed*

USING BACKSCATTERED ULTRASOUND SIGNALS TO CHARACTERIZE NORMAL HUMAN LIVER PERIODICITY WITH THE SPECTRAL AUTOCORRELATION METHOD

Christiano Bittencourt Machado*, Wagner Coelho de Albuquerque Pereira, Mahmoud Meziri, Pascal Laugier

**PEB/COPPE/UFRJ - Brazil, Nova Friburgo, Brazil*

Introduction: nowadays the spectral analysis of the radio-frequency (RF) signal from biological tissues using ultrasound (US) is a promising research topic regarding the acquisition of quantitative diagnostic information. The mean scatterer spacing (MSS) has been studied in the characterization of medium periodicity. In order to estimate MSS, it has been proposed the spectral autocorrelation (SAC) method (Varghese and Donohue, 1993). This technique basically generates a matrix in the frequency domain from the ultrasound signals, where the periodicity is related to off-diagonal peaks. The present work aims to use SAC to characterize in vitro normal human liver periodicity using backscattered 20-MHz ultrasound signals. Materials and Methods: Five human hepatic samples (about 7-mm thick) were studied. They have been previously classified as normal after biopsy. A total of 300 ultrasound backscattered signals were collected from each specimen, and then processed with the SAC method. The MSS is estimated from the frequency corresponding to the spectral peak. Histograms of the estimates were constructed to analyze distribution patterns. Results: the MSS estimates are compatible with literature (mean MSS = 1,02±0,08 mm, considering the five samples together). The histograms show several specific modes. Discussion and conclusion: comparing SAC results with other spectral analysis methods from literature, although the limited number of specimens, it can be seen that there is a good agreement in estimates, being the MSS around 1 mm (which is also compatible with the medical literature). Nevertheless, the several important modes observed in the histograms may represent various periodicities inside the tissue. The next step is to analyze fibrotic hepatic tissues, and to compare them with the results here presented, to see if it is possible to differentiate the normal and pathological conditions.

Session VN2: Vehicle Noise Vibration and Harshness

chairs:

Helcio Onusic - *Brazil*

Takeshi Abe - *USA*

14:00-15:40 **Room:** Arpoador

14:00-14:20

1449 _____ *contributed*

VIBRATION STANDARDS FOR CITY BUSES

Francisco Parentes R. Corrêa

RIOTRILHOS/RJ, Rio de Janeiro, Brazil

Metropolitan trains are subject to well defined standards for noise and vibration. Even specifications for maximun acceptable accelerations and decelerations are provided, in order to ensure a confortable travel for passengers. But buses are a different matter. People who deal with public transport planning are aware of how difficult it is to convince city people to change their private cars for public transport commuting, and perhaps the lack of noise and vibration standards for buses is a part of it. Acceleration and deceleration standards are both comfort and security standards, at least were Rio de Janeiro city buses are concerned – people sometimes fall because buses somtimes break or depart too fast, or make curves at high speed. Noise and vibration engineers must deal with these problems, developing adequate vibratin standards. On the present work, the guidelines for these standards and a bus vibration measurement program are discussed.

14:20-14:40

1985 _____ *contributed*

BOOMING NOISE STUDY ON HYBRID CARS

Antonio Vecchio*, Herman Van der Auweraer, Karl Janssens, Filip Deblauwe

**LMS Int., Leuven, Belgium*

The Toyota Prius represents the first worldwide commercially produced hybrid vehicle. Recently the Toyota produced the new Prius version, significantly improving the performances of its predecessor and introducing the concept of "Hybrid Synergy Drive" (THS II), an evolution of the past "Toyota Hybrid System" (THS). Three rotating components form the vehicle transmission. The internal combustion engine is a 4-cylinders 4-strokes engine using the Atkinson thermodynamic cycle; the electric motor and the generator are both three-phases permanent magnet synchronous AC motors. These three rotating components are connected each other with a kind of CVT transmission charac-

terized by a planetary gear box, referred to as Power Split Device. An electronic control system regulates the rpm of the three components based on many variables such as the external loads, the fuel consumption, the emissions, the state of charge of batteries and the user power demand, which directly relates to torque. This paper reports on the results of a test campaigns carried out on both THS and THS II to assess vibration and acoustic responses under real on-road conditions. The analysis deals with multiple rpm order tracking and shows how different rotating components affect the interior vibro-acoustic comfort as well as the car drivability and pleasantness.

14:40-15:00

1626 _____ *contributed*

CHARACTERIZATION OF ADAPTIVE FILTERS USED IN THE IDENTIFICATION PROCESS OF ANNOYING NOISES IN VEHICLES

Jose Ignacio Huertas Cardozo*, Javier Maurico Antelis

* *Instituto Tecnologico de Estudios Superiores de Monterrey Campus Toluca, Toluca, Mexico*

To identify annoying noises inside vehicle cabins, it is necessary to capture the sounds present inside them and eliminate or attenuate all external noises from the obtained signal. Typically, the main external noises are those produced by the engine operation, the tires movement and the wind flowing around the body of the vehicle. To eliminate these kinds of noises, LMS, RLS and Kalman adaptive filters are used. They have demonstrated adequate performance in terms of convergence, tracking and computational requirements. However, for this application they do not show the desired results at times. Therefore, it is necessary to characterize the performance of these filters and select the one most suitable for the application of identification of annoying noises in vehicles. This work addresses this need. Analytical and experimental work was developed to characterize the performance of the LMS, RLS and Kalman filters in terms of filtering capacity and filtering quality as a function of the frequency and phase of the input signals. Additionally, a subjective evaluation was performed asking a group of users about the filter that best reproduces well-defined noises when they are recorded from moving vehicles. Results showed that the RLS filter is the most suitable for this application. Additionally, it was found that for low frequency input signals all the filters show the lowest filtering capacity.

15:00-15:20

1762 _____ *contributed*

IMPROVEMENT TECHNIQUES FOR LOW FREQUENCY BOOM NOISE OF SPORTS UTILITY VEHICLES

Kyong Ryol Yoon

Hyundai MotorCompany, Whasung-Si, South Korea

Noise and vibration problems in SUV's and minivans are getting important due to customer's high demand for a quiet interior. In these vehicles, a tailgate plays a critical role in these problems, especially vehicle's low frequency booming phenomena, because it has relatively weak mounting structures while a large amount of mass and volume is fitted to a rear part of the vehicle body. Also, recently developed vehicles equipped with high powered engines have encountered with coupling problems between power train and tailgate at an idle operation. In this paper, the modal analysis on a tail gate component has been carried out and the analysis results have been correlated with a test. In order to estimate the vehicle structural-acoustic performance, simulations on an idle shake and an idle boom have been conducted using FEA. Road shake and road noise simulations also have been done to hold the effect of tailgate sensitivity with respect to a low frequency noise. A series of various case studies have been conducted and their results have been applied into designing tailgate structures. Throughout the case studies, an emphasis has been placed on searching for high performance optimized solutions.

15:20-15:40

1683 _____ *contributed*

IMPROVEMENT TECHNOLOGY OF THE LOW FREQUENCY NOISE IN THE CAR

Jackie Jiang*, Jonny Ho

* *Center for Measurement Standards, Hsinchu, Taiwan*

This text mainly carries on the characteristic analysis of the sound to the noise in a certain limousine of cars, and then according to its sound speciality , carry on the corresponding improvement scheme. 1/3 Oct frequency spectrum of the noise analyses from the car , and after professional personnel's subjective appraisal, assert that the weight of low frequency is the main reason causing the noise in the car to be too high, and determine in order to improve the vibration amount of the car body structure, regarded as the tactics of improving the low frequency noise. And then test through the transmitting rate of every vibration of car body, determine the thickness , size and location of the damping material . Pass real car test finally, prove that the low frequency noise improves the effect and reaches 4.5 dB in the car, the whole noise improves the effect and reaches more than 3 dB.

Session VI2: Vibration Isolation and Damping

chairs:

Balakrishna Thanedar - *USA*

Luvercy Azevedo - *Brazil*

14:00-15:20 **Room:** Business Master 145

14:00-14:20

1553 _____ *contributed*

A CASE FOR GALLEY INSERT ISOLATION IN AIRPLANE CABIN

Balakrishna Thanedar

The Boeing Company, USA, Seattle, USA

A galley is a structural unit located within the airplane from which food and beverages are served. In conjunction with the airplane food service a large number of galley inserts such as ovens, refrigerators / freezers, air chillers, wine chillers, galley waste disposal, espresso coffee-maker, etc. are housed as a part of the galley system. Noise sources that are associated with the galley insert operation in an airplane are identified. Using the test bench and / or airplane test data, the impact of these on the galley work area acoustics is evaluated. Especially on long flights, this impact can become noticeable. There exists a possibility of minimizing such noise impact by improving quality control and addingvibration isolation. Experience has shown that introduction of vibration isolation has resulted in a marked reduction of the structure-borne noise. An example of noise and vibration reduction for a typical air chiller is provided.

14:20-14:40

1684 _____ *contributed*

OPTIMAL CONSTRAINED LAYER DAMPING PLACEMENT ON A PLANAR STRUCTURE FOR MINIMIZATION OF RADIATED SOUND POWER AND VIBRATORY ENERGY

Hui Zheng⋆, S. Lim, C. Lu, H. Lee

⋆ *Institute of High Performance Computing, Singapore*

An optimization study of a constrained layer damping (CLD) treatment for noise control is presented. The energy-based approach and assumed-mode method are used to derive the equations governing the displacement responses of a simply-supported beam with a partial CLD patch to formulate the objective function of the optimization problem. The vibration responses of the damped structure is calculated in a frequency range of interest by employing the direct frequency response method and the results are used to obtain the baffled structure's radiated sound power by Rayleigh's integral formulae. A genetic algorithm-based penalty function method is employed to search for the optimal placement of the partial CLD patch and shear modulus of the viscoelastic layer for minimizing the radiated sound power from the damped beam under a broadband transverse force. The results are compared with those for the minimization of vibratory energy. It is revealed that certain differences exist between the optimal CLD placements for the two different objectives. More reduction in the sound power radiated from the damped structure can be achieved by optimizing the CLD patch with the objective to minimize the radiated sound power than that to minimize the vibratory energy under the constraint in additive weight duo to CLD treatment.

14:40-15:00

1869 _____ *contributed*

FINITE ELEMENT ANALYSIS OF SHUNTED PIEZOCERAMICS FOR PASSIVE VIBRATION CONTROL

Danuza Cristina Santana ⋆, Yann Meyer, Domingos Alves Rade, Manuel Collet

⋆ *Federal University of Uberlândia, Uberlândia, Brazil*

In the present paper, the finite element modeling of vibrating structures combined with piezoelectric materials and passive electric circuits (shunt circuits) is addressed, with emphasis placed on the analysis of two circuit topologies: resistive shunts and resistive-inductive shunts. The underlying formulation is first presented and then some numerical simulations using commercial finite element software are performed considering a free-free square plate and a complex piezoelectric vibrating beam accelerometer cell for which some target vibration modes must be attenuated. Results are presented and evaluated in terms of the vibration attenuation attained in each case analyzed.

15:00-15:20

2098 _____ *contributed*

SUBSTRUCTURAL COUPLING USING GENERALIZED EQUIVALENT QUANTITIES

Sergio Floody⋆, Jorge Arenas

⋆ *Universidad Perez Rosales, Santiago, Chile*

The final aim of this work is to apply the Generalized Equivalent Quantities method for vibration neutralizers (absorbers) to problems involving sub structural coupling, by means of the Finite Element Method. By using this method it is possible to represent the behaviour of a vibration neutralizer as a mass and a viscous damper connected to ground, resulting in a joint model that does not have additional degrees of freedom. By

noticing this property of the Generalized Equivalent Quantities, a complex mechanical system can thus be represented as a set of masses and equivalent viscous dampers, which will be dependent on both frequency and position. Therefore, the impedance of the common interface that each subsystem has with another vibrating mechanical system can be represented based on these quantities, resulting in a reduction of both the total number of equations and the order of the involved matrices in the joint model. A numerical example using membranes it will be presented.

Session AP3: Airport Noise

chairs:

Delia Dimitriu - *Romania*

Jan Schumacher - *Germany*

16:00-18:00 **Room:** Flamengo 2

16:00-16:20

1928 _____ *contributed*

LIEGE/BIERSET AIRPORT, BRUSSELS SOUTH/CHARLEROI AIRPORT:AN INTEGRATED APPROACH OF THE NOISE IMPACT OF AIRPORTS

Jean-Pierre Clairbois ⋆, Phillipe Debroux, David Meganck, Dirk Van der Poorten

⋆ *A-TECH, Brussels, Belgium*

Today, many airports are concerned by the impact of noise on their inhabited environment. Few have no strategy, many others do but strategies differ a lot from each other. In this paper, we present the different strategies kept for 3 Belgian airports, with their advantages and drawbacks. Basically, two opposite strategies apply: in Wallonia, the airports of Liège/Bierset and Brussels South/Charleroi operate with a flight routes concentration accompanied by several actions on the ground, while Brussels National/Zaventem has been obliged to scatter the flight routes with no further actions. For both Walloon airports, the process started with exhaustive measurement surveys of the existing noise, previous to the airports extension (30 points / weeks). The optimisation process was based on impact studies of several practical scenarios, together with the advice of airport authorities, pilots, acousticians ... When the final routes have been fixed, then the corresponding Lden noise contours have been officially published and action plans on the ground have been decided. The action plans consider the permanent track and noise monitoring (radar and airport data, 16 Noise Monitoring Terminals on the impacted zones), and considerations about sound insulation of houses (sound proofing the existing ones, rules for building new ones). Furthermore, hundred of exhaustive "mobile measurements" are scheduled in order to verify the validity of the contours. The routes concentration can be very successful if the whole package of the following actions is undertaken: route optimisation, routes official definition, permanent monitoring of the respect of the routes, permanent monitoring of the noise at ground, sound proofing of the houses, rules for urban development and new building construction. Altogether, those actions lead to global management of airport noise, which allows a managed development of future activities, taking the environment into account.

16:20-16:40

1955 _____ *contributed*

CEPSTRAL RECONSTRUCTION OF AIRCRAFT TRAJECTORY FROM FLYOVER NOISE

Federico Miyara ⋆, Vivian Pasch, Susana Cabanellas, Marta Yanitelli

⋆ *Universidad Nacional de Rosario, Rosario, Argentina*

The knowledge of the trajectory of an aircraft during flyover, along with the digital recording of its noise, allows an inexpensive way to characterize the aircraft acoustically. As was shown in previous work (Internoise 2001, paper in01-653), this can be accomplished through the analysis of the interference pattern created by ground reflections (the so-called comb filter effect). In the present paper, the cancelled and reinforced frequencies are computed by means of a technique derived from cepstral analysis. The inverse FFT is applied to the logarithm of the average FFT spectra of several consecutive frames and then the location of the peak within a carefully chosen interval is found. The reciprocal of this "quefrency" yields an estimate of the first reinforced frequency, getting around the rather imprecise graphical approach performed on a spectrogram.

16:40-17:00

1966 _____ *contributed*

NOISE LEVEL PRODUCED INSIDE "ZONE 2" OF NZSP BY AIRCRAFT OPERATIONS AT SALGADO FILHO INTERNATIONAL AIRPORT, IN PORTO ALEGRE, RS, BRAZIL

Luciano B. Nabinger⋆, Miguel Aloysio Sattler

⋆ *Nabinger Acústica LTDA, Porto Alegre, Brazil*

This paper summarizes part of a Master's dissertation elaborated in the course of Civil Engineering of the Federal University of Rio Grande do Sul, and presents results related to the levels of noise caused by landings and take-offs of aircraft operating in Runway 29 at Salgado Filho International Airport in the city of Porto Alegre, Brazil. The paper presents the noise levels of the different equipment (aircraft models) registered in the period, and analyses whether there is a correspondence between the two Brazilian rules in force, in connection with the acoustic area. We checked up whether the levels of acoustic insulation as set by NBR 8572 meet the levels of acoustic comfort established by NBR 10152. The acoustic registrations have been made in one single spot inside "Area 2" of the NZSP – Noise Zoning Specific Plan for the city of Porto Alegre, and take the SEL rate into consideration for such analysis. The plan is approved by Instruction 1.145/GM5 of the Air Force, which also sets the specific plans of all 66 Brazilian airports administered by INFRAERO. We have counted on INFRAERO collaboration for identifying the aircraft and obtaining meteorological

data. In order to analyze the results, we have used the Evaluator software, kindly provided by the firm Brüel&Kjaer, through which we were able to subtract the "events" (an aircraft passing by), identified in the acoustic measurements, and get the results for background noise without the aircraft being present. Such methodology has enabled us to exactly assess the sound impact caused by aircraft noise at the spot under study. The data acquisition procedures meet ISO 3891-1978 (Procedure for describing aircraft noise heard on the ground), and STNA Guide Monitoring (Monitorage bruit et trajectories d´avions).

17:00-17:20

2089 _____ *contributed*

MULTI-OBJECTIVE OPTIMIZATION OF NOISE ABATEMENT TRAJECTORIES

Dries Visser

Faculty of Aerospace Engineering, Delft, Netherlands

This paper presents a trade-off study that has been conducted using a recently developed tool for the analysis and design of noise abatement procedures around airports. This new tool, called NOISHHH, combines a noise model, a geographic information system, and a dynamic trajectory optimization algorithm. The NOISHHH tool generates routings and flight-paths for both arrivals and departures that minimize the noise impact in the residential communities surrounding the airport, while satisfying all imposed operational and safety constraints Many current noise abatement procedures are local adaptations of generic procedures that aim to optimize noise footprints for selected aircraft types. Such generic procedures do not take into account the actual population distribution in the areas surrounding the airport, and therefore cannot be seen as true noise impact mitigation measures. The NOISHHH tool features a multi-objective optimization capability that permits to explore both generic and site-specific noise abatement criteria. Using this capability we have conducted a noise performance trade-off between arrival trajectories that are optimized according to three different types of noise abatement criteria. Also fuel-consumption is included in the composite performance index. Typically, these different criteria are not compatible; the variables that optimize one objective may be far from optimal for the others. The main focus of this paper is to provide insight into the actual sensitivities in the multi-objective noise performance trade-off process, taking into account both generic and site-specific criteria. It is clear that improvements with respect to noise impact may not come at the expense of a reduction in aircraft throughput capacity. To address the capacity issue, the possibility to include time-constraints in the trajectory optimization process is also explored in this study. The potential community noise benefits of arrival trajectories calculated with NOISHHH are illustrated in an example scenario based on an approach from the north to runway 06 of Amsterdam Airport Schiphol in the Netherlands. The presented numerical examples rely on a model of the Boeing 737-300 twinjet transport. Key Results It is shown that improvement with respect to one particular noise criterion is often achieved at the expense of one or more of the other criteria. Using the insights gained into the sensitivities in the noise trade-off process, a "compromise" trajectories were synthesized that address all defined noise criteria in an equitable fashion. The possibility to include time-constraints in the trajectory optimization formulation is also demonstrated.

17:20-17:40

1527 _____ *contributed*

AIRCRAFT FLIGHT PROCEDURE DESIGN WITH RESPECT TO NOISE ABATEMENT AS WELL AS ECONOMICAL AND PILOT WORKLOAD ASPECTS

Reinhard Koenig*, Jens Heider, Michael Maierhofer

* *German Aerospace Center, Braunschweig, Germany*

Aircraft flight procedures for departure and approach have been already optimized in the past. But lower engine and higher airframe noise levels of modern airliners as well as additional possibilities for aircraft guidance and control lead to the fact that existing noise abatement procedures do not exploit the full noise reduction potential. The main measures on approach procedures for noise reduction are increased height, decreased thrust and delayed configuration changes. Sometimes these measures are contradictory, e.g. an increased height means a steeper approach, which only can be performed by extended landing flaps with gear down and idle thrust setting. To calculate the correct immission values the methods used have to take into account that airframe noise may be dominant, if engines are operated near idle thrust. The paper describes the design process of reduced noise approach procedures with respect to safety, economy, passenger comfort and pilot workload. Several approach procedures are investigated. The Segmented Continuous Descent Approach (SCDA) is the most suitable for the given demands and therefore selected to be investigated within full flight simulator and flight test. The benefit of the SCDA in terms of smaler areas of Sound Exposure Level (SEL) related to a Low Drag Low Power Approach (LDLP) covers the major part of the approach. Due to the assessment of pilot workload 44 pilots in total (mean flight experience 11 year) were tested either on a A320-full-flight simulator (Lufthansa Flight Training) in Frankfurt or on the A330-test simulator (Centre for Flight Simulation) in Berlin. They performed a LDLP landing scenario followed by three SCDA procedures. Flight simulation data as well as physiological and psychological data were recorded during all test sessions. Noise levels on ground are calculated using the DLR noise simulation software SIMUL.

17:40-18:00

1628 _____ *contributed*

EVALUATION THE INFLUENCE OF NOISE ABATEMENT PROCEDURES TO PILOT'S WORKLOAD AND SAFETY BY USING AN AIRBUS A330/340 FULL FLIGHT SIMULATOR

Ekkehart Schubert*, Oliver Lehmann, Gerhard Huettig

**Institute of Aeronautics and Astronautics, Technische Universität Berlin, Berlin, Germany*

Future growth of air traffic leads to higher noise emissions, even if new or modernized aircraft will improve this situation. A possible mitigation strategy is the development and validation of noise abatement procedures. However, new aircraft operating procedures will affect flight safety, aircraft performance, crew workload and pilot acceptance. Therefore, evaluation of technical aspects in particular with regard to human factors is essential. An Airbus A330/340 Full Flight Simulator installed at the Institute of Aeronautics & Astronautics (Technische Universität Berlin, Germany), linked with a special experimental environment (Scientific Research Facility), assures high quality results in these fields of research. The evaluation of human factors based on recording of physiological parameters (Eye-tracking, Electrophysiology), subjective measurements (e.g. questionnaires / interviews regarding fatigue, sleepiness, tension, workload and acceptance) and multi-video / audio data. In addition, specific technical parameter from the simulation process (such as flight aerodynamic/mechanical data, deviations and indications) and pilot's interaction with the cockpit human machine interface were recorded. To obtain highly accurate and reliable data fully rated line pilots will have to take part in any research investigation. Additionally the simulator setup and definition of accurate scenarios and exact reproduction are key features of the available experimental system. Therefore, involvement of airlines and air traffic control are required in defining realistic scenarios (Crew Coordination Concept / Standard Operation Procedures). Different research projects at our Institute keep focus on evaluation of new operational procedures, pilot's workload and new or modified avionic systems. This lecture gives a detailed overview of our simulator experimental environment and presents initial results from an simulator based project related to noise abatement procedures (Partners: German Aerospace Center (DLR) and Lufthansa German Airlines / The German Ministry of Research and Technology supported this study).

Session BA2: Building Acoustics

chairs:

Elvira B. Viveiros - *Brazil*

Peter Barry - *Brazil*

16:00-18:20 **Room:** Rio 1

16:00-16:20

1619 _____ *contributed*

SOLUTIONS FOR SOUND INSULATION INCLUDING SUSPENDED CEILINGS

Nils-Åke Andersson

Saint-Gobain Ecophon AB, Hyllinge, Sweden

Many offices are nowadays built with full flexibility, which means that strong acoustic requirements must be fulfilled both concerning sound absorption and sound insulation properties. Open plan offices need good speech intelligibility at local workplaces, as well as acoustic privacy between working places. There is, on the other hand, a need for adequate sound insulation between open office areas and private offices or meeting rooms, as well as between these rooms. Fairly often offices are not built to meet these acoustic demands. Flexibility means normally a wall to wall ceiling system to which you attach movable partitions and in order to achieve high enough sound insulation between rooms you need ceiling tiles with excellent sound insulation properties. This paper presents some findings about room-to-room sound insulation in this context. Which sound insulation result can be achieved between two rooms, according to ISO 140-9/ASTM E-1414? What about installing vertical barriers and how sensitive are they to gaps and openings? How can additional absorbers in the plenum improve sound insulation? Measurements show that appropriate sound insulation between two spaces can be achieved in various ways. Either by ceiling systems with additional barriers or absorbers or by the ceiling panels themselves. A limited gap or opening in a barrier or in a ceiling panel might not necessarily destroy the sound insulation. It seems that barriers are possible to use in many situations as they do not need to be cut to fit exactly.

16:20-16:40

1661 _____ *contributed*

CONTROL OF LOW FREQUENCY SOUND INSULATION BY CURVED POLYMER FILMS

Kohei Yamamoto ⋆, Kimura Kazunori, Okubo Tomonao, Kodama Hidekazu, Date Munehiro, Fukada Eiichi

⋆ *Kobayasi Institute of Physical Research, Kokubunji, Japan*

Acoustic impedance of a curved film is represented by two terms. The first term is proportional to elastic constant, the reciprocal of the squared radius of curvature and the reciprocal of frequency. The second term is proportional to the density of the film and frequency. The latter leads to the well-known mass law that the transmission loss (TL) through the film increases with increasing frequency. The former leads the elasticity law effective in a low frequency range that the TL increases with decreasing frequency. A sound insulation panel with an area of 20 x 30 cm2 was constructed using curved plates of polyethylene terephtalate (PET) with a thickness of 1.5 mm and a radius of curvature of about 30 cm. The TL of the panel was 28 dB at 400 Hz and increased with decreasing frequency. A similar panel was constructed using curved films of polyvinylidene fluoride (PVDF) with a thickness of 40 x 10-6 m and polyurethane foams. The elasticity of this piezoelectric film is changeable by connecting a feed-back negative capacitance circuit. The TL of this panel was 15 dB at 300 Hz and increased with decreasing frequency. By changing apparent elasticity of PVDF film, 15 dB increase of TL was obtained at 300 Hz, resulting in 30 dB for the TL of the panel.

16:40-17:00

1431 _____ *contributed*

NOISE REDUCTION OF AIR COOLING REFRIGERATOR BY APPLYING THE IMPERVIOUS THIN LAYER DAMPING STRUCTURE TO COOLING AIR BAFFLE PLATE

Yadong Lu⋆, Li Hongqi, Tian Jing, Liu Ke, Li Ying

⋆ *Institute of Acoustics, Chinese Academy of Sciences, Beijing, P. R. China*

As we know, noise emitted from an air fan in a freezer compartment of refrigerator is a main source except refrigeration compressor's noise. The freezing air coming from the fan directly impinges upon wind baffle mounted in front of the fan and results in a strong flexural vibration of the wind baffle plate embedded in a freezer compartment, which further leads to structural vibration of the inner walls of the freezer compartment, thus a large amount of noise in which low-frequency noise components dominate radiates to the outside. Because of large size of the wind baffle's surface, fan noise is significantly amplified due to the presence of the wind baffle aiming at redistributing the freezing air. In order to reduce the noise radiated by air cooling refrigerator, a new method by locally applying the impervious thin film damping structure to the solid wind baffle installed in the freezer compartment is presented in this paper. The hard baffle plate's partial region just in front of the freezing air fan is replaced by the impervious thin film damping structure by opening a circular hole on the baffle plate. Although the air impinging on the thin film will increase much more noise, but the generated noise is chiefly a mid/high-frequency noise, which can be easily insulated by closing a door of the freezer compartment during fan's operating period. Furthermore, while the door opens, the freezing air fan will stop immediately, noise arising from the membrane flexural vibration won't generate any more. By this noise reduction method, total sound power level of the test refrigerator is reduced by 2.4-2.6 dBA at different operation conditions.

17:00-17:20

1534 _____ *contributed*

ACOUSTIC PERFORMANCE OF SLOT VENTILATORS AND THEIR EFFECT ON THE SOUND INSULATION OF A WINDOW

Jacek Nurzynski

Building Research Institute, Warsaw, Poland

Windows used in a building with natural ventilation, which are prevailing in Poland, shouldn't be perfectly tight. The minimum value of air permeability coefficient should be provided to maintain constant airflow in the living area. To satisfy this requirement windows are equipped with different air openings or air transfer devices which are frequently in a form of so called slot vents. The acoustic performance of slot ventilator is described by Dn,e,w measured in accordance with ISO 140-10 as for small building elements installed in a partition board when being tested (EN 13141-1:2004). Although, the question is how it work while fitted into the window frame and what is the real effect of such an air slot on the sound insulation of a window. The Dn,e,w indicator value causes some misconceptions because window and slot vent with the same decibel rating won't give the same sound reduction when used together. The paper presents the results of laboratory tests carried out on slot vents themselves, then on windows equipped with the vents. Theoretical calculations are compared with empirical results. Difficulties in slot ventilators installing at the test facility in a manner representative of field practice and the method of performance assessment are discussed. The shape of sound insulation characteristics of a slot vent and a window are totally different. Does the single number indicator Dn,e,w give precise description of the acoustic properties of slot vent? Is it enough data to calculate the total weighted sound reduction index of a window with an air opening?

17:20-17:40

1776 _____ *contributed*

FLOOR IMPACT NOISE REDUCTION IN SHIP CABIN BY USING FLOATING FLOOR

Hyun-Sil Kim*, Kim Bong-ki, Cha Sun-il, Kim Young-soo

* *Korea Inst. of Machinery & Materials, Daejon, Korea*

In this paper, floor impact noise reduction by using floating floor in cruise ship cabin is studied. A mock-up is built by using 6 mm steel plate, and two identical cabins are made where 25 mm sandwich panel is used to construct wall and ceiling inside the steel structure. Various floating floor systems are tested for several combinations of steel deck, VL (Viscoelastic Layer), mineral wool (density: 150 kg/m^3), and floor covering plates. Normalized impact noise is measured according to ISO 140-7 (field measurement of impact sound insulation of floors, 1998). It is shown that the normalized impact sound Ln,w of the bare steel floor is 73 dB, where Ln,w of the 6 mm steel deck + 1 mm VL + mineral wool (25 mm – 70 mm in thickness) + 3.2 mm steel plate is reduced to 42 dB – 50 dB. It is found that the effect of VL is negligible when it is used between steel deck and mineral wool, since most vibration absorption occurs in the mineral wool. The direction of the mineral wool fiber affects floor impact noise significantly, in which horizontal direction is quieter than vertical direction by 5 – 7 dB, because vertical direction results in stiffer spring constant than horizontal direction. It is measured that the Young's modulus of the horizontal fiber direction is 1.3x105 to 1.7x105 N/m^2, where that of the vertical fiber direction is 1.7x106 N/m^2.

17:40-18:00

1892 _____ *contributed*

PREMOLDED PANELS WITH RECYCLED RUBBER

Deyse Christina B. Macedo*, Rejane Maria Tubino, Maria Luiza Carvalho, Maria de Fátima Neto, Cynthia Borges

* *CMEC / UFG, Goiânia, Brazil*

The possibility of transforming used tyre rubber from residue to a by-product is the main approach in these studies developed with this material so far in Brazil. Premolded panels with different percentages of rubber were examined. It is possible to improve characteristics of existent products to obtain more deformation with good noise attenuation of the material. A sequence of problems relating to undesirable noises can be solved. Among other advantages involved in the recycled process of tyre rubber in civil construction is the use of waste products contributing to environmental conservation, consequently attending the standards 258-99 and 301-03 of CONAMA (National Environment Council of Brazil). These standards determine that tyre rubber importers and producers have until 2005 to correct the destination of all residue production. Another benefit is the solution to serious problems of public health, beyond the cost reduction due to the substitution of part of the sand by a low cost product. This paper analyzed the possibility of improving the acoustic isolation of premolded panels (reference and three different percentages of rubber 5%, 10% and 15% in substitution of the fine aggregate, in volume). These panels were tested in a reverberation room at the Building Systems Development Laboratory of Furnas Centrais Elétricas S. A., according to the standard ISO -140-3 and ISO 717-1. Analyzed through the Sound Reduction Index (R) and Weighted Sound Reduction Index (Rw), the premolded panels with rubber compared among themselves presented improvement in noise attenuation according to the increase in rubber percentages.

18:00-18:20

2079 _____ *contributed*

NOISE FROM ELEVATOR INSTALLATIONS IN PENTHOUSES

Jordi Romeu*, J. Ignácio Palacios, R. Torres

* *LEAM-UPC, Terrassa, Spain*

Noise from building installations is one of the most common noise source inside households. Concretely, typical Spanish electromechanical elevator installations tend to cause noise problems in penthouses, because the machine is placed close to that kind of households. Typically, noise levels inside the penthouses are around 35-40 dBA measured using five second Leq measurements, and Lmax values are around 45 dBA, which are clearly over the values permitted by regulations. In most of cases, noise from that kind of installations is structure borne transmitted. In this work a penthouse is completely tested, measuring noise and vibration simultaneously in different points of the floor and walls, as well as in the machine, in order to know the transmission paths from the machine to the household. Results have demonstrated that the bands between 125 and 315 Hz are the most important ones, and that the requirements of vibration insulation for those frequencies are around 2% of transmissibility. Simulation by Statistical Energy Analysis have been carried out and correlated with measurements in order to estimate the influence of the tipology of walls and floors in noise levels inside the penthouses.

Session EP3: Environmental Noise Problems and Approaches

chairs:

Sergio Beristain - *Mexico*

Antonio Perez-Lopez - *Spain*

16:00-18:20 **Room:** Flamengo 1

16:00-16:20

1708 _____ *contributed*

NOISE IN PARKS, GARDENS AND PUBLIC SQUARES

Sergio Beristain

Instituto Mexicano de Acústica, Ciudad de Mexico, Mexico

Places normally considered as quiet espaces for peple inlarge cities to walk, relax ad even meditate, have become recently in something different. Nowadays, many parks, gardens and public squares have been transformed in multiple noise sources, ranging from improvised artists, commercial sites, etc., where many of them, in order to publizise their activities or products, generate noise beyond any standard, and as informal business with grate movility, are hard to control. But you can also find public shows, either free or organized by national or local authorities, by commercial institutions or political parties, which in order to celebrate a given historical date, or the beating of the contender, organize events with megaphonic equipment, which last till late at night. Although performers and public might vary from event to event, neighbors are always the same, and people willing to relax have to change activity. But the main problem is the lack of control

16:20-16:40

1792 _____ *contributed*

A SIMPLIFIED MEASUREMENT AND ANALYSIS APPROACH FOR THE ASSESSMENT OF THE ENVIRONMENTAL NOISE FROM MINING ACTIVITIES

Guido Alfaro Degan*, Caterina Cigna, Dario Lippiello, Enrico Lovera, Mario Patrucco, Mario Pinzari

* *DIMI, Università degli Studi Roma, Roma, Italy*

Mining & quarrying activities provide essential row material for industry, but, due to their features, they may involve environmental impact and substantially interfere with human activity. Hence, in order to get an effective sustainability, asides from the obvious compliance to the enforced law requirements, a compulsory step is to identify the best evaluation techniques and suitable reduction methods for pollutant emissions. Nevertheless, unlike other industrial activities, the mining operations imply a continuous modification of the interested area and of the general working layout: therefore, a fast , effective, repeatable and low cost emission analysis technique in needed. The paper refers on the main results of a research work aimed to identify a simplified but effective technique for the measurement and analysis of environmental noise impact and aimed to forecast the expectable noise due to new mining operations start ups or to the development of the existing ones. As a first step, both a data base of the emitted sound power and a direct measurements technique (based on measured SPL over enveloping surfaces on reflecting plane) have been set up to evaluate the noise generated by the most common sources in a series of different scenarios. Simple corrective factors, drawn from direct in situ measurements, are proposed in order to take into account, in each special situation (e.g. mining technique, equipment, work organization, mined material characteristics and site features), the parameters recognized as substantially influencing the noise propagation rate, and discussed in comparison with noise propagation models derived from adaptation of the ISO 9613-1/2 1993 method. Next step is the set up of a database of impact mitigation measures (from literature and direct experience): the expectable noise reduction can then be evaluated together with the economical aspects, so that the analysis can be developed taken into account also the sustainable development criteria.

16:40-17:00

1836 _____ *contributed*

UTILIZATION OF C-WEIGHTED AS A FACTOR OF VERIFICATION FOR LOW-FREQUENCY PREDOMINANCE IN THE EVALUATION OF CHARACTERIZATION OF ENVIRONMENTAL NOISE

Krisdany Cavalcante

Métron Acústica, Belo Horizonte, Brazil

Living with "Noise" is a common fact of daily life for great urban centers inhabitants. Many researches have indicated that the noise levels generated by industry, traffic and places dedicated to leisure activities are frequently upper the allowed limits, becoming a problem known as Environmental Noise. The currently Brazilian legislation and technique norms just consider noise analysis, with the utilization of the A-weighted. A great number of materials presented as acoustic products has been commercialized for people that do not know the technical aspects, following just orientation given by catalogues and folders for selling these. Some materials present good performance for sound absorption, but just for high frequencies. Evaluating situations described by people who felt bothered by the noise generated for external sources, it became evident after applying some measurements and evaluations, that was

not possible to characterize them as noise pollution situations, once the results presented in dB(A) are met within allowed limited. These situations make it impossible for the public agent the reporting of the situation that was responsible for bothering the claimer. Some of the evaluated situations showed occurrences of structural vibration provoked by low-frequency sounds that were generated either by machines and audio equipments. In this sense, this study presents the results of the comparisons carried out between data evaluated by the use of dB(A) and dB(C). Specifically, the main aim of this study was to verify an alternate and viable method of analysis of low-frequency contamination, by comparing the results in dB(C) and dB(A). When the sound level meters equipped with 1/1-and 1/3-octave are not available.

17:00-17:20

1967 _____ *contributed*

THE LOW FREQUENCY NOISE CONTROL IN TAIWAN

Chuang Shiun-Cheng⋆, Hsu Yuan-Ching, Kuo Hung-Liang, Chung-Ho Yu

⋆ *Environmental Protection Administration, Taipei, Taiwan*

From 1992, the noise generated from the factories, business places, entertainment establishments, construction sites and public announcement facilities should not exceed the noise control criteria for each category of noise control zone. Recently, the number of noise complaints increased every year. There are about thirty thousand cases of noise complaints in 2003. Some of the cases were not solved after the environmental protection officials measured in site. Among the cases, some cases were not exceed the Noise Control Standard limit but still annoyed the complaint persons. The spectrum analysis was been made and that some main noise distributed in low frequency. It showed that the existed noise criteria and limit need to be revised for such annoyance. The purpose of this study was to assess the L.F. noise and suggest the noise control criteria to amend the regulation. And study the existed criteria and summit the criteria refined suggestion are also completed. After reviewing several different criteria for low frequency noise such as Germany, Japan, Denmark, Netherlands and then one hundreds complaints sites where been annoyed by low frequency noise have been measured and studied. The sources of suite were cooling tower, air condition etc. The draft of criteria was discussed on the committee. Finally, the low frequency noise criteria ware completed to authorities and been amended in Noise Control Standard articles. The procedure of the low frequency noise assessment specifies how to measure and judge when there is a low frequency complaint.

17:20-17:40

1994 _____ *contributed*

URBAN FORM INTERFERENCE ON THE ENVIRONMENTAL NOISE IN THE CITY OF ARACAJU - BRAZIL

Italo C. Montalvão Guedes⋆, Stelamaris Bertoli

⋆ *UNICAMP - Civil Engineering and Architecture Faculty, Campinas, Brazil*

This paper is part of a Master Degree research comprising an environmental noise survey at the suburb called Jardins in the city of Aracaju, state of Sergipe. The main objective of this paper is to provide an indication of how the interaction between noise sources and the physical features of urban form exerts its influence on the environmental noise of the suburb. To achieve this, observations of the existing urban form and acoustic spaces have been made, besides a collection of acoustic, traffic composition and geometric form measurements carried out at particular points in the area. The obtained results will serve as the basis of information for future research steps to be carried out and also serve as a technical aid for the planning and designing of cities, in terms of acoustic comfort.

17:40-18:00

1519 _____ *contributed*

SOCIAL ACOUSTIC SURVEY AND NOISE MITIGATION SOLUTIONS ON A PORTUGUESE URBAN HIGHWAY

Cecilia Rocha⋆, Antonio Carvalho

⋆*Feup, Porto, Portugal*

As result of the European Directive 2002/49/CE approval on the 25th June 2002, the Portuguese government through the Portuguese Road Authority (EP – Empresa Pública Estradas de Portugal) and the support of the University of Porto, decided to analyse the situation on one of the most noise annoyed areas of Portugal concerning road traffic (LAeq up to 77 dB), and to evaluate the need for noise mitigation solutions. This paper refers to the analysis of those particular circumstances regarding a high-speed regional ring, crossing the urban expansion zone of Porto (named IC23-VCI) that exceeds the yearly limit of 6 million vehicle movements settled by the European Directive. In fact, there are actually, over 50 million movements a year on that road (AMDT = 140000 vehicles) with a circulating speed of about 100 km/h (light vehicles) and 80 km/h (heavy vehicles). Such a noise-challenging road has tremendous implications on the welfare of local inhabitants. To assess the subjective noise annoyance caused by this road, a social acoustic survey was carried out (5000 inquiries mailed) that indicates a high percentage of very annoyed and extremely annoyed persons (44% of the returned answers). Concerning noise mitigation solutions, the analysis of the situation:

measurements, noise maps [actual conditions and future developments], local constraints [safety, available space, drainage system and interference with other infra-structures (electricity, gas, telephone and cable TV facilities)] in addition to the Portuguese Noise Code limits, demanded the need for lowering the noise levels at the closest receivers. The typical noise mitigation solutions considered were: drainage pavement (already in place), noise barriers, retaining walls covered with absorbing materials and facade sound insulation.

18:00-18:20

1972 _____ *contributed*

A SURVEY OF URBAN NOISE ANNOYANCE IN A LARGE BRAZILIAN CITY: THE IMPORTANCE OF A SUBJECTIVE ANALYSIS IN CONJUNCTION WITH A OBJECTIVE ANALYSIS

Paulo H.T. Zannin*, Fabiano B. Diniz, José Augusto C. Ferreira

* *Universidade Federal do Paraná, Curitiba, Brazil*

This study describes the reaction to environmental noise of the population of Curitiba (1,6 Million inhabitants). Out of 1000 distributed forms, 860 were returned. The main isolated noise sources revealed by the survey as disturbing were traffic (73%) and neighbors (38%). As a class, neighborhood noise was pointed out as the most disturbing type of noise as 100% of the surveyed people indicated at least one of the items belonging to this class: neighbors, animals, sirens, civil construction, religions temples, night clubs, toys, domestic electric appliances. The main outcomes of exposure to noise were: irritability (58%), difficulty to concentrate (42%), sleeping disorders (20%) and headaches (20%). In this survey it is also discussed the importance of the realization of objective surveys, in other words, noise emission measurements in conjunction with the subjective evaluation of the reaction of the urban population to the environmental noise. The present survey shows that in the subjective evaluation performed in the city of Curitiba, the perception of the population is that the urban noise has increased. On the other hand, another study conducted in the same city, where only the noise emission levels were evaluated, has showed a decrease on the urban noise.

Session GV1: General Vibration

chairs:

Roberto Jordan - *Brazil*

José R.F. Arruda - *Brazil*

16:00-18:20 **Room:** Business Master 145

16:00-16:20

1933 _____ *invited*

FRICTION-INDUCED STICK-SLIP VIBRATIONS OF GLASS-RUN SEALING SYSTEMS

Uije Kim*, Luc Mongeau, Charles Krousgrill

* *Ray W. Herrick Laboratories / Purdue University, West Lafayette, USA*

The problem of squealing from vehicle windows opened or closed in partly wet conditions has been investigated. Experiments were conducted using a glass-run seal sample and a tangentially moving glass piece installed on a test bench. The instantaneous velocity of the glass was measured along with the total dynamic frictional force for varying normal static loads and sprayed-water distributions. The characteristics of squeal vibrations and the influence of normal load and water distribution were studied. The relation between friction force and speed was also investigated. The vibration of the seal sample was simulated using a three-dimensional finite element model. Stick-slip motion was obtained in the time marching simulations. The instantaneous shear stress distribution was examined. The propagation of slipping nodes was discovered. The slipping node propagation speed was compared with the speed of shear waves and the glass speed

16:20-16:40

1820 _____ *invited*

DYNAMICS OF THE HYDRAULIC PIVOT OF AN INTERNAL COMBUSTION ENGINE VALVE COMMAND MECHANISM: MATHEMATICAL MODELING AND EXPERIMENTAL WORK

Flávio J. Garzeri*, Reyolando M. Brasil

* *Noise and Vibration Laboratory, General Motors of Brazil, Indaiatuba, Brazil*

Small four cylinders internal combustion engines are a standard feature of most Brazilian made automobiles. To extract more power from this kind of motors, high rpm speeds are usually required in their design. That calls for high performance of the valve command systems. Our goal in this paper is to develop adequate mathematical models of the behavior of the hydraulic pivot and to validate them via experimental work. This

pivot is designed to eliminate gaps between the rocker follower and the camshaft. Its length growth is due to the filling up the oil chamber in its base. A ball valve localized in the plunger controls the flow of pressurized oil. The initial gap, before the engine is started, is eliminated by a slack spring that is also important while oil pressure is low during the starting up procedure. Motor performance and valve seat insert durability depend on the design optimization of this system. A set of both quasi-static and dynamic tests has already been performed and we intend to use the results in two coupled mathematical models.

16:40-17:00

1592 _____ *invited*

VIBRATION ANALYSIS OF A HEMISPHERICAL PIEZOCERAMIC SHELL

Chan-Shin Chou*, Chang Chia-ou, Shieh Fa-hwa

* *National Taiwan University, Taipei, R. O. China*

The purpose of this paper is to investigate the constitutive equations for a thin piezoceramic hemispherical shell with thickness polarization and electrode-covered face. Base on Niordson thin shell theory of nonelectric shell, Rogacheva piezoelectric shell theory and Tiersten piezoelectric plate theory are employed to derive the equations. The constitutive relations of Tiersten piezoelectric plate theory is rewrite from covariant tensor form to mixed tensor form. Then follow Niordson thin shell theory, which included the extensional deformation of the middle surface, the constitutive equations of a homogeneous and anisotropic thin shell was derived in an invariant form. With the assumption that the normal stress on the middle surface is negligible, then the three-dimensional cannonical constitutive equations can be written two-dimensional equations in terms of curvature coordinates. Using dimensional analysis and invariance properties we found that strain-energy density and electric potential energy density can be written in a simple quadratic function of strain tensor, bending tensor and electrical field of the middle surface of the hemispherical piezoceramic Shell. Coefficients of the constitutive equations for four cases; pure shear, pure tension, pure twist and pure bending are determined.

17:00-17:20

1921 _____ *invited*

RESPONSE OF A SHIP'S PANEL TO TURBULENT BOUNDARY LAYER PRESSURE FLUCTUATIONS

Elena Ciappi*, Francesca Magionesi

* *INSEAN, Rome, Italy*

An important hydrodynamic noise source for high speed vessels is the turbulent boundary layer attached to the ship's hull. To evaluate the structural vibrations induced by the fluctuating pressure field it is important to provide an accurate description of the spectral characteristics of the pressure load. In this frame an experimental campaign devoted to pressure and structural vibrations measurements was performed in a large towing tank on a model of a high speed catamaran. The pressure data analysis was devoted to the derivation of simplified analytical models for the pressure cross spectral density. The structural measurements were performed on a plexiglass plate inserted in the hull bottom. The comparison of the experimental data with the results of a numerical analysis demonstrated the effectiveness of the laws adopted for the pressure spectra description.

17:20-17:40

2046 _____ *contributed*

ACCELEROMETER SENSITIVITY FOR VIBRATION MEASUREMENT

Kuang-Yih Tsuei

Center for Measurement Standards/Industrial Technology Research Institute, Hsinchu,, R.O.C.

Data measuring continuous or impact vibration are usually obtained using accelerometers. Since recording the vibration amplitudes and frequencies requires knowing only the accelerometer's sensitivity, examination or calibration of this sensitivity is of great importance for vibration measurement. The vibration amplitudes encountered in normal circumstances may vary considerably, but accelerometer sensitivity is commonly examined or calibrated under a given vibration amplitude. Can other vibration levels be accurately measured by this sensitivity? This paper tries to find an accelerometer sensitivity suitable for different vibration magnitudes. Sensitivities are tested under different amplitudes following ISO 16063-11, "Methods for the Calibration of Vibration and Shock Transducers, Part 11: Primary vibration calibration by laser interferometry". The maximum relative error among sensitivities is less than 1.0%. Therefore, this is not a significant factor for measuring vibration and a sensitivity obtained under any given amplitude can be used for other ranges.

17:40-18:00

1615 _____ *contributed*

PRACTICAL APPLICATION OF A PORTABLE VIBRATION ANALYSIS SYSTEM FOR MEASUREMENTS ON AIRCRAFT ENGINES

Kevin Bernard Ginn *, H. Konstantin-Hansen, J. Courrech, Philippe Streiff

* *Brüel & Kjær A/S, NÆRUM, Denmark*

This paper presents a system developed to ensure the maintenance of helicopter engines and to optimize the up-time of the aircraft. The system is primarily intended for the field verification on the ground of specific engines based on a portable front-end and dedicated software. Vibration measurements are made according

to the procedures specified by the engine manufacturer. The system enables the raw data gathered at the service site to be analysed by the specialists at Turbomeca. The use of the system in trouble shooting will be illustrated by case stories

18:00-18:20

1547 _____ *contributed*

COMPARISION OF DATA ACQUISITION SYSTEMS PERFORMANCE IN A MODAL TESTING OF FLEXIBLE PLATE

Victor H. Dezotti ⋆, Everaldo de Barros, Leandro de Camargo

⋆ *CTA/IAE-AIE, São José dos Campos, Brazil*

During vibration testing of space vehicles, the response of a large variety of transducers, including accelerometers, strain gauges and microphones, is measured and processed in order to provide the experimental dynamic behavior of the structure. For this purpose, data acquisition systems are employed and therefore, they are a key element for the success of the laboratory simulations. The instrumentation employed for data acquisition and further processing and analysis in the vibration test conducted at Centro Técnico Aeroespacial/Instituto de Aeronáutica e Espaço, the research center of the Brazilian Air Force, includes two systems. One of them is a VXI module Agilent E1432A 16 Channel 51.2 kSa/s Digitizer plus DSP and the software Data Physics SignalCalc 620. The other system is a closed-loop vibration control system Spectral Dynamics Jaguar and the Signal Analysis CATS program. For quality reasons and according ISO/IEC 17025 requirements for the competence of testing laboratories, the data acquisition systems performance must be compared to validate their application on tests. In this paper, the systems performance for modal testing is evaluated and compared through the modal identification of a free-free flexible plate. It is not the intention to elect a winner system, but to validate the systems for modal testing. The results suggested that the systems are qualified for this purpose.

Session MR3: Measurements in Room and Building Acoustics

chairs:

Michael Vorländer - *Germany*

Swen Müller - *Brazil*

16:00-18:20 **Room:** Botafogo

16:00-16:20

1578 _____ *contributed*

SOUND INSULATION EVALUATION USING TRANSFER FUNCTION MEASUREMENTS

Rodolfo Venegas ⋆, Marco Antonio Nabuco, Paulo Massarani

⋆ *Departamento de Acústica, Universidad Pérez Rosales, Santiago, Chile*

The regular methods for sound insulation between rooms, audiometric cabins and other adjacent closed spaces deal with average sound pressure measurements and random sound excitation. The acoustic field can be as diffuse as found in reverberation chambers or the well determined stationary waves filed of rectangular rooms. The use of random noise excitation can require averages in time to reduce the expected inherent uncertainties. The use of new deterministic techniques as MLS or the up grade of the well known old sweep sine excitation can avoid such time consuming averaging processes allowing lower measurements uncertainties inherent to deterministic excitation. With the new available frontend devices and signal analysers it is relatively easy to get acoustic transfer function between two points in space which can be in different closed adjacent enclosures as rooms or cabins. With those transfer functions on the hand it is possible to obtain the level differences required by the international standard, as suggested in the draft document ISO/DIS 18233. This paper shows some results for repeatability testing using both random and deterministic excitation methods. Some comments about the advantages and difficulties to perform the methods are also presented.

16:20-16:40

1804 _____ *contributed*

SOUND INSULATION OF PLASTERBOARD WALLS AND AIRFLOW RESISTIVITY: AN EMPIRICAL EXAMINATION WITH RESPECT TO PRACTICAL APPLICATIONS

M. M. Stani⋆, H. Muellner, I. Plotizin, Karl Zlabinger

⋆ *Versuchsanstalt TGM, Department Acoustics and Building Physics, Wien, Austria*

Basing on former research works and due to the fact, that specifications of products and systems for plasterboard walls have changed in the last years and considering the results of a recent research study of TGM, showing that a number of "secondary" construction details could cause an undesired effect to the sound insulation of plasterboard walls it was decided to make a special research with the aim to verify the existing kowledges or to find out major deviations caused by the above mentioned facts. To eliminate the sound transmission by the studs there was chosen to assemble a plasterboard wall with double frames of metal studs with a depth of 50 mm. The two rows of studs werde distanced for 15 mm to avoid sound transmission via rigid insulation boards made of mineralwool and expanded polystyrene being included in the research program as well as light weighted new developed and standard products of mineralwool and even a biogenic material such as hemp. Additional to the above mentioned influence parameters the fitness for use of test stands in the limiting sphere can cause wrong measurement results and interpretations. Therefore it is not possible under certain circumstances to determine the influence of special construction details by measurement and as a consequence exist considerable difficulties to check the validity of theoretical models. Considering these facts it was the intention of the empirical approach to reexamine the influence of the cavity insulation materials on the one hand and possible interactions between the systeme components on the other hand. The testing of the lightweighted cavity wall construction with a lot of variations was carried out in a test stand according ISO 140-1. The airflow resistivity of the applied porous insulation materials was tested according to ISO 9053. The results of the study support the clarification of important questions for the practical application of lightweighted partition walls.

16:40-17:00

2011 _____ *contributed*

SCALED ABSORPTION MATERIALS FOR SCALE MODELING

Ranny L. X. Nascimento*, Moysés Zindeluk

* *UFRJ /COPPE, Rio de Janeiro, Brazil*

In the present work, a 1:8 small-scale reverberation chamber has been built to measure the sound absorption coefficients of different types of material, in accordance with the international standard ISO 354 method (measurements of sound absorption), in order to develop a catalogue of equivalent scale absorbing materials to be used in architectural acoustic studies with scale models of rooms. This necessity stems from the lack of information on sound absorption characteristics of different types of substitution similar materials. The volume of the small-scale reverberation chamber is equivalent to a real volume of 200 cubic meters. Such a chamber is relatively cheap and its configuration can be easily modified. Scale models of rooms have regained importance, as compared to numerical modeling, due to persisting limitations of numerical procedures in fully reproducing physical phenomena, such as diffusion, diffraction, and absorption, still limited in precision in computational models for complex environments. Numerical methods may also be validated by comparison to experimental results, and reduced models are easier and cheaper to build, which is very useful in teaching environments and early project development stages. It must be taken into account that scale-model reverberation chambers have the same experimental drawbacks as room scale models and, as a consequence, the similarity conditions should be carefully followed.

17:00-17:20

2051 _____ *contributed*

COMPARISON BETWEEN REVERBERATION TIMES CALCULATED AND MEASURED

Silvana Stumm*, Andressa Ferreira, Daniele Zwirtes, Elaine Carvalho da Paz, Elenise Nunes, Martin Tows, Paulo H.T. Zannin

* *UNIVERSIDADE FEDERAL DO PARANÁ, Curitiba, Brazil*

Aiming for quality in the development of educational activities, the acoustic condition of classrooms is of great importance. The objective of this article is to evaluate two theoretical methods of calculating the Reverberation Time (RT) in classrooms based on formulas of Sabine and Hohmann, Setzer and Wehling. As a case study, the classrooms of the Federal University of Paraná (UFPR) were used; located in Brach III, sector of Technology, block IV in the city of Curitiba, Brazil. To contribute to the values found from the applied formulas, RT measurements had been carried through in situ. The results showed Sabine's Modified Equation (Indirect Method), to be the most recommended because the results were closer to the values of the experimental Reverberation Time.

17:20-17:40

1585 _____ *contributed*

AN OPEN-SOURCE PLATFORM FOR MUSICAL ROOM ACOUSTICS RESEARCH

Leo Ueda*, Fabio Kon, Fernando Iazzetta

* *USP, São Paulo, Brazil*

AcMus is an ongoing project to develop a software for estimation, measurement, analysis and simulation of rooms specially designed for musical performance. The system under development is organized in modules. All modules shall be integrated in a way as to allow seamless flow of data regardless of the variety of data types and structures involved in the system. Portability and accessibility of the software developed has been a major concern in the implementation of the system, and for this reason it has been developed as an open source

project, so that users and system designers can collaborate with its further improvement. The measurement system is based on the sine sweep method and should provide tools for the acoustic optimization of rooms designed for musical performance. It also provides a toolbox to help in the analysis and design of environments such as music halls, lecture theatres, etc. for the specific use of music appreciation. The system core is being implemented in Java, with great care to make it platform neutral. The implementation is based on the sophisticated Eclipse platform (www.eclipse.org), which will facilitate the system's extensibility and flexibility, enabling the construction of an open platform for Acoustics experimentation, freely available to researchers in the field.

17:40-18:00

1521 _____ *contributed*

DETERMINATION OF THE ACOUSTIC ABSORPTION COEFFICIENT OF THE VEGETAL SPONGE

Minéia Johann Scherer*, Jorge Luiz Pizzuti dos Santos

* *Universidade Federal de Santa Maria, São Paulo, Brazil*

The acoustic treatment of an indoor environment has the finality of providing an optimum reverberation time for determined space and activity, guaranteeing the acoustic comfort for users and the sound intelligibility, in other words, satisfactory understanding of the message by the listener. The most part of the used materials in building has rigid characteristic and consequent high sound reflection. Due to it, we need, in the most part of the times, add absorbent materials to the place, in order to provide the desired acoustic quality. There are some industrialized products used as acoustic absorbents, as for example the glass wool. However, its use has been discussed, in both cases, due to their high costs and because the environment impact that they cause during their life cycles. This way, several researches has been done to investigate the absorbent characteristics of recyclable or natural materials. This work has as objective to verify the sonourous absorption coefficient of the vegetal sponge (Luffa cylindrica), that, by its porous structure, presents potentiality as sonourous absorbent. It consists on an ecologically right material, because it has vegetal origin of renewable source and it is grown in a simple way, without prejudicing the environment and it decomposes organically, in other words, it is biodegradable. The procedure of mensuration of the sonourous absorption coefficient follows the recommendations of the international standard ISO 354, thus the essay was done in reverberation chamber of the thermo-acoustic laboratory of UFSM. The final results show the performance of the vegetal sponge as sonorous absorbent, in 100Hz to 400Hz frequencies, supplying, thus, a database for the utilization of this material in acoustic corrections, either on its natural form or on the development of some product.

18:00-18:20

1550 _____ *contributed*

EVALUATION AND OPTIMIZATION OF ACOUSTICAL ENVIRONMENTS IN EATING ESTABLISHMENTS

Zohreh Razavi*, Murray Hodgson

* *UBC, Vancouver, Canada*

Complaints from hard-of-hearing faculty members at UBC about communicating verbally in one of the upscale restaurants on the campus led to a study of acoustical environments in eating establishments and how to optimize them. Speech intelligibility and speech privacy are important considerations in the design of eating establishments; however, they are commonly overlooked. In this preliminary research, three bistros were considered. Physical measurements were done and associated acceptability criteria applied to evaluate the environments. The noise exposures of employees and customers were measured and compared to maximum permitted occupational limits. Worker noise exposures were in the range 80-84 dBA. Customers were often exposed to levels over 75 dBA especially at lunchtime it was exceeded 80 dBA. The CATT room-acoustical prediction model was used to study the physical and acoustical factors that affect the acoustical environments in eating establishments and how optimize them. The effect of facility modifications, including the use of sound-absorbing wall panels, lowered and improved acoustical ceilings, and partial barriers between tables were predicted.

Session ON: Outdoor Noise

chairs:

Mario R. Serra - *Argentina*

Davi Akkerman - *Brazil*

16:00-18:20 **Room:** Rio 2

16:00-16:20

1861 _____ *invited*

TEMPORAL FLUCTUATION OF ATMOSPHERIC ABSORPTION ON SOUND AND ITS EFFECT ON AIRCRAFT NOISE PROPAGATION AROUND INTERNATIONAL AIRPORTS IN THE WORLD DURING A YEAR

Yasuaki Okada ⋆, Yoshihisa Koichi, Tatsuda Kenji, Iwase Teruo

⋆ *Meijo University, Nagoya, Japan*

In order to perform the long-term prediction of outdoor sound propagation more accurately, it is necessary to examine the fluctuation of attenuation coefficients for atmospheric absorption during a year. There are large variations with time and place in actual meteorological conditions on which the attenuation coefficients depend strongly. Attenuation coefficients for atmospheric absorption were calculated from meteorological data observed at ten international airports in the world during a year by using the calculation method described in ISO 9613-1. The calculated results show that the variability characteristics of the attenuation coefficients during a year depend strongly upon both the sonic frequency and the place. Next the effects of the atmospheric absorption on aircraft noise propagation around the international airports were examined using the calculated attenuation coefficients. It has been found that the A-weighted sound pressure levels and sound spectra of aircraft noise vary strongly due to the changes of real atmospheric conditions during a year.

16:20-16:40

1862 _____ *invited*

THE EFFECT OF ATMOSPHERIC ABSORPTION ON ENVIRONMENTAL NOISE PROPAGATION IN AN URBAN AREA

Koichi Yoshihisa ⋆, Okada Yasuaki, Tatsuda Kenji, Iwase Teruo

⋆ *Meijo University, Nagoya, Japan*

It is general that the long term measurement of noise is carried out around the highway or the airport, but there is not so much measurement of total noise generated from various sources in an urban area. The authors have been made measurements of environmental noise which consist of various noise such as transportation noise, construction noise and industrial noise on Nagoya city in Japan at a roof of an 5 stories building located on hilltop since January 1st of 2000. In the measurement, 1/3 octave band sound pressure levels with the frequency range of 1Hz to 10kHz are measured at every 1 second. At the same time of acoustical measurements., meteorological conditions were observed near the microphone .In this paper, the Authors present the variability characteristics of measured sound pressure level during a year and the relationships between the measured sound pressure level and calculated attenuation coefficients due to atmospheric absorption from measured temperature, humidity and atmospheric pressure by using the calculation method described ISO 9613-1. There is a tendency that sound pressure level of the high frequency components decrease with increasing calculated absorption coefficients. As a result?of this study, it has been found that the effect of atmospheric absorption on the environmental noise spectra in urban area is large and not neglected in A-weighted sound pressure level changes.

16:40-17:00

1523 _____ *invited*

COUPLING BEM AND RAY METHOD TO COMPUTE OUTDOOR SOUND PROPAGATION

Sebastian Hampel⋆, Sabine Langer, Heinz Antes

⋆ *University of Braunschweig, Braunschweig, Germany*

When outdoor sound propagation over large distances is considered, refraction resulting from wind or temperature profiles has to be taken into account. To compute the sound propagation for such problems, ray tracing methods are widely used. They request a much lower computation effort compared to wave-based methods such as FEM or BEM. Additionally, ray tracing methods can handle wind and temperature profiles considerably easier. However, they cannot implicitly cover wave phenomena such as diffraction at obstacles. For such problems the BEM is well suited and it furthermore fulfills the Sommerfeld radiation condition implicitly, which is important for exterior problems in particular. To make use of the advantages of both methods - ray method and BEM - a computation model is presented which combines them: in the near field where obstacles and complex geometries occur - and so diffraction and multiple reflection are expected - the model uses the BEM. Then a ray model is coupled to compute the sound immission in the far field. Both applied methods are described and the coupling procedure is presented. Finally, the coupling method is validated and the model is applied on a typical example problem.

17:00-17:20

1905 _____ *contributed*

QUALITATIVE AND QUANTITATIVE STUDY ON RELATIVE INFLUENCE OF PHYSICAL PARAMETERS AFFECTING LONG-RANGE SOUND PROPAGATION

Fabrice Junker*, Benoit Gauvreau, Michel Berengier, Philippe Blanc-Benon, Cora Cremezi

* *Électricité de France (EDF) R&D, Clamart Cedex, France*

This work is related to a French national research project entitled "classification of relative influence of physical parameters for long range acoustic propagation". This project is supported by the French Ministry of Ecology and Sustainable Development. It aims at studying relative influence of the whole propagation parameters for different acoustical situations (source-receiver geometry, ground impedance, source spectrum, etc.), and for more or less complex configurations (atmospheric conditions, topography, etc.). In this paper, the presented study is performed both numerically and experimentally, in order to fill in a "sensibility matrix" (database) in N dimensions, N being the number of influent parameters. Thus, numerical predictions are obtained using "laboratory" models such as those developed by each partner (parabolic equation, analytical models, etc.) and/or engineering models. First results of this sensibility study are presented and discussed. Moreover, a very important experimental campaign will be carried out at an experimental (monitoring) site in France, involving dozens of micrometeorological and acoustic sensors during several months. Those experimental data will be used to confirm and complement numerical predictions. The corresponding experimental protocol is briefly presented in the paper.

17:20-17:40

1746 _____ *contributed*

A MARKOVIAN TECHNIQUE FOR PREDICTING NOISE PROPAGATION IN A STREET CONTAINING OBSTRUCTIONS

Zaiton Haron*, David Oldham

* *University of Liverpool, Liverpool, United Kingdom*

The propagation characteristics of city streets is a topic of considerable current interest and a number of models have been proposed based upon façade reflections which are specular, diffuse or mixed. However, these models generally assume that the street channel is empty and hence do not account for the effect of objects such as street furniture, vegetation or vehicles. In this paper an approach to the prediction of propagation in streets containing a distribution is proposed based upon treating propagation as a Markov process using a 2 dimensional model. Results obtained are compared with those obtained using ray tracing. It is concluded that the Markov method offers an efficient technique for investigating the effect of obstructions on the propagation of sound in streets.

17:40-18:00

1670 _____ *contributed*

ESTIMATING LONG-TERM REPRESENTATIVE SPL IN COMPLEX ENVIRONMENTS USING A COUPLING METHOD BASED ON ACOUSTIC (MW-WAPE) AND MICROMETEOROLOGICAL (SUBMESO) NUMERICAL PREDICTIONS

Benoit Gauvreau *, Bertrand Lihoreau, Michel Berengier, Philippe Blanc-Benon, Isabelle Calmet

* *LCPC, Bouguenais cedex, France*

This paper presents a method for estimating an acoustic level representative of the "long-term" sound pressure level. This is done through a coupling method using output data from a micrometeorological code as input data for a new acoustic code. The first part of this paper provides a brief description of our acoustic (MW-WAPE) and micrometeorological (SUBMESO) codes respectively, next coupled through a suited routine. Our new parabolic equation (PE) code can deal with complex propagation situations including mixed influence of ground characteristics (topography, obstacles, impedance jumps, etc.) and atmospheric conditions (refraction and turbulence). Its associated micrometeorological code (SUBMESO) simulates wind and temperature fields over moderately complex terrain with high resolution. The second part is devoted to some comparisons between numerical predictions and experimental data issued from the LCPC experimental (monitoring) site located at Saint-Berthevin (F). Very good agreement with experimental data is obtained for both acoustical and micrometeorological predictions.

18:00-18:20

1466 _____ *contributed*

FOLLOW-UP ON NOISE LEVEL EMITTED BY A NEW 735 KV TRANSMISSION LINE AND ITS ATTACHED SUBSTATION

Blaise Gosselin

Hydro-Quebec, Montreal, Canada

A major ice storm hit northeastern North America in 1998, causing a major power failure in the Montreal region (Quebec, Canada). Hydro-Quebec added a large number of new installations to bolster supply reliability in the area, including a new 735 kV transmission line extending for 140 km and a new 735/120 kV substation. Although the impact assessment concluded that noise emitted by the transmission line and substation would not have a major impact on nearby communities, there was concern about noise at the public hearing for the project. To address this, the public hearing board recommended that noise emitted by the transmission

line and substation be followed up after construction. A study was carried out before construction to establish background noise levels. Levels from 24 dBA to 43 dBA were measured (LAF95). A follow-up study was carried out following commissioning of the line and substation. The impulsive noise emitted by circuit breakers and the continuous noise emitted by high voltage power transformers and shunt reactors were evaluated. Noise was imperceptible or barely perceptible in residential areas near the station. The results of the follow-up on transmission line noise presented in the paper are based on measurements carried out in 2004. Other measurements will be taken in 2005 and 2006. All measurements were attended by an observer, to ensure that weather and environmental conditions were noted. Under fair weather conditions, noise levels ranged from 30 to 45 dBA (not limited to noise emitted by the transmission line). Under rainy conditions, noise varied from 51 to 54 dBA, increasing to 59 dBA in heavy rain. Finally, noise levels ranged from 49 to 52 dBA in snowy conditions. Additional details such as noise spectrum and duration of noise after rain cessation are also presented in the paper.

Session PH1: Physiological Health Effects Resulting from Environmental Noise Exposure

chairs:

Thais Morata - *Brazil*

Peter Lercher - *Austria*

16:00-18:00 **Room:** Lagoa

16:00-16:20

1898 _____ *invited*

HEALTH EFFECTS OF NEIGHBOURHOOD NOISE INDUCED ANNOYANCE

Christian Maschke*, Hildegard Niemann

* *Research Network "Noise&Health", Berlin, Germany*

Environmental noise, irrespective of its source – whether traffic noise or neighbourhood activity – remains a key issue in urban areas. One of the main effects of noise is annoyance. Noise-induced annoyance generally constitutes a sui generis environmental effect category characterized by a loss in quality of life. So far, it has not been possible to epidemiologically verify what role noise-induced neighbourhood annoyance plays in the impairment of health. Conclusions by analogy have led to the concern that chronically severe annoyance could trigger a vicious circle of severe annoyance – negative emotional reaction – neuro-vegetative-hormonal regulatory disorders – illness. Within the context of the LARES study, noise annoyance by neighbourhood was surveyed and evaluated in connection with medically diagnosed illnesses. Adults who indicated chronically strong annoyance by neighbourhood noise were found to have an increased health risk in the cardio-vascular system, the movement apparatus as well as depression and migraine. With regards to the elderly, noise annoyance induced illness through neighbourhood noise was in general a lower risk than in adults. It can be assumed that the effect of noise-induced annoyance in the elderly is concealed by physical consequences of age (with a strong increase of illnesses). With children, the effect of noise-induced annoyance from neighbourhood noise is evident in the respiratory system. The increased illness risks in the respiratory system of children do not seem to be caused primarily by air pollutants but though emotional stress.

16:20-16:40

1545 _____ *contributed*

TEMPORARY THRESHOLD SHIFT OF DISC JOCKEYS (DJS) FROM CURITIBA/BRAZIL

Lorayne Santos*, Thais Morata, Evelyn Joice Albizu

* *Department of Communication Disorders, Universidade Tuiuti do Paraná, Curitiba, Brazil*

OBJECTIVES: To evaluate the hearing conditions of DJ's from nightclubs in Curitiba, the capital of Paraná State. The hearing of a DJ is very important not only for himself but also for his professional career and they are, most part of their job time, exposed to a high sound levels. The hearing losses complains done by the DJ's helped us to develop this research and alert us to the need of a orientation about preventing hearing losses among the community involved and to those who participate in the survey. METHODS: Some nightclubs were selected for the evaluation. All of them were crowded and had about the same conditions of noise exposition. The results before and after an exposition to the noise, produced by the music electronic amplified were compared; the levels of the sound pressure created by the music in the nightclubs were analyzed by the use of a dosimeter. The total of 30 DJ's of Curitiba were analyzed using tonal audiometric, timpanometric and otoacoustic emissions (OAE) and the distortion product (DPOAE) some other exams. These were done before and after the exposition respecting time for acoustic rest. The measurements of the sound pressure level were done at the same night then the audiologic evaluation. One dosimeter was placed in each DJ's, according to the rules of occupational noise measurement.

16:40-17:00

1460 _____ *contributed*

CHILDREN'S SOUND EXPOSURE

Stuart J. McLaren*, Philip J. Dickinson

* *Massey University Wellington, Wellington, New Zealand*

Many children have a measurable hearing loss before they even go to school. From the time of their birth, many children are flung into a world of (mainly totally unnecessary) noise and through no fault of their own are faced with health problems and handicap later in life. During their school days many will find it difficult to keep up with the curriculum and in terms of academia fall by the wayside – not through any lack of ability but simply because they could not hear all that was being said to them. Those that have special needs are even more seriously affected and often little thought is given to their protection. By the time they reach adulthood more than 50% may have a significant hearing loss that will prove a severe handicap throughout their adult life. This situation is totally preventable. For all but a few children, the hearing loss is noise induced. A large component comes from uncontrolled sound in leisure activities, but regrettably excessive sound from some controlled activities, may also be partly to blame.

17:00-17:20

1513 _____ *invited*

NOISE, ANNOYANCE AND FATIGUE IN PRE-SCHOOL ENVIRONMENTS

Ulf Landström

National Institute for Working Life, Umeå, Sweden

In an investigation including seven pre-schools, sound exposure was analysed in the perspective of noise sources, noise levels, frequency character and temporal pattern of the sound. Included in the study was also to analyse the way in which the employees were effected by the noise and how the size of the classes, noise exposure and adverse effects were correlated. The average dBA value in the schools was found to be 75 dBA. The noise was dominated by the high frequency fluctuating sounds from the activities of the children, especially their voices. The number of children in the classes was found to have a minor effect on the average daily noise exposure. As expected, a doubling of the number of children causes an increase of approximately 3 dB of the daily exposure of the employees. On the other hand during specific activities, e.g. in play rooms and dining rooms; the noise levels were highly effected by the number of children. A doubling of the number of children in the plying rooms was correlated to a 15-20 dB increase of the sound level, due to the children's attempt shout over each other in larger groups. About 75% of the workers had difficulties in hearing the voices from others during more than on fourth of the working day. 90% of the workers considered that the noise made the work more difficult to carry out. High levels of the annoying and tiring effects were reported daily among one fourth of the workers. A significant correlation was furthermore observed between annoyance due to noise and being worned-out. About one forth of the workers reported to have daily fatigue during their work and spare times.

17:20-17:40

2028 _____ *invited*

OBSERVATION ON THE INFLUENCE OF NON-ACOUSTICAL FACTORS ON PERCEIVED NOISE ANNOYANCE IN A FIELD EXPERIMENT

Bert De Coensel*, Dick Botteldooren, Tom De Muer, Peter Lercher, Birgitta Berglund, Mats Nilsson

* *Ghent University, Ghent, Belgium*

The influence of non-acoustical factors on noise annoyance was studied in a unique field experiment. An innovative system was implemented for selecting representative participants from the Dutch population, as regards age, gender, level of education, noise sensitivity, reported anxiety, pre-exposure to train and road traffic noise, general quality of the living environment, and general health. It was grounded in 1500 participants' responses to a specifically constructed questionnaire, which contained items from a nationwide Dutch and Eurobarometer surveys. Finally, 100 representative participants were selected. During the experiment, which took place in a realistic setting (living room of holiday cottage), groups of 5-7 participants were asked to be seated, relax, reading a magazine or newspaper and were served refreshments. During their stay, traffic noise was reproduced in an ecologically valid way in outdoor loudspeakers. Every ten minutes, the participants were asked to assess traffic noise annoyance. At the beginning and after at least 1 hour of the experiment, participants were also asked to scale the annoyance of a set of 7 reference sounds utilized for master scaling. In this field experiment, residual effect on noise annoyance was found from non-acoustical factors like noise sensitivity, environmental worry, and health status. Even after master scaling, it seems that interindividual variation in traffic-noise annoyance remains which is dependent on certain important non-acoustical factors.

17:40-18:00

1409 _____ *contributed*

HEARING THRESHOLD SHIFTS AND THEIR RESTITUTION AS PHYSIOLOGICAL COSTS OF HEAVY METAL, TECHNO, AND CLASSICAL MUSIC

Hartmut Irle*, Frank Körner, Helmut Strasser

* *University of Siegen, Siegen, Germany*

Different kinds of music (heavy metal, techno, and classical music) were utilized to address the question whether sound exposures with different frequency and time structures may have different effects after all, i.e. that they differ in their potential danger to the human hearing. In Test Series I (TS I), 10 test subjects (Ss) were exposed to a medley of typical heavy metal music with an exposure level of 94 dB(A) for 1 hour (h). The exposure in TS II was also 94 dB(A) for 1 h and consisted of a compilation of so-called techno music. In TS III, the Ss were exposed to representative classical music at 94 dB(A) for one hour. The exposures' aural effects were measured via the hearing threshold shifts within 2 minutes after the end of the exposure (TTS2) and during the restitution course until the resting threshold was once again reached. Additionally, the area underneath the restitution curve, the Integrated Restitution Temporary Threshold Shifts (IRTTS), was determined as a summary measure of the "physiological costs." Consistent with previous studies, it could once again be shown that an energy-equivalent rating of sound exposures can lead to dangerously wrong assessments. While techno music caused total physiological costs which were comparable to those from heavy metal music and led to restitution times up to 4 h, the physiological costs associated with classical music amounted to only $\frac{1}{4}$ of those from the other two exposures. With respect to classical music and heavy metal, the results of a previous study could be confirmed. Of course, the risk of long-term hearing damage increases if the hearing experiences daily threshold shifts due to noise in the workplace which coincide with restitution processes which have not yet completely subsided. Furthermore, the exposure by techno and heavy metal music is typically much higher than 94 dB(A) / 1 h, the limit in this test which was chosen for ethical reasons.

Session UL3: Ultrasound

chairs:

Flávio Buiochi - *Brazil*

Rodrigo Costa-Félix - *Brazil*

16:00-17:40 **Room:** Business Master 136

16:00-16:20

1936 _____ *contributed*

ACOUSTIC ABSORBER FOR ULTRASONIC APPLICATIONS

Marco Aurélio Brizzotti Andrade *, Flávio Buiochi, Julio Cezar Adamowski

* *USP, Taubaté, Brazil*

The development of anechoic materials for applications in radiation force balance targets or in walls of water-filled tanks is a long-standing problem in megahertz frequency ranges due to the difficulty in obtaining low acoustic reflection and high acoustic energy absorption. This paper describes an absorbing composite material based on silicon rubber matrix containing alumina powder. To absorb the acoustic wave propagating in water the characteristic acoustic impedances of the absorbing material and the water must be equal. Besides, the transmission loss in the absorbing material must be high enough to attenuate at a reasonable level that acoustic wave. The absorbing material is obtained by adding alumina powder in a silicone rubber matrix. To demonstrate the usefulness of these materials in an application of general interest, these composites were characterized using the through-transmission method for ultrasonic absorption and propagation velocity measurements, and the pulse-echo method for the reflection coefficient measurements. The composition of the absorber is presented, along with values for the temperature variation of the echo reduction and transmission loss. The measurement temperature range is from 15.8°C to 35.2°C. It is verified that the composite with 9.8% mass fraction of alumina at 20 oC provides a 43 dB echo reduction and an attenuation of 5.8 dB/cm at 1 MHz.

16:20-16:40

1843 _____ *contributed*

RANDOM THINNING OF SEGMENTED ANNULAR ARRAYS

Gregorio Godoy *, Oscar Martínez, Alberto Ibañez, Luis Gomez-Ullate

* *E.U.P. de Linares, Universidad de Jaén, Jaén, Spain*

Nowadays, two-dimensional (2D) arrays design is based in a square matrix (SM) distribution of elements, which

requires a pitch of l/2 in order to eliminate grating lobes. From this condition, a 2D array will contain between 1500 and 16000 elements, which are much higher than the number of channels of present image systems. A well known technique for reducing the number of active elements is based on randomly eliminating a part of the elements from the aperture. Segmented-annular (SA) arrays constitute an alternative to SM arrays for the generation of volumetric images, because they have lower periodicity than squared patterns, and therefore they allow increasing the inter-element distance up to l or even further. SA arrays, then, the number of elements are divided by four with respect to SM arrays using the full aperture. However, this number is still a challenge for the existent technology, so requiring thinning the aperture. In this work, a thinning technique based on random sparse is applied to segmented-annular arrays and squared-matrix arrays. Several random layouts are applied to equivalent SQ and SA arrays (equivalent arrays have the same active area and the same number of elements, which are of similar size and aspect ratio), and the comparative results are then theoretically analyzed in the paper.

16:40-17:00

1794 _____ *contributed*

SIMULATING ECHO RESPONSES FROM ARBITRARY-GEOMETRY TARGETS USING MODE CONVERSION APPROACH

Flávio Buiochi⋆, Oscar Martínez, Luis Gómez-Ullate, Francisco Montero de Espinosa

⋆ *Escola Politécnica da USP, São Paulo, Brazil*

A computational method, based on the spatial impulse response and on the discrete representation computational concept, is proposed for the determination of the echo responses from arbitrary-geometry targets. A major contribution of this paper is the development of an improved version of the method considering a mode conversion approach at the reflector surface. It is supposed that each point of the transducer aperture can be considered as a source radiating hemispherical wave to the reflector. The local interaction with each of the hemispherical waves at the reflector surface can be modeled as a plane wave impinging on a planar surface, using the respective reflection coefficient. The method operates by dividing the transmitted aperture, the reflector surface, and the receiver aperture into elementary areas. First, the velocity potential impulse response is calculated in each of the elementary areas of the reflector using the Rayleigh integral, considering the superposition of hemispherical waves with the respective mode conversion approach. Second, the reflected velocity potential impulse response is calculated by applying the Rayleigh-Sommerfeld integral to the reflector surface. Finally, the spatial-average acoustic pressure over the surface of the receiver is determined by a temporal convolution between the excitation signal and the spatial-average reflected velocity potential impulse response. The method is valid for all field regions and can be performed for any excitation waveform radiated from an arbitrary acoustic aperture. The number of elementary areas used to discretize the acoustic apertures and the target limits the precision of the computational method. The effects of target geometry, position, and material on both the amplitude and shape of the echo response are studied. The model is compared to experimental results obtained using broadband transducers together with, for instance, plane and cylindrical concave rectangular reflectors (acrylic and aluminum) in a water medium, and good agreement are found.

17:00-17:20

1893 _____ *contributed*

TEMPERATURE FIELD MAPPING OF ULTRASONIC BEAMS APPLIED TO PHYSIOTHERAPY

Camila S. Furtado⋆, Wagner C. de A. Pereira, Marco Von Krüger

⋆ *COPPE / UFRJ, Rio de Janeiro, Brazil*

The aim of the ongoing research is to measure the heating spatial distribution produced by a 1 MHz therapy ultrasound transducer. Such transducer is placed in a water tank and insonates a gel phantom at different depths (4, 7 and 9 cm) and at different intensities, ranging from 0.1 to 1 W/cm^2. The gel phantom contains a matrix of seven thermocouples equally spaced (0.5 cm). Each thermocouple generates a heating/cooling curve for each depth and intensity. The evaluation of the ultrasonic energy deposition rate is made based on the processing of the curves recorded respectively during irradiation and post irradiation periods. Preliminary results suggest occurrence of nonlinear effects at higher intensity levels.

17:20-17:40

1802 _____ *contributed*

VARIANCE ON THE TISSUE ELASTICTY IMAGING BY 2-D SPECKLE TRACKING

Antonio Adilton O. Carneiro⋆, Jingfeng Jiang, Timothy Hall

⋆ *USP, Ribeirão Preto, Brazil*

Elasticity imaging (EI) by ultrasound is a powerful tool for mechanical evaluation of biological tissue. Efforts are underway to introduce this new imaging modality into diagnostic ultrasound machines. In ultrasonic elasticity imaging, displacement estimates are first obtained using speckle tracking between a pair of pre- and post-compression radio-frequency (rf) echo fields. Then, strain that correlates to local tissue elasticity can be derived. Motion tracking methods are classically known as 'template matching' or 'time delay estimation' algorithms and consist of the search for equivalent patterns between pre- and pos-compressed

images delimited by a small kernel. In this work we evaluated the error variance of the speckle displacements using three 2-D speckle tracking methods and varying kernel size. The variance of the speckle displacement with respect to the kernel size was evaluated using simulated rf fields. A Gaussian random number generator was used to simulate a discrete homogenous tissue impedance distribution. That impedance distribution was convolved with a realistic ultrasound pulse that closely matches that of our clinical ultrasound transducer. To achieve that, we first obtained a two-dimensional point spread function (PSF) of our linear array transducer (VFX13-5) by cross-correlating rf data acquired from a uniform tissue-mimicking phantom on a clinical ultrasound system (Sonoline Antares, Siemens Medical Solutions Inc. USA) operating at 10 MHz and sampled with 40 MHz. The best fit of the axial PSF was obtained with Gaussian-modulated cosine pulse of center frequency of 7.5 MHz and bandwidth of 80%. Typical echo field used in this work consists of 312 rf-lines of 2048 points each. We verified that there is a 'best' kernel size to obtain the minimum variance of the displacement estimates evaluated by template matching methods and that this size depends on factors such as the amount of axial deformation and shear, rf-line spacing and sampling frequency. The results obtained in this work will be used to improve the efficiency and accuracy of tracking motion for real-time freehand elasticity imaging synthesis that being implemented on a clinical ultrasonic imaging system. * This work is supported in part by grants from CDMRP DAMD17-00-1-0596, NIH-R01CA100373, the University of Wisconsin-Madison and the University of São Paulo.

Session VN3: Vehicle Noise Vibration and Harshness

chairs:

Helcio Onusic - *Brazil*

Takeshi Abe - *USA*

16:00-18:20 **Room:** Arpoador

16:00-16:20

1989 _____ *contributed*

INFLUENCE OF VEHICLE FRONT DOOR ACOUSTIC ON LOW FREQUENCY AUDIO RESPONSE

Rodrigo Nicoletti*, Alice B. Rodrigues

**Ford Motor Co., Salvador, Brazil*

Vehicle audio system performance can be influenced by various parameters, among them, the structural behavior of the front door; the acoustic behavior of the front door; and the interaction between the front door structure and vehicle acoustic cavity. During the development of a Ford Motor Co. vehicle, there was an opportunity to enhance audio performance by checking the effects of front door cavities and structure. For that, the air cavities and door structure are modeled via Finite Element Method and modal analysis is performed. Numerical results show the presence of door cavity and structure resonances at low frequency range that could be related to the poor vehicle audio response at low frequencies detected experimentally.

16:20-16:40

1969 _____ *contributed*

INTERIOR NOISE REDUCTION STUDY IN THE TRACTOR CAB

Du Hwan Chun

Yeungnam University, Gyongsan, South Corea

This paper investigates the noise reduction scheme in tractor cabin by using various steps of experiment and computational method. The experiments were performed in the field as well as in the lab to facilitate the detail test procedure. Some of the test results were compared with computational results. Several noise sources and paths were identified including the engine compartment, hydraulic system and its components, structural characteristics of the cab, window, mounting bracket and machine frame etc. Throughout the several design changes, cab noise level was reduced by approximately 5 dBA.

16:40-17:00

2001 _____ *contributed*

MEASUREMENTS AND SIMULATIONS OF ACOUSTICAL PERFORMANCE OF PLASTIC AIR INTAKE MANIFOLDS FOR INTERNAL COMBUSTION ENGINES

Michele Battistoni*, Giulio Pispola, Carlo Nazareno Grimaldi, Gianluca Mattogno

* *Università di Perugia, Perugia, Italy*

Automotive engine manufacturers are focusing increasingly their attention on noise generated by air intake systems. In particular in recent years the increased usage of plastics for air intake manifold (AIM) production, in place of metallic materials, made the NVH optimization more complicated. In this framework, it is very important not only the minimization of the noise generated via fluid propagation (orifice-noise from inlets) but also of the noise radiated via the coupled fluid-structure interaction. In this work acoustical performance of an AIM prototype has been experimentally and numerically investigated. From the experimental point of view, the acoustic analysis was performed by means of acoustic intensity measurements around the body. In order to minimize the noise contribution from all the other sources of an operating engine, the AIM was assembled on an engine head which was mounted on a dynamic flow test bench, where the intake valvetrain was driven by an electrical motor. The intake orifice noise was differently treated, both leaving the orifice open and employing a dissipative muffler. Simulations through a coupled fluid-structure approach were performed. The normal modes of the structure were previously calculated on a fully-detailed FEM model and checked through accelerometric data; material properties could then be properly chosen. Measured data of the pressure pulsations at the inlet valves was used as excitation and applied to a coarsened acoustic Indirect-BEM model of the AIM coupled with a structural FEM one. Tuning of experimental and numerical acoustic data was useful for defining a practical analysis procedure for NVH design of plastic AIMs.

17:00-17:20

1817 _____ *contributed*

EFFICIENT MODELS OF THE ACOUSTIC RADIATION AND TRANSMISSION PROPERTIES OF COMPLEX TRIMMED STRUCTURES

Vincent Cotoni*, Phil Shorter, Arnaud Charpentier, Bryce Gardner

* *ESI Group, Bloomfield Hills, USA*

A number of advances have been made recently in the development of a Hybrid method for rigorously coupling finite element and statistical energy analysis descriptions of the dynamics of a vibro-acoustic system. The method provides an efficient way to analyze the acoustic radiation and transmission properties of a complex structure across a broad frequency range. This paper provides an overview of various numerical studies that have been performed to validate the 'Hybrid area junction' formulation for coupling FE structures with trimmed SEA fluids.

17:20-17:40

1526 _____ *contributed*

SENSITIVITY ANALYSIS OF KEY NVH METRICS FOR ENGINE MOUNTS OPTIMIZATION BY EXPERIMENTAL APPROACH

Ming-Hung Lu*, Jen Ming Une

* *Industrial Technology Research Institute, Chutung, Hsinchu, Taiwan*

This paper describes the experimental sensitivity evaluation process for engine mounts optimization. The engineering approach, test method, ranking methodology and the results are all explained in detail in the paper. The study was motivated by the NVH problems of a target vehicle with excessive dynamic forces across the engine mounts. However, the dynamic force through the engine mounts is not the only engineering design metric, the customer requests for a good ride and satisfying acoustic performance also play crucial roles for engine mounts design. For this study, system dynamic analysis has been performed by the CAE group to predict the normal rigid body modes of the new powertrain. Preliminary trial compression mount rates were also suggested by the CAE group. The NVH sensitivity evaluation was performed on three different trial engine mounts with compression rates ranging between 140 and 230 N/mm. For each mount the NVH tests performed included a subjective assessment as well as objective measurements of interior noise, idle NVH, secondary ride, mount attenuation and powertrain rigid body modes. Based on the characteristics of each mount, the best compromise of mount rate for the next phase of vehicle verification tests can be defined. The results show that the softest mount, 140 N/mm, gives the best idle NVH under air-conditioning operating. The mount with 165 N/mm rate has the best interior noise performance. The mount with the stiffest rate 230 N/mm has the best secondary ride performance. Based on the weighting priority adopted according to customers preference and detailed tabular comparisons among the mounts, the compression rate of 165 N/mm is chosen as the best compromise specification for the target vehicle for further development.

17:40-18:00

1604 _____ *contributed*

VIBRATION AND NOISE OF FOREST MACHINE DRIVERS

Esko Sorainen ⋆, Aki Vähänikkilä, Teemu Pasanen, Esko Rytkönen

⋆ *Finnish Institute of Occupational Health, Kuopio, Finland*

The exposure of forest machine drivers to whole-body vibration and noise was studied in harvesting, soil tilling, and draining. Twenty-two forest machines of different age and manufacturer were chosen as the objects of the study. Vibration was recorded simultaneously along three mutually perpendicular axes, both from the seat and from the floor of the machine, next to the seat fastening. The measurements and the analyses were made according to the directive 2002/44/EC and the standard ISO 2631 (1997). The noise exposure of the drivers was measured simultaneously with the vibration measurements. In addition, the noise inside the cabins was recorded for frequency analyses. In eight-hour daily exposure, the vibration dose measured in the driver's seat exceeded the limit dose value of 21 m/s1.75 in 16 out of the 22 forest machines. The RMS-acceleration of vibration measured in the driver's seat exceeded the limit value 1.15 m/s2 in 11 forest machines. The vibration doses of the drivers were most powerful in the tilling machines, and exceeded 21 m/s1.75 in all the cases. Also, the RMS-acceleration of vibration exceeded 1.15 m/s2 in all the tilling machines. The excess occurred mainly in the side-to-side-direction. In all the seats there were vibration isolators at least in the z-direction. The vertical vibration was most powerful at frequencies below 20 Hz, and side-to side vibration at frequencies below 5 Hz, both in the seat and in the floor. Also, at the frequencies in question, the floor vibration typically became more powerful in the seat. The A-weighted equivalent sound pressure of the drivers was between 65-85 dB(A). The A-weighted sound pressure level was most powerful in many cases starting from 80 Hz.

18:00-18:20

2049 _____ *contributed*

PREDICTION OF RANDOM INCIDENCE TRANSMISSION LOSS BASED ON NORMAL INCIDENCE FOUR-MICROPHONE MEASUREMENTS

Taewook Yoo⋆, J. Stuart Bolton, Jonathan Alexander

⋆ *Purdue University, West Lafayette, USA*

The use of the four-microphone standing wave tube to assess the acoustical properties of sound absorbing materials is becoming increasingly popular. The objective of the present work was to demonstrate that it is possible, under certain conditions, to predict the random incidence transmission loss of sound absorbing materials based on normal incidence measurements in a four-microphone standing wave tube. If a porous material may be modeled as being isotropic and either perfectly rigid or limp, it may be characterized as an effective fluid in terms of its complex density and wave number. The latter quantities may then be used in conjunction with plane wave theories to predict random incidence properties. That procedure is demonstrated here by using two different porous media. Good agreement was found between the estimated and directly measured random incidence transmission losses. The accuracy of the procedure may however, be limited at both low and high frequencies. At low frequencies, the estimated material properties may be affected by the constraint of the sample around its edge. At high frequencies, higher order mode propagation within the sample may affect the results owing to the typically subsonic wave speeds in porous media.

Tuesday 9 August 2005

Old Tramway - *Bonde*

Distinguished Lecture 4

08:30-09:30 h **Room:** Rio 1+2

Engineering Acoustics meets Annoyance Evaluation

Michael Vorländer
Prof. Dr.-Ing., Institute of Technical Acoustics, Aachen University, Germany

Michael Vorländer is Professor and Director of the Institute of Technical Acoustics at Aachen University. His main interests include room acoustics, building acoustics, psychoacoustics and acoustic measurements. In addition to academic work, his involvement in the national and international acoustics community has included the following responsibilities: - President of the European Acoustics Association, EAA - Board Member of the German Acoustical Society (DEGA), 1998 - 2004 - Editor-in-Chief of *ACTA ACUSTICA united with ACUSTICA*, 1998 – 2003 - Editorial Board Member of *Applied Acoustics*, since 1996 - Founding chairman of the Technical Committee *Room and Building Acoustics* of EAA, 1999 – 2001.

The discussion of problems in noise control is usually simplified by using single numbers, for instance dB(A), R_w or NC, RC, etc. Noise-induced hearing loss, for instance, can well be described by sound levels indeed. Other factors of noise impact, however, like acoustic comfort cannot be quantified easy since the actual context of the noise problem and the activities of the humans affected must be considered. It is therefore necessary to continously discuss the relation between acoustics engineering and annoyance or comfort, its measurement and evaluation. In short: acousticians have to talk to psychologists and sociologists. The link between the these disciplines should be a single number again, to be derived from objective measurements. In many situations, however, existing single number quantities do not reflect all dimensions of the problem. Basic research is required to create better and new single number quantities describing the relevant factors of comfort and annoyance with a more specific meaning. In particular the technique of auralization can be beneficial for subjective tests in this respect. In this contribution recent developments of auralization in noise control are introduced and demonstrated in examples of basic research on acoustic comfort and annoyance.

Session AT1: Assessment of Noise: Temporal Aspects in the Psychological Evaluation of Single and Combined Noise Sources

chairs:

Hugo Fastl - *Germany*

Sonoko Kuwano - *Japan*

10:00-12:00 **Room:** Business Master 136

10:00-10:20

1689 _____ *invited*

RAILWAY BONUS AND AIRCRAFT MALUS FOR DIFFERENT DIRECTIONS OF THE SOUND-SOURCE?

Hugo Fastl*, Sonoko Kuwano, Seiichiro Namba

* *TU Muenchen Germany, Muenchen, Germany*

Even for same LAeq, noise immissions from different types of traffic noise elicit not always the same loudness and annoyance. Frequently, railway noise is perceived as less annoying than roadtraffic noise (railway bonus), whereas aircraft noise can be perceived as more annoying than road traffic noise (aircraft malus). As one possible reason for the aircraft malus - in addition to differences in spectral distribution and temporal structure - sometimes the hypothesis is put forward that sounds which come from above a person are perceived as particularly dangerous and annoying. In order to challenge this hypothesis, psychoacoustic experiments were performed in which the same immissions of equal LAeq from railway noise, road traffic noise, and aircraft noise were presented by loudspeakers in front of versus above the subjects. They had to rate the overall loudness of the noise immissions by category scaling, magnitude estimation, and line length. Results are presented in which the magnitude of bonus or malus is given as a function of the direction of the sound sources. Of particular interest are "natural" situations like e.g. road traffic noise from front and aircraft noise from above.

10:20-10:40

1639 _____ *invited*

SUBJECTIVE IMPRESSION OF STEADY STATE AND INTERMITTENT SOUNDS

Sonoko Kuwano*, Hugo Fastl, Seiichiro Namba

* *Osaka University, Suita, Japan*

It is accepted that LAeq is a good metric for the evaluation of environmental noises. However, the subjective impression may differ depending on the temporal structure of the sound. In this study, the subjective impression of steady state and intermittent sounds was examined. The component sound has 30ms rise- and fall-time without steady state portion and LAmax was 70 dB. The carrier was white noise. The number of component sounds was varied from 5 to 80 in 4800ms total duration of the sound. The steady state sound with the same duration was also used. The sound levels of the steady state sounds were 53, 59 and 65 dBA. The loudness and the subjective impression of these sounds were judged using magnitude estimation and semantic differential, respectively, by fourteen German participants. The results showed that the loudness of intermittent sounds was judged louder than that of steady state sound even if LAeq and LAE values were equal. It was also found that the intermittent sounds were judged more annoying and unpleasant than steady state sounds.

10:40-11:00

1532 _____ *invited*

TRADE OFF EFFECT OF SEAT VIBRATION TO THE PERCEPTION OF SOUND QUALITY OF CAR INTERIOR NOISE

Takeo Hashimoto*, Shigeko Hatano

* *Seikei University, Musashino, Japan*

From our previous studies, the perception of sound quality of car interior noise is strongly affected by the stimulus simultaneously exposed to the subject with car interior noise, such as seat vibrations and moving seanery through the front windscreen. So far, we have measured subjective effects of the trade off levels in SPL (dB) on sound quality under the conditions that seat vibrations and moving seanery were presented simultaneously with car interior noise. The sound quality attributes we dealt with were unpleasantness, powerfulness and booming sensation. The results obtained were simple addition of each trade off level, i.e,trade off levels for seat vibration and for moving seanery in case of the evaluation of powerfullness but the relation was more complicated for unpleasantness. In this study, we have measured the trade off level in SPL(dB) under the condtions that car interior noise alone was presented or car interior noise together with the various seat vibrations were exposed to the subjects to find the how much the trade off level could be for the same three attributes.

11:00-11:20

2104 _____ *invited*

SOUND ENVIRONMENT IN COMMUTER TRAINS

Jiro Kaku*, Takehisa Okamoto, Tadasu Hatoh

* *Kobayasi Institute of Physical Research, Kokubunji, Japan*

Desirable sound environment in a commuter train is discussed in this paper based on the results of a questionnaire survey, field measurements and a psychological experiment. The result of the questionnaire survey suggests that most of passengers generally accept the current sound environment in commuter trains as an unavoidable circumstance. However, passengers feel the rail-joint noise and the squeal noise as annoying sound due to their impulsive and ear-piercing characteristics. The results of the field measurement indicate that the cabin noise of a train running under the ground is about 8 dB higher than that of trains running on the ground. Nevertheless, this level difference is not reflected on the passengers' impression of annoyance with the cabin noise. The results of the psychological experiment indicate that the volume of announcements that exceeds the cabin noise by 5-10 dB is preferable for passengers and the passengers' unpleasantness toward the announcements increases when the difference of sound level between the announcements and the cabin noise is more than 10 dB or less than 5dB.

11:20-11:40

1438 _____ *invited*

ANNOYANCE CAUSED BY SIMULTANEOUSLY AND SUCCESSIVELY PRESENTED MULTIPLE NOISE SOURCES

Joos Vos

TNO Human Factors, Soesterberg, The Netherlands

A considerable part of the population is exposed to simultaneous and/or successive environmental sounds from different sources. To prevent or reduce the annoyance in areas with two or more different sound sources, insight is needed into the population's total annoyance caused by all sounds together. The results from the experiments reported in Vos [J. Acoust. Soc. Am. 91, 3330-3345 (1992)] support a weighted summation model which accurately predicts the total rating sound level for simultaneously presented combinations of several types of sounds, both in conditions in which two or more sounds are about equally annoying, and in conditions in which one of the sounds is much more annoying than the sounds of the remaining sources. In the latter experiments the optimal k-value, being the sole free parameter in the model, turned out to be 15. In the present study the model is tested both for simultaneously and for successively presented sounds from a tracked vehicle (a Leopard tank), gunfire (pistols and rifles), and civil road traffic. For the simultaneous presentation mode, the results obtained with the help of a rating scale are compared with those obtained with the method of paired comparison. For the simultaneously presented sounds, the optimal k-value was equal to 17 and 16 in the rating paradigm and the method of paired comparison, respectively. Moreover, the rms of the differences between the experimental results and the model predictions was as small as about 1 dB. For the successively presented sounds the optimal k-value was equal to 12, and again, the rms was about 1 dB. Since in all three experiments the previous results were excellently replicated, we conclude that the model holds both for simultaneous and for successive sounds, and that the two paradigms applied yield essentially the same results.

11:40-12:00

1560 _____ *invited*

COMBINED ANNOYANCE DUE TO THE SHINKANSEN RAILWAY NOISE AND VIBRATION

Shigenori Yokoshima*, Akihiro Tamura

* *Kanagawa Environmental Research Center, Hiratsuka, Japan*

The purpose of this study is to clarify the integrated annoyance caused by Shinkansen noise and vibration. Social surveys on community responses to noise and vibration were carried out in residential areas along the Tokaido Shinkansen railway in Kanagawa Prefecture, Japan, from 2001 to 2003. More than 1000 questionnaires were completed. Afterwards Shinkansen noise exposure (LAeq) and vibration exposure (LVmax) at each respondent's dwelling were estimated. For detached houses, the annoyance caused by Shinkansen noise with higher LVmax range was more serious than that with lower LVmax range. Likewise, the dose-response curve for Shinkansen vibration was also affected by Shinkansen noise. Compared to trunk roads and conventional railways, it is found that the annoyance reactions to Shinkansen noise and vibration were high respectively. These findings probably confirm the interaction between noise and vibration annoyances. For apartment houses, no significant difference was found in the annoyance response to Shinkansen noise between higher and lower LVmax ranges; in contrast, Shinkansen noise slightly affected the dose-response curve for Shinkansen vibration. LAeq and LVmax in apartment houses were higher and lower than those in detached houses respectively. Judging from the annoyance reactions and exposure levels in apartment houses, there can be no interaction between noise and vibration annoyances. These results indicate that a concept of "combined annoyance", a synthetic annoyance, is necessary for assessing the effects of Shinkansen noise and vibration on inhabitants' living environments in detached houses. In order to investigate each effect of the exposures on the combined annoyance, we applied covariance structure analysis to a structural equation model. It was found that the effect of 5dB in LAeq on the combined annoyance was equal to that of 10dB in LVmax.

Session BA3: Building Acoustics

chairs:

Elvira B. Viveiros - *Brazil*

Jacques Roland - *France*

10:00-12:00 **Room:** Rio 1

10:00-10:20

2065 _____ *invited*

RESTRUCTURING THE ISO 140 SERIES FOR THE FUTURE – BACKGROUND AND APPROACH

Birgit Rasmussen*, Eddy Gerretsen

* *VELUX A/S, Horsholm, Denmark*

ISO 140 is the basic series of standards in Building Acoustics and consists of several parts relating to laboratory and field measurements. The standards were originally prepared by ISO/TC 43/SC 2 WGs in the early sixties and since then updated and implemented as European standards through CEN/TC 126. The ISO 140 series now consists of more than 10 parts, and new parts are under preparation. The ISO 140 laboratory standards cover a variety of building elements such as walls, windows, glazings, floors, floor coverings and air intakes. However, round robin tests have shown that the reproducibility is highly unsatisfactory for some product types due to insufficient or lacking instructions about mounting and boundary conditions, cf eg the European round robin on light-weight walls, which has led to preparation of Amendments to ISO 140-1 & 140-3. In order to improve the structure of the standards for easier updating, ISO/TC 43/SC 2 has decided to re-arrange the ISO 140 series. As a first step, the restructuring is restricted to the parts for laboratory measurements of the acoustic performance of products, i.e. ISO 140-1, -3, -6, -8, -10, -11, -16. The aim is to re-arrange the contents of these parts into a more logical structure in a new series, ISO 10140, without changing the contents for the time being. The existing product related instructions about mounting and boundary conditions are collected in one of the 6 parts in the new series. The new structure will also allow easier updating in other aspects, eg new measurement techniques. ISO/CDs were circulated for enquiry in February 2005. The paper describes the shortcomings of the present ISO series, the advantages of the new structure, the approach to the restructuring process and the long-term implications and perspectives for laboratory as well as field standards.

10:20-10:40

1697 _____ *contributed*

REVERSE SEA USED FOR CHARACTERIZATION AND PREDICTION OF FLANKING TRANSMISSION IN TIMBER LIGHT WEIGHT CONSTRUCTION

Jean-Luc Kouyoumji

CTBA, Bordeaux, France

The particularity of acoustic design in timber framed structures is the absence of any specific engineering, as builders use recipes and check 'the results' after. The analysis of acoustic and vibration transmissions of complex double-leaf timber framed structures was done using Statistical Energy Analysis (SEA) as a means of investigation. SEA proves to be a seductive theory because it can be easily applied. Indeed, its developments do not need any elaborate numerical method. SEA modeling involves cutting the structure into sub-systems and decomposing the spectrum into octaves or thirds of octave. In this way, the exchange of energy flow in the sub-structure can be analyzed. The parameters that govern acoustic transmission between sub-systems are thus loss factors and coupling loss factors. These factors can be identified experimentally by reversing the problem (Reverse SEA). This particularity makes SEA a most effective design tool in structural acoustics and vibration. In this article we present results of reverse SEA applied on a basic double leaf timber framed horizontal 'T' junction to determine specific dumping loss factors and coupling loss factors, as bibliographical coupling models for timber construction were found to be unsuitable. We conducted a series of vibration tests on a structure which partly reproduced a timber construction. Using Reverse SEA to measure coupling is an original method which lessens the uncertainty caused by compositional choices. Measured dumping and coupling loss factors were used to elaborate a hybrid model aimed at calculating insulation between two rooms, as well as the vibration reduction indices.

10:40-11:00

1779 _____ *contributed*

THE EFFECT OF CONCRETE SLAB THICKNESS ON THE HEAVY-WEIGHT IMPACT SOUND

Jeong Ho Jeong*, Young Jeong, Jin Yoong Jeon

* *Hanyang University, Seoul, Korea*

Regulations concerning floor impact noise in apartment buildings in Korea were enacted in 2004. One influential factor in floor impact noise transmission is the thickness of the concrete slab. In this study, floor impact sound was measured in 88 units in an apartment complex. These units had concrete slabs varying in thickness from 120 180mm. A standard floor impact noise test was also conducted in a building with slab

thicknesses of 140 240mm. Heavy weight impact sound pressure level (Li,Fmax,AW) decreased as slab thickness increased at a rate of about 1 dB/15mm.

11:00-11:20

1819 _____ *contributed*

EFFECT OF THE SPATIAL REPARTITION OF THE INCIDENT FIELD ON LABORATORY AIRBORNE SOUND INSULATION MEASUREMENT OF BUILDING ELEMENTS

Jacques Roland*, Claire Brutel, Michel Villot, Catherine Guigou

* *C.S.T.B., Saint-Martin-d'Hères, France*

The sound reduction index of building elements is measured according to ISO standard 140/3, between two rooms where the acoustic field is considered as diffuse. The volume of the rooms is generally between 50 and 100 m3, and the reverberation time between 1 and 2 s. Different shapes, including the presence of niches, and absorbing material are used in order to achieve such constrains. As a result, the intensity impinging on the element on the source side is not constant versus the angle of incidence. Some measurements have been performed in a test rig, using acoustic holography, showing typical values of intensity against angle of incidence. Calculations using a multilayer approach show the resulting effect on measured sound reduction index, and particularly on double layers structures which are very sensitive to the angle of incidence.

11:20-11:40

1873 _____ *contributed*

MECHANICAL PARAMETERS MEASUREMENT OF TRANSVERSE ISOTROPIC MINERAL WOOL

Jérôme Tran-van*, Xavier Olny

**Saint-Gobain Isover, Courbevoie, France*

In field such as aeronautics, automotive or engineering, open porous materials are widely used for their acoustic properties in sound transmission and absorption. One of the most encountered products in building acoustics are mineral (glass or stone) wools. Due to the manufacturing process, they generally present an anisotropic structure. It consists in planes of fibres running parallels one to each other. Modelling the acoustical behaviour of porous elastic medium generally consider it as isotropic (e.g. Biot-Johnson-Allard's model). In order to take into account the anisotropy of mineral wools, the transverse isotropic model can be introduced. In this model, mechanical parameters of the material (Young modulus, Poisson ratio and structural damping) become direction dependant. In this paper, the transverse isotropic model is briefly recalled. Secondly, the mechanical parameters measurement method principle and theory using a standard setup is presented. It consists in an adaptation of an already existing method modified by Langlois et al from the GAUS. The improvements proposed here allows to measure properties of the medium in the two main directions (perpendicular and parallel to the fibres plane). Then results obtained for various mineral wools are explained to outline the experimental advantages and drawbacks of such a measurement. The conclusion deals with the interest of transverse isotropic mechanical parameters measurements in order to obtain a more accurate description of mineral wools acoustic behaviour.

11:40-12:00

1878 _____ *contributed*

INVESTIGATION ON SOUND PRESSURE DISTRIBUTION GENERATED BY HEAVY WEIGHT FLOOR IMPACT SOURCE

Ryu Tomitaka*, Tomotaka Hiramatsu, Atsushi Tabata

* *TAISEI CORPORATION / Technology Center, Yokohama, Japan*

Generally, heavy weight floor impact sound generated by the heavy and soft impact source such as those of children jumping and running has a tendency to be resonant in lower frequency band than 63Hz (1/1 octave band center frequency). Therefore, the resonance mode of sound may be generated strongly by the spatial shape of the room. At times, the phenomenon of the resonance mode may exert an influence on the evaluation of heavy weight floor impact sound (for example JIS A 1418-2, 1419-2). In this time, the experimental measurement and the investigation on the relation between the sound pressure distribution in the room and the shape, etc of the room were carried out at the wooden structure house. In this paper, the investigated results were described.

Session EP4: Environmental Noise Problems and Approaches

chairs:

Sergio Beristain - *Mexico*

Antonio Perez-Lopez - *Spain*

10:00-11:40 **Room:** Flamengo 1

10:00-10:20

1946 _____ *contributed*

TRAFFIC NOISE EVALUATION INTEGRATED METHODOLOGY

Fernanda Simões ⋆, Paulo F. Soares, José Yshibac, Generoso De Angelis Netod

⋆ *Universidade Estadual de Maringá/Departamento de Engenharia Civil, Maringá, Brazil*

Nowadays the urban transportation becomes necessary to community due to cities development. However, this development has promoted environment impact caused by accidents, traffic conflict and noise vehicles, specially where the traffic is heavy. This paper propose an integrated methodology to traffic noise evaluation considering the characteristics of road system. One of the ways to analyze the life quality of population is collecting data about noise interference and annoyance. The methodology development defined how that database can be collected. To validate this methodology was selected as study object at Maringá downtown, northwest city of Paraná State, Brazil. Established road configuration set like geometry and pavement, it was realized noise measurements inside a vehicle jointly a simultaneous shooting at representative sectors. Database was classified by vehicle categories and will generate different maps to noise traffic control and others improvements like noise reduction seeking a better community life quality.

10:20-10:40

1901 _____ *contributed*

AN ACOUSTIC IMPACT: RAILWAY LINEAR SOURCE MODELS

Luciano Santarpia⋆, Amalia Gelfu

⋆ *Universita La Sapienza - dipartimento di fisica tecnica, Italy*

The Directive CEE/CEEA/CE n° 49:2002 and the Recommendation of the European Commission: 6 August 2003, for the determination and the management of the environmental noise, proposes, for the States Members, either the use of national methods of calculation adapts to the definitions of the acoustic descriptors of the UE; or the use of recommended method RMR96, adapted to the definitions of acoustic descriptors UE, (RMR2002) with the objective to create an European map of the environmental noise. The present job wants to evidence the methodological differences between the RMR 96 methods standardizes and RMR2002, and to estimate the dBA differences between then and the other models of railway traffic, like CETUR, C.S.T.B., Simplified Model, SCHALL 03, RML2. PREDICTOR Software version 3,0, of Bruel&Kjaer, in application of the method RML2, supplies an acoustic map of the territory in agreement RMR model recommended.

10:40-11:00

1937 _____ *contributed*

CONSTRUCTION OF ELECTRIC EXCHANGE SYSTEM WHEREBY ENVIRONMENTAL NOISE IS CONSIDERED TO BE AN ENERGY SOURCE

Yasuhiro Tokita ⋆, Ryu Yoonsun, Yasuhiro Oikawa, Yoshio Yamasaki

⋆ *WERI, Waseda University, Shinjuku, Japan*

Our group has produced the system whereby noise is exchanged for thermal energy, and been able to extract the heat from the noise. Noise is usually absorbed by some substance and finally exchanged for thermal energy. Therefore this system has advantage that it never produces additional heat loads in a global environment. It is also very unique that energy of noise is actively consumed by the energy exchange. Noise is an unusual type of energy because waste of noise is encouraged. It is thought that noise is applied as an alternative energy. This system, however, has disadvantage that energy transformed is very little, because energy of noise is little. Therefore, the system that extracted the energy of noise from very wide area was proposed. It consisted of many thermoacoustic tubes. It is difficult to sum the thermal energy that was transformed by the many tubes if energy after exchanging is heat. The system whereby energy of noise is exchanged to electric energy has been produced, although we understand that the efficiency of exchange is reduced. Thermal energy that was transformed by thermoacoustic tubes was transformed into electric energy by Peltier devices again. Though electric energy that was transformed by only one apparatus is very little, it is easy to sum the energy that was transformed by many apparatus. We imagine that noise barriers that consist of the numerous apparatus were placed beside the railroads or highways. The barriers absorb sound energy of the traffic noise, and transform into electric energy. Several apparatus that transform the energy of noise into electric energy have been prepared and investigated whether electric energy that was transformed by these apparatus can be summed up. It has verified that the total voltage that was transformed is approximately proportional to the number of the apparatus used.

11:00-11:20

2004 _____ *contributed*

SAINTS JOHNS BLUFF ROAD PILE DRIVER ACOUSTICAL BLANKET NOISE REDUCTION ANALYSIS;JACKSONVILLE, FLORIDA

Bernard I. Kinney Jr.

Bernard Kinney Associates, Boca Raton, USA

The Florida Department of Transportation District II, as a result of ongoing legal issues with the City of Jacksonville, Florida was forced to ensure compliance with the City of Jacksonville Noise Ordinance. Specifically, the Jacksonville Environmental Protection Board - Rule 4.0 Noise Pollution Control (Section 4.208 Construction or Maintenance Projects). The purpose of this evaluation was to analyze the existing construction noise impacts associated with the construction of Saint Johns Bluff Road and to provide the appropriate noise reduction measures to allow the roadway construction to continue in a timely manner while meeting the criterion set forth in the City of Jacksonville Noise Ordinance. The results of the preliminary field noise analysis indicated that an Acoustical Enclosure would be required around the Pile Driver in order to meet the criterion set forth in the local jurisdiction noise ordinance. The results of the post application noise reduction analysis indicated that a substantial noise reduction (10-17 dBA) was achieved which exceeded the anticipated insertion loss results. As a result, the Florida Department of Transportation District II was able to successfully complete the construction improvements along Saint Johns Bluff Road and maintain compliance with the City of Jacksonville Noise Ordinance.

11:20-11:40

1903 _____ *contributed*

URBAN NOISE: MEASUREMENT TIME AND MODELING OF NOISE LEVELS IN THREE DIFFERENT CITIES

Alice Elizabeth González*, Martín Gavirondo Cardozo, Esteban Pérez Rocamora, Alberto Bracho Rodríguez

* *Facultad de Ingeniería UdelaR (Uruguay), Montevideo, Uruguay*

Noise maps, intended as management tools, must give information with sufficient precision (reliability), a reazonable price (economy) and update possibilities (actualization) to give a good description of the studied place. Urban noise measurements need to be dense enough to give a good spatial representation of noise levels in the city. They must also last enough to be stable and reliable, but not extremely long in order not to increase field work costs . Data from field measurement campaigns carried out to obtain a noise map, might also be used to develop predictive noise models in order to update the noise map in an indirect way, or to evaluate noise impact of possible traffic management changes (circulation patterns, bus ways, etc.). Predictive models application in the same city for which they were developed is a guarantee of the adequacy of the tool, specially when its accuracy and range of application is specified. If no accuracy or application range is given, unpredictable errors will occur without any previous advise. This paper compares recommended noise measurement time for three different cities: a European one (Valencia, Spain); a South American city a bit larger than the previous one (Montevideo, Uruguay); and a small town in Uruguay (Rivera). The differences obtained are expected to be due not only by hourly traffic. Then, predictive models are used in all the cases and their outputs are compared. Differences are large enough to show the risks of using predictive models developed for cities with different characteristics (urban, social and cultural differences, including different recommended noise measurement time), even when hourly traffic would suggest its applicability.

Session GV2: General Vibration

chairs:

Roberto Jordan - *Brazil*

José R.F. Arruda - *Brazil*

10:00-12:00 **Room:** Business Master 145

10:00-10:20

1501 _____ *contributed*

DIESEL ENGINE CONDITION MONITORING BY USE OF SURFACE VIBRATION SIGNALS

Jianyuan Zhu

Shanghai Maritime University, Shanghai, P. R. of China

This paper conducts an investigation on condition monitoring of the component parts inside the cylinders of diesel engine by use of engine surface vibration signals. The main bearing housing and the cylinder block surface vibration signals are measured and analyzed for diagnosis of the working conditions of the components inside the engine cylinders. The characteristics of engine surface vibration signals under different working conditions are described, the properties of the exciting sources of engine vibration and the principal features of piston slaps are discussed, and some criteria suitable for diesel engine condition monitoring and fault diagnosis are proposed. The experimental investigations are carried out on a medium speed four-stroke turbo-charged 8-cylinder marine main diesel engine while the ship is in operation. The analytic and experimental results show that the main exciting source of cylinder block surface vibration is the piston slap, which is imposed on the

cylinder liner while the side thrust of the piston changes its directions. The changes of vibration character parameters of cylinder block can be used to identify the variations in cylinder liner clearance and the conditions of the components inside the cylinders. The relationships between the character parameters of cylinder block surface vibration and the working conditions of the components inside the cylinders are presented. The obtained results show that it is feasible and effective to diagnose the working conditions of the components inside engine cylinders by surface vibration monitoring.

RIO 2005 inter-noise ENVIRONMENTAL NOISE CONTROL
The 2005 Congress and Exposition on Noise Control Engineering
07-10 August 2005 - Rio de Janeiro - Brazil

10:20-10:40

1548 _____ *contributed*

A CONTRIBUTION FOR NONLINEAR STRUCTURAL DYNAMICS CHARACTERIZATION OF CANTILEVER BEAMS

Everaldo de Barros*, Mathias Mauro

* *CTA/IAE-AIE, Sao Jose dos Campos, Brazil*

Successful experiments in nonlinear vibrations have been carried out with cantilever beams under harmonic base excitation. A flexible slender cantilever has been chosen as a convenient structure to exhibit modal interactions, subharmonic, superharmonic and chaotic motions, and others interesting nonlinear phenomena. The tools employed to analyze the dynamics of the beam generally include frequency- and force-response curves. To produce force-response curves, one keeps the excitation frequency constant and slowly varies the excitation amplitude, on the other hand, to produce frequency-response curves, one keeps the excitation amplitude fixed and slowly varies the excitation frequency. However, keeping the excitation amplitude constant while varying the excitation frequency is a difficult task with an open-loop measurement system. In this paper, it is proposed a closed-loop monitor vibration system available with the electromagnetic shaker in order to keep the harmonic base excitation amplitude constant. This experimental setup constitutes a significant improvement to produce frequency-response curves and the advantages of this setup are evaluated in a case study. The beam is excited with a periodic base motion transverse to the axis of the beam near the third natural frequency. Modal interactions and two-period quasi-periodic motion are observed involving the first and the third modes. Frequency-response curves, phase space and Poincaré map are used to characterize the dynamics of the beam.

10:40-11:00

1750 _____ *contributed*

VIBRATION TESTING OF THE FIRST STAGE BOOSTER ADAPTER FOR THE FIRST VSB-30 SOUNDING ROCKET VEHICLE TEST FLIGHT

Everaldo de Barros*, Domingos J. Strafacci, Ailson N. Campos

* *CTA/IAE-AIE, Sao Jose dos Campos, Brazil*

This work presents the evaluation of the dynamic response under random vibration of the first stage booster adapter of the VSB-30 sounding rocket vehicle. The VSB-30 is a two-stage sounding rocket developed to launch payloads for scientific and technological experiments in the space environment of microgravity, provided by sounding rockets. The partners involved in the development of the vehicle are Centro Técnico Aeroespacial (CTA-Brazil), Deutsches Zentrum für Luft und Raumfahrt (DLR), Swedish Space Corporation and Kayser-Threde GmbH from Germany. The methodology proposed for the qualification of the first vehicle involves the evaluation of acceleration transmissibility, random vibration levels and power spectrum density at different locations around three vibration axes of the first stage booster adapter. A single axis vibration test system and a closed-loop control system were employed to generate the vibration corresponding to the excitation spectra considered to the mechanical testing. The excitation and response signals were measured using accelerometers. The experimental results suggested that the module was qualified for the first VSB-30 test flight.

11:00-11:20

2014 _____ *contributed*

PHASE REQUIREMENTS FOR NON-NULL ENERGY FLOW IN ONE-DIMENSIONAL DOMAIN

Moysés Zindeluk*, Pedro Lisbôa Pereira Dias

* *Universidade Federal do Rio de Janeiro - COPPE/PEM, Rio de Janeiro, Brazil*

The purpose of this article is to show the requirements for a phase, particularly a spatial phase, for the energy density spatial variation function and the energy flow not to be null in a one-dimensional structural member. By using the Fundamental Theorem of Calculus, these requirements are shown. A simple example of complex mode is applied, and the effectiveness of this representation of energy flow is shown. It can be concluded that spatial phase, such as that introduced in real structures by non-proportional damping, has to be taken into account when modal models are constructed for measurements and simulations, to render accurate results.

11:20-11:40

2064 _____ *contributed*

COMPARING GENDER INFLUENCE AGAINST AGE, CORPOREAL MASS INDEX AND VISION ON COMFORT LEVELS TO WHOLE-BODY HUMAN VIBRATION

Maria Lucia Machado Duarte*, Matheus Brito Pereira, Marcos Roberto Misael, Luiz Eduardo de Assis Freitas Filho

* *DEMEC/UFMG, Belo Horizonte, Brazil*

When studying comfort levels to whole-body human vibration, there are many parameters that influence the results obtained. There is no standard that shows in a simple manner how to evaluate accurately the known effects of vibration on the body, as mentioned in the Handbook of Human Vibration by Griffin. Most Standards do not even mention which variables have the large influence on response. Therefore, they do not provide the necessary information to effectively reduce the vibration effects. The results presented in this work are first attempts to try to evaluate the influence of some known parameters on the threshold vibration levels and maximum acceptable vibration levels obtained for whole-body human vibration. Gender parameter influence is compared against age, corporeal mass index (CMI) and vision to verify which of the parameters have the most influence in the results obtained.

11:40-12:00

1650 _____ *contributed*

SPECTRAL ANALYSIS OF ACOUSTICS AND VIBRATION SIGNALS USING UNDER SAMPLED DATA

Peter Wagstaff*, Christian Chassaignon

* *University of Compiègne, Compiegne, France*

A number of practical situations occur when it is difficult to sample acoustical or vibration data at a frequency high enough to avoid the effects of aliasing. One of the ways of dealing with this problem is using the so called "Super Nyquist" approach when the aliased peaks in the extended undersampled spectrum may be identified and discarded if the approximate frequencies of the true peaks are known. This information may be available using data from previous experience or numerical calculations. Another alternative is to calculate several spectra using different sampling frequencies which would be chosen to have non coincident aliases leaving only the true spectral peaks present at the same frequencies in the different spectra.. Using a series of sampling frequencies each of which is a prime number harmonic of the fundamental sampling frequency the effective non aliased bandwidth of the spectral analysis is increased well above the highest sampling frequency. In this paper new spectral analysis techniques are introduced which enable spectral peaks to be identified at frequencies over a total bandwidth which can be twenty to fifty times greater than the effective sampling frequency. The analysis is performed with the aid of specific irregular sampling procedures and the aliases are identified and removed using optimised pattern recognition techniques. These techniques are particularly well adapted to non-contact blade vibration measurements on rotating machines such as fans, propellers and turbines but have a number of other practical applications. The procedure is illustrated with the aid of a simulation of results of "tip timing" data for a compressor fan.

Session NU1: Numerical Techniques

chairs:

Svend Gade - *Denmark*

Jorge P. Arenas - *Chile*

Marcelo Magalhães - *Brazil*

10:00-12:00 **Room:** Flamengo 2

10:00-10:20

1942 _____ *invited*

INFLUENCE OF THE COST FUNCTION IN THE EFFICIENCY OF THE 'EQUIVALENT SOURCES-GENETIC ALGORITHMS' TECHNIQUE

Yves J.R. Gounot*, Ricardo E. Musafir

* *COPPE / UFRJ, Rio de Janeiro, Brazil*

The combination of the equivalent sources method with genetic algorithms can remove the difficulty of selecting 'good' source positioning, which is the main handicap of the method in its original formulation. However, the efficiency of the combined method depends on the cost (i.e., error) function to be minimized. This paper presents an investigation on the influence on the algorithm efficiency of using different cost functions, referred as $\mathscr{L}_\mu$ ($\mu = 1$ to 5) and defined in terms of the μ^{th} power of the local boundary velocity error. The method is applied to a three-dimensional scattering problem. The results show that, while $\mathscr{L}_1$ leads to very poor results, $\mathscr{L}_3$, besides leading to solutions with better precision relatively to the least square method ($\mathscr{L}_2$), also increases the algorithm convergence. Results with higher powers ($\mu = 4$ and 5) show an inverse effect. These results are explained in terms of the stronger emphasis given to the regions of higher errors in each case.

10:20-10:40

2075 _____ *invited*

MODELLING VIBRATION ISOLATORS AT MID AND HIGH FREQUENCY USING HYBRID FE-SEA ANALYSIS

Bryce K. Gardner*, Philip J. Shorter, Vincent Cotoni

* *ESI US R&D Inc, San Diego, USA*

Vibration isolators are often modelled as simple single degree of freedom systems. Such an approach is often adequate for characterizing the low frequency performance of a vibration isolator (assuming that the effective spring stiffness and damping loss factor of the isolator can be obtained). However at mid to high frequencies, two problems are often encountered. The first is that the impedance of the structures connected to the isolator become important (assumptions of rigid body behaviour of the components of interest are generally not valid). The second is that the internal dynamic behaviour of the isolator becomes important (internal resonances of the isolator degrade the isolation performance). This paper describes the development of a Hybrid FE-SEA model of an in-situ vibration isolator that addresses these problems

10:40-11:00

1372 _____ *contributed*

FEM/FEM VERSUS FEM/BEM VIBRO-ACOUSTIC COUPLING TECHNIQUES APPLIED TO THE BRAZILIAN VEHICLE SATELLITE LAUNCHER (VLS) FAIRING PROBLEM: ADVANTAGES AND DRAWBACKS

Rogério Pirk *, Luis Carlos Sandoval Góes, Wim Desmet, Paul Sas

* *Aerospace Technical Center - CTA, San Diego, USA*

Fluid-structure interactions are always present in real life dynamic systems, during operations. However, analysts, due to the complexity of building a vibro-acoustic model and also because sometimes the coupling effect has no significance, often apply "one way" analysis, or uncoupled analysis. This analysis procedure is done in two steps, on which the structural part and the fluid part are modeled separately. Nevertheless, sometimes it is important to consider the mutual influence of the vibro-acoustic system, where the acoustic and structural matrices are coupled and the influence of the structural displacement on the fluid domain, as well as the acoustic pressure of the fluid domain on the structural body, are accounted in one coupled matrix. Low frequency coupling techniques, or deterministic coupling techniques, were used to calculate the Brazilian Satellite Launcher Vehicle (VLS) fairing behavior. The well-known structural FEM/fluid FEM technique and structural FEM/fluid BEM technique were applied to model the fairing body and its acoustic cavity. Calculations were done, which yielded the low frequency acoustic cavity as well as the skin responses. This paper describes the applied procedures to build up the vibro-acoustic models of the VLS. The obtained results are described and a comparison between FEM/FEM versus FEM/BEM techniques is presented. In such a comparison, parameters as computational efficiency, allocated memory, processing time, obtained results and modeling are considered.

11:00-11:20

1422 _____ *contributed*

TRANSIENT ANALYSIS OF GREAT CONCRETE STRUCTURE USING THE FINITE ELEMENT TECHNIQUE

Maria Alzira Nunes*, Marcus Antônio Duarte

* *UFU, Uberlandia, Brazil*

One of the great problems of the modern society says respect to the effect of the noise during sleeping. The noise increases the duration of the superficial sleep periods while the necessary periods for resting are drastically reduced. In modern buildings where the flats have fit flagstones and great free surfaces, only an walk during the night can turn a tragedy for the rest of the neighbor in the under flat. The level of transmitted impulsive noise between flats is strongly dependent on the flagstone configurations. In function of the diverse possibilities of existing plants it would be interesting for the architect and the civil engineer to predict the transmitted impulsive noise levels between superpose flats to define the best acoustic project. On this way a study of the applicability, and viability, of the use of the finite element method for the solution of vibroacoustics problem resultant of impacts in residential flagstone is interesting. The main problem of this aproach is the properties of the element used to modeling flagstone and structural beams which is highly nonlinear because the stiffiness of the concrete to traction is zero together. In set with the usual dimensions of the flagstone make impracticable the dynamic simulations of the transient responses due to impulsive forces. To resolve this problem, this study uses linear shells and beams to model the flagstone transient dynamic response. Given a flagstone geometry, at fisrt ,through a static deflexion analysis, the parameters values of the linear elements is adjusted so that the analisys results are in agreement with the nonlinear results. It was done a series of simulations with a small flagstone to study the influency of the impulsive parameter (intensity and duration of the impact) precision. Finally, the simulations are compared with a experimental measurements of a residential flat for validations purposes.

11:20-11:40

1446 _____ *contributed*

VIBRATION AND ACOUSTICS IN POROUS INSULATING MATERIALS - THE HELP OF FE NUMERICAL SIMULATIONS FOR THE ANALYSIS OF EXPERIMENTS IN ROOMS AND TUBES

Pierre Lamary ⋆, Jose Maria dos Santos, Renato Pavanello, Olivier Tanneau, Sylvie Moyne

⋆ *UNICAMP, Campinas, Brazil*

To illustrate our purpose we first recall the results of a 4 years study, carried out at the ISMEP, of trimmed fuselage panels of aircraft and multilayered insulating systems. We underline the complementarities of real tests in transmissibility rooms with a set of FE and analytical methods we have developed. Two major difficulties exist i) high performance panel tests rapidly reach the limit of the experimental device, ii) short wave length in poroelastic material do not allow us direct 3D finite element calculations in all the frequency band [0 ; 6,000 Hz] of interest. Therefore, 3D models are completed with 2D models and an analytical method. We show that all this numerical tools are needed to understand the tests and to investigate some particular points as the mounting of the panel in the acoustic room. An other problematic question with poro-elastic materials is that the characterization of the material itself, which is of prior importance for inputting data in numerical models, is highly difficult to carry out. This second point motivates present research at UNICAMP based on the use of FE numerical calculations to determine the absorption and the transmissibility of porous samples in tubes. The construction of modified tubes are also envisaged for a better control of the boundary conditions during tests while the FE model will allow us to recover some fundamental characteristics by inverse calculation. We learned from our first simulations that high precisions calculations are needed to substitute the real device with a numerical one. We list at the end of the paper, new research involving virtual and real tests: curved panels, active control, noise inside a simplified aircraft cabin. From sub-structures to samples of materials, FE calculation proves itself of most practical benefits to exploit tests involving porous materials.

11:40-12:00

1600 _____ *contributed*

STUDY ON THE VIBRATION CHARACTERISTICS OF THE ULTRA LARGE CONTAINER SHIP

Jin-Hwa Park⋆, Jang-Woo Lee, Jong-Gug Bae

⋆*HYUNDAI HEAVY IND. CO, Ulsan, Korea*

The container ship has become much larger in capacity and faster in speed for transportation efficiency since its start in sixties. In recent, large number of container ship beyond 9,000 TEU are under construction or will be delivered this year and coming years. In relation to large container ship, the larger slow speed diesel engine above 12 cylinders and larger propeller are provided for maximum speed of around 25 knots. Due to these trends, the possibility of vibration problem was expected to be high in container ship with the flexible hull structure and high tall towered accommodation for good visibility. Therefore the vibration characteristics of ultra large container ship with 12,700 TEU were investigated at design stage. In this paper, the extensive vibration analysis by 3-dimensional finite element model were firstly performed in order to calculate the major natural frequencies and their corresponding mode shapes and to predict the vibration responses at major positions for the ultra large container ship with twin propulsion system. Secondly the parametric study, which is according to change of deckhouse location, propulsion system and propeller blade number, were also carried out to get their effects on vibration. From the analysis results, the vibration characteristics of the ultra large container ship were expected to be very good.

Session PH2: Physiological Health Effects Resulting from Environmental Noise Exposure

chairs:

Thais Morata - *Brazil*

Peter Lercher - *Austria*

10:00-12:00 **Room:** Lagoa

10:00-10:20

1725 _____ *invited*

IMPLICATIONS OF THE RANCH STUDY FOR EXPLORING MECHANISMS OF NOISE EFFECTS ON COGNITION.

Charlotte Clark ⋆, Stephen Stansfeld, Mary Haines, Tamuno Alfred, Hugh Davies, Elise van Kempen, Isabel Lopez-Barrio

⋆ *Queen Mary University of London, London, UK*

The RANCH (Road traffic and aircraft noise exposure and children's cognition and health) study has examined the effect of road traffic and aircraft noise exposure on the cognitive performance of 2844 children aged 9-10 from schools around three major airports in the Netherlands, Spain and the United Kingdom. A linear exposure-effect relationship between chronic aircraft noise exposure and reading comprehension was found in all three countries after adjustment for age, gender, parental employment, home ownership, mother's education, classroom insulation, main language spoken

at home, parental support, long-standing illness and crowding. This paper presents further analyses exploring mechanisms underlying the effect of aircraft noise on reading comprehension. The most prevalent hypothesis, that noise restricts attention to central cues during complex learning related tasks was examined, along with the hypothesis that working memory and recognition memory, both of which are essential in the process of interpreting and understanding text, mediate the relationship between aircraft noise and reading comprehension. Multilevel modelling analyses, with children nested within schools, examined the mediating role of sustained attention, working memory and recognition memory on the observed association between aircraft noise and reading comprehension. Sustained attention, working memory and recognition memory were all significantly related to reading comprehension ($p<0.001$) but did not mediate the relationship between aircraft noise exposure and reading comprehension. The implication of these results for current models of the mechanisms underlying noise effects will be examined. In particular, we will present new theoretical models hypothesising alternative cognitive and non-cognitive mechanisms (e.g. different types of attention, motivation) that can be tested in future studies.

10:20-10:40

1763 _____ *contributed*

RECOVERY MODEL OF TEMPORARY THRESHOLDS SHIFTS FROM EXPOSURES WITH THE SAME $L_{(AEQ,T)}$ AND DIFFERENT FREQUENCY COMPONENTS

Rodrigo Ordoñez⋆, Dorte Hammershøi

⋆ *Aalborg University, Aalborg Øst, Denmark*

Temporary Threshold Shifts (TTS) were determined for 9 subjects exposed to three different band-passed signals taken from one channel of a binaural recording of an industrial mill. The three 2-octave bands were: Low (125 to 500 Hz), mid (500 Hz to 2 kHz), and high (2 kHz to 8 kHz). The band-passed signals were adjusted to give the same equivalent A-weighted sound exposure according to ISO-1999 (1990) and were presented to one ear of the subjects in three separate experimental sessions. The results were used in a recovery model based on a least-squares fit of the data to a superposition of exponential functions. The recovery model showed good agreement with the average TTS across subjects and confirms that the high band caused the greatest TTS. The difference between the TTS caused by exposures with the same A-weighted equivalent level, suggests that the frequency characteristics of exposure signals may not be well characterised by the A-weighting curve. The present paper presents the recovery model and discusses the application of the model to the present TTS data.

10:40-11:00

1539 _____ *contributed*

NOISE AND ITS EFFECTS AMONG FISHERMEN FROM THE STATE OF PARANÁ, BRAZIL

Michele C. Paini⋆, Thais Morata, Evelyn J. Albizu

⋆ *Department of Communication Disorders, Universidade Tuiuti do Paraná, Curitiba, Paraná, Brazil*

OBJECTIVES: to verify the hearing losses of fishermen from the coastal of the Paraná State in the south of Brazil and what were the main causes. During a evaluation about risks in the fishing activity, some fishermen complained about the necessity of having a television or radio on so they would be able to sleep, they would listen to the boat engine noise even after all the fishing had finished and they were far away from their boats or any other noise. METHODS: interview with fishermen in several communities to verify who were exposed to high sound levels and which were there activities and schedule of work. Questionnaires were done to be able to collect all the information and anamnesis with fishermen exposed to high sound pressure levels. The study was cross-sectional, simultaneously considering groups of fishermen exposed to higher sound pressure level and fishermen, which uses small boats without engine however also exposed by boats that passes close to them. The evaluation was done with 100 fishermen exposed to the noise of the engine of their boat and 50 fishermen had no engine in their boat. The engines of the boats were also evaluated as well as all the fishing activities. Fishermen have peculiar work pattern that deviates considerably from that of the regular industrial worker, in addition they are exposed to unfavorable climatic variations, sleep deprivation, humidity, sun and vibration. The selected fishermen were evaluated in a mobile van, which visited several fishing communities of the coastal. All of them were tested in the same mobile van using the same test booth under the same audiometric conditions. CONCLUSION: the hearing examination of the fishermen belonging to the main fishing communities showed there is a quite poor hearing and it's work-related to noise exposure, possibly in combination with other ototraumatic factors. Technical noise abatement on board, better conditions of the boat engine, ear protection and annual hearing check-ups could improve the hearing of these professionals considerably.

11:00-11:20

1571 _____ *contributed*

THE INFLUENCE OF COURTYARD QUALITY ON ANNOYANCE AND WELL-BEING IN NOISE-EXPOSED URBAN RESIDENTIAL AREAS

Anita Gidlöf Gunnarsson⋆, Evy Öhrström

⋆ *Department of Environmental Medicine, Göteborg University, Göteborg, Sweden*

Noise has documented adverse health effects, however,

psychological processes and moderating factors influence the relationship between noise and health outcomes. Research on restorative environments suggests that certain environments provide high quality restorative experiences that may act as moderators of adverse conditions. A questionnaire study was conducted in urban residential areas with road-traffic noise exposure between LAeq, 24h 58 to 68 dB at the most exposed façade. The dwellings had "quiet" indoor section/s and faced a "quiet" outdoor courtyard (LAeq, 24h $<$ 45 dB). The present paper examines the physical environmental quality of the "quiet" courtyards (PEQC) and explores the effect of PEQC on health and well-being. Data were collected from 358 residents (18 to 75 years of age) and four groups were formed based on sound-level categories (58-62 and 63-68 dB) and PEQC classification (low and high). At both sound-level categories, the results indicated that high PEQC-classified "quiet" courtyards provided opportunities for rest and relaxation, which may have moderated the effects of noise with regard to less noise annoyance and noise-disturbed outdoor activities. However, due to high sound levels at the trafficked side of the dwelling, a "quiet" indoor section and a high PEQC-classified "quiet" courtyard could not counterbalance completely the adverse health effects of noise. Thus, 17 and 28 % were still noise annoyed at 58-62 and 63-68 dB, respectively.

11:20-11:40

1962 _____ *contributed*

2F1-F2 DPOAE FINE STRUCTURE FOR 12 SYMPHONY ORCHESTRA MUSICIANS BEFORE AND AFTER REHEARSAL.

Karen Reuter⋆, Dorte Hammershøi

⋆*Aalborg University, Aalborg Øst, Denmark*

The distortion product otoacoustic emission (DPOAE) fine structure is revealed, when measuring DPOAE with a very fine frequency resolution. It is characterized by consistent maxima and minima with notches of up to 20 dB depth. The fine structure is known also from absolute hearing thresholds, and it has been suggested that the fine structures correlate with hearing level. In a previous study the prevalence and character of distortion product otoacoustic emission (DPOAE) fine structure was analyzed for 40 young, normal-hearing subjects. In this study the DPOAE fine structure was determined and analyzed for 12 symphony orchestra musicians using the same measurement parameters as in the previous study. Only musicians, without known hearing problems, participated in the study. The purpose of this study was to analyze the DPOAE fine structure characteristics in this group of exposed test subjects, before and after rehearsal, and to compare with the non-exposed group of subjects.

11:40-12:00

1432 _____ *invited*

HEARING IMPAIRMENT AMONG YOUNG PEOPLE

Mario Rene Serra ⋆, Ester Biassoni, Marta Pavlik, Carlos Curet, Silvia Abraham, Gloria Minoldo, Silvia Joekes, María Rosa Yacci, José Moreno Barral, Raul Reynoso, María Eugenia Barteik

⋆ *CINTRA - Centro de Investigación y Transferencia Acústica, Córdoba, Argentina*

Multidisciplinary project addressed to find the causes of hearing impairment in the young people and to contribute to its prevention. It is based in a previous study with adolescents of middle socio-economic level over four years, where the exposure to high sound levels during the leisure activities was cause of hearing disorders in the adolescents with tender ears, at the age of only 17/18. Nevertheless, the same sound levels did not damage the ears of other adolescents of the same study. Social, biomedical, molecular-genetic and acoustical factors give the opportunity to move forward in the understanding of the hearing impairments, to assist young people, to establish social mechanisms and to develop new ways of prevention. This time, a programme addressed to the adolescents of low socio-economic level, future applicants for jobs in factories, has been implemented, starting with those of 14/15 years, attending the schools which are annually selected to work, and re-tested at the age of 17/18. The aspects considered are: - Hearing diagnosis applying conventional and extended high frequency audiometry and acoustics otoemisions. A vehicle has been acoustically prepared and equipped as a movable audiometric booth. - Determination of psychosocial variables and recreational habits. - Measurements of sound immission during recreational activities. - Application of standarized metrological procedures. - When hearing disorders are detected, counselling, assistance and medical treatment required is provided. The prevailing genetic mutations are studied and the genotype-fenotype correlations are established. Our purpose is: - to define the etiology of the problem; - to give personal advising; - to implement educative campaign; - to contibute with scientific guidelines in the elaboration of standards and bylaws related with the hearing health.

Session RA1: Room Acoustics

chairs:

Sylvio Bistafa - *Brazil*

Roberto A. Tenenbaum - *Brazil*

10:00-12:00 **Room:** Botafogo

10:00-10:20

1474 *invited*

AUDITORY ROOM SIZE PERCEPTION FOR MODELED AND MEASURED ROOMS

Densil Cabrera ⋆, Daeup Jeong, Hyun Jeong Kwak, Ji-Young Kim

⋆ *University of Sydney, University of Sydney, Australia*

Although there are many studies investigating auditory spatial impression in rooms, there are few that directly investigate the seemingly more basic question of auditory room size perception. In this study, subjective experiments using the method of paired comparisons were conducted to obtain room size ratings using binaurally presented stimuli. In the first experiment, binaural impulse responses from a computer-modelled room were used to auralize an anechoic speech sample. Room volume, source-receiver distance and reverberation time were investigated as parameters. The second experiment used binaural recordings of speech made in a real room of fixed size (for the same anechoic speech sample as Experiment I), with source-receiver distance and reverberation time as experiment parameters. The final experiment used binaural impulse responses of a concert auditorium convolved with anechoic music – so that both the room volume and reverberation time were constant. Results show that reverberation time strongly affects room size perception (much more so than the physical room volume). In a room of fixed volume but variable absorption and source-receiver distance, clarity index can be a good predictor of perceived room size. A comparison of Experiments I and II shows little or no difference between results for auralizations of computer modelled rooms and binaural reproductions of a real room. Results from the second and third experiments were compared with results from previous studies (of auditory distance perception, speech quality and spatial impression) which used identical stimuli. Auditory room size perception is not closely related to auditory distance perception (Experiment II), and is related to auditory intimacy (music stimuli, Experiment III) and speech quality (speech stimuli, Experiment II).

10:20-10:40

1508 *invited*

LARGESCALE FINITE ELEMENT SOUND FIELD ANALYSIS, DESIGN AND SCIENTIFIC TOOL FOR ROOM ACOUSTICS

Toru Otsuru⋆, Noriko Okamoto, Reiji Tomiku, Daisuke Azuma, Koichi Yamamura

⋆ *Oita University, Oita City, Japan*

Large-scale finite element sound field analysis(LsFE-SFA, for short) has been developed by the authors recently. The LsFE-SFA enables us to investigate room acoustics by solving the wave equation computationally. The outline of both mathematical and physical basis of the LsFE-SFA is described briefly first, and the applicability of LsFE-SFA onto the problems on room acoustics is discussed. Basic accuracy of LsFE-SFA is given with the results of sound field computation in a cavity comparing with those obtained by the other numerical methods. The computed objective is one of the standard problems listed on the web-site of "Benchmark Platform form on Computational Methods for Architectural/Environmental Acoustics" run by AIJ(Architectural Institute of Japan), and several absorbent conditions are added to clarify the effect of dissipation treatment. The treatment utilizes the surface impedance to model boundaries' absorption. Then, to confirm the validity of the iterative solver utilized in the system to solve a linear equation, several sound fields in a reverberation room computed by LsFE-SFA are compared with the results obtained by a modal summation approach. Finally, an application onto the sound field in a music hall is given to show its applicability in the field of room acoustics.

10:40-11:00

1889 *invited*

PERCEIVED SPEECH PRIVACY IN COMPUTER SIMULATED OPEN-PLAN OFFICES

Claudiu B. Pop⋆, Jens Holger Rindel

⋆ *The University of Sydney, Sydney, Australia*

In open plan offices the lack of speech privacy between the workstations is one of the major acoustic problems. Improving the speech privacy in an open plan design is therefore the main concern for a successful open plan environment. The project described in this paper aimed at finding an objective parameter that correlates well with the perceived degree of speech privacy and deriving a clear method for evaluation of the acoustic conditions in open plan offices. Acoustic measurements were carried out in an open plan office, followed by data analysis at the Acoustic Department, DTU. A computer model of the actual office was developed using the ODEON room acoustic software, allowing a systematic investigation of the possible influence of various acoustic conditions on the speech privacy. Four

different versions of acoustic treatment of the office were used and three different distances from the speech source. Listening tests were performed with the twelve sound files obtained from the simulations, in all cases including a masking noise from a ventilation system. It was found that the Speech Transmission Index (STI) is a good descriptor of perceived speech privacy, and values below 0.30 are required in order to obtain a "moderately good" speech privacy condition.

11:00-11:20

1624 _____ *invited*

THE DISTRIBUTION OF ABSORPTION MATERIALS IN A RECTANGULAR ROOM

Lau Nijs

TUDelft, Faculty of Architecture, Delft, Netherlands

Students in Architecture are taught Sabine's formula for the reverberation time (RT) and common theory for the sound pressure level (SPL), but actually, these equations are for a cubic space with a diffuse sound field and absorption materials distributed homogeneously through the room. Public spaces like restaurants, open plan offices or sports facilities, however, never fulfil these conditions. The influence of room shape and uneven absorption distribution on RT has been investigated for many decades. The consequences for SPL have been dealt with much less, although SPL may be more important than RT in the spaces mentioned. A simple mirror sources model (which gives the same results as a ray-tracing program without scattering) is used to derive general rules for a rectangular enclosure. The model predicts RT and SPL to increase in almost any case. RT is mainly influenced by the longest dimension, while SPL is decreased when absorption is perpendicular to the shortest dimension; it explains why ceiling absorption is effective. Results from the mirror sources model are put together into one simple formula, which depends on the mean free path and the absorption distribution over the three directions.

11:20-11:40

2100 _____ *invited*

ARE THE SCATTERING AND THE ABSORPTION COEFFICIENTS TWO FACES OF A SAME COIN?REVERBERATION TIME IN TWO CASES ANALYZED.

Higini Arau

ESTUDI ACUSTIC H.ARAU, Barcelona, Spain

The scattering coefficient is intended to be used in room acoustic calculations and simulation / auralization models. The scattering coefficient, d, defines the fraction of the scattered sound that is uniformly diffused with smaller energy in relation to the specular energy. This loss of sound energy taken place by dispersion gives the sensation that the material on which impacts the incident sound has a bigger absorption seemingly that it is obtained only applying the coefficient of absorption statistical. Therefore in the programs of room acoustic simulation it seems that the scattering coefficients are more used to adjust the reverberation time to values wanted, that were well-known before by other method possibly analytic, that necessity of really producing dispersion. We ask: What effect has diffuse reflection on RT? Will diffuse reflection always affect the RT? In this sense are the acoustic room simulation solve the problem? In this communication we will try to clarify a little more of how much the problem RT calculation is dependent of "absorption true", or due to "apparent absorption", in where perhaps is included the diffusion of the sound as absorbent effect. We will make a RT calculation of two real cases, using PC Acoustic room simulation and analytic methods, and we will analyze what happens.

11:40-12:00

1497 _____ *contributed*

ACOUSTIC COMPUTER MODELLING: A CASE STUDY TO COMPARE PREDICTIONS BY CATT AND ODEON WITH MEASURED RESULTS

Chris Field*, Savithri Shimada

**Arup Acoustics, Sydney, Australia*

This paper presents a case study for the prediction of room acoustic parameters in a church auditorium using both CATT and ODEON software, and compares the predictions with the same parameters determined from analysis using the measured impulse responses. The church auditorium included predominantly hard surface finishes and required acoustic treatment for multipurpose use. Impulse response measurements were made in the space using swept sine and MLS techniques. CATT and ODEON models were built for predictions using as-built drawings. Comparison of predicted and measured acoustic parameters indicated good agreement of STI and RT when the appropriate input parameters for each respective software package were used.

Session SC1: Soundscape and Community noise

chairs:

Brigitte Schulte-Fortkamp - *Germany*

Marion Burgess - *Australia*

10:00-11:40 **Room:** Rio 2

10:00-10:20

2045 _____ *invited*

APPROACHES TO MANAGEMENT OF MOTOR SPORTS NOISE

Marion Burgess

UNSW@ADFA, Canberra, Australia

The impact from recreational motor sports noise can be of great concern to the surrounding residential areas and there is clearly a need for effective methods for noise management. However the rights of the community to be able to enjoy their private space without excessive noise impact need to be balanced against the rights of part of the community to enjoy a recreational activity. The legislators with the responsibility for setting and enforcing appropriate noise limits for the operation of the facility need to take this into consideration along with other factors such as the type of noise produced and frequency of occurrence of the activity. Criteria applicable for industrial noise or other types of noise in the community are not directly applicable to noise from recreation activities. This paper will discuss approaches to the management of motor sports noise which endeavour to take these various factors into consideration.

10:20-10:40

1643 _____ *invited*

ON THE ADEQUATE SOUND LEVELS FOR ACOUSTIC SIGNS FOR THE VISUALLY IMPAIRED: A BASIC STUDY FOR BARRIER-FREE SOUNDSCAPE DESIGNS

Koji Nagahata ⋆, Katsuya Yamauchi, Mari Ueda, Shin-Ichiro Iwamiya

⋆ *Fukushima University, Fukushima, Japan*

Acoustic traffic signals and the entrance chimes of public buildings are the two most common auditory signals for the visually impaired in Japan. The importance of these sounds is well known to even non-impaired citizens, and the number of these sounds has been increasing in particular in urban districts. However, there are currently no standards for the sound levels of these signals, and thus they are adjusted through ad hoc rules. Though signals which have been set up with adequate sound levels can be a great help to the visually impaired, those set up with inadequate sound levels are largely ineffective. They can cause noise problems when too loud and can be ineffective, or even useless, when too low. It is therefore necessary that adequate sound levels for these sounds be determined. In this study, adequate sound levels were investigated in a psychoacoustical experiment. Environmental sounds and auditory signals for the visually impaired were recorded with a Head And Torso Simulator (HATS). The recorded environmental sounds and auditory signals were then played simultaneously via headphones, and the visually impaired participants were required to adjust the sound level of each acoustical sign to an adequate level. Results showed that the adjusted sound levels of both types of signals were different among the participants, and the maximum difference was about 20 dB. However, participants could be divided into two groups depending on their chosen strategy for adjusting the sound levels. One group adjusted the sound levels of the auditory signals through comparison with the maximum environmental sound, while the other group adjusted the sound level according to the normal conditions of the acoustic environment.

10:40-11:00

1850 _____ *invited*

THE EXPLORATION OF THE LISTENER'S PERCEPTUAL REALITY – THE POTENTIAL OF EXPLORATIVE METHODS WITH RESPECT TO COMMUNITY NOISE RESEARCH

André Fiebig⋆, Schulte-Fortkamp Brigitte

⋆*ITA TU-Berlin, Berlin, Germany*

The soundscape approach shows that it is necessary to implement new methods and innovative approaches for the understanding of human perception. However, an elaborate dialogue of the usefulness and applicability of these approaches in particular is still missing. Fortunately, the need of using and combining subjective and objective data in order to comprehend the process of human perception and evaluation sufficiently has almost been accepted. The question is, however, how this goal can be achieved. In two different surveys human perception of soundscapes is evaluated using explorative methods. These approaches allow to examine appropriately the listener's perceptual reality in a specific environment. Both methods are going to be introduced because of their explanatory power for the object of research. Furthermore, the opportunity of adequately collecting and analyzing qualitative data with regard to soundscape research is going to be reviewed and methodologically discussed from different perspectives. By means of the discussion the exploitation of discovered conclusions based on qualitative data for community noise research is going to be pointed out.

11:00-11:20

1472 _____ *invited*

RESEARCH ON SOUNDSCAPE OF URBAN OPEN SPACES FOR THE PRACTICAL DESIGN

Jian Ge*, Jiang Lu, Hongfeng Guo

* *Saga University, Japan, Saga, Japan*

In the design of urban open space, visual sense is always regarded as absolutely important while impressions from other senses such as auditory sense are often neglected. With the high speed urbanization, our cities are facing the problem of losing the amenity of natural, historical, cultural and social sound environment. It is obvious that favorable and congruent soundscape could reinforce the visual aesthetics and strengthen its pleasure and presence. In this paper, through investigations in Saga Forest Park of Japan, the nature of soundscape in urban open spaces is studied from the following aspects: (1) main components and structure of soundscape; (2) subjective evaluation of sound components; (3) soundscape zones and their characteristics; and (4) relative importance of soundscape components and their design priority. According to the results of the above studies, we practiced soundscape design as a part of landscape planning of Ting Hu Water City in Shengzhou of China. The design of soundscape is performed by plus design (increasing of favorable components) and minus design (deletion of unfavorable sound components). During plus design, we put focus on the natural sound, activity sound and sports sound which have obtained high evaluation from investigation. In minus design, we planed to delete or reduce the sound components which are disliked by people, or incongruous with the environment such as transportation sound, broadcasting and background music. Furthermore, we designed the spatial formation of soundscape into three zones such as natural soundscape zone, sports soundscape zone, and historical, cultural and folk soundscape zone, with identified characteristics. The research and design practice of this paper can not only benefit to clarify the direction of soundscape design of urban open spaces, but will also present a new and valuable perspective for the research and design of environmental acoustics, and furthermore can put forward a comprehensive concept for the design of urban open spaces.

11:20-11:40

1887 _____ *invited*

INCOME AS A MEDIATOR OF ROAD TRAFFIC NOISE EXPOSURE AND ANNOYANCE

Aslak Fyhri

Institute of Trasnport Economics, Oslo, Norway

Studies of the impact of noise on noise reactions have often also studied the possible impacts of non-acoustic variables such as income, education and occupational status. These studies have not found any important effect of these variables on annoyance. One reason might be that indirect effects have not been taken properly into account. Resource variables such as income can influence noise annoyance as modifiers of dose-response relationships. However, a possible indirect effect of income on annoyance is mediated by noise exposure level, and will not show up in dose-response models featuring income only as a possible modifier. The relationship between road traffic noise exposure, income and annoyance is investigated more thoroughly in this paper. Structural equation models have been constructed that allow us to estimate the path coefficients, and to control for other background variables. The models are estimated using data from eight socio-acoustic surveys combining individual noise exposure measures with questions on noise perception and background characteristics. The hypothesis that high-income groups are able to buy themselves free from noise is partly confirmed. Such an effect is found for residents of a small to medium city, but not for residents of a larger city. However, no effect is found of income as a mediator of annoyance. The importance of taking indirect effects into account is thus confirmed.

Session TN1: Transportation Noise

chairs:

Vivian Silva Mizutani - *Brazil*

Jordi Romeu - *Spain*

10:00-12:00 **Room:** Copacabana

10:00-10:20

1558 _____ *contributed*

POSSIBILITY OF INTERNATIONAL STANDARDIZATION OF ROAD TRAFFIC NOISE PREDICTION MODEL - PART 2 APPLICATION OF JARI MODEL TO LOW-NOISE TYPE ROAD SURFACES

Yasuo Oshino*, Keisuke Tsukui, Gijsjan Van Blokland, Hideki Tachibana

* *Japan Automobile Research Institute, Tsukuba, Japan*

To investigate the reduction measures of road traffic noise effectively, it is useful to establish a calculation model which can be applied to roads in different countries. We have reported in a previous paper (Part 1) that the road traffic noise calculation model developed by Japan Automobile Research Institute (JARI) is applicable also to the urban roads in European countries which are paved with dense asphalt concrete. However, in Europe, various types of road surfaces have been developed for noise reduction. Therefore, for further investigation of an internationalization of the road traf-

fic noise calculation model, it is necessary to establish a model applicable also on low-noise road surfaces developed in different countries. In this study, firstly, the sound power levels of road vehicles on low-noise road surfaces in the Netherlands were measured and the calculation model for them was made. Secondly, the road traffic noise calculation model developed by JARI was applied to urban roads of the low-noise road surfaces in the Netherlands and the noise levels at roadside points were calculated. The values of LAeq calculated using the JARI model were fairly in good agreement with the measured values within 2 dB. Consequently, it has been found that the JARI model is applicable also to urban roads of the low-noise road surfaces in Europe.

10:20-10:40

1767 _____ *contributed*

INFRASOUND PRESSURE LEVEL IN THE MOBILITY INDUSTRY

Vivian S. Mizutani*, Helcio Onusic

* *EMBRAER, São José dos Campos, Brazil*

This article presents the results of experimental investigations regarding infrasound pressure levels in commercial vehicles, passenger cars and aircrafts under differentiated conditions. The investigations come from measurements effected in specific conditions as follows: speed and high variation, cabin shape, windows and solar roof closed, totally and partially opened. Under the action of wind attack, the passenger compartment behaves sometimes like a cavity called Helmholtz resonator. The windows, the solar roof apertures and the volume are important parameters in this research. The infrasound levels as well the spectrum profiles are analyzed under different conditions, and the results coming from passenger cars and commercial vehicles are compared. The time exposition is associated to the levels and some aspects concerning comfort and injury are discussed.

10:40-11:00

1815 _____ *contributed*

EXPERIMENT AND CALCULATION OF SOUND RADIATION CHARACTERISTICS FROM SEMI-UNDERGROUND ROAD

Shinichi Sakamoto*, Jin Hirano, Fumiaki Satoh, Hideki Tachibana, Osamu Funahashi, Teiji Mori

* *I.I.S., Univ. of Tokyo, Meguro-ku, Japan*

It is difficult to assess road traffic noise around semi-underground roads because the noise propagation is complicated due to multiple reflections inside the structures. Previously, the authors reported numerical analysis on sound radiation from the structure which was made with the finite difference method (FDM) and demonstrated the complicity of the sound propagation. Following the study, the authors have investigated an energy-based simplified calculation method as an engineering model which was established based on a scale model experiment. In order to confirm the validity of these calculation methods, measurement data for real road structure is strongly required. In this study, an in-situ sound propagation measurement using a loudspeaker was performed and sound propagation characteristics from the structure were measured as such a reference data. In order to obtain useful data for confirming and developing the calculation model for road traffic noise prediction, discrete source points should be distributed along driving lanes in the road structure. The source positions extend over a considerably long distance and therefore the influence of background noise becomes severe. In this sound propagation measurement, the long swept-sine signal method was adopted in order to obtain enough signal to noise ratio. Receiving points were positioned in vertical direction on both road sides in order to acquire directivity characteristics of sound radiation from the mouth of the structure. The measurement results were compared with calculation results made with the two methods; the 2-dimensional FDM and simplified calculation model which was proposed as an energy-based conventional calculation model by the authors. Through the comparison, accuracy of the two calculation methods is discussed.

11:00-11:20

1635 _____ *contributed*

ANALYSIS OF THE EFFECTIVENESS OF A PREDICTIVE MODEL DURING THE EXECUTION OF THE A-66 HIGHWAY (SPAIN)

Marcos Fuentes *, Jesús Cepeda, Eduardo García, Berta Melcón, Mercedes de Barrios, Gabriel Búrdalo, David Fernández

* *Universidad de León, León, Spain*

In a new infrastrucuture, it is necessary to diminish the acoustical impact produced on the inhabitants of near residential nuclei. Before the execution of the infrastrucuture, the only possibility is to calculate a strategic noise map. During the execution of the A-66 motorway between the cities of León and Benavente (in the northwest of Spain), the Acoustics Laboratory (University of León) -in collaboration with ACS group, responsible for building the highway, and the Spanish Public Work Ministry- developed a noise map by means of techniques of computer simulation in which the corrections to implement in the project were propose and its repercussion studied. The simulated map analyzed the Metropolitan Area of the city of León affected by the infrastructure Then the railcar was not constracted and it was not possible to validate the model in order to know if the calculated levels of sonorous pressure were fit to the reality. At the moment of its opening to the vehicles traffic it has been possible to make measures in situ and to verify if the margin of error established on the noise levels recommended by the WHO, as well as the location of the most conflicting zones, were correct.

11:20-11:40

2015 _____ *contributed*

TRAFFIC NOISE ASSESSMENT OF DEVELOPING URBAN ARIAS IN GREECE – THE CITY OF ATHENS CASE

Sotirios Dalianis⋆, Kayafas Eleytherios

⋆*NTUA, Athens, Greece*

ABSTRACT This paper describes a statistical method for assessing disturbance in distinctly populated arias due to traffic noise elaborating the concept on noise events. Traffic noise assessment is usually produced using (L(A)eq) levels for every hour which correspond to a continuous stationary noise source equivalent to the non-stationary sound pressure levels actually measured in an acoustic environment. It is obvious that this index is not taking in to account differences of the (L(A)eq) levels or noise events occurring in the time interval of one hour. In addition to using the A-weighted equivalent continuous sound level L((A)eq), as an index of annoyance this approach uses additional parameters such as: the amplitude difference between the sound pressure level of noise events in comparison to the background noise, the number and the frequency of occurrence of events and the short time spectral characteristics of noise. The method detects events and classifies according to the disturbance they may cause. The developed method was used to assess disturbance from road traffic noise of major motorways in the city of Athens, Greece as well as railway and air traffic noise. Several noise descriptors are presented and used to evaluate the disturbance caused by transportation noise.

11:40-12:00

1441 _____ *contributed*

A SOCIAL SURVEY ON THE EFFECTS OF HIGH-SPEED MAGLEV NOISE ON RESIDENTS IN SHANGHAI

Tang Feng⋆, Chen Xiao-Hong, Li Tan-Feng

⋆*School of Transportation Engineering, Tongji University, Shanghai, China*

A study based on social survey was performed to assess the impact of noise experienced by residents living in the vicinity of maglev line in Shanghai which is the world's first revenue maglev system. 320 residents were interviewed by a face-to-face questionnaire and noise exposure measurements were taken at each site in addition to time log of maglev noise. The positive correlation between A-weighted sound exposure level and percentage highly annoyed was found. Under the track the onset rate of maglev noise reached 30dB/s, and 86.5% of responses reported either scare or palpitation when they met the maglev under the track. It is suggested that noise impact close to maglev track should be treated seriously.

Session VN4: Vehicle Noise Vibration and Harshness

chairs:

Helcio Onusic - *Brazil*

Takeshi Abe - *USA*

10:00-12:00 **Room:** Arpoador

10:00-10:20

1463 _____ *contributed*

EXPERIMENTALLY EXTRACTED COUNTERMEASURES AGAINST PISTON SLAP NOISE FOR A DIESEL ENGINE

Yasuo Miura⋆, Naoya Kojima

⋆*HINO MOTORS, LTD., Hini-Shi, Japan*

The impulsive piston slap noise of turbo-charged, after-cooled direct injection diesel engines installed in medium duty trucks causes higher sound power and worse sound quality than naturally aspirated direct injection diesel engines. In order to find out the design guide for countermeasures against piston slap noise, the generating mechanism of piston slap noise was investigated. The piston slap noise of a test engine was confirmed as the major noise source of engine sound power. The piston movement inside the cylinder liner and the vibration of the cylinder block of the test engine were experimentally analyzed, and these were found out to change under the same operating conditions at idling. From these experimental results, the clearance between the piston and the liner, and the piston pin offset were proposed as the countermeasures against piston slap noise and were investigated to elucidate the relation with engine sound power. It was clarified that the clearance between the piston and the liner, and the piston pin offset indicated rectilinear relations to the engine sound power level. In addition, sensory evaluation of the sound quality was carried out to extract countermeasures to reduce piston slap noise to a completely unrecognizable level by using the criteria of the sensory evaluation. It was elucidated that the sensory evaluation score had good relations with the A-weighted sound power level and the high frequency range level of the engine sound power. Therefore two countermeasures to reduce piston slap noise to a completely unrecognizable level were extracted.

10:20-10:40

1678 _____ *contributed*

DEVICES FOR DAMPING DRIVE SHAFT RESONANCE AND REDUCING IN-VEHICLE NOISE

Haran Periyathamby*, Kevin Niebel

**DANA CORPORATION, Maumee, USA*

During vehicle development and prototype testing, automotive manufacturers identify operating ranges that could be sensitive to transmission and or rear axle gear whine excitation. In some cases the breathing modes of the drive-shaft tube are very sensitive to this form of excitation and could affect the NVH rating of the vehicle. Usually adding or removing masses to the drive shaft solves the problem. However there are cases where an alternative method is required. The most common solution is to increase the damping by inserting cardboard liners or foam into the tube of the drive shaft. However, this form of damping can be sensitive to moisture and temperature thus giving inconsistent results in an operating environment. In this paper an alternative method to the cardboard deadener approach is investigated and presented with the experimental result. The intention of this paper is to demonstrate a dampening device based on the Helmholtz resonator principle to overcome the limitation posed by extreme cold weather operating condition on cardboard deadener approach.

10:40-11:00

1987 _____ *contributed*

EXPERIMENTAL TRANSFER PATH ANALYSIS OF A HYBRID BUS

Antonio Vecchio *, Herman Van der Auweraer, Karl Janssens, Filip Deblauwe

* *LMS Int., Leuven, Belgium*

The Toyota Prius represents the first worldwide commercially produced hybrid vehicle. Recently the Toyota produced the new Prius version, significantly improving the performances of its predecessor and introducing the concept of "Hybrid Synergy Drive" (THS II), an evolution of the past "Toyota Hybrid System" (THS). Three rotating components form the vehicle transmission. The internal combustion engine is a 4-cylinders 4-strokes engine using the Atkinson thermodynamic cycle; the electric motor and the generator are both three-phases permanent magnet synchronous AC motors. These three rotating components are connected each other with a kind of CVT transmission characterized by a planetary gear box, referred to as Power Split Device. An electronic control system regulates the rpm of the three components based on many variables such as the external loads, the fuel consumption, the emissions, the state of charge of batteries and the user power demand, which directly relates to torque. This paper reports on the results of a test campaigns carried out on both THS and THS II to assess vibration and acoustic responses under real on-road conditions. The analysis deals with multiple rpm order tracking and shows how different rotating components affect the interior vibro-acoustic comfort as well as the car drivability and pleasantness.

11:00-11:20

1427 _____ *contributed*

SOURCE IDENTIFICATION USING SENSOR ARRAY WITH SEMI-RANDOM CONFIGURATION FOR ENHANCED PERFORMANCE

Percy Wang*, Michael Johns

**SRI, Rochester Hills, USA*

Beam forming techniques have been revisted during the last few years, these has been using in mid to high frequency ranges for noise source identification for many industries including automotive industry. The benefit of beamformer is it can use less less sensor than NAH(Near-field Acoustical holography) and take care of higher frequency range with ease in time domain processing. The authors have investigated several sensor array design and its spatial coverages using coarray functions in previous Internoise conferences. In this paper, a new design of sensor array is proposed, this uses much less sensors needed than regular configurations, and with multiple test iterations that has semi-random configurations. The proposal is aimed for quicker measurement setup and more accuracy. MATLAB is used to simulate the array design, compared against previous and nominal sensor array using same amount of sensors as a guideline, spatial resolution and spectral resolution are both enhanced.

11:20-11:40

1445 _____ *contributed*

TOWARDS REDUCING BRAKE SQUEAL PROPENSITY

Antti T. Papinniemi*, Joseph C. Lai, Jiye Zhao

**UNSW@ADFA, Canberra, Australia*

Since the interior noise and vibration levels in motor vehicles have been reduced significantly over the past two decades, brake squeal has become an increasing concern to car manufacturers as it is a source of customer dissatisfaction and of warranty cost. Although the braking performance of a brake system is not affected by brake squeal, most customers interpret it as indicative of a defective brake. Despite extensive studies of brake squeal over many years and progress made, brake squeal still occurs and remains a challenging problem to be fully understood and overcome. This is because brake squeal is a transient phenomenon and is highly dependent on geometries of brake components, complex interface conditions between components and material properties that are functions of temperature and pressure. In this paper, a systematic study of

brake squeal will be described. Results using finite element complex eignevalue modelling techniques to predict unstable modes of a sample brake system will be presented. Comparisons will be made between the numerical results and experimental measurements. Energy and modal participation methods will be used to assess components for modification to reduce brake squeal propensity. The results of a parametric study of critical parameters (such as geometry, contact stiffness, material properties including stiffness, damping and friction coefficient) that influence brake squeal propensity will be discussed.

11:40-12:00

1590 _____ *contributed*

A STUDY ON IN-PLANE VIBRATION MODES IN DISC BRAKE SQUEAL NOISE

Antti T. Papinniemi*, Jiye T. Zhao, Joseph C. Lai

**PBR Australia, East Bentleigh, Australia*

Brake squeal noise has been an ongoing concern with automotive brake systems since their inception. Although they do not usually directly affect the mechanical performance of the brake, brake noise concerns can impact significantly on customer satisfaction levels and warranty costs. Interest in the in-plane vibration modes of disc brake rotors has grown in recent years because there has been a strong correlation between many brake noise occurrences and natural frequencies of the disc brake rotor's in-plane modes. However, the exact nature of the in-plane modes, and their interaction with rotor bending modes is not fully understood. In this paper, a study identifying and controlling brake noise related to the brake rotor's in-plane modes is presented. A problem brake system was investigated by using a large scale finite element model to predict the stability of the brake rotor modes. In-plane motion was identified from the analysis that correlates well to noise dynamometer measurement. Alternative designs were investigated analytically before prototypes were manufactured and tested. The noise testing results of the proposed designs was found to be in excellent agreement with the analytical predictions.

Distinguished Lecture 5

13:00-14:00 h **Room:** Rio 1+2

Predicting the Response Statistics of Uncertain Structures Using Extended Versions of SEA

Robin S. Langley
University of Cambridge, UK

Professor of Mechanical Engineering, Department of Engineering, University of Cambridge. Director of Structural Acoustics Ltd. Research activities in Dynamics of offshore structures; noise and vibration in aerospace, marine and automotive structures; random vibration; statistical energy analysis. Author of over 100 journal publications and 50 conference papers. Member of the Editorial Board: Journal of Sound and Vibration, Applied Ocean Research, IMechE Journal of Aerospace Engineering.

The dynamic analysis of a complex vibro-acoustic system is difficult for two reasons: firstly the system may require very many degrees of freedom to describe the response, and secondly the response may be sensitive to small imperfections in the manufacturing process. Both of these problems become increasingly severe as the excitation frequency increases, due to the reducing wavelength of the system deformation. This presentation will review recent progress in the development of response prediction methods for complex systems of this type. Attention will be directed initially at high-frequency problems where, under certain conditions, the mean response over an ensemble of uncertain systems can be predicted by using Statistical Energy Analysis (SEA). The extension of SEA to yield the ensemble variance will be reported, and a number of theoretical and experimental validation studies will be described. The further extension of SEA to deal with lower frequency vibrations will then be described, and this involves the use of a hybrid method that couples SEA and finite element technologies. The use of the hybrid method to predict the ensemble mean and variance of the response will be discussed, and again a number of theoretical and experimental case studies will be presented.

Session AR1: Aeroacoustics

chairs:

Marvin Goldstein - *USA*

Serge Lewy - *France*

14:00-15:40 **Room:** Flamengo 1

14:00-14:20

1451 _____ *invited*

JET NOISE PREDICTIONS BASED ON TWO DIFFERENT FORMS OF LILLEY'S EQUATION

Marvin Goldstein ⋆, Abbas Khavaran, Ricardo E. Musafir

⋆*NASA Glenn Research Center, Cleveland, USA*

The acoustic analogy, introduced by Lighthill1 over 50 years ago, remains the principal tool for predicting the noise from high speed air jets. Its most general formulation amounts to rearranging the Navier-Stokes equations into a form that separates out the linear terms and associates them with propagation effects that can then be determined as part of the solution. The nonlinear terms are treated as "known" source functions to be determined by modeling and, in more recent approaches, with some or all of the model parameters being determined from a steady RANS calculation. A popular form of the analogy assumes the "base" flow (about which the linearization is carried out) to be parallel and the resulting equation is usually referred to as a Lilley's2 equation. In this presentation, the far field acoustic spectra at 90° to the downstream axis of some typical high speed jets are calculated from two different forms of Lilley's equation. More or less standard approximations are introduced to minimize the turbulent source function information that has to be inputted, and the remaining information is determined from some recent measurements of Harper-Bourne. These measurements, which were limited to a single point in a low Mach number flow, are extended to other conditions with the aid of a highly developed RANS calculation, known as the WIND code. The results are compared with experimental data over a range of Mach numbers. Both forms of the Lilley equation lead to predictions that are in excellent agreement with the experimental data at subsonic Mach numbers. The agreement is also fairly good at supersonic speeds, but the data appears to be slightly contaminated by shock- associated noise in this case.

14:20-14:40

1988 _____ *invited*

JET NOISE PREDICTIONS BASED ON TWO DIFFERENT FORMS OF LILLEY'S EQUATION-PART 2

Marvin Goldstein ⋆, Abbas Khavaran, Ricardo E. Musafir

⋆*NASA Glenn Research Center, Cleveland, USA*

The formulations of the acoustic analogy developed in Part 1 are combined with some recent measurements of the appropriate turbulent source function in order to calculate the far field acoustic spectra at 90° to the downstream axis of some typical high speed jets. The source measurements, which were limited to a single point in a low Mach number flow, were extended to other conditions with the aid of a RANS code with a turbulence model. The results are compared with experimental data over a range of Mach numbers. Both forms of the analogy lead to predictions that are in fair agreement with the experimental data at subsonic Mach numbers. The agreement is not quite as good at supersonic speeds, but the data appears to be slightly contaminated by shock- associated noise in this case.

14:40-15:00

1854 _____ *invited*

LES STUDIES ON SOUND GENERATION AND CONTROL IN SHEAR FLOWS

Eldad Avital⋆, Victoria Suponitsky, Mikel Alonso

⋆*Queen Mary Univ. of London, London, UK*

Large Eddy Simulation (LES) is steadily gaining maturity as a Computational Fluid Dynamics (CFD) mean to study unsteady turbulent or even transitional flows. The large scale turbulent structures are simulated while the small scale structures are modelled. Thus LES can be seen as a middle way between the Direct Numerical Simulation (DNS) where all scales are simulated to RANS where all the turbulent scales are modelled. In this paper we will look at two LES studies of low speed shear flows of a moderate Reynolds number. The first case is the free jet and the second case is of an open cavity flow. In both cases the flow is taken as incompressible and the sound source is taken as compact. Lighthill's theory or a variation is used to calculate the sound source and its emitted sound field. Two forms of free jets are studied, circular and elliptic both show the basic features of a mixing region followed by a transition region. The elliptic jet shows a higher degree of mixing which results in a higher generation of small scale structures and a higher sound emission in the lateral quadrupoles and in higher frequencies than the circular jet. However the circular jet shows a higher total acoustic power output. The open cavity flow simulations show the well recognized flow oscillations, whose frequencies correspond well to existing models. It is shown that a simple form of an active flow control in the form of a steady injection and suction

can lead to a strong decrease in the flow oscillations and thus to an attenuation of the dipole noise. This attenuation is found to be affected by a threshold in the injection/suction level and is associated with a change in the flow characteristics.

15:00-15:20

1999 _____ *contributed*

MECHANISMS OF NOISE RADIATION BY TURBULENCE NEAR A RIGID BODY

Victor Kopiev

TsAGI, Acoustic Division, Moscow, Russia

With continued success in engine noise reduction, airframe noise has emerged as a potentially significant contributor to overall acoustic emissions, particularly at landing conditions. The dominant sources of airframe noise are known to be associated with unsteadiness of separated and/or vortical flow regions around the high-lift system (i.e., flaps and slats) and the aircraft undercarriage (i.e., landing gear). Due to the complexity of three-dimensional vortices that may contribute to flow unsteadiness and the importance of surface geometry in scattering these vortical structures into sound, airframe noise is an extremely complex and challenging problem. In this paper we consider well-known situation when circular cylinder is streamlining by turbulent flow and analyze new experimental results recently obtained by azimuthal decomposition technique. It is surely accepted that the dipole term is localize on the body surface. From this point of view the dipole appearance in the separation zone seems to be absolutely unfeasible. However the experiment evidently demonstrated the fictitious shift of dipole into the region far downstream from the cylinder. We discuss the role of small quadrupole sources in the separation zone which are usually neglected. They appear to be strongly connected with the dipole sources located on the cylinder. Interference leads to surprising picture of the resulting sound field: equivalent dipole sources are located in the separation zone far downstream from the cylinder. This effect manifests a dual role of small quadrupole sources in the low frequency range: (i) quadrupoles located closely to the cylindrical surface create the dipole sources in the cylinder (which radiate the main noise) and (ii) quadrupoles displace the dipole source far downstream due to the interference. So, even for small Mach number these quadrupole sources must be considered for correct noise prediction and mechanisms revealing.

15:20-15:40

1918 _____ *invited*

STUDY ON BLAST NOISE IN SUPERSONIC FLOW

Duck-Joo Lee*, In Cheol Lee, Sung Ho Ko, Sung Dae Woo, Guk Jung Kang, In Woo Kim

* *KAIST, Daejeon, South Korea*

CFD (computational fluid dynamics)-CAA (computational aeroacoustics) coupled methods are developed for the analysis of blast noise. CFD methods can analyze complicated situations such as moving body easily. And CAA methods can only analyze simple cases but produce more correct results with help of high-order, high resolution schemes. To maximize the merits of both methods, CFD methods are applied on near flow field, and CAA methods are applied on far acoustic field. Using CFD methods and CAA methods, a distributed monopole problem is simulated and the results are compared to each other. These results show the difference between CFD methods and CAA methods, and give the need of CFD-CAA coupled methods. The interface boundary conditions, which is the most important thing for CFD-CAA coupled methods are studied by two different methods. Both methods yield good results. And the effects of the distance between sound source and interface boundary are investigated. The result is better if the distance is shorter. The developed CFD-CAA coupled methods are applied to analysis of supersonic shock noise for validation. From the results, the developed methods can be used for not only simple cases but also complicated practical cases. After validation, the developed methods are applied to the problem of real high pressure condition. For near field flow analysis, the realistic condition of high pressure is simulated without projectile effect. Using a silencer of simple type, we can reduce maximum pressure of blast noise up to 76%. And the effect of key parameters such as diameter, length of a silencer and number of baffle are investigated. For noise analysis, noise of near field and far field is calculated both with silencer and without silencer. From the noise directivity map, we can know the characteristics of a blast noise and its silencer. Additionally, a method for analysis of blast noise is studied when there is a sound shield around muzzle device.

Session AT2: Assessment of Noise: Temporal Aspects in the Psychological Evaluation of Single and Combined Noise Sources

chairs:

Hugo Fastl - *Germany*

Sonoko Kuwano - *Japan*

14:00-15:20 **Room:** Business Master 136

14:00-14:20

1570 _____ *invited*

EFFECTS OF SIMULTANEOUS EXPOSURE TO NOISE FROM ROAD- AND RAILWAY TRAFFIC

Evy Öhrström*, Annbritt Skånberg, Lars Barregård, Helena Svensson, Pär Ängerheim

* *Göteborg University Sweden, Gothenburg, Sweden*

Environmental noise, in particular road traffic noise, is a growing and well recognized environmental health problem. However, when noise from road traffic occurs simultaneously with noise from other sources, only limited knowledge exists of the effects on health. A socio-acoustic survey was conducted in residential areas in Lerum, a community east of Gothenburg, Sweden. Noise exposure was calculated for railway and road traffic separately and for the total noise exposure from both sources. The survey was conducted in areas with sound levels ranging from LAeq, 24h 45 dB - 72 dB for both road traffic and railway noise. A sample of 2905 persons aged 18 -75 years was selected. The response rate was 71 % (1953 persons). The objectives were to assess various adverse health effects and to clarify the possible impact of exposure to two noise sources. Preliminary results show that road traffic noise caused a somewhat lower extent of annoyance as compared to railway noise. In areas exposed to high sound levels both from road traffic and railway noise, there seemed to be an interaction effect for noise annoyance. This effect appeared at sound levels above LAeq,24h 55 dB. For both noise sources, the most common adverse effects were disturbances on sleep and relaxation during day time and for railway noise, disturbance of communication. Keywords: road traffic noise; railway noise; annoyance; sleep disturbance

14:20-14:40

1788 _____ *contributed*

A COMBINED RATING SYSTEM AND CRITERIA FOR MULTIPLE NOISES IN RESIDENTIAL BUILDINGS

Jong Kwan Ryu*, Pyoung Jik Lee, Jin Yong Jeon

* *Hanyang University, Seoul, Korea*

A survey and auditory experiments on multiple residential noises such as floor impact, air-borne, bathroom, drainage and traffic noises were conducted to develop a combined rating system and to establish criteria for multiple residential noises. Subjective reactions to each residential noise such as annoyance, activity disturbance, sleep disturbance, noise sensitivity and satisfaction for individual noise, and the effect of individual noise perception on the evaluation of overall noise environment were investigated from the survey. Auditory experiments were undertaken to determine the allowable noise level for each residential noise source and the percent satisfaction for individual noise levels. From the results of the survey and the auditory experiments, a combined rating system was developed and annoyance criteria for multiple residential noises were suggested.

14:40-15:00

1790 _____ *contributed*

THE DEVELOPMENT OF A NOISE ANNOYANCE SCALE FOR RESIDENTIAL NOISE RATING

Jong Kwan Ryu*, Jeong Ho Jeong, Jin Yong Jeon

* *Hanyang University, Seoul, Korea*

A 5-point and a 7-point verbal noise annoyance scale were developed in this study. The 5-point annoyance scale for outside environmental noise was developed from a survey conducted in four Korean cities. Then auditory experiment using residential noises such as air-borne, bathroom drainage, and traffic noise was conducted to compare the effectiveness of the 5-point and 7-point scale for rating residential indoor noise. The result showed that 7-point scale was more useful to get more various responses to indoor residential noise and to rate annoyance of noise in detail. The 7-point verbal scale for residential indoor noise was also developed from additional auditory experiment. The modifiers used in the scales were selected according to the method proposed by ICBEN (International Commission on Biological Effect of Noise) Team 6. As a result, the difference between the intensity of 21 modifiers investigated in survey and auditory experiment was very small. It was also found that the intensity of the selected modifiers in 7-point noise annoyance scales was highly correlated with noise levels, and the intensity difference between each point in 7-point annoyance scales was almost identical.

15:00-15:20

1486 _____ *contributed*

INFRASOUND ASSESSMENT IN A TABACCO FACTORY PREPARATION SECTION

Ilya Tsukernikov*, Boris Klimov, Igor Nekrasov

* *SC "NIIPOLYGRAPHMASH", Moscow, Russian Federation*

The infrasound is recognized as a harmful industrial factor, which is capable to have an adverse effect on human beings and working efficiency of the person. Presence of the intensive infrasound levels was fixed at workstations of various kinds of vehicles, enterprises of an iron and steel industry, operators of compressor shops. Results of infrasound researches on the tobacco preparation line of one of tobacco factories are given in the report. Parameters and features of infrasound formation by the line equipment, which include vibratory conveyors, a screen shaker and a shaking conveyor, are investigated. Clowns rotation frequencies of the specified equipment are within the range from 325 rpm (5,4 Hz) up to 612 rpm (10,2 Hz) and the working strokes (vibration peak values) make 1-2 inches. Research problems included: definition of infrasonic field stability and sizes of sound pressure levels reduction to be required at workstations; measurement of infrasound field distribution over the tobacco workshop with the purpose of determining regions of the maximal and minimal sound pressure levels concentration; revealing of the sources radiating increased infrasound levels. It is fixed, that the sound pressure levels of infrasound for all workstations reach the greatest values in the octave band with central frequency 8 Hz. The received data testify to steady excess of the permissible values for two octave bands with central frequencies 8 Hz and 16 Hz accordingly by 10-17 dB and 9-13 dB. The infrasonic field has complex character of spatial distribution with maxima in the areas of workstations location. The reasons of the increased sound pressure levels are determined and the initial material for development of infrasound-control measures in the shop is received.

15:20-15:40

1559 _____ *invited*

EFFECTS OF TEMPORALLY CHANGING SOUNDS ON COGNITIVE PERFORMANCE

Juergen Hellbrueck *, Andreas Liebl, Sabine Schlittmeier, Alexandra Schmid

* *Catholic University of Eichstaett-Ingolstadt, Eichstaett, Germany*

An overview on several experiments concerning the influence of temporally changing sounds on cognitive performance is presented. Sound conditions include background speech, music, traffic noise, office noise, and animal sounds as well. Effects of such sounds on verbal short-term memory, selective attentional processes, reasoning tasks, and text comprehension were investigated. Furthermore, questionnaire data too have been raised. Our experiments show that temporally changing sounds, in contrast to steady-state sounds, have detrimental effects on tasks which basically imply serial verbal short-term memory performance. Neither sound intensity nor habituation to sounds has an influence on this effect. Therefore, the effects of changing-state sounds on short-term memory are interpreted as a result of preattentive information processing. Central executive processes such as selective attention, however, seem to be predominantly influenced by sound intensity and thereby depending on arousal. This might be explained in terms of attentional capacity theories. Finally, complex cognitive activities such as text comprehension, are also primarily affected by temporally varying sounds, especially by speech. In this case, however, semantic content of speech seems to play a prominent role.

Session BA4: Building Acoustics

chairs:

Elvira B. Viveiros - *Brazil*

Stelamaris R. Bertoli - *Brazil*

14:20-15:40 **Room:** Rio 1

14:20-14:40

1475 _____ *contributed*

RECIPROCITY AS AN ANALYSING TECHNIQUE IN BUILDING ACOUSTICS

Nathalie Geebelen*, Gerrit L.G. Vermeir

* *K.U.Leuven, Leuven, Belgium*

The theorem of reciprocity exists in many forms and is therefore applied in a wide range of mostly coupled scientific fields such as electroacoustics, electromechanics, electromagnetism, etc. The author's interest, in particular, goes out to possible applications of the theorem in the fields of building acoustics and noise control. In these areas we encounter the acoustic and vibro-acoustic reciprocity fundamentals. This paper first states the principles of reciprocity, with, of course, special attention to the acoustic and vibro-acoustic form of the postulate. As mentioned, the theorem is very broad and general resulting in the risk of appearing vague. That's why, secondly, a series of application examples originating from different domains is given. The last part is reserved for experimental results. Reciprocity relations are verified for different test walls and floors, with the aim to use these relations for control of building structures such as floating floors. Floating floors enhance both the airborne and structure born sound insulation between adjacent rooms. However, it

is a precondition that the construction is build up skillfully. Structural defects like sound bridges or leakage will cause an insulation decrease. Therefore, a non-destructive control technique for locating these defects would be a very useful instrument.

14:40-15:00

1543 _____ *contributed*

PERFORMANCE EVALUATION ON THE EUROPEAN PATTERN EN 12345-1 IN THE PREDICTION OF SOUND INSULATION LEVELS BETWEEN THE ROOMS IN BRAZILIAN BUILDINGS

José Augusto Coelho Ferreira ⋆, Carolina Marcon, Paulo H.T. Zannin

⋆ *Universidade Federal do Paraná , Curitiba, Brazil*

This work compared the soundproofing coefficients measured "in situ", among residence rooms built in Curitiba and composed by constructive elements widely used in Brazil, to a simulation of coefficients using the software "Bastian." This software bases its calculation method on European Standard EN 12354. Through statistic analysis, we found out that the calculation method showed a good performance on the simulation of soundproofing coefficient among the residence rooms evaluated. Key Words: Sound insulation, Building acoustic.

15:00-15:20

1612 _____ *contributed*

ACOUSTIC COMFORT IN LEISURE BUILDINGS

Davi Akkerman⋆, Marcos Holtz

⋆ *Harmonia Acústica, São Paulo, Brazil*

São Paulo is the largest city in South America. With 15 million inhabitants, it is known as the major business and commercial center in Brazil. Similarly as the biggest cities in the world, SAO PAULO is highly urban and dense. Its growth trend is vertical. "SESC" (Serviço Social do Comércio), is a non governmental institution that provides very well equipped buildings in many districts all around, offering multi activities for the city's population by supplying recreational, social and cultural needs. The construction of "SESC-PINHEIROS TOWER" was recently finished. This building has 12 (twelve) pavements, five of which are underground. Basically, our task was to integrate the project from the first drawings up to the finished construction, optimizing the Acoustics at installations such as: - Multi purpose Theater (1000 seated places) - Restaurant - Auditorium - Fitness Center - Indoor Swimming Pool - 2 Sports Gymnasiums - Ventilation & Air Conditioning Rooms This paper illustrates , how the Acoustical Engineer can improve the quality of a building by joining a Project Team, comprising Architect, Builder, Structural Engineer, Installations and other experts.

15:20-15:40

1693 _____ *contributed*

ACCESSIBILITY AND USABILITY FOR DISABLED PEOPLE WITH REGARD TO ACOUSTICS - AN OVERVIEW OF THE SITUATION IN SWEDEN.

Carsten Svensson⋆, Pierre Chigot, Jasper Cole, Nils-Åke Andersson

⋆ *Saint-Gobain Ecophon AB, Hyllinge, Sweden*

A "society for all" is on the agenda in several countries. In line with it, buildings have to be accessible and usable for people with disabilities such as limited orientation capacity. An important principle is that all people have equal rights and are of equal value. It is a principle of Swedish building legislation that all new buildings and those which are renovated should be fully accessible for disabled people. Since 2001 it has also been required that easily eliminated obstacles to accessibility and usability shall be remedied before the end of 2010. In spite of this, many buildings are still inaccessible and unusable for people with disabilities. This paper elucidates what policies, legislation and other documents in Sweden say about accessibility and usability with regard to acoustics. It also highlights who benefits particularly from good acoustics and how acoustics can be applied in practice with regard to accessibility and usability. Keywords: accessibility, usability, acoustics, disabilities, limited orientation capacity

Session MT1: Metrology

chairs:

George Wong - *Canada*

Gustavo P. Ripper - *Brazil*

14:00-15:40 **Room:** Business Master 145

14:00-14:20

1437 _____ *invited*

SOME RECENT DEVELOPMENTS AT THE INSTITUTE FOR NATIONAL MEASUREMENT STANDARDS CANADA

George Wong⋆, Lixue Wu, Peter Hanes, Won-Suk Ohm

⋆ *National Research Council Canada, Ottawa, Canada*

This presentation is aimed to provide information on some recent research and development at the Institute for National Measurement Standards, National Research Council Canada. The discussion will include the measurement of the pressure coefficients of LS1P and LS2P laboratory standard microphones, and an investigation into the sensitivity stability of LS1P microphones; the development of a method for low frequency calibration of accelerometers; and the detection of electromagnetic interference during sound pressure level measurements.

14:20-14:40

1701 _____ *invited*

ADJUSTMENT ON LEVEL LINEARITY AROUND LOWER BOUNDARY OF LINEAR OPERATING RANGE OF SOUND LEVEL METER

Hiroaki Takinami⋆, Masaharu Ohya, Tomoharu Wakabayashi, Kiyokatsu Iwahashi

⋆ *RION Co., Ltd., Kokubunji, Japan*

The linear operating range of sound level meter is defined based on level linearity errors. Generally, the upper boundary of the linear operating range depends on the supply voltage for the electronic circuits of the instrument, and the lower boundary depends on the level of the inherent noise of the instrument. For almost all the instruments, the lower boundary level of the range which level linearity errors are less than 0.5 dB is approximately 10 dB greater than the level of the equivalent inherent noise. Around the lower boundary of the linear operating range, the indicated level is the level of the sum of the input signal and the equivalent inherent noise. The level linearity errors are estimated from the simple equation, if the level of the equivalent inherent noise is known. Therefore, if the level of the equivalent inherent noise of the individual inherent noise is known, it is possible to adjust the indicated level according to the input signal level, and it is possible to decrease the lower boundary level of the linear operating range of the instrument. As the results of applying the adjustment, the lower boundary level is decreased approximately 5 dB than the level without the adjustment in the temperature range from -10 degrees to 50 degrees.

14:40-15:00

2073 _____ *contributed*

FREE-FIELD RECIPROCITY CALIBRATION METHOD OF LABORATORY STANDARD MICROPHONE

Sang Joon Suh⋆, Kwon Hyu-Sang, Gap Suh Jae

⋆ *Korea Research Institute of Standards and Science, Daejeon, Korea*

The standard in acoustic metrology is realized by calibrating a condenser microphone which must be reciprocal. The pressure sensitivity is determined with a closed coupler where the sound pressure is assumed to be uniform. This pressure calibration method has been widely used as the reference until now. However the free-field sensitivity that the microphone is placed in a free-field should be determined because it must be in usual. The free-field calibration has much more problems than the pressure calibration in realization, and the measured signal should be enhanced before sensitivity evaluation by reducing the noise which must be physical, electrical, and so on. The cleaning technique of multi-path noise in time domain is proposed here. The proposed method shortens the pulse train in time domain to be better separated by broadening the FRF in frequency domain. Some experimental results show what it works well. The calibration facilities and the procedures in KRISS are introduced with the accumulated results through the repeated measurements.

15:00-15:20

1607 _____ *contributed*

MICROPHONE CALIBRATION

Gunnar Rasmussen

G.R.A.S. Sound & Vibration, Vedbaek, Denmark

The IEC 1094-2 scope specifies a primary method of determining the pressure sensitivity "so as to establish a reproducible and accurate basis for the measurement of sound pressure using the reciprocity technique". Other techniques are available e.g. the pistonphone. Using a precision pistonphone the two methods reciprocity and pistonphone agree very well. An absolute calibration accuracy has been determined to within ±0,05 dB at reference conditions for the pistonphone. By careful control of the atmospheric pressure conditions and the calibration temperature, the calibration far exceeds the requirements for a class LS calibrator. The close control of atmospheric pressure and temperature en-

able field calibrations with a precision pistonphone of sound systems at any altitude on earth with laboratory accuracy and minimize the errors involved with usual calibrators. Present standards does not cover calibration at low frequencies very well. The use of 1.000 Hz as reference frequency does not ensure the best performance of the measuring system. At 250 Hz the uncertainty for calibration error in acoustics is minimized. The discrepancy in the standardised hearing threshold curves clearly indicate the problems with the present IEC 61672 standards when we compare to the proposed normal hearing thresholds for frequencies below 20 Hz. The standardised methods only cover the calibration at higher frequencies. A calibration which cover the frequency range 1 – 200 Hz, where the microphone air equalisation system play an important role, is proposed.

15:20-15:40

1865 _____ *contributed*

REALIZATION AND CHARACETRIZATION OF OMNIDIRECIONAL SOUND SOURCES

Enver Sadikoglu ⋆, Cafer Kirbas, Eyüp Bilgiç, Baki Karaböce, Izzet Turan

⋆ *TUBITAK UME, Gebze, Turkey*

Few applications for building acoustics measurements require usage of omnidirectional sound sources. Verification tests of special acoustical enviroments according to relevant ISO standards, sound absorption, sound transmission, reverberation time measurements are the typical examples. According to the definition, omnidirectional sound source produces sound uniformly in all directions with sufficient amplitude, low distortion within the audible frequency range (20 Hz-20 kHz). However, in practice it is very difficult to obtain an uniform sound field from only one sound source by taking care of their sound distribution and frequency response covering full audible range. The main reason is that sound sources are usually designed to operate efficiently only in a limited frequency range. In order to cover all audible range, sound sources of different sizes, shapes and in different configurations have to be used. Characterization of the sources from metrological point of view requires special acoustical environment and precise instrumentation. Omnidirectional sound sources covering audible frequency range were designed and produced to use in laboratory measurements in National Metrology Institute of Turkey (UME). Some of them was designed to be used as reference sound sources for accurate acoustical calibration and measurements. The directivity patterns of the sources were determined in Full Anechoic Chamber. Technical details related to the design of the sources and results obtained during evaluation of the omnidirectional sound sources performance are presented in this paper.

Session NU2: Numerical Techniques

chairs:

Svend Gade - *Denmark*

Jorge P. Arenas - *Chile*

14:00-15:40 **Room:** Flamengo 2

14:00-14:20

1831 _____ *contributed*

A FINITE ELEMENT MODEL FOR NOISE FROM FIRING RANGES

Morten Huseby

Norwegian Defence Research Establishment, Kjeller, Norway

A three-dimensional, finite element model for noise propagation on firing ranges is considered. The goal is to perform calculations over geometrically complicated domains with sound velocity and ground parameters which are varying over the domain. The parameters are found by field measurements. The equivalent fluid model is used for the sound propagation in the porous ground, leading to a variable coefficient, dampened wave equation. The complete air-ground composite medium can then be described by one unified equation where the air-ground domains are implicitly coupled by the variable coefficients. A finite element method in space and a explicit finite difference scheme in time is used to discretize the equations. The goal is to be able to correctly describe the noise emission from firing ranges. A first planed test is to compare computations to measurements done with detonations of C4 explosives in a region at Finnskogen, Norway. In carrying out such fine scaled computations in 3D over relatively large distances, we require large computational resources. The code is therefore implemented for use on parallel super-computers, in order to have available up to 500 GB of distributed memory.

14:20-14:40

1864 _____ *contributed*

MEASUREMENT AND MODELING OF VARIATION OF STRUCTURAL DYNAMIC RESPONSES

Katsuhiko Kuroda⋆, Toru Yamazaki

⋆*Kanagawa University, Yokohama, Japan*

The objective of this paper is to investigate statistical variations occurring in the dynamic characteristics of structures and to model the variation to eigen properties. If the structure is uncertain then the response will be random, and it can be expected that the response

statistics will depend on all the details of the uncertainty of the model. Dynamic response of a structure can be expressed in terms of the modes of vibration. Quantifying the dynamic response of a structure is concerned with the variability of each natural frequency and damping ratio. Frequency response functions (Inertance) are measured for about 100 steel cans experimentally. In addition, experimental modal analysis is performed to recognize each natural frequencies and damping ratios. It is shown that the distributions of the natural frequencies and the damping ratios are described by normal distribution. To simulate the variance of inertances measured, each natural frequency and damping ratio of a base FE model is considered to have variances which are estimated by the measurement. The FE model for a can is built and is compared to the experimental modal analysis results. The model gives the base natural frequency and then they are fluctuated according to the distributions of measured in order to estimate lots of inertances. The fluctuation of calculated inertances are very similar to those of measured. This simulation procedure can also be applied to simulate the dynamic responses of ten identical products which are a part of Laser beam printer.

14:40-15:00

1656 _____ *contributed*

THE IRRADIATION EFFICIENCY OF SIMPLY SUPPORTED BEAM-REINFORCED PLATES WITH STRUCTURAL OPTIMIZATION BY GENETIC ALGORITHMS

Fábio Fiates*, Arcanjo Lenzi

* *Unisul, Florianópolis, Brazil*

The study of the irradiation efficiency of structural components has been subject of many researches along the years, since its precise understanding provides conditions for predicting the sound pressure field where these components are operating. This is the case of sound pressure generated at the accommodation area in offshore platforms, due to vibrations transmitted throughout the structure, excited by vibrations of large machines. It is known that reinforcing beams affects the irradiation efficiency of plates, which is increased since sound cancellations effects are interrupted in the vicinities of the beams. From the Rayleigh Integral, one can have the sound pressure field on the plate, which is necessary to calculate the irradiation efficiency. Fourier Transforms can solve this integral. When FFT algorithms are used, the integral is resolved in a very fast way, when compared with a numerical integration. This work presents results of irradiation efficiency of plane plates, considering the effects of the flexibility (web and flange own modes) of the reinforcing beams. The velocity distribution is obtained by Finite Elements and considers the real influence of the reinforcement. The results show that increases in the irradiation efficiency occur when the plate is reinforced. Comparisons of irradiation efficiencies will be shown, among simply supported plates and beam-reinforced plates, along with the FFT technique. This work also presents a structural optimization of a plate with one reinforcement, using Genetic Algorithms to select the best beam in order to minimize the irradiation efficiency of the beam-reinforced plate

15:00-15:20

2105 _____ *contributed*

DYNAMIC ANALYSIS OF FRAME STRUCTURES AT HIGH FREQUENCIES USING ENERGY FINITE ELEMENTS AND SPECTRAL ELEMENTS

Edmilson Oliveira Santos *, J.M. dos Santos, José Roberto Arruda

* *UNICAMP, Campinas, Brazil*

The Energy Finite Element Method (EFEM) is based upon an approximation of the partial differential equations that result from the energy balance and energy coupling relations for different structural configurations and wave types. The coupling relations are used to describe the energy exchange among various subsystems. The EFEM can be expressed in a standard finite element (FE) approach, which is similar to a heat conduction problem. The Spectral Element Method (SEM) is based upon the exact solution of the partial differential equations in the frequency domain. Elements are assembled using the direct stiffness method. Therefore, a spectral element is equivalent to an infinite number of finite elements for a homogeneous medium. For this reason, the SEM, when it can be used, is more adequate to predict the dynamic response at higher frequencies than the FE method. In this paper, these two methods are used to predict the dynamic response of frame-type structures at high frequencies. Responses simulated with EFEM involving longitudinal and transversal waves in coupled beams are analyzed and compared with the solutions obtained by SEM. Experimental results from the INCE T-shaped beam are presented and compared with the simulated results.

15:20-15:40

1452 _____ *contributed*

DETERMINATION OF THE TRANSFER FUNCTION OF A FINITE PLATE COVERED WITH A FOAM LAYER

Vitor Litwinczik*, Walter Lauriks, Arcanjo Lenzi

* *EMC, UFSC, Florianópolis, Brazil*

In this work the behavior of an elastic plate covered with a foam layer is analyzed based on the mobility transfer function of the structure obtained on the free side of the foam layer. Covered plates are commonly found on the aeronautic and automobilistic industries. In such structures, the coating has the aim of reduce the structural sound radiated by the plate as well as the acoustical energy in the medium. In this paper, the

foam is modelled based on the Biot's theory that considers the porous material as a flexible structure [1]. To obtain the foam surface velocity, a simplified solution based on trigonometric functions is used. The hypothesis assumed to solve the linear system composed by the boundary conditions of the problem are presented and the numerical results validated comparing them with experimental FRF. The analyzed system consists of a simply supported thin plate covered with a foam layer driven by a point harmonic force, assuming only flexural vibration in the plate. It will be shown that the response has two different behavior according the foam resonance frequency. At frequencies lower than the foam resonance frequency the structure surface behavior is determined by the base plate behavior and at frequencies near the foam resonance the foam movement is dominant.

Session PS: Psychoacoustics

chairs:

Ana Cláudia Fiorini - *Brazil*

Raquel Fava de Bitencourt - *Brazil*

14:00-15:40 **Room:** Lagoa

14:00-14:20

1565 _____ *contributed*

THE INFLUENCE OF DIFFERENT HEAD GEOMETRIES ON SPATIAL HEARING

Janina Fels

RWTH Aachen University, Germany, Aachen, Germany

The spatial hearing, and how we hear noise and sound, is strongly dependent on our individual head-related transfer functions (HRTF). In order to obtain spatial noise measures artificial heads are used. Spatial cues, such as the Interaural Time Difference and the Interaural Level Difference can be deduced from the HRTF. The first varies a lot with the head width, whether the effect of the second cue is more complex. Many investigations showed that there exist numerous individual differences between the HRTFs of adults caused by the differences in the head geometries. This work investigates the influence of the head and torso dimensions on the spatial hearing. The most important head dimensions are the height of the head, the width of the head, its length and the distance from ear to the shoulder. Thus, for the construction of artificial heads in the future, the results here presented indicate in which dimension bigger tolerances could be accepted and which dimensions must be chosen more accurately. As a first attempt to construct a detailed database, a statistical analysis of head and torso dimensions representing the data from children up to adults is made. Using the Boundary Element Method (BEM) the spatial cues can be derived out of CAD models from the head. These models were created by varying each parameter at a time, in order to investigate the effect of only this parameter on the HRTF, its impulse response and on the spatial cues for different incidence of sound.

14:20-14:40

1809 _____ *contributed*

EXPERIMENTAL STUDY ON THE APPLICATION OF TIME-DELAY TECHNIQUE TO PUBLIC ADDRESS SYSTEM IN A TUNNEL

Sakae Yokoyama ⋆, Shinichi Sakamoto, Hideki Tachibana, Seiya Tazawa

⋆ *I.I.S., The University of Tokyo, Meguro-ku, Japan*

For the improvement of speech intelligibility (easiness of hearing) of the public address system for emergency evacuation in a tunnel, the authors are proposing the application of successive time-delay technique to the system and have performed an experimental investigation in an actual tunnel. In the experiment, 5 directional loudspeakers were set at an interval of 150 m in the tunnel and the delay network providing a time-delay estimated from the sound speed in the field was applied. By comparing the difference of speech intelligibility between the conditions with/without the time-delay, the effect of the technique was examined. In an anechoic room, subjective experiments on speech intelligibility were performed using a 6-channel recording/reproduction technique. By this technique, the natural impression can be realized with 3-dimensional information. For these experiments, in the tunnel the announcement reproduced through 5 loudspeakers was recorded by using a 6-channel recording system and the recorded sound was reproduced through a 6-channel reproduction system in an anechoic room. At the center point of the reproduced sound field (hearing position), subjective tests were performed. From the results, it was confirmed that the successive time-delay technique is effective.

14:40-15:00

1849 _____ *contributed*

THE EFFECT OF VISION ON JUDGMENT OF AUDITORY DISTANCE AND VOICE LEVEL IN A NATURAL ENVIRONMENT

Robert Karsh⋆, Tomasz Letowski

⋆ *U.S. Army Research Laboratory, Aberdeen Proving Ground, USA*

The aim of the present study was to examine whether visual perception of space affects the level of voice production and the auditory perception of distance to an invisible sound source. Nine participants performed an auditory detection task in a wooded area at night and in the daytime. Stimuli were 30 single-syllable Eng-

lish words presented at random intervals from five loudspeakers hidden on the forest floor. All listeners performed the task while blindfolded, while wearing night vision goggles, and while wearing nothing over the eyes. The listener's task was to report verbally, the perceived direction and distance to the sound source and then to repeat the presented word. The listeners were asked to make their verbal reports loudly enough to only be heard by an experimenter situated 2.5 meters behind the listener. Auditory distance estimates of the sounds and the listener's voice level data are presented and discussed in the context of the environmental and listening conditions.

15:00-15:20

1860 _____ *contributed*

MUTUAL EFFECT OF THE DIFFICULTIES OF SIMULTANEOUS TASK ON SIMULATED DRIVING AND AUDITORY WORKING.

Hiromits Miyazono*, Ryoji Baba, Ryouichi Hayama, Yoshifumi Chisaki, Tsuyoshi Usagawa, Masanao Ebata

* *Prefectural University of Kumamoto, Kumamoto, Japan*

In Japan, the revised regulation of traffic was enforced in 1st Nov. 2004 and prohibited use of cellular phone while driving. It seems to emphasize on a dangerous for phone operation on the driving, though a conversation with hands-free equipment is excluded. Some studies said that a conversation without phone holding draw attention and there was same dangerous holding the phone. However, the difficulties of task which the contents of the conversation or mental load were not controlled enough to discuss. This research also examined the effects of a cellular phone conversation on simulated driving in condition that the difficulties of both tasks controlled. A mental arithmetical task, auditory task, was used as a conversation with handheld equipment. The sound of single figure presented via headphone and listener responded the answer of the calculation in a voice. The number of increasing place was defined as the difficulties of auditory task. Simplified driving game on Laptop PC was used as the driving and the difficulties were uncertainty of the signal to change to red and twist of the curve. As a result, the reaction time for red light increased adding auditory task to simulated driving. It was reconfirmed the dangerous of a cellular phone conversation without manual manipulation or holding of the phone. The more negative effects appeared under lower difficulty of driving which running on dull-curved road and under less uncertainty of the signal to change in this experiment. There was only a few effect of the difficulty of auditory task. Analyzing of time series on driving, the delay of response to red light emerged in condition of thinking and response the answer than in that of hearing and memory. In addition, the more effects appeared on not only hearing and thinking but also waiting for sound.

15:20-15:40

1902 _____ *contributed*

EFFECTS OF LISTENING ATTITUDE ON LOUDNESS OF SIGNAL SOUND UNDER NOISE ENVIRONMENT

Takeshi Akita*, Kenji Eto, Katsuyoshi Inao, Naoko Sano

* *Tokyo Denki University, Chiyoda-ku, Japan*

Effects of listening attitude and signal to noise ratio on perception of loudness of signal sound are investigated in the present research. Sound that is not paid attention to is ordinarily neglected by people in noise environment. In that case, it is supposed that loudness of the sound is perceived lower than actual loudness. Signal sound such as warning signal in public place should be planned to be heard clearly even by people who do not attend to it. If such underestimate occurs with listening attitude of less attention to the sound, it is necessary that volume of signal sound is properly determined so that every person who has no intention to hear his surrounding sound can realize the signal. On the basis of these considerations, two experiments that aim to reveal effects of listening attitude on perceived loudness are carried out. In each experiment, subjects are instructed to estimate loudness of signal sound that is presented over background noise recorded in the crowd under two listening conditions. The one is the condition that subjects attend to signal sound, the other is that they pay no attention to it. Results show that an underestimate of loudness occurs when subjects intend to neglect the signal sound. The tendency is strong under the condition of little signal to noise ratio, and it is estimated that the difference between perceived and actual loudness corresponds to about 3 dB under the condition of signal to noise ratio of 5 dB. According to the results of the present research, it is supposed that decrease of noise that makes signal sound clear is necessary to be planned with consideration of peoples' listening attitude to the signal in public place.

Session RA2: Room Acoustics

chairs:

Sylvio Bistafa - *Brazil*

Roberto A. Tenenbaum - *Brazil*

14:00-15:40 **Room:** Botafogo

14:00-14:20

1423 _____ *invited*

SPEECH INTELLIGIBILITY STUDY IN UNIVERSITY CLASSROOMS: AN IMPROVED METRIC TO ASSESS HIGH BACKGROUND NOISE LEVELS

Ludimila Medrado*, Roberto A. Tenenbaum

* *UFRJ, Rio de Janeiro, Brazil*

The paper presents the results obtained from several acoustical measurements performed in three university classrooms located at Universidade Federal do Rio de Janeiro. In each room, articulation tests were taken, using three different word lists with distinct intensity levels and a artificial speaker as sound source. The results were used as a direct estimate of speech intelligibility (SI). Besides articulation tests, impulse responses at six microphone positions and one source point were obtained using the sweep sine technique. Background noise levels were also registered at the same microphone positions. These data were used to compute two intelligibility metrics: Useful to detrimental sound ratio (U50) and speech transmission index (STI). Both metrics were then compared with SI scores, by fitting third-order polynomial functions, which resulted in coefficients of determination of 79% and 90%, respectively. Due to the high background noise in the rooms, the U50 metric did not present a satisfatory correlation with the SI scores. In fact, the influence of background noise in the metric is not enough to deal with situations with high noise level. Therefore, a change in the original expression of U50 was proposed, in order to increase the influence of the background noise on its final value. The new improved metric was then applied to the classrooms, showing a better correlation with the speech intelligibility, increasing the coefficient of determination by up to 10%.

14:20-14:40

1782 _____ *invited*

PREDICTING ACOUSTICS IN CLASS ROOMS

Claus L. Christensen*, Jens H. Rindel

* *ODEON A/S, Lyngby, Denmark*

Typical class rooms have fairly simple geometries, even so room acoustics in this type of room is difficult to predict using today's room acoustics computer modeling software. The reasons why acoustics of class room are harder to predict than acoustics of complicated concert halls might be explained by some typical features of these rooms; parallel walls, low ceiling height (the rooms are flat) and very uneven distribution of absorption. It is suggested that a part of the explanation to the problem lies in the way scattering is implemented in current models relying on the use of scattering coefficients that are used in order to describe surface scattering (roughness of material) as well scattering of reflected sound caused by limited surface size (diffraction). A method which combines scattering caused by diffraction due to surface dimensions, angle of incidence and incident path length with surface scattering is presented. Each of the two scattering effects is modeled as frequency dependent functions.

14:40-15:00

1702 _____ *contributed*

IMPACT OF EDUCATIONAL EQUIPMENT NOISE ON SMART CLASSROOM ACOUSTICS

Sabeer Mir*, Adel Abdou

* *King Fahd University of Petroleum & Minerals, Dhahran, Dhahran, Saudi Arabia*

Numerous studies investigated the acoustics of conventional classrooms for good Speech Intelligibility (SI). However, a new generation of high-tech classrooms referred to, as "smart classrooms" is becoming a necessity at educational institutions. This paper describes the features of smart classrooms focusing particularly on the Background Noise (BN) generated by instructional equipment. Measurements were conducted in similar classrooms to assess the magnitude and characteristics of generated noise. With instructional equipment in operation, measurements revealed an appreciable increase in the ambient noise level. A computer model of a typical smart classroom is developed to investigate the appropriateness of the classroom layout and alternative surface finishes as published by the Acoustical Society of America (ASA) for creating a learning environment with desirable listening conditions. To determine the impact of the resulting BN due to instructional equipment noise on SI in such specialized enclosures, simulations of the classroom model with recommended surface finishes under various BN conditions were carried out. Results showed the need to restrict the overall BN level to NC-25, and emphasized the selection of quieter operating instructional equipment. Alternative surface treatments need to be investigated to further verify ideal surface finishes for this emerging generation of classrooms.

15:00-15:20

2009 _____ *contributed*

SURVEY ON SOUND ENVIRONMENT IN CLASSROOMS DURING SCHOOL HOURS FOR HEARING IMPAIRED STUDENTS

Keiko Nishizawa*, Tetsuya Sakuma

* *The University of Tokyo, Bunkyo-ku, Japan*

In order to investigate the relationship between the actual situations of sound environment and the hearing impaired students' impressions in classrooms, we performed a survey during school hours by measurements of sound levels and by questionnaires to the students. In the survey, we selected instruction rooms for hearing impaired students and normal classrooms for 3 different grades, and the measurements are done in the classrooms, their adjacent rooms and corridors. The questionnaires were distributed to not only the hearing impaired but also normal studensts just after classes, asking about the following impressions: intelligibility of hearing voices, distraction with noises generated by furniture dragging, air conditioning and transmitted from adjacent spaces, and requirement for silence in the classroom. The measured result showed that LAeq ranged from 60 to 65 dBA in the instruction rooms, and those in the normal classrooms for the 3rd and 9th grades were about 80 and 70 dBA, respectively. The hearing impaired students pointed out distraction with all kinds of noises in the instruction rooms, while not only they but also the normal students evaluated the dragging noise to be most distracted in the normal classrooms. In this survey, the hearing impaired in the elementary school required more silent classrooms, and this requirement was also pointed out by the normal students in the elementary school more keenly than the junior high school.

15:20-15:40

2017 _____ *contributed*

THE ACOUSTICS OF THE LERNING ENVIRONMENTS ANS IMPLICATIONS TO COMMUNICATION AND LEARNING

Sotirios Dalianis*, George, Campourakis

* *NTUA, Athens, Greece*

The acoustic environment of education buildings is related to learning difficulties and this applies to all levels of education, especially to nursery and early learning stages. Although the legislation for noise levels in adult working environments is extensively reviewed there are few references for school environments in relation to noise levels, construction and room acoustics. In this paper we study learning difficulties aspects in relation to noise levels and reverberation time of different learning environments including nursery, early learning stages, primary and secondary education and higher education lecture rooms. The particularity of each environment is analysed and the effects of room acoustics and noise level are concerned. These elements have implications to students learning process as well to teachers working environment quality. Construction aspects of such environments are discussed.

Session SC2: Soundscape and Community Noise

chairs:

Gaetano Licitra - *Italy*

Marion Burgess - *Australia*

14:20-15:40 **Room:** Rio 2

14:20-14:40

1931 _____ *invited*

THE IMPORTANCE OF THE IMMEDIATE SOUNDSCAPE FOR ANNOYANCE IN THE URBAN LIVING ENVIRONMENT

Kerstin Persson Waye*, Agneta Agge

* *Department of Environmental Medicine, Göteborg University, Gothenburg, Sweden*

The environment is experienced through our perception and interpretation of sensory inputs from e.g. smell, touch, sight and hearing. The perceptions and the memory they imprint can be assumed to be of large importance for how we value the environment emotionally. For assessment of noise and different types of adverse health effects, it has become increasingly apparent that human reacts to the soundscape as a whole and also that the visual information may be of importance for the interpretation of sounds and development of noise disturbance. The urban soundscape is dominated by road traffic noise, but in sheltered areas and during quieter time periods other sound signals contribute to the soundscape. This contribution may be positive or negative for health and wellbeing depending on their perceived intrusiveness and/or unpleasantness. A socio-acoustic study investigated whether sounds from compressor and ventilation units (CV-units), as part of a total urban soundscape are of importance for annoyance and health. The study population comprised 473 residents (response rate 63%-67%) living in flats surrounding eight courtyards exposed to traffic noise on one side of their flat and to CV-unit sounds on the other side. The exposures from CV-units were categorised into Level Low (LL, n=263), Level Moderate (LM, n=80) and Level High (LH, n=130). The noise exposures were recorded indoors in a bedroom facing the courtyard in a selection of apartments as well as outdoors in the yard. Traffic noise outdoor levels were calculated. The average indoor SPL from CV-units was 23dBA, 44dBC, (LL), 27dBA, 47dBC

(LM) and 30dBA, 51dBC (LH). Results showed a high and significant prevalence of noise annoyance due to CV-units with 22.5% and 50% annoyed in the highest exposure categories (LM, LH) compared to 8.5% in LL. The study shows that the total soundscape needs to be evaluated in order to predict a good living environment. Peoples' emotional and visual descriptions of their courtyard differed between exposure categories and a significant influence of descriptions related to pollution and calmness but not for pleasantness was found for reported noise annoyance. Key words: soundscape, ventilation noise, noise annoyance, life quality.

14:40-15:00

1978 _____ *invited*

CHARACTERIZATION OF URBAN SOUNDSCAPE USING PSYCHOACOUSTIC CRITERIA

Catherine Semidor

GRECO EAPBx, Talence, France

In a previous paper [Forum Acusticum 2002], the importance of the psychoacoustic criteria to characterize the urban sound environment in a more satisfactory way than using Equivalent Sound Level only was considered. In order to validate this assertion a survey was carried out to analyse binaural sound recordings of very short extracts from the urban scene, called "sonoscene". The choice of the sonoscenes enables us to compare several significant urban soundscapes from interior and exterior public areas. The binaural recordings were investigated using dBFA software according to ISO 532B and the different criteria studied are Loudness, Roughness, Sharpness and Fluctuation Strength. The results show significant correlations between the qualityof some sound sources sonoscene and the psychoacoustic criteria, for example in the case of human activities: voice noises and the values of Fluctuation Strength or in the case of traffic: horn noises and Loudness.

15:00-15:20

1979 _____ *invited*

INTERACTING QUANTITIES OF THE SOUNDSCAPE DUE TO TRANSPORT MODES

Jacques Beaumont*, Catherine Semidor

**LTE-INRETS, Bron Cedex, France*

In order to propose pertinent Noise Indicators to underline the impact of traffic noise in the urban environment, interacting parameters are listed. This paper deals with the way to interrelate the different quantities used to describe the type of areas, the characteristics of the sound sources (the different transport modes) and the target information. The goal of the study is to classify noise situations of the exposed population, particularly during quiet periods (evening and night when the background noise has a relative weak value). The choice of the indicators depends on the duration of the noise events, their emergence frequency and level. Long-term effects are evaluated by energetic indexes ($L_{Aeq,T}$ or L_{DEN}), statistical indexes (L_{10}, L_{50},...), number of noise events and so on. These indicators do not suit the noise situation explained above. It needs indicators which are able to describe time-frequency contents to avoid the masking of short but significant noise events.

15:20-15:40

2033 _____ *invited*

A MODEL FOR NOISE ANNOYANCE BASED ON NOTICE-EVENTS

Tom De Muer*, Dick Botteldooren, Bert De Coensel, Birgitta Berglund, Mats Nilsson, Peter Lercher

* *INTEC, Ghent University, Gent, Belgium*

Classical dose response relationships for environmental noise annoyance have been based on Ldn or Lden. These exposure measures are essentially based on an energy averaging measure, LAeq. Differences between groups of sources (e.g. continuous or event based) are accounted for by using separate dose-effect relationships. In society today, one often sees that event loudness is traded for number of events which is perfectly acceptable within the LAeq based annoyance concept. Clearly a more unified theory for noise annoyance is needed to fully account for the effect of such trade-offs. In this work we investigate the hypothesis that noise annoyance is primarily determined by noticing the intruding sound. This hypothesis has been forwarded before by several researchers but was never elaborated upon. The model we present here, starts by careful prediction of the occurrence of 'notice-events'. It takes into account signal to noise ratio of the target sound with respect to the ambient (natural) background level, the indoor background level, the activity the listener is engaged in, etc. A notice event can in this model be caused both by a (sudden) increase in noise level or by a change in activity and alertness for intruding noise by the recipient. The impact of noticing an event on global noise annoyance is assumed to depend primarily on the signal to noise ratio. A field experiment in a natural setting was conducted that allowed for participants to engage in other activities than just listening to the sound. The target sounds were train noise with varying event intensity and number of events and road traffic noise both highway and roads with less intense traffic. The outdoor background level due to natural sources ranged between 39 and 49 dB(A). This experiment is mainly used to extract the constants needed in the proposed model.

Session TN2: Transportation Noise

chairs:

Vivian Silva Mizutani - *Brazil*

Keith Attenborough - *UK*

14:00-15:40 **Room:** Copacabana

14:00-14:20

1433 _____ *contributed*

SILENT ROADS FOR EFFECTIVE NOISE REDUCTION

Wim van Keulen

VANKEULEN advies, Vlijmen, Netherlands

Noise pollution due to road traffic is a major problem. The most effective way to reduce traffic noise is the application of silent road types. The severity of traffic noise requires the large-scale introduction of low noise technology. Among the several technologies available, the application of low noise surfacings is not only the most cost-effective but also can be implemented on short notice. These advantages have led to the development and application of several types of low noise surfacings. Low noise or silent road surfacings are considered to be among the most effective means of reducing traffic noise and, as a result of continuous study and optimization, improvements in both the total reduction and the application range of the reducing effect are to be expected in the near future. Especially, in countries with less experience with respect to silent roads, these road types also have to be durable in order to limit expensive maintenance. Furthermore, application of silent roads needs proper legislation and generally accepted test methods to establish the acoustic properties and to be able to control the performance after being produced as well as during its life time. Silent roads will lead to lower noise barriers or no barriers at all [1]. This induces a significant cut in overall expenses. Silent roads are not luxury products but they contribute significantly to the welfare of everyone.

14:20-14:40

1469 _____ *contributed*

THE INFLUENCE OF THE RECONSTRUCTION OF THE TRAM TRACKS ON THE LEVEL OF NOISE

Stjepan Lakusic*, Tatjana Rukavina, Vesna Dragcevic

* *University of Zagreb, Faculty of Civil Engineering, Zagreb, Croatia*

The level of noise during tram operation depends on a number of factors. As generators of increased noise levels, the type of tram and the operating speed can be acted upon momentarily. The type of track base, type of rails and the rail fastening systems represent a group of factors that can be acted upon only during reconstruction, which means in longer time periods. In the endeavour to undertake adequate measures for reducing the level of noise during tram operation, in conjunction with Zagreb's Streetcar Company, the Department of Transportation of the Faculty of Civil Engineering, Zagreb University (Croatia) carried out research on the influence of track reconstruction on the noise level. As representative, the tracks chosen were the ones located on a separate strip (between carriageways), set on a continuous concrete base. The reconstruction of the tracks encompassed a complete change of rails, as well as making new rail fastening systems to the base. Short term noise level measurements, during a daily period before and after the completion of the works on the reconstruction of the tracks, were performed. The research results represent a contribution in defining the measure of influence that the usual way of reconstructing the tram tracks, carried out in the City of Zagreb, has on the reduction of the noise levels.

RIO 2005 inter-noise ENVIRONMENTAL NOISE CONTROL
The 2005 Congress and Exposition on Noise Control Engineering
07-10 August 2005 - Rio de Janeiro - Brazil

14:40-15:00

1583 _____ *contributed*

PREDICTED INFLUENCE OF BALLAST AND POROUS CONCRETE ON RAIL NOISE

Keith Attenborough *, Patrice Boulanger, Qin Qin, Rick Jones

* *University of Hull, Hull, UK*

Values of flow resistivity, porosity, viscous characteristic length and tortuosity either measured non-acoustically or deduced from impedance tube data for railway ballast and porous concrete have been used, together with appropriate impedance models and an assumed source spectrum in boundary element simulations of the spectra and overall A-weighted sound pressure levels at 1.5 m height and 20 m from the nearest rail due to rail/wheel sources. Time averaging has been used to allow for the 3D effects of the sleepers. It is concluded that, compared with flat ballast, the ballast shoulders in the reference profile have an important effect on rail/wheel noise. However neither provision of additional banked ballast areas nor replacing nonporous by porous sleepers is predicted to result in significant further reductions in overall A-weighted levels. On the other hand, replacing non-porous concrete track by porous concrete on slab tracks is predicted to give a useful reduction.

15:00-15:20

1663 _____ *contributed*

PREDICTION OF CONVENTIONAL RAILROAD NOISE

Daejoon Kang*, Jaewon Lee, Wooseok Lee

**National Institute of Environmental Research (NIER), Koyang, South Korea*

Railroad noise is one of the main causes of environmental impact. Whenever a new railroad line is planned or a housing project near an existing railroad is proposed, an estimate of the relevant noise levels is usually required. For this, it is necessary to quantify those parameters that affect the railroad noise. This paper presents several prediction of conventional railroad noise.

15:20-15:40

1753 _____ *contributed*

HEALTH EFFECTS OF NOISE FROM RAILWAY TRAFFIC – THE HEAT STUDY

Gösta L. Bluhm*, Emma Nordling

* *Occupational and Environmental Health, Stockholm, Sweden*

Several studies have investigated health effects of noise from road- and airway traffic. Railway traffic is not so well studied. The aim of this study was to investigate the prevalence of annoyance, sleep disturbance and hypertension in relation to noise from a heavily trafficked railway north of Stockholm. The noise levels were calculated using the Nordic Prediction Model for railway traffic. A postal questionnaire was sent to a stratified random sample of 1016 persons with their residences located within three equivalent noise exposure categories, (45-54, 55-59 and $\geq$60 LAeq,24h) and a control area without railway noise. Maximum noise levels were also calculated and separated in four levels ($<$65, 65-74, 75-79 and $\geq$80dBAmax). The response rate was 65% among exposed and 69% in the control group. The questionnaire provided information on annoyance and sleep disturbances due to noise but also education level, as well as living conditions, residential time and prevalence of hypertension. There was a clear association between reported annoyance and calculated noise exposure levels. Equivalent noise levels seemed to be better correlated than maximal noise levels in this respect. Daily annoyance amounted to 58% in the highest equivalent exposure category , 32% in the middle category and 23% in the lowest category Sleep disturbances were reported once a week or more often by 25%, 18% and 10% in the three equivalent exposure categories. Corresponding figures regarding hypertension diagnosed by a doctor were 13%, 20% and 15% respectively among exposed and 15% in the control group. There was an obvious exposure-response relation between calculated exposure levels of railway traffic noise and the prevalence of annoyance and sleep disturbance. Annoyance was reported in a high degree already at lower noise levels. The study did not indicate any association between exposure to railway noise and high blood pressure.

Session VN5: Vehicle Noise Vibration and Harshness

chairs:

Helcio Onusic - *Brazil*

Takeshi Abe - *USA*

14:00-15:20 **Room:** Arpoador

14:00-14:20

1503 _____ *contributed*

OBTENSION OF THE RESPONSE OF RANDOM EXCITED PLATE STRUCTURES BY MEANS OF AN EXPERIMENTAL APPROACH

Casimiro José Gabriel*, Jules G. Slama , Arcanjo Lenzi

* *Universidade Federal do Rio de Janeiro - COPPE, Rio de Janeiro, Brazil*

An experimental approach to solving problems related to structures punctually excited by an ergodic stationary random force has being tested during the last six years in beams and beamed- structures. It was named "Energetic Modal Interpolation Methodology" (MIME), and allowed the prediction of structure response as displacement, velocity or acceleration, as well as internal forces, power flow due to all internal forces in each structural element and power transmitted by means of element coupling. In the present paper, we intend to introduce MIME for the first applications to plates and plate-beamed structures. In future works, the methodology will be extended to study of sound/fluid interaction.

14:20-14:40

1633 _____ *contributed*

PROBABILISTIC MODELING OF ACOUSTIC FATIGUE FAILURES IN AIRCRAFT STRUCTURES

Sergey Baranov

Russian Aviation Co, Moscow, Russia

Under consideration are probabilistic models used to forecast development of fatigue damages of aircraft structures, which suffer fatigue failures resulted from engine jet noise, pressure fluctuations in turbulent boundary layer or other high-level wide-band loads in acoustic frequency range. Damage probability dynam-

ics is represented with the aid of Markov networks where development of fatigue damages is represented by continuous time, discrete state Markov processes with piece-wise constant interstate transition rates. These rates are used as free parameters to be identified during network training. The method of chi-square minimum is used to identify unknown network parameters, with observed and expected histograms of damage distributions being compared at the given time points. The concept of forecasting multifactor Markov networks, which represent subtle features of system development and improve concordance between observed and predicted data, is described. Their decomposition technique simplifies significantly both the model identification and calculation of the state probability functions.

14:40-15:00

1798 _____ *contributed*

INTEGRATING SEA INTO DESIGN AND EVALUATION OF VEHICLE SUBASSEMBLY CONCEPTS

Chadwyck T. Musser⋆, Philippe Moron

⋆ *Cambridge Collaborative, Inc., Cambridge, USA*

Statistical Energy Analysis (SEA) is an established technique for predicting vehicle NVH. Since SEA is more sensitive to certain parameters such as material properties, damping, absorption, and treatment thickness and coverage than to fine details of geometry, using SEA is especially practical and can be particularly advantageous in the early design phase of a vehicle development project. Different concepts for various vehicle subassemblies such as dash, doors, roof, floor, etc., can be effectively evaluated for feasibility at a very early stage in the design process. Such concept studies can prevent design failures and can also be used to improve subassembly NVH target setting. An introduction to SEA and summary of the established use of SEA for vehicle NVH design and development are presented. A proposed methodology for application of SEA to vehicle design is presented, addressing model validation, contribution analysis, target setting, design sensitivity analysis, and optimization for different design concepts and proposed configurations of the vehicle and vehicle subassemblies. A concrete example of an SEA vehicle subassembly model and modeling considerations is presented, followed by a summary and set of conclusions.

15:00-15:20

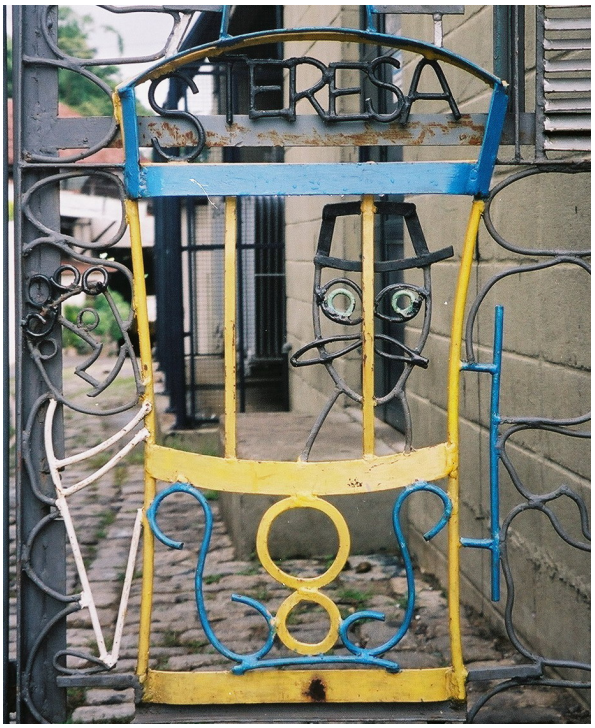
1858 _____ *contributed*

EXPERIMENTAL VERIFICATION FOR DRIVELINE CLUNK IN FREE VIBRATION AND SIMULATION FOR CLUNK IN A TYPICAL DRIVING SITUATION

Ashley R. Crowther⋆, Nong Zhang, Chris Chapman

⋆ *UTS, Sydney / Ohio State University, Newport, Australia*

Driveline clunk is an objectionable vibro-acoustic source. It occurs on gear separations and impacts and is largely influenced by the amount of lash, transient vibrations and mean load. Ensuring customer satisfaction in vehicles with traditional powertrains or new configurations, such as hybrid, DCT, variable displacement engines, etc. requires manufacturers to refine systems to reduce clunk noise. In this paper the source is examined. First, a reduced model of the drivetrain sub-system of a powertrain test rig is used for experimental verification of linear and non-linear responses in transient vibration. In the test, the wheel hubs are loaded with an applied torque which excites free vibration of the torsional system when released. The main oscillation excited is driveline shuffle from the tires to the parking pawl mechanism, which results with clunk from gear impacts on the shuffle torque reversals. The free vibration test, analysis and simulation concur providing verification of the modelling and system parameters and the research provides understanding of the relationship between driveline shuffle and clunk. Damping ratios for shuffle and axle modes are taken from the linear responses (with no gear impacts) of the preloaded drivetrain and used in the simulation. Single sided and double sided impact responses are illustrated. Then results from simulations using a reduced model are presented for the transient analysis of gear impacts in a typical driving situation for an automatic transmission powertrain. Impacts within the gear pairs are affected by the engine surging, shaft stiffness, component inertias, engine harmonics, drag torques, braking, viscous damping and vehicle load. The nature of these impacts, the clunk, from shuffle and axle transients is illustrated.



Session AR2: Aeroacoustics

chairs:

Marvin Goldstein - *USA*

Serge Lewy - *France*

16:00-18:00 **Room:** Flamengo 1

16:00-16:20

1424 _____ *invited*

PREDICTION OF TURBOFAN ROTOR OR STATOR BROADBAND NOISE RADIATION

Serge Lewy

ONERA, Chatillon, France

Fan broadband noise has become the major component of overall sound levels radiated by modern turbofans due to past progress in tone control. Its reduction is thus a new challenge to design quieter aircraft. Present work extends previous papers on rotor acoustics towards a unified model predicting either rotor or stator forward and aft radiation. Sources are limited to blade and vane random loads which are known to be the main terms. The computational input is a generic blade or vane pressure spectrum. It is flat in accordance with several tests, and decreases at high frequency such that overall pressure fluctuations on airfoil remain finite. Sound propagation in the nacelle is calculated thanks to the analytical Green's function in a hard-walled cylindrical duct. Reflections on the duct exit are neglected which is rather valid except for modes near cut-off. Directivity of free-field radiation is deduced using either a Rayleigh integral (Tyler and Sofrin model) or a Kirchhoff integral on the duct exit cross-section. The second method is better for computing lateral radiation because there is no hypothesis of flanged inlet, and is required if the advancing speed is taken into account. However, both of them give very similar results if flow velocity is neglected. It is expected that forward radiation is mainly due to the rotor, and that aft radiation comes from the outlet guide vanes. Sound power spectra and directivities are in good agreement with existing semi-empirical predictions for forward radiation, but there are large discrepancies on directivities downwards. It is shown through the Snell's law that this can be due to refraction in the hot jet at higher speed. It is also planned to improve the accuracy of the results in the near future by using input data coming from computational fluid dynamics instead of a generic spectrum.

16:20-16:40

2010 _____ *invited*

ACOUSTIC BARRIER – A SOUND GENERATOR?

Eldad Avital

Queen Mary Univ. of London, London, UK

Acoustic barriers are widely used to reduce noise pollution and their effect on sound propagation has been extensively studied. The performance of acoustic barriers is known to deteriorate in the presence of wind due to shear refraction, turbulence scattering and thermal effects. Extensive research has also been put into understanding and predicting those effects, although more can be done, particularly in terms of turbulence scattering. However the wake behind the barrier that reduces the barrier performance can also produce sound by itself. In this work we use the LES method to study the sound generation by two barrier configurations, a wall and a T barrier. The flow is assumed to be incompressible and Lighthill-Curle's acoustic theory is used to calculate the streamwise dipole, assuming a compact source. Thus the considered sound field has a much larger wave length than that usually deflected by the barrier when generated by external sources. The simulations reveal a large wake behind the barriers, leading to the generation of the dipole source. Time history and frequency spectra of the dipole sources are analysed to identify characteristics and the effect of the barrier geometry.

16:40-17:00

1554 _____ *contributed*

JOINT ACCEPTANCE DUE TO RECTANGULAR PANEL PATCH EXCITATION BY TURBULENT FLOW USING COMPLEX ITERATED ERROR FUNCTIONS

Robert G. Rackl*, Michael A. Epton

* *The Boeing Company, Seattle, USA*

In the situation of turbulent flow over a panel, we use the concept of "joint acceptance" which provides the fraction of the turbulent flow energy that is transferred to structure exposed to that turbulence. When the vibrational power in a panel has been determined its transfer to adjacent structures and acoustic spaces can be calculated such as in the estimation of aircraft interior noise levels. The calculation of joint acceptance requires knowledge of structural (modal frequencies and shapes) and flow (cross-spectral density) properties, and the solution of a double integral over the panel surface. Aerodynamic sources of noise often excite only a portion of an exterior panel (for example shock/boundary layer interaction). In this paper, analytical results for joint acceptance are obtained for patch excitation of a simply supported rectangular panel for several assumptions for the mathematical form of the cross-spectral density.

17:00-17:20

1682 _____ *contributed*

THE CHARACTERISTICS OF THE AEOLIAN TONE GENERATED FROM ELLIPTIC AND RECTANGULAR CYLINDERS

Hajime Fujita

Nihon University, Chiyoda-ku, Japan

The characteristics of the Aeolian tone generated from elliptic and rectangular cylinders with cross sectional aspect ratio of 1 to 4 are studied experimentally in a low noise wind tunnel. The thickness of the models is kept constant at 10 mm and the chord length is changed as 10, 20, 30 and 40 mm. Three mean free stream velocities, 10, 18 and 25 m/s are chosen for the experiment. The Reynolds number amounts to the range of 6700 to 70000 based on the chord length of the model. As for the elliptic cylinders, the effective Strouhal number based on the model effective width to the flow and the free stream velocity are nearly constant for the chord length or aspect ratio change. For the model with aspect ratio 4, there are some angles of attack where no Karman vortex shedding is found but instead, high frequency sound related to the boundary layer instability is observed. The Aeolian tone level is lower for higher aspect ratio model. The characteristics of the Aeolian tone from elliptic cylinders are in general affected by relatively small change of the Reynolds number and the angle of attack. As for the rectangular cylinders, the aspect ratio shows some critical value for the occurrence of the reattachment of the separated flow to the side surface. For the model with aspect ratio 2, reattachment angle of attack is smaller than that of the square cylinder and very sharp and drastic change of the Strouhal number at the reattachment is observed. Around this angle of attack, the peak level of the Aeolian tone is very low compared to other models. For the models with aspect ratios 3 and 4, it is not clear the flow along the side surface always reattached for this range of Reynolds number or not.

17:20-17:40

2090 _____ *contributed*

DEVELOPMENT OF A LOW NOISE WIND TUNNEL

Michael Kingan*, John R. Pearse

**University of Canterbury, Christchurch, New Zealand*

A number of modifications to the low noise wind tunnel in the Department of Mechanical Engineering at the University of Canterbury were made to reduce the background noise of the wind tunnel so as to improve the quality of acoustic measurements at the outlet jet. The modifications included relocating the fans further away from the outlet jet, lining a significant portion of the wind tunnel with absorption material, adding a low frequency absorber section and placing an 'anechoic shelter' over the outlet jet to reduce background noise from the environment. These modifications have resulted in a significant reduction (6dB) in the wind tunnel background noise for frequencies above 100Hz. New speed controllers for the wind tunnel fans have also been installed and have allowed the implementation of a feedback control system to automatically set the desired wind tunnel speed. The maximum airflow speed at the outlet jet has been increased from 39m/s to 48m/s, due to the increased efficiency of the new tunnel configuration.

17:40-18:00

2106 _____ *invited*

ON THE EMISSION OF SOUND FROM A SOURCE INSIDE A LAMINAR SHEAR LAYER

Luis Manuel Braga da Costa Campos*, M. Kobayashi

**Instituto Superior Tecnico, Portugal*

The [11] acoustic analogy describing the generation of sound by turbulence and inhomogeneities in an unbounded medium at rest is extended to a plane unidirectional shear mean flow: (i) the linear, non-dissipative terms form the acoustic wave equation in a plane unidirectional shear flow [6, 4], with the acoustic pressure as variable; (ii) all the remaining terms are nonlinear or dissipative, and specify the sources of sound in a shear flow, generalizing the original Lighthill tensor. The sources of sound consist of three terms, modelling turbulence, inhomogeneities and dissipative effects, broadly similar to the original Lighthill tensor, with additional three terms proportional to the vorticity of the mean flow. The Green's function for the acoustic wave equation in a plane unidirectional shear flow is obtained exactly for all frequencies. The result applies to any shear velocity profile and is illustrated for the hyperbolic tangent shear layer. The acoustic pressure due to a point monopole source is plotted as a function of the coordinate transverse to the shear layer, for several source positions in the shear flow, and several values of the shear layer thickness, free stream Mach number and angle of incidence.

Session AN1: Aircraft Interior Noise and Technology

chairs:

Dominique Collin - *France*

Carlos Grandi - *Brazil*

16:00-18:00 **Room:** Business Master 136

16:00-16:20

1660 _____ *contributed*

APPLICATION OF ACOUSTICALLY TUNED RESONATORS FOR THE IMPROVEMENT OF SOUND INSULATION IN AIRCRAFT

Marieke H.C. Hannink ⋆, Jacob Vlasma, Ysbrand Wijnant, André de Boer

⋆ *University of Twente, Enschede, The Netherlands*

One of the aims of the EU project FACE (Friendly Aircraft Cabin Environment) is to reduce aircraft interior noise. For modern aircraft flying at cruise conditions, the turbulent boundary layer is the main source for cabin noise. Normally, the turbulent boundary layer causes the trim panels to vibrate, and hence to radiate sound into the aircraft cabin. The purpose of the present work is to reduce this kind of noise by means of sound insulating trim panels with tuned acoustic resonators. The length and the radius of these resonators are tuned in such a way that the volume velocities at the vibrating panel surface and at the entrance of the resonators are equal in magnitude but opposite in phase. In this way, maximum reduction of the radiated sound can be achieved for a specified frequency range. Because of the repetitive pattern of the resonators in the panel, the influence of the resonators on the sound radiated in normal direction by the panel is studied with a one-dimensional model. The so-called low reduced frequency model is extended to describe the viscothermal wave propagation in the vibrating resonators. An advantage of the viscothermal effects is that, in the low frequency range, more sound reduction is obtained than if these effects are not present or very small. Calculations show that a large reduction of the radiated sound can be achieved. The model is also validated by experiments in an impedance tube. Good agreement is found between theory and measurements.

16:20-16:40

1745 _____ *contributed*

EXECUTIVE JETS: INTERIOR NOISE METRICS

Adriana Brasil Amarante

EMBRAER, São José dos Campos, Brazil

The aircraft comfort has gained special attention lately and represents one of the market goals to conquer outstanding executive clients. Comfort comprises many aspects of human perception as design, air quality, temperature, cabin pressure, vibration and noise. The purpose herein is to discuss aircraft interior noise metrics regarding subjective impressions that lead to pleasant environments. Aircraft manufacturers and flight operators are used to deal with interior noise in terms of Speech Interference Levels (SIL) and A-weighted overall sound pressure levels (dBA). These metrics, however, are insufficient to describe and qualify noise as comfort parameter. A simple procedure to get closer results to these subjective impressions is to calculate loudness from spectrum analysis in terms of one-third octave-bands, the same input to calculate dBA and SIL. In fact, loudness has been a very powerful metric in many engineering applications mainly for sound quality evaluations. However, its application to describe aircraft interior noise is still minor. Complete sound quality analysis by means of binaural head recordings, noise and vibration mapping and intensity measurements are highly appreciated for new developments and main noise sources identification. It is the single number total loudness (N, in sone) that seems to be more accurate when applied as comparison parameter.

16:40-17:00

1886 _____ *contributed*

PRESSURE FIELD IDENTIFICATION USING VIBRATORY MEASUREMENTS ON A PLATE

Charles Pezerat⋆, Nicolas Torato, Jean Louis Guyader

⋆*LVA/INSA Lyon, Villeurbane, France*

Boundary pressure due to turbulent flow acting on a structure is an important source of noise in planes, cars, etc... The classical way to identify the exciting pressure field is measurement of acoustic pressure in order to characterize correlation length to be used in a boundary pressure model [10][11]. This is a complicated experimental procedure, especially when obstacles are present into the fluid and when pressure map are needed. The approach presented here is based on an indirect measurement that uses the vibration field of the structure excited by a Turbulent Boundary Layer (TBL), then an inverse problem is solved in order to identify the force density producing the vibration field. The RIFF method was developed at INSA and published in the paper: 'Force Analysis technique : Reconstruction of force distribution on plates' by Ch. Pezerat and J.- L. Guyader, Acta Acustica vol(86), 2000, pp322-332. The advantage of the RIFF approach is that the force density applied to the structure is local and in particular does not depend on the boundary conditions located outside the windows of measurement. In this paper, the possibility of reconstructing the boundary pressure field produced by obstacles placed in a flow, from the measurement of plate vibrations and use of the RIFF method, is investigated. The boundary pressure is first

calculated using the FlowVision software for different conditions of flow and obstacle, then the plate response to one of these excitations is calculated to produce data to be used in the RIFF method. Results are presented comparing the exact excitation field and reconstructed ones after resolution of the inverse problem. Agreement is quite good, demonstrating the ability of this indirect measurement of the boundary pressure. Applications to measurement in planes in real flight conditions are possible with only inboard measurement, the use of laser vibrometer permits in addition to have a map of the boundary pressure.

17:00-17:20

2057 _____ *contributed*

APPLICATION OF THE INVERSE METHOD TO THE CHARACTERIZATION OF POROUS AND FIBROUS MATERIALS USED IN AIRCRAFT NOISE INSULATION PACKAGES

Thiago Zmijevski ⋆, Samir N.Y. Gerges, Marcelo Santos, Mario Trichês jr., Julio Cordioli, Fernando Knaeben

⋆ *UFSC, Florianópolis, Brazil*

Porous materials are widely applied in noise control solutions due to their good sound absorption properties. Theoretical porous material models based on Biot's Theory have been used to assist in selecting materials, estimating performance and design layered configurations. Several material parameters (e.g., airflow resistivity, porosity, tortuosity, characteristic lengths, etc.) required in porous material models are not available from material suppliers. However, these parameters are widely used in FEM (Finite Element Methods) and SEA (Statistical Energy Analysis) models. Experimental characterization is not an easy task because it involves a lot of equipment and complex techniques. The inverse characterization method has become an alternative technique to obtain the Biot's parameters of porous and fibrous materials. This paper describes a study carried on to verify the applicability and accuracy of this procedure. Part of the work was developed using the commercial software Foam-X, developed by the ESI Group.

17:20-17:40

2091 _____ *contributed*

FAN NOISE CONTROL BY ENCLOSURE MODIFICATION

Moohyung Lee⋆, J. Stuart Bolton, Kenichi Seki, Hiroto Ido

⋆ *Purdue University, West Lafayette, USA*

Axial fans are widely used for electronic cooling, and their use often results in a noise nuisance. Here, a structural modification scheme for reducing the sound power radiated by an axial fan mounted to one surface of an enclosure is described. The proposed modification is based on a physical understanding of the nature of acoustic sources. An axial fan operating in free space exhibits a dipole-like radiation pattern at frequencies sufficiently low that the source is compact. When the fan is mounted to an enclosure, however, the sound radiation pattern becomes monopole-like since only one side of the fan is exposed to the exterior space; thus it radiates more efficiently than the same fan in free space. This radiation enhancement can be reduced by introducing a second "path" that allows the sound fields on both sides of the fan to interact each other, thus reducing the radiation efficiency of the fan towards its free-space value. Experimental results are presented here that demonstrate this effect. The sound field radiated by a fan mounted to a consumer electronics enclosure was visualized by using near-field acoustical holography and the results of various structural modifications were compared. First, to demonstrate the effect, the top of enclosure was replaced by an acoustically transparent mylar sheet. Then two types of acoustical paths, i.e., a grilled port and a perforated panel, were introduced on top of original enclosure close to fan location. In the mylar-top case, clear conversion from a monopole to a dipole was observed. In the other two cases, the sound fields did not exhibit clear dipole-like sound fields but the fan radiation efficiency was reduced. As a result, a significant reduction of sound power was achieved in all cases especially at low-order, blade passing tones, usually the primary contributors to the radiated sound power.

17:40-18:00

1495 _____ *contributed*

ENERGY DISSIPATION AT OSCILLATIONS OF A FRAMED LAYERED SHELL LIMITING AN ACOUSTIC VOLUME

Boris Efimtsov⋆, L.A. Lazarev, S.N. Baranov

⋆ *Central AeroHydrodynamic Institute (TsAGI), Moscow, Russia*

Oscillations of a thin cylindrical shell stiffened by a regular system of longitudinal and transversal stiffeners (stringers and rings) with a layered sound insulating structure enclosing the acoustic volume under low-frequency harmonic excitation are investigated. Its elasto-acoustic interaction with sound insulating layers, exterior medium and the medium in the closed volume with identical end caps impedances (generally arbitrary) is taken into account. The principal attention is given to parametric investigations of the layered sound insulating structure (made of fibrous materials, particularly) effect on energy dissipation in the shell itself, in the acoustic volume enclosed by it and in the exterior medium. The cases of strong and weak coupling between the elastic modes of the shell and the acoustic modes of the closed volume are considered.

Session BA5: Building Acoustics

chairs:

Elvira B. Viveiros - *Brazil*

Stelamaris Rolla Bertoli - *Brazil*

16:00-18:00 **Room:** Rio 1

16:00-16:20

1700 _____ *contributed*

SOUND INSULATION PERFORMANCE OF BRAZILIAN DWELLINGS:FROM COLONIAL AGES TO CONTEMPORARY ARCHITECTURE

Elizabeth Duarte*, Elvira B. Viveiros

* *UFSC, Florianópolis, Brazil*

The 20th century experienced a constant search towards lightweight constructions, which tends to go against good sound insulated partitions. In Brazil, in particular, this is an important issue, as there is no build regulations concerning acoustic comfort and, therefore, builders target economical goals only. This paper proposes an analysis of the sound insulation performance of Brazilian houses along the centuries. First, a survey of the most important and typical constructions for different periods of Brazilian history is shown. Subsequently, analytical prediction of the sound insulation of their components are performed and evaluated along a timeline. It is demonstrated and quantified the exponential decrease of building components performance. The aspects that collaborate to the maintenance of this situation are discussed and possible ways out are proposed.

16:20-16:40

1735 _____ *contributed*

TRAINS PASSING CLOSE TO A CINEMA - A CASE STUDY

Anthony Nash

Charles M. Salter Associates, San Francisco, USA

A new cinema complex is exposed to airborne noise and vibration from commuter trains that pass within five meters from the exterior facade. During construction, the buildings were treated with several noise control systems to help mitigate potential disturbance from the trains. One of these systems is a concrete raft (or "floating") floor supported by discrete glass fiber cubes. The raft floor helps control the effects of groundborne vibration above 100 hertz. Once the buildings were completed, it was found that the noise reduction was excellent in the speech range (i.e., at frequencies greater than 200 hertz, train events were not measurable within the cinema). For frequencies below 200 hertz, however, the interior noise level increased 10-to-15 decibels during the train passby. In this low frequency range, the noise reduction varied significantly throughout each train event. Variations in the "apparent" noise reduction are probably a result of groundborne vibration exciting the interior surfaces of the building.

16:40-17:00

1777 _____ *contributed*

INDOOR NOISE LIMIT OF APARTMENT HOUSES FOR ROAD TRAFFIC NOISES IN KOREA

Sun-Woo Kim*, Gil-soo Jang, Chan Kook, Min-Jeong Song, Ju-Yeob Lee

* *School of Architecture, Jeonnam National University, Gwangju, Korea*

The indoor noise limits for road traffic noise are needed to secure comfortable acoustical quality in apartment houses. To achieve this goal, investigations of the actual conditions on the indoor and outdoor noise of apartment houses were conducted. And then, psychoacoustic experiments were carried out with road traffic sound sources modulated by the transmission loss characteristics of the external windows. Finally, the correlation analysis between noise rating indices and subjective responses were accomplished, and the analysis of the satisfactory percentage of the dose-response curves vary from respondents done. The results of this study may be used to evaluate the acoustic threshold level for road traffic noise or as a basis for specifying the desired acoustic environment of dwellings

17:00-17:20

1778 _____ *contributed*

THE EFFECT OF REINFORCEMENT SLAB AND BEAM ON THE HEAVY-WEIGHT IMPACT SOUND

Jeong Ho Jeong*, Seung Yup Yoo, Jin Yong Jeon

* *Hanyang University, Seoul, Korea*

Low frequency heavy-weight impact sound is the most irritating noise in Korean high-rise reinforced concrete apartment buildings. This low frequency noise is generated by foot traffic due to the fact that Koreans do not wear shoes at home. The transmission of the noise is facilitated by a load bearing wall structural system without beams and columns which is used in these buildings. In order to control low frequency heavy-weight impact noise, floating floors using isolation materials such as glass-wool mat and poly-urethane mat are used. However, it has been difficult to control low frequency heavy-weight impact sound using isolation material. Therefore, in this study, reinforcement of concrete slab using beams and plate was analyzed. Using the FEM analysis, the effect of concrete beam and FRP (fiber-glass reinforced plastic) plates and beams on the bang machine impact vibration acceleration level

was conducted. The 3 4dB floor impact vibration acceleration level was reduced and the natural frequency of slabs were changed. Also, a reinforcement beam was tested to verify the reduction of floor impact sound pressure level.

17:20-17:40

1810 _____ *contributed*

TOOLS FOR BUILDING ACOUSTICS DESIGN AND EXPERIMENTAL PERFORMANCES

Franco Cotana⋆, Michele Goretti

⋆ *University of Perugia, Perugia, Italy*

By issuing the Regulation concerning control and reduction of the acoustic pollution, Umbria Region has imposed the acoustic design for buildings and the check of passive acoustic requirements, defined by Italian national laws. The new Umbrian legislation judges the acoustic design absolutely necessary to obtain the planning permission. Afterwards it must be attested that the works correspond to the acoustic design in order to obtain the declaration of habitability. Finally the town council, with the technical support of the environmental protection regional agency, carries out sample controls comparing the works with the design evaluations. In this paper the results of acoustic measurements and calculations about different typologies of floors and fronts are compared, analysed and explained, in order to find a simplified evaluation method for passive acoustic requirements and to provide useful instruments for acoustic design.

17:40-18:00

1944 _____ *contributed*

ACOUSTIC ADEQUACIES IMPLEMENTED IN TWO SHOOTING ROOMS AND TWO CABINS OF GUNS IN THE BALLISTIC TUNNELS OF A FIREARM AND AMMUNITION FACTORY

Luciano B. Nabinger

Nabinger Acústica LTDA, Porto Alegre, Brazil

Abstract This article deals with an acoustic adequacy work performed in an industry engaged in the manufacture of firearms and ammunitions. Interventions were conducted in four (4) distinct places with overall areas inferior to 10 m^2, all of them used for shooting different firearms (calibers 12, 16, 20, 22, 28 and 36), varying in accordance with the location. We intervened in two test shooting rooms for testing ammunition and two fire cabins for testing guns in ballistic tunnels. The purpose of the industry was to fit the work environment into the noise and impact limits established in the RN-15-Activities or unhealthy operations [1]. Measurements previous to implementation of the projects registered noise levels up to 137.0 dB (C), which levels are liable to cause pain and even irreversible deafness depending on the length of exposure. To solve the problem acoustic conditioning systems were implemented in all the spaces and an acoustic insulation system at the source, near the provete (shooting machine) inside one of the ballistic tunnels. One of the challenges was to intervene in the physical space complying with the factory safety restrictions, using impact and fire-resistant materials, as well as to find a way to make cleaning easier, in order to avoid powder accumulation. Measurements were made in dB(L), dB(A) and dB(C) with records being made at each second in thirds and eighths, in the frequencies between 6.3 and 20,000 Hz – picking up noises between 70.4 and 150.4 dB through the use of an acoustic attenuator at the tip of the microphone. The measurements were performed in the F (Fast) and I (Impulsive) modes, as recommended for measuring shots by firearms. Implementation of the project which had for its purpose to reduce the Maximum Levels of noises noted at approximately 9 dB(A), achieved its objective through reductions between 9 and 13.1 dB(A), depending on the environment and the caliber used.

Session MT2: Metrology

chairs:

George Wong - *Canada*

Gustavo P. Ripper - *Brazil*

16:00-17:40 **Room:** Business Master 145

16:00-16:20

1895 _____ *contributed*

PRIMARY CALIBRATION OF SINGLE-POINT LASER DOPPLER VIBROMETERS (LDV)

Gustavo P. Ripper⋆, Ronaldo Dias, Guilherme Garcia, Moysés Zindeluk

⋆ *INMETRO, Duque de Caxias, Brazil*

The Laser Doppler Vibrometer (LDV) is a powerful non-contact transducer, which is capable of accurately measuring point velocities from a remote position by means of interferometric techniques. International standards, such as the ISO/IEC standard 17025 [1], require measurement traceability to the International System of Units (SI). Traceability [2] is to be established through an unbroken chain of calibrations, linking measuring and testing equipment to the national or international measurement standards. At present, standard procedures specifying how to calibrate a laser vibrometer are still an open issue [3]. As laser vibrometers are becoming more and more a standard measurement tool for the mechanical engineer, the establishment of standards and calibration procedures becomes more urgent. Otherwise, LDVs can not be used in many applications such as a reference for the calibration of accelerometers by secondary laborato-

ries. The vibration laboratory of Inmetro has two digital laser vibrometers and is developing a method to trace them back to the Brazilian national measurement standards. Basically, two alternative methods are applicable: Primary calibration by laser interferometry [4], and secondary calibration by comparison to a reference transducer traceable to a national standard [5]. This paper focuses on the primary calibration of laser vibrometers against a homodyne quadrature interferometric system. The theory of the method is briefly described. The experimental set-up is presented and some results are given.

16:20-16:40

1896 _____ *contributed*

THE TEMPERATURE EFFECT ON GAIN OF CHARGE AMPLIFIERS

Gustavo P. Ripper⋆, Ronaldo Dias, Guilherme Garcia, Moysés Zindeluk

⋆ *INMETRO, Duque de Caxias, Brazil*

Calibrations of accelerometers made in accordance with the international standard ISO 16063 have to take into consideration the environmental conditions of the reference measuring chain, which is most frequently composed of a piezoelectric standard accelerometer and a charge amplifier. Manufacturers usually report only the temperature sensitivity of accelerometers for slowly varying ambient changes. Specifications range from typically -0.03%/°C for piezoelectric accelerometers that use quartz crystal elements to + 0.04%/°C for accelerometers that use ferroelectric elements. This paper focuses on the effect of temperature on the gain of charge amplifiers. Two different models of amplifier were placed in a temperature chamber and electrical calibrations using charge simulated input signals were carried out in the frequency range from 10 Hz to 10 kHz. The measurements were made at 2°C temperature steps between 18°C and 28°C. It was verified that, at each frequency, the gain of these amplifiers presented a linear behavior with temperature. A matrix of regression coefficients was determined from least squares fits to the measured data. Therefore, the effect of temperature on the amplifiers' gain can be established for any temperature within the range of measurement. Relative deviations from the reference gain at 23°C are presented in graphical form. The presented methodology is a helpful tool for the choice of the best charge amplifier for an accelerometer calibration system and provides a way to evaluate and correct for the effect of an environmental parameter that can significantly influence the uncertainty of measurement in accelerometer calibrations.

16:40-17:00

1461 _____ *contributed*

STUDY ON THE MEASURING DEVICE OF MUZZLE VELOCITY USING MAGNETIC FIELD GRADIENT SENSOR

In-Woo Kim⋆, Je-Wook Chae, Jo Ryu Bong

⋆ *Agency for Defense Developement, Daejun, Korea*

In the conventional weapon system, such as gun and small arms, it is a general trend that for maximization of its performance and enhancement of its effectiveness, the firing control system(FCS) is developed and applied with the guns and small arms in the world. The FCS of the small arms for infantry man is composed of a few of sensors for acquisition of input data of FCS, such as range measurement, position sensing of weapon, temperature, etc., computer, displayer and power pack, and also the air burst ammunition is developed in parallel for the maximization of FCS's effectiveness. Since the flight time setting fuze for the air burst ammunition is adapted for next rifle, the measuring device of the muzzle velocity is needed to overcome the variation of muzzle velocity due to producing procedures and the differences of the using temperatures and so maintain the burst position accuracy. This paper contained the technical information on the development of the measuring device of muzzle velocity, which designed in compact & light weight configuration with reliability and accuracy.

17:00-17:20

1587 _____ *contributed*

ACCREDITATION TO ISO/IEC 17025 FOR A CONSULTING COMPANY – A BENEFIT OR NOT?

Jörgen K. Svensson

Ingemansson Technology AB, Gothenburg, Sweden

Ingemansson Technology AB holds accreditation to ISO/IEC 17025 at four of eight offices in Sweden and Denmark. In total, more than 100 noise & vibration standards and other measurement methods are listed in the accreditation, given by SWEDAC. Many hours are spent to establish the quality system required, and to maintain and continuously improve the quality in measurement commissions. Question arises – is this undoubtedly of benefit for the company, economically or otherwise? Costs include not only the initial creation of the quality system and the acquisition of the accreditation, but also yearly fees to SWEDAC, education of consulting engineers, calibration and maintenance of instruments, software verification, internal and external surveys and revisions, document handling, report checking, support etc. Once taken the decision to acquire accreditation, the goal is to cover these costs through numerous measurement commissions. A consulting job generally includes measurements of some kind. Most of them are carried out in field and not

in a cosy laboratory. It turns out, however, that only a minority of more than 400 measurement tasks performed yearly will end with a report issued within the accreditation. A big task is to make our clients understand the idea of spending a little more money to get an accreditation stamp on the report, when a simple survey using a few measurement positions and a good estimation of the usefulness of the measurement would be sufficient. The absence of forcing regulations demanding accredited measurements is a problem to present to the authorities. You will also find a hesitation among the employees to expand the effort in a measurement operation beyond what is motivated by the scope of the commission. The use of accreditation or not in measurement tasks is a continuous matter of discussion. Conditions at the measurement site do not always allow the prescriptions in the standard to be followed. Which exceptions can be tolerated? What is the measurement uncertainty? This paper describes how we manage the questions – or not.

RIO 2005 inter-noise ENVIRONMENTAL NOISE CONTROL
The 2005 Congress and Exposition on Noise Control Engineering
07-10 August 2005 - Rio de Janeiro - Brazil

17:20-17:40

1900 _____ *contributed*

ACOUSTICAL MEASUREMENTS FOR EVERYONE

Matthias Blau

IHA, FH OOW, Oldenburg, Germany

Computers equipped with audio interfaces provide an excellent platform for acoustical measurements, which has the additional advantage that it is commonly accessible in education and research environments. This work is an attempt to promote the use of these resources by introducing a project to provide suitable software to perform acoustical measurements. The key features of the project are that it a) is completely based on open-source software, b) is open, flexible and extensible, c) can be used with both high end (multi-channel external) or low end (onboard) audio interfaces and sensors, d) offers possibilities to implement the LLL-approach (Listen to it, Look at it, anaLyze it) to acoustical measurements, and e) includes documentation and in-depth discussions of underlying principles. Sample applications so far include sound level measurements, octave and 3rd-octave band analysis, reverberation time, transfer function and room impulse measurements. Further applications can easily be designed and may extend beyond pure measurement tasks, especially to listening tests. In this paper, the general concepts of the project are presented along with a demonstration of some example measurements.

Session NB: Noise Barriers

chairs:

Marco A. M. Vecci - *Brazil*
Fabio R. Arruda - *Brazil*

16:00-18:20 **Room:** Lagoa

16:00-16:20

1483 _____ *contributed*

NOISE BARRIERS: DEPENDANCE ON TOPOGRAPHY

Yiorgos Bamnios*, Athanasios Trochidis

* *TEI OF THESSALONIKI, Thessaloniki, Greece*

Noise barriers are considered as the most effective and easy-to-use method to decrease road traffic and railway noise. However their effectivenes depends, to a large extent, on the topography of the area under consideration. Thus, in many locations the use of noise barriers has no significant result on noise reduction and alternative solutions should be examined. In this paper the performance of noise barriers for various types of topografy is examined and alternative choices are investigated, including the combined use of noise barriers together with tunnels. In addition, results are presented for a highway passing from locations with different topographical characteristics.

16:20-16:40

1964 _____ *contributed*

INFLUENCE OF SPECTRAL EMISSION ON THE DIMENSIONS OF ACOUSTICAL BARRIERS

Maria de Fatima Ferreira Neto*, Vitor Carlos Tadeia Rosão

* *SCHIU, Engenharia de Vibração e Ruído Lda, São Paulo, Brazil*

Acoustical barriers are wide implemented and the way to estimate its attenuation is well known. However, the spectral emission of sources such as road traffic is not well established. So, the intent of this communication is to define the influence of spectral emission on the dimensions of acoustical barriers and the level of uncertainty occurring when we do not know the characteristics of the spectrum. We have calculated the difference between the dimensions of barriers to give the same attenuation, for three types of spectral emission with the same overall level: low frequency, median frequency and high frequency. We will define the relations of these spectrums with real characteristics of traffic.

16:40-17:00

1531 _____ *contributed*

NOISE BARRIER WITH A LAMELLAR DIFFRACTOR ON TOP

Marinus M. Boone

TU Delft, Delft, Netherlands

The diffracted sound field at the top of a thin noise barrier or screen is reduced in the shadow region behind the barrier by manipulating of the phase behaviour of the sound field above the screen with a number of horizontal thin plates or lamellas, which are placed on top of the screen. The benefit of such lamellas as compared to a high closed screen is that these horizontal lamellas have a low wind resistance and are transparant for horizontal viewing through the structure. By these means this construction has practical advantages as compared to a higher screen.The sound reduction behind the screen is obtained by the phase changes of the sound field that passes the lamellas. The preferred phase behaviour is obtained by tuning the widths of the lamellas as a function of height for a certain source position. It is shown by computer simulations that this diffractor gives a considerable improvement of the screening below the line of sight as compared with a screen without the diffractor. The simulation results are confirmed with measurements in a physical scale model with a scale factor of 1:20.

17:00-17:20

1956 _____ *contributed*

NUMERICAL ANALYSIS OF THE ADDITIONAL ATTENUATION DUE TO THE TOPS OF EDGE MODIFIED BARRIERS

Tetsuya Sakuma⋆, Noriyuki Takamura, Yosuke Yasuda, Shinichi Sakamoto

⋆ *Univ of Tokyo, Bunkyo-ku, Japan*

In the Japanese assessment scheme for road traffic noise, called ASJ RTN-Model 2003, LAeq at a receiving point is estimated by integrating the time history of sound energy with a single moving vehicle, taking into account the insertion loss of noise barriers. In this model, the effect of an edge modified barrier is considered to be composed of that of a straight barrier and the additional effect of its top. In this paper, the fast multipole BEM is applied to examine the behavior of the additional attenuation in 3D space. Firstly, regarding the insertion loss of a straight and a bent barrier, the calculated results are compared with those measured in scale model. At low frequencies good agreement can be seen, while as the frequency goes up, discrepancy appears depending on the horizontal direction of propagation. Secondly, the additional attenuation of two types of edge modified barriers, having the same top but different heights, is calculated to examine to what extent it depends on the height. It was seen that the height considerably affects the fluctuation of additional attenuation in horizontal directions, but does not affect so much the total attenuation integrated over the directions.

17:20-17:40

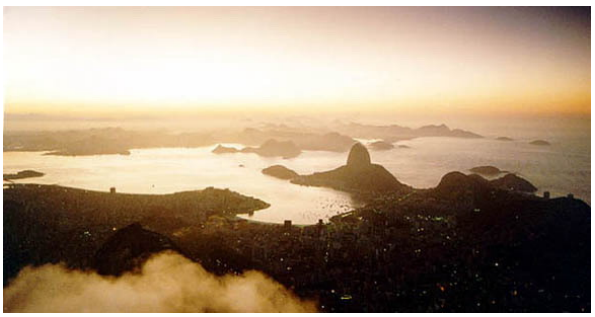
1954 _____ *contributed*

MONITORING AND EVALUATION OF THE WALL EFFECT

Aline Lisot⋆, Paulo Reschetti junior, Paulo F. Soares

⋆ *Universidade Estadual de Maringá/Departamento de Engenharia Civil, Maringá, Brazil*

In the current context it is possible to observe that the sound pollution is increasing simultaneously with the population density. The noise produced is recognized as one of the most critical problems related to environmental pollution because the threat it represents to population quality of life. In urban atmospheres the control of the noise generated by the traffic of vehicles becomes more and more important. One way of carry out such control is through the use of physical bulkheads as the case of walls that inhibits the sound propagation. The walls are defined as a device with specific mass and height, installed between the sound source and the receiver. The aim is to provoke reduction of the level of sonorous pressure by diffraction. The present work is constituted of a study case associated to the efficiency of such kind of obstacles. The adopted methodology consisted of choosing typical obstacles in significant points located at the city of Maringá (northwest of the state of Paraná, Brazil), and sampling values related to the level of sonorous pressure. The intention was to apply such methodology for determining statistical indicators of sound pollution for variable distances from the acoustic obstacle. Of all the studied atmospheres, the main interest concerns the case of a school positioned in front of a highway of intense traffic. For instance, the produced noise can interfere in the teacher-students communication, what implies in the reduction of the students attention with possibly occurrence of learning deficiencies. Through the collected information, the effectiveness of the walls was discussed and analyzed in terms of their usefulness as strategy for controlling traffic noise.



17:40-18:00

1709 _____ *contributed*

EXPERIMENTAL STUDY ON THE PERFORMANCE OF A SIMPLE NOISE BARRIER IN PRESENCE OF A HELMHOLTZ RESONATOR BURIED IN THE GROUND

Djamel Ouis

Malmö University, Malmö, Sweden

This study addresses the problem of performance of a noise barrier when a Helmholtz resonator is buried in the ground on the side of the sound source. The noise barrier is a simple upright one and the Helmholtz resonator consists of a series of adjacent containers buried in the ground and tuned by means of tubes connected to the containers at frequencies typical to traffic noise. The study is conducted at a scale model level and comparisons are made on measurements conducted with, and without resonators to investigate the effect of these latter on the reduction (enhancement) of traffic noise that is already reduced through the interposition of a simple barrier between the noise source and the receiver. The investigation shows that the volume of the cavity of the resonator has an effect on the additional reduction of sound at the receiver at low frequencies whereas at high frequencies the resonator has a negative contribution to the overall insertion loss.

18:00-18:20

1868 _____ *contributed*

A STUDY ON EFFECTIVE CONFIGURATIONS OF SOUND BARRIERS FOR SHINKANSEN TRACK

Yufuko Abe ⋆, Kiyoshi Nagakura, Toshiki Kitagawa, Kaoru Murata, Shin-Ichiro Tanaka, Yukie Ogata

⋆ *Railway Technical Research Institute, Kokubunji-shi, Japan*

Sound barriers have been widely adopted and installed to reduce the noise level produced at locations adjacent to Shinkansen track. Although a number of different types of sound barriers with specific features in their configurations have been developed; a quantitative evaluation for their advantages has not been clarified as yet. Therefore, a number of experiments with scaled models were carried out. Experiments were made to various types of sound barriers to evaluate the noise level as reduced. Furthermore, we proposed sound barriers of effective configurations based on the experimental results.

Session NU3: Numerical Techniques

chairs:

Jorge P. Arenas - *Chile*

Alice H. Botteon Rodrigues - *Brazil*

16:00-18:20 **Room:** Flamengo 2

16:00-16:20

1605 _____ *contributed*

DECAY WITH DISTANCE AND STATISTICAL ENERGY ANALYSIS: A MODIFICATION OF THE POWER BALANCE EQUATION TO HANDLE DECAY ACROSS SUBSYSTEMS

Claes R. Fredö

Ingemansson Technology AB, Göteborg, Sweden

The assumption of diffuse (constant) field response limits the applicability of SEA for analysis of structure-borne sound e.g. in automotive structures as these are damped and, thus response decay with distance. Large errors can arise when decay matters. A relatively simple modification of the SEA equations can be shown to solve the problem of decay with distance across subsystems. It appears that the modification can be implemented into SEA software without too much problem. An analytical model is used to demonstrate the errors when the conventional SEA approach is used and the merit of modified SEA equations. A generic three plate case is used as showcase and benchmarked against the conventional SEA approach in which decay with distance is attempted through divisioning into smaller subsystems.

16:20-16:40

1756 _____ *contributed*

NUMERICAL ESTIMATION OF SOUND RADIATION FROM SOME ANNULAR BAFFLED PLATES

Jorge P. Arenas

Univ. Austral de Chile, Valdivia, Chile

The problem of estimating the sound field generated by some vibrating plates is still the subject of both theoretical and experimental studies in the field of vibro-acoustics. Due to its practical importance, a method to numerically estimate the sound radiated from an annular circular plate is presented. It has been assumed that the plate is homogeneous, isotropic, of small thickness, and it is mounted flush in an infinite baffle. The origin of a polar coordinate system is taken to coincide with the centre of the annular plate. Then, the vibration problem is formulated in terms of Bessel

and modified Bessel functions. The sound power radiated by a baffled vibrating plate can be expressed in terms of the volume velocities of a number of elemental radiators when the vibrating plate is divided into small virtual elements. Each element is treated as a circular piston having an area equal to that of the corresponding element giving the entries for the surface resistance matrix as self-resistance and cross-resistance terms. Thus, combination of the surface resistance matrix with the volume velocity vector on a discretised vibration surface gives the sound power radiated. The sound radiation efficiency can be estimated by using the velocity average on the vibrating surface. Then, it is possible to obtain the sound radiation from structural modes and from radiation modes. Numerical results for the sound radiation efficiency of some vibration modes are presented as a function of a dimensionless parameter. The accuracy of the method is analysed by comparison with well-known asymptotic results of sound radiation efficiency published in the literature. Results showed that the method is accurate enough to predict the sound radiation in the low frequency range but highly dependent on the number of elementary radiators used in the calculations.

16:40-17:00

1813 _____ *contributed*

VIBROACOUSTIC ANALYSIS OF SOUND TRANSMISSION IN DOUBLE-GLASS TIMBER WINDOWS

Gerard Borello⋆, Jean-Luc Kouyoumji

⋆*InterAC, L'Union, France*

Inside the frame of a research program handled by the CTBA to promote vibroacoustic prediction in the French wood industry, analysis of sound transmission in timber windows has been undertaken. Several windows were tested with both classical sound transmission tests in reverberant room and completed by Experimental SEA (Statistical Energy Analysis) tests for better understanding of the structural coupling especially in double-glass construction. Predictive techniques such as analytic SEA were then used to derive a full theoretical vibroacoustic model of the related timber windows and results compared to tests. As SEA (as implemented in commercial software) was found not enough reliable for predicting double-glass behaviour, a specific model was developed for double-glass prediction. This model is based on a full acoustic-to-structure coupling formulation. All structural and acoustic modes are analytically derived and mass and stiffness matrices assembled using appropriate modal synthesis. A pseudo-random pressure field is applied to the emitter plate to simulate diffuse field conditions and joint acceptances are computed using reciprocity from modal radiation properties of plate modes, all computed by spatial FFT. This model has been successful in predicting double-glass behaviour from 100 Hz up to 5000 Hz. Faster formulations are now being derived to be used in dedicated software packages that could be used by the wood industry.

17:00-17:20

1894 _____ *contributed*

DETERMINATION OF INTERNAL AND COUPLING LOSS FACTOR OF A BOX TYPE STRUCTURE USING THE POWER INJECTION METHOD

Ana Libardi⋆, Paulo S. Varoto

⋆*University of Sao Paulo, Sao Carlos, Brazil*

The Statistical Energy Analysis (SEA) approach offers an useful tool for predicting the transmission of noise and vibration at high frequencies. This paper concentrates on the application of the Power Injection Method (PIM), which is the basis of the experimental Statistical Energy Analysis, to a box type structure, which consist of six plates and one acoustic cavity, forming a total of seven subsystems. The PIM method cited above requires the excitation of all subsystems and the measurement of the corresponding input power. The cavity should therefore be driven in addition to the excitation of the structural subsystems. Therefore, a driver-tube-horn device is constructed to measure the power input into acoustic cavity. Several experiments are conducted in order to acquire necessary data to the application of the PIM. From the measurements the internal loss factor and also the coupling loss factors are obtained and a correlation analysis with results obtained from a computational analysis is performed revealing a good agreement with the experimental results. The experimental analysis of the PIM approach contributes to rising important questions on practical application of SEA and provides some recommendations on the definition of test setup parameters concerned with the mechanical and acoustical excitation mechanisms as well as the determination of the input power from the acceleration and sound pressure measurements.

17:20-17:40

2025 _____ *contributed*

SEA MODELING FOR SOUND PACKAGE DESIGN: A CORRELATION STUDY FOR A MORPHED AUTOMOTIVE SEA MODEL

Alice H. Botteon Rodrigues

MSX/Ford, Salvador, Brazil

In general, sound package design is done experimentally and at the latest stages of the vehicle development, leaving much room for enhancement but little time to do so. In addition there is always a need to decrease costs and weight, maintaining or even improving performance. For this reason, the use of tools such as Statistical Energy Analysis (SEA) from the beginning of the development process was established. This methodology can predict responses such as pressure and vibration levels, for mid and high frequency ranges, before physical prototype becomes available. The model in this work was built with the intent of

analyzing sound package design having engine, tailpipe and induction noise applied as load cases. For each load case, measurements were performed in a similar vehicle, providing input data to the model. The results are compared to the SPL measured at the driver's outer ear during the same experiment. The objective is to meet the targets for interior noise, combining cost and efficiency. This paper presents results from a vehicle SEA model morphed to a B sized car by updating dimensions, connections and changing sound package parameters. A good correlation level was achieved.

17:40-18:00

1453 _____ *contributed*

PREDICTING DIRECT SOUND TRANSMISSION BETWEEN TWO ACOUSTIC SPACES AT LOW FREQUENCIES

Paulo F.A. Santos ⋆, Max de Castro Magalhães, Antonio Tadeu

⋆ *University of Coimbra, Coimbra, Portugal*

This paper covers the development and application of a two-dimensional Boundary Element Method (BEM) model to investigate the sound transmission characteristics of two acoustic-structural coupled volumes. The model has been developed to predict the sound pressure in each room as well as the Noise Reduction. The main objective here is to compare the results obtained using the BEM model with those using other methods, e.g. the Component Mode Synthesis technique, which can replicate the boundary conditions at the interface between acoustic volumes. Although simulations have shown substantial differences between the models at low frequencies, the BEM model showed fair agreement when compared to previously published results. Simulations show the effect of the structural and acoustic modes included on the calculated frequency response and also shown the coupling effect between the acoustic volumes.

18:00-18:20

2082 _____ *contributed*

INFLUENCE OF SMOOTHING TO THE INVERESE FINITE ELEMENT METHOD FOR ACOUSTIC HOTSPOT IDENTIFICATION

Joachim A. Drecnkhan⋆, Delf Sachau

⋆ *Helmut Schmidt University, Hamburg, Germany*

Detecting acoustic hot spots in closed interiors is a difficult and time demanding procedure. At the current state-of-the-art sound intensity measurements are conducted over the complete surface, to detect hotspots where sound is transmitted into the cabin. Since this method is highly ineffective different solution approaches have been proposed to solve this problem, for example acoustic holography, inverse boundary element method and inverse finite element method. All the above mentioned methods use mathematical tools for the reconstruction of the sound field and have the difficulty that the problem is ill-posed. Therefore, all these methods need regularization techniques to find an acceptable solution. In general, the solution of the regularized solution can be improved by using more information about the calculated system. In this paper the additional information for the regularization will be achieved by smoothing of the measurement data before starting the inverse calculation. This results in a better starting point, since the smoothed measured data is closer to correct data. The approach described in this paper models the sound field in the frequency domain using finite elements. Measurements in the interior of the cabin are used as boundary conditions for the finite element analysis. The differences between the inverse finite element calculation using smoothed measurement data and not smoothed data are shown. Additionally, the influence of the smoothing on different regularization mechanisms, e.g. truncated singular value decomposition (TSVD) or Tikhonov regularization is shown.

Session RA3: Room Acoustics

chairs:

Sylvio Bistafa - *Brazil*

Roberto A. Tenenbaum - *Brazil*

16:00-18:00 **Room:** Botafogo

16:00-16:20

1816 _____ *contributed*

REVERBERATION CHARACTERISTICS IN A ROOM WITH UNEVENLY-DISTRIBUTED ABSORBERS: EXPERIMENTAL AND NUMERICAL STUDIES

Yosuke Yasuda⋆, Shinichi Sakamoto, Ayumi Ushiyama, Hideki Tachibana

⋆ *The University of Tokyo, Meguro-ku, Japan*

It is often observed that the reverberation time in a room with unevenly-distributed sound absorbers, such as a room having an absorptive floor and/or ceiling, is often longer in middle- and high-frequency range than the values obtained using Eyring's formula, since the assumption of diffuse sound field is not satisfied. In this study, this phenomenon was investigated through scale model experiment and three-dimensional wave-based numerical analysis. Reverberation time in a room having absorptive floor and/or ceiling was confirmed to be longer in the middle- and high-frequency range, and the arrangement of absorbers were also confirmed to affect the frequency characteristic of the reverberation time. The increase of reverberation time is caused by slow decay of axial and tangential modes in the horizontal

direction. The frequency characteristic of reverberation time depends on the height of the room. The reverberation time is longer in high-frequency range (where the wavelength is sufficiently shorter compared to the height of the ceiling) than in low-frequency range when frequency characteristics of the absorption coefficients of the absorbers are flat. As a means to improve such an uneven reverberation time property in a room with highly absorptive floor/ceiling, the placement of diffusers in the vertical direction and inward-inclining walls (when in a room with highly absorptive floor) has been found to be effective.

16:20-16:40

1925 _____ *contributed*

FINITE ELEMENT SOUND FIELD ANALYSIS FOR A MEASUREMENT OF AN AVERAGED SOUND PRESSURE LEVELS IN ROOMS

Reiji Tomiku*, Toru Otsuru

* *Japan, Oita, Japan*

An averaged sound pressure level is utilized for several ISO standards and the Japanese Industrial Standards for acoustics. There remain issues caused by differences of sound fields or diffuseness in rooms used for the measurements. On the other hand, the authors presented a finite elemental procedure and that sound pressure distributions in an irregularly shaped reverberation room obtained by the authors' finite element analysis were in good agreement with those of measurements on various conditions caused by absorbent materials. The authors have also proven that data obtained by the analysis were applied to calculate descriptors of diffuseness of sound fields in a regularly and the irregularly shaped reverberation rooms and showed effectiveness of the method for quantitative evaluations of the sound fields. In this study, difference among averaged sound pressure levels caused by combinations of sampling points are investigated using results of finite element sound field analysis and Monte Carlo method. A cumulative relative frequency of the averaged sound pressure levels, which are difference within 0.5 dB from an averaged sound pressure level of all the FEM results, are calculated to use the investigation. At first, we introduce a procedure of our method and show an appropriate number of monte carlo trials for this paper. Next, relationships among the cumulative relative frequencies, sound source locations and number of sound source are investigated in three rooms. It is clarified that the effect on the cumulative relative frequencies by increasing the number of sound sources depends on frequency and room size. Finally, the difference among averaged sound pressure levels are compared with a standard deviation of sound pressure level distribution in twenty sound fields analyzed by FEM.

16:40-17:00

1727 _____ *contributed*

ACOUSTICAL DIAGNOSIS OF EXISTING AUDITORIUM THROUGH COMPUTER MODELLING: AN APPLIED STUDY CASE

Francesco Patania *, Antonio Gagliano, Francesco Nocera, Antonino Borzì

* *University of Catania, Catania, Italy*

Projects or acoustics corrections within the architectonic spaces that host both theatrical shows and exhibitions request an accurate study of the acoustical parameters of the hall in order to guarantee good quality listening and understanding both music and speech. In this way, people may utilize specific softwares that implement models of the sound waves propagation, ie. "Ray Tracing", that in function of the geometry of the auditorium and the acoustical characteristics of the material used, allow to determine the distribution of sound and the room- acuostic parameters. The proposed paper wants to show the results of the Raysoft software used in the study of acustic quality of the congress meeting room at the Centro Polifunzionale of the Council of Nicolosi, that is a little town on Etna Volcano slope. The operating procedure is articulated in the following phases. - Definition of the geometrical and architectural features of the meeting room - Individualisation of the acoustic property of the surfaces treatment and its relative characteristics - Determination of the energy distribution of the sound within the room - Determination of the Reverberation Time (RT) and Sound Pressure Level (SPL) by measurements in field - Analysis of the "acoustic response" of the room - Proposal for the corrective intervention to optimize acoustic performance of the room. The values of the Reverberation Time calculated by the RAYSOFT model have been compared with the time values of Reverberation Time measured within the auditorium. This comparation has allowed one to verify both the accuracy and the grade of worthiness of the elaboration using the proposed model

17:00-17:20

1535 _____ *contributed*

AURALIZATION AS A TOOL TO PREDICT THE ACOUSTICAL QUALITY OF OPEN PLAN OFFICES

Monika Rychtarikova*, Lau Nijs, Gerrit L.G. Vermeir

* *K.U.Leuven, Laboratory of Acoustics, Laboratory of Building Physics, Leuven, Belgium*

From the acoustical point of view, spaces like open plan offices, restaurants or railway stations can be understood as multi-source environments. The acoustical quality depends on the situation. Sometimes, speech privacy is of interest, in other cases speech intelligibility is desired, but in any case high sound levels should be avoided. Higher sound levels can be ac-

ceptable in a railway station or a students' restaurant, but in an open plan office, the global masking noise is preferably lower than 48 dB(A). In many ray-tracing programs an auralization method is incorporated to make sound audible. In our research this method is used to demonstrate the acoustical quality in an office space to architects and future users. In the example of this paper a U-shaped open plan office is analyzed. Measured and simulated results are compared and the influence of several architectural set-ups is expressed in acoustical quantities and is made audible. The result is an interactive demonstration set-up for explaining the acoustical consequences of different positions of source and receiver, of different finishing and of different combinations of source groups.

17:20-17:40

1891 _____ *contributed*

LAYERED SOUND ABSORBERS MADE OF MICRO-PERFORATED FOILS, POROUS AND OTHER MATERIALS

Christian Nocke*, Jean-Marc Scherrer, Hilge Catja

* *Akustikbuero Oldenburg, Oldenburg, Oldenburg*

With the development of micro-perforated materials that can easily be stretched into any form impressive new interior designs in rooms with a sound absorptive property have become available. Stretched foils used as ceilings, wall coverings and other set-ups have been applied for more than 30 years. By introducing a nearly invisible micro-perforation into the stretched material the foil becomes sound absorptive. The basic physical mechanism is viscous friction in the micro pores. The classical theory of micro-perforated panel absorbers (MPA) by D.-Y. Maa allows the prediction of sound absorptive properties of single and multi-layered set-ups of microperforated layers. In this contribution measured sound absorption coefficients of set-ups with micro-perforated foils as well as combinations with different porous materials will be presented. Furthermore combinations between classical plate resonators and micro-perforated materials will be discussed. Different real life applications in various rooms (restaurant, church, court room etc.) will be presented.

17:40-18:00

1981 _____ *contributed*

COMPARISON OF ACOUSTICAL PARAMETERS DERIVED FROM IMPULSE RESPONSES OBTAINED WITH DIFFERENT EXCITATION SIGNALS

Antonio Vela *, Miguel Arana, María San Martín, Ricardo San Martín, Emilio Aramendia

* *Universidad Pública de Navarra, Pamplona, Spain*

Parameters related to the perceived quality in room acoustics were measured in three positions of an auditorium. They were derived from the room impulse response (RIR) obtained by using three different excitation signals: pseudo-impulsive (firecracker), Sweep and MLS. The rest of the experimental equipment was the same in all cases. The software used for the assessment was winMLS-2004 (Morset Sound Development). In general, the mean values of the parameters obtained with the three techniques were similar. Small standard deviations were achieved for Sweep and MLS signals. Deviations for firecrackers were slightly higher. This is mainly due to the lack of repeatability of firecrackers in contrast with the use of deterministic signals, like sweeps or MLS. Sweeps are attractive because of the ease of increasing the signal to noise ratio compared to MLS-based measurements, using the same amplifier, loudspeaker and measurement duration. It's concluded that the three techniques are adequate to obtain impulse responses, although sweep and MLS signals provide more repetitive results. The drawback of using firecrackers is that more measurements are needed in order to minimize deviation. However, it's a cheap technique because of its simplicity and the light weight of the equipment.

Session SQ1: Sound Quality

chairs:

Patricia Davies - *USA*

Stephan Paul - *Brazil*

16:00-17:40 **Room:** Arpoador

16:00-16:20

1888 _____ *invited*

A FIRST EXPLORATION OF AUDITORY DESCRIPTORS FOR BRAZILIAN PORTUGUESE

Stephan Paul

Lab. of Vibration and Acoustics, Fed. Univ. of Santa Catarina, Florianópolis, Brazil

Evaluation of sounds by classical methods like semantic differential need to use an appropriate verbal space for description and evaluation of the subjective impression on the sound. As for different European languages (German, English, French, Italian) and Japanese such investigation was already carried out for different soundscapes (car interior, interior of aircraft, urban environment) within Spanish and Portuguese, the two most spoken languages in Latin-America, no similar verbal space was investigated and no suitable semantic differentials are existing. As there is a need for a concept specific semantic differential for evaluation of car interior sounds we are interested in the possibility to use existing semantic differentials in German, English, French or Italian language to be adopted for the use in Portuguese. To get an impression on the dimension of the verbal space in Brazilian Portuguese and

of the suitability of a translated semantic differential, attributes refering to car interior sounds have been collected and the results have been compared with existing concept-specific semantic differential in German.

16:20-16:40

1743 _____ *invited*

DESIGN MODIFICATION TO IMPROVE THE QUALITY OF SOUND FOR THE REFRIGERATOR

Jeawon Lee*, Jaeman Joo, Jinkyung Lee

**Samsung Electronics, Suwon, Korea*

Until now, product mostly has revealed physical quantities created by the standpoint of engineers. Consumers, however, perceive and evaluate products on the non-physical characteristics, such as feelings, emotions, and experiences in different social and cultural situations. Especially, for the household appliances such as a refrigerator, the sound is heavily related to the satisfaction of a customer who is a real user of the product and is very important factor to decide purchasing as well as visual design. Therefore, in this research, not only the simple sound pressure level but also the consumer's sense of hearing evaluate the noise from the refrigerator. And also, in order to improve the quality of sound through the design change, the consumer's evaluation is analyzed and related to the engineering quantities. In this research, the sounds from 4 models of refrigerators are evaluated by 40 consumers, the real users. By using the Zwicker parameters and so on, the result is investigated to find the most effective parameters for the good feeling of sound. Finally, the design of the worst model is modified to improve its quality of sound and the modified model is evaluated with the original models again to validate the effect of design modification.

16:40-17:00

1627 _____ *contributed*

INTERPRETATION AND COMPARISON OF PERCEPTUAL SPACES

Jan Stepanek

Academy of Performing Arts, Prague, Czech Republic

Low-dimensional multidimensional perceptual space of objects is obtained as a result of the evaluation of some psychoacoustic experiments (e.g. proximity ratings evaluated using multidimensional scaling). Various methods for perceptual space external interpretation and perceptual space comparison are discussed. Method of 'immersion' of variable external to given N-dimensional perceptual space in the case of correlated orthogonal dimensions is described. The main idea of the immersion is optimally fitting external scale; this means the search for such direction in perceptual space, when object projections on this direction have maximal correlation with immersed external variable. Only event of immersion with significant correlation is taken into account for perceptual space interpretation. It is known that in the case of uncorrelated orthogonal dimensions the immersion is given by multiple regression of these dimensions. Described solution uses numerical computation which is independent according to correlation of dimensions. Two examples of immersion use are given: 1) interpretation of perceptual space of violin timbre using verbal descriptions and acoustic characteristics of violin tones, 2) comparison of perceptual spaces obtained for different groups of violin timbre judges. Results of immersion in both examples are discussed and compared with classical interpretation methods: 1) correlation of external scales with dimension coordinates, 2) Procrustean similarity transformation.

17:00-17:20

1711 _____ *contributed*

WHAT'S SO HOT ABOUT SOUND? - INFLUENCE OF HVAC SOUNDS ON THERMAL COMFORT

Vincent Roussarie *, Edouard Siekiersky, Stephanie Viollon, Sandrine Segretain, Stephanie Bojago

* *PSA Peugeot Citroën, Division of Research and Automotive Innovation, "Perception and Human factors" Department, Vélizy-Villacoublay Cedex, France*

Whether in automotive industry or building science, researchers have been working on the improvement of indoor environments comfort, examining thermal, acoustical, visual conditions... Whereas modalities are proved to interact one with each other, lots of studies only deal with one of the perceptual dimensions at a time. In this framework, a research work conducted by both EDF R&D and PSA DRIA, aims at investigating the auditory and thermal cross-modal interactions involved in the perception of HVAC systems. More precisely, two questions were investigated: are there specific sounds which are more or less suitable for a HVAC system ("sound design" point of view)? Is the ventilation noise able to modify thermal comfort ("sensory interaction" point of view)? Laboratory experiments were organised in a thermal cabin and involved 80 subjects. The auditory stimuli were synthesized, based on different filters applied to a white noise basis. The parameters of these filters were selected in accordance to the spectral shape of real HVAC sounds which were previously recorded in cars and in room contexts. The air ambient temperature in the cabin was controlled and set at 30°C. The thermal stimuli were diffused on the subject's face and chest. They were controlled and successively set at 18, 22, 26 and 30°C. Results show that some noises are more suitable for air-conditioning systems than others. We also found significant thermal and auditory interactions: a specific sound significantly enhanced thermal comfort. These results tend to prove that the designing of HVAC devices should take into account both thermal and auditory dimensions in order to provide the most comfortable thermal conditions in car or at home.

17:20-17:40

1880 _____ *contributed*

NON-STATIONARY CHARACTERISTICS EFFECT ON REFRIGERATORS SOUND QUALITY

Marcos Pinho⋆, Murilo Bernardi

⋆ *Tecumseh do Brasil, São Carlos, Brazil*

Over the recent years, manufactures have focused on improving the radiated acoustic noise emitted from a wide variety of appliances in response to the consumer's improvements demand. In the refrigerators case, the noise is labeled by the sound power spectrum according to the international standard ISO 8960, result of a temporal average, once the refrigerator's noise is assumed to be stationary during the whole measurement extent. However, there are noises that vary during the regular operation of the product which are not considered in this analysis. So, psychoacoustic metrics that can quantify these non-stationary sounds from refrigerator are interesting. This paper shows the statistical parameter kurtosis being used to quantify a kind of modulation present in these products noise, which is not identified by the psychoacoustic parameters (roughness and fluctuation strength) usually indicated on the analysis of this kind of effect. A comparative result of different refrigerators sounds is presented in the end.

Session SC3: Soundscape and Community Noise

chairs:

Gaetano Licitra - *Italy*

Marion Burgess - *Australia*

16:00-18:00 **Room:** Rio 2

16:00-16:20

1968 _____ *invited*

CHALLENGES OF CHARACTERIZING NATURAL SOUNDSCAPES

Micah Downing⋆, Christopher Hobbs

⋆ *Wyle Laboratories, Inc., Arlington, USA*

Abstract There are many resources and values intrinsic to natural and wilderness areas, and the natural soundscape is one of those resources. The natural soundscape is an important aspect of one's experience of the scenery and solitude. Moreover, noise intrusions can lessen one's enjoyment of the experience. For researchers, characterizing natural soundscapes presents several challenges. First, measurement strategies must include the effects of temporal and spatial variations. Second, acoustical instrumentation must be portable and rugged, measure continuous one-third octave band spectra, and have low noise floors. Third, analysis of sound data must distill the information into meaningful measures while retaining the complexity of the soundscape. Once the natural soundscape is characterized, then assessment of current or potential noise intrusions can be evaluated. This presentation will highlight these aspects with examples from soundscape measurements made at Zion National Park. [This work partially sponsored by the US National Park Service]

16:20-16:40

1675 _____ *contributed*

A SOUNDSCAPE MODEL FOR CHILDREN EXPOSED TO AIRCRAFT AND ROAD TRAFFIC NOISE AT HOME

Belinda de Frutos Torres⋆, Isabel Lopez-Barrio

⋆ *Universidad San Pablo CEU, Madrid, Spain*

A soundscape model for children exposed to aircraft and road traffic noise was tested with the structural equation modelling (SEM) technique. The SEM was applied to a sample of 250 children of 9-10 years old, from schools near Barajas airport in Madrid. The aim was to evaluate the school soundscape. The model included two noise sources (road traffic and aircraft) and the degree of interference in school activities and annoyance based on these noise sources. A pleasantness appraisal of the sounds at school and the individual differences on children´s cognitive and coping style were also studied. An acceptable fit was obtained (χ^2 =88,54 df=64 p=0,023; GFI=0.874; AGFI=0.792; RSMEA=0.06). As expected, the perceived quality of sound had the strongest effect on soundscape pleasantness, which also received the influence of road traffic and aircraft agreeableness and the negative effect of aircraft annoyance. Individual differences played a role in the soundscape evaluation. Cognitive style activated coping strategies and coping style also played a significant role in the perception of noise interference. The model accounts for 41.7% of home soundscape pleasantness variance, which is explained mainly by perceived quality of sound, car and aircraft agreeableness and aircraft annoyance with a negative effect. As anticipated, individual differences had a certain modulating effect on dealing with noise.

16:40-17:00

1673 _____ *contributed*

A SOUNDSCAPE MODEL FOR CHILDREN EXPOSED TO AIRCRAFT AND ROAD TRAFFIC NOISE AT SCHOOL

Isabel Lopez-Barrio⋆, Belinda de Frutos Torres

⋆ *Instituto de Acústica (CSIC), Madrid, Spain*

A soundscape model for children exposed to aircraft

and road traffic noise was tested with the structural equation modelling (SEM) technique. The SEM was applied to a sample of 250 children of 9-10 years old, from schools near Barajas airport in Madrid. The aim was to evaluate the school soundscape. The model included two noise sources (road traffic and aircraft) and the degree of interference in school activities and annoyance based on these noise sources. A pleasantness appraisal of the sounds at school and the individual differences on children´s cognitive and coping style were also studied. An acceptable fit was obtained (GFI=0.953; AGFI=0.915; RSMEA=0.10). As expected, the perceived quality of sound had the strongest effect on soundscape pleasantness, which also received the influence of road traffic and aircraft agreeableness and the negative effect of aircraft annoyance. Individual differences played a role in the soundscape evaluation. Cognitive style activated coping strategies and coping style also played a significant role in the perception of noise interference. The model accounts for 41.7% of school soundscape pleasantness variance, which is explained mainly by perceived quality of sound, car and aircraft agreeableness and aircraft annoyance with a negative effect. As anticipated, individual differences had a certain modulating effect on dealing with noise.

17:00-17:20

1715 _____ *contributed*

EXTREME AUDIO AND THE CITY

Fernando J. Elizondo-Garza

UANL-FIME, San Nicolas, Mexico

In this presentation will be discussed the problem of the extreme audio systems as generators of very high noise levels in the cities. The cases of the "boom cars" and the home audio systems will be analyzed. This problematic is presented from the point of view of the technology, the behavior of the owners of the audio equipments, and the effects over the environment. The point of view of the promoters and the opponents of a prohibition to this type of sound sources will also be presented.

17:20-17:40

2018 _____ *contributed*

HOW NOISY IS OUR CITY? URBAN SOUNDSCAPE AT HOME, NEIGHBOURHOOD AND COMMUNITY LEVELS

Kin-Che Lam*, Pak-Kin Chan, Wing-Chi Hui

* *The Chinese University of Hong Kong, Shatin, Hong Kong*

Abstract: Noise assessment in most cities is usually undertaken by determining the noise exposure at the façade of dwellings. It seldom takes into account the noise exposure of residents outside their homes even though urban inhabitants spend considerable amount of time in their neighbourhoods and communities. Studies have shown that people's annoyance with transportation noise is affected not only by the noise exposure at their dwellings but also by the entire environscape. Thus, consideration of the acoustical environment in the neighbourhood and community levels will give a more comprehensive picture of how noisy our cities are. To do so, we have used the noise mapping technique to determine the noise exposure of urban inhabitants in their dwellings, neighbourhoods and communities and relate these three dimensions to different urban fabrics in Hong Kong. This paper reports findings of the variations in, and relationships of, the acoustical environment at the home, neighbourhood and community levels in Hong Kong. It also explores the relationship of these three dimensions in different urban landscapes and examines the possible effects of different noise reduction strategies on the noise exposure of the urban population. Such results will have implications on our understanding of the urban acoustical environment and effects of urban growth and various noise management strategies.

17:40-18:00

1654 _____ *contributed*

THE SOUNDSCAPES AND THE URBAN DEVELOPMENT: COPACABANA - A SEASHORE RESIDENTAL AREA AND TRAPICHERO - A HILLSIDE RESIDENTIAL AREA

Andréa Q.S.F Rêgo

QR Arquitetura e Urbanismo / Proub-UFRJ, Rio de Janeiro, Brazil

This document is part of a doctorate thesis in urban design, which I'm developing at Universidade Federal do Rio de Janeiro. The main objective of the thesis is to identify how the soundscape is associated to the urban development and to the culture of a social group that produces and uses this urban space, having the city of Rio de Janeiro as the case study. The second objective is to identify new parameters of sound quality associated to cultural values. Therefore, I will analyze the methodology applicability to other sensorial parameters, such as the sense of smell and warmth. The city of Rio de Janeiro has a rich geography that defines two very different landscapes - hillside and seashore. Historically, both were occupied by the human settlement at the same time as two sides of a development vector. According to the Schafer's theory(1), different landscapes define different keynote sounds; the basis for the other sounds produced as a result of the technology and culture. On the other hand, Rapoport(2) says that the organization of space reflects the activities, values and purposes of the social groups, so there is an intense lack of congruence between social and physical spaces. Putting these together, I will demonstrate how the soundscape accompanies the urban development as a result of social acts. Of course, the importance of economic and politic forces in the process of ur-

ban development could not be neglected, but they are not the focus of this study. The two environments - Copacabana, seashore e Trapicheiro, hillside, will be reconstructed describing, in parallel, the soundscape and the urban landscape. The chronicles will be used as sources to research the sounds of the past. The analysis was based on three moments: the beginning of urbanization (early 1900's), the 1950's and nowadays. (1)Schafer, R. Murray. The Soundscape - Our Sonic Environment and the Tuning of the World. Destiny Books. Rochester, 1994. (2)Rapoport, Amos. The Meaning of the Built Environment - A Nonverbal Communication Approach. The University of Arizona Press, 1990.

RIO 2005 inter-noise ENVIRONMENTAL NOISE CONTROL
The 2005 Congress and Exposition on Noise Control Engineering
07-10 August 2005 - Rio de Janeiro - Brazil

Session TN3: Transportation Noise

chairs:

Vivian Silva Mizutani - *Brazil*

Keith Attenborough - *UK*

16:00-17:40 **Room:** Copacabana

16:00-16:20

1984 _____ *contributed*

RESONANCE FREQUENCIES OF RAIL AND WHEEL UNDER CAR LOADINGS

Shing Chen

Industrial Technology Research Institute, Hsinchu, Republic of China

The resonance frequencies of wheel and rail depend upon the types of fasteners and car loadings. At an elevated tangent track, the train noise is dominated by vertical rail vibration. At curved track, one part of the train noise is from both horizontal and vertical vibration of rail and the other part of noise is a series of resonant frequencies of rail and wheel are excited between 2500 Hz and 3500 Hz due to the friction interaction of wheel and rail. The squeal noise between 2500 Hz and 3500 Hz is manifest for small curvature and radiates with a noise bandwidth around 300 Hz. It is suitable that one can assume noise source locations of MRT train with conductor rail are mainly from wheel and rail when predicts the insertion loss of a noise barrier.

16:20-16:40

2003 _____ *contributed*

STRUCTURE BORNE SOUND FROM A LIGHTRAIL IN A FISHNET STOCKING

Martijn Vercammen

Peutz, Mook, The Netherlands

A new line for lightrail is developed in the western, urban part of the Netherlands. Part of this line is projected in the centre of the Hague. To connect to existing rail and to enable the use of the ground floor level as shopping area it was decided to make the rail at an height of approx. 7 m above groundlevel. A steel construction like a fishnet stocking was designed to make it transparent and to prevent that the street under it will be dark and gloomy. Important concern was the sound radiation of such a steel structure, that can be quite high, e.g. the well known Chicago Elevated Train. The SPL should be acceptable for the people near and under the railway. To assess the sound radiation an impedance model was made to calculate the vibration in the steel structure from a given source strength. The source strength was obtained form several measurements with different light rail trains and different tracks. Using the radiation characteristics of the open steel structure the sound radiation was determined. The calculations were done for different configurations of the track supports. It was found that for a sufficient reduction of sound radiation it was necessary to apply concrete beams as supports in combination with resiliently mounted rails. This combination provides a significant reduction for the middle and high frequencies. The low radiation factor of the steel beams provides a sufficient reduction for the low frequencies. The expected equivalent sound pressure levels at ground level around the elevated rail are approx. 75 dB(A) during passage, which is expected to be sufficiently low to be acceptable for the shopping public.

16:40-17:00

2032 _____ *contributed*

CHARACTERIZATION OF GROUND VIBRATION CAUSED BY TRAINS FOR DIFFERENT CONFIGURATIONS

Joan Cardona *, Jordi Romeu, Meritxell Genescà, Jaume Solé

* *LEAM-UPC, Terrassa, Spain*

The railway network is rising, with both surface and underground railway (especially this last one) and the modernization process of the existing railway is a fact. For these reasons, it is important to have a tool to predict the vibration level caused by the trains passing-by, and that the prediction tool is adapted to each regions characteristics. The algorithms and models used to predict soil vibration propagation (Barkan expres-

sion e.g.) are referred to a punctual vibration source whereas a train could be considered as a linear source. Train pass-by vibration measurements were carried out for different soil typologies and different rail configurations: surface rail, rail in a false tunnel and rail in a real tunnel. That measurements show that experimental geometric damping coefficients are little different than the theoretical ones, getting that the coefficient values for a false tunnel configuration are lower than the theoretical values and the coefficient value for a real tunnel configuration are higher than those theoretical ones. In this paper an expression that relates ground vibration propagation due to a punctual source to the propagation according to a linear source is developed (the same that occurs with sound propagation), in a similar way with previous works. It is validated with the aforementioned measurements which have been carried out in Spain and which collect three different rail configurations. The results allow to obtain a ground vibration propagation model adjusted to the constructive and soil characteristics of the measurement sites, which are representative of the North-East region of Spain, as well as to determine the frequency influence on the attenuation process during the ground vibration propagation.

17:00-17:20

1538 _____ *contributed*

RESPONSE OF HULL PLATES DUE TO TURBULENT BOUNDARY LAYERS

Anders Nilsson

MWL/KTH, Stockholm, Sweden

A turbulent boundary layer-TBL- can be developed in a fluid close to a structure at sufficiently high flow velocities. For a ship travelling through water, the TBL, when developed, excites the hull plates. Part of the acoustic power induced in the hull is transmitted as vibrations in the ship structure to the accommodation spaces. The structures enclosing the accommodations radiates noise into these spaces. The acoustic power radiated due to this effect is proportional to the power induced in the hull structure by the TBL. It is therefore essential to determine the relative importance of the TBL effect as compared to the acoustic power induced in the ship structure by other sources like water jets, engines etc. A model has been developed for the prediction of velocity levels of hull plates which are excited by turbulent boundary layers. The model is based on the theory developed by Corcos. It is found that the velocity of the hull plates strongly depends on the speed of the ship. The acoustic power induced in the hull can be reduced if the thickness of the hull plates is increased. Other parameters like frame distance and height of hull plate are of secondary importance. The effect of turbulent boundary layer excitation is most efficiently reduced by changing the hull shape or by changing the transmission path from the hull plates to the accommodation decks. The prediction program is described.

17:20-17:40

1859 _____ *contributed*

FOUNDATION IMPEDANCE MEASUREMENT OF A PROPULSION REDUCTION GEAR

Jae Seung Kim⋆, Kim Hyun Sil, Kim Bong Ki, Kang Hyun Ju, Kim Sang Ryul

⋆ *Korea Institute of Machinery & Materials, Seoul, Korea*

The impedance of machinery foundations is one of the important factors that determine the transfer characteristics of structure-borne noise from machinery to the structure in which the machineries are installed. For naval ships where the suppression of underwater radiated noise is utmost important, it is a common practice to make the impedance values of propulsion machinery foundations to be as large as possible. Measurement of foundation impedances of propulsion reduction gears of a naval ship being built is described and the measured impedances are presented. Specifically, two impact hammers with different sizes have been used to excite the foundation structure. For small impact hammer, impedances were measured using a soft tip and a hard tip respectively. The combinations of impact methods adopted are pursued to investigate the effectiveness and/or limitations when exciting extremely stiff and massive structures such as the foundation of marine propulsion plants treated here.

Wednesday 10 August 2005

Sugar Loaf - *Pão de Açucar*

Distinguished Lecture 6

08:30-09:30 h **Room:** Rio 1+2

Porous Materials for Sound Absorption and Transmission Control

J. Stuart Bolton
Professor, Ray W. Herrick Labs., School of Mechanical Engineering, Purdue University, USA

Current Research Interests: Active Noise Control, Effective Use of Noise Control Material, Measurement of Material Properties, Holographic Visualization of Sound Fields, Experimental Identification of Structure-Borne Noise Fields, Optimum Design of Centrifugal Fans and Outdoor Sound Propagation.

This presentation begins with a discussion of the general types of porous materials, i.e., rigid, limp, and elastic, and of their general physical properties. The macroscopic properties (e.g., flow resistivity, porosity, tortuosity, etc.) that control the acoustical behavior of each type of porous material are then defined and discussed, as are methods for their measurement. The acoustical characterization of porous media is considered next, followed by a discussion of modeling porous materials with particular reference to elastic porous materials such as foams. The special characteristics of elastic porous materials are illustrated through experimental and computational examples involving sound absorption and sound transmission. In particular, the importance of apparently small details of foam layer boundary conditions is emphasized. Finally, foam finite elements that are capable of predicting the behavior of finite-sized noise control treatments having realistic shapes are discussed. By using foam finite element models it is possible to perform optimal design studies: i.e., to design real treatments that yield optimal acoustical performance at a given treatment volume or weight.

Session AC1: Active Noise and Vibration Control

chairs:

Eduardo Bauzer Medeiros - *Brazil*

J. Stuart Bolton - *USA*

10:00-12:00 **Room:** Lagoa

10:00-10:20

1652 _____ *contributed*

ACOUSTICALLY EVALUATING MEASUREMENT OF ACTIVE INSULATION PLATES OF FLOOR IMPACT NOISE

Sadao Akishita ⋆, Atsushi Mitani, Hidenobu Uchida, Masazumi Shioda

⋆ *Ritsumeikan University, Kusatsu, Japan*

The paper describes the acoustically evaluating measurement of the active control system for insulating floor impact noise in condominiums. The control system is comprised of actively controlled modular plates, which in assembled state cover the whole surface of concrete slab structure in the ceiling, and in each of which the mechanical vibration is controlled independently with five actuators of moving coil and five sensors of vibration acceleration. In order to decrease the computing load of the controller, the technique of decoupling the natural modes of vibration in the plate was applied, which yielded the parallel control system of the vibration mode with reduction of the acceleration signals by 10[dB] or more for the dominating lowest modes. The control is operated with micro-computer systems, composed of a FPGA board with analogue I/O and a micro-computer board of DSP. The feed-back control for reducing the three main vibration modes is processed at 10[kHz] sampling rate. The acoustically evaluating measurement is conducted in two reverberation chambers systems with a concrete slab compartment wall of 3.7[m] by 2.9[m], on one surface of which twelve modular plates of the active control are installed. The first measurement is operated with an impact on the other surface of the wall, and the second measurement with a sound excitement in one chamber. The further details of the measurement and the micro-computer control systems are reported in this paper.

10:20-10:40

1419 _____ *contributed*

A STUDY OF CASES USING ACTIVE NOISE CONTROL WITH NEURAL NETWORK AND REAL TIME IDENTIFICATION

Rosely Maria Campos ⋆, René Marcelino Abritta Teixeira, Eduardo Bauzer Medeiros

⋆ *PUC.Minas, Belo Horizonte, Brazil*

The present work describes some of the research effort on Active Noise Control (ANC) being jointly developed by the Catholic University of Minas Gerais (PUC-MINAS) and the Federal University of Minas Gerais (UFMG). Considerations about the implementation of Digital Signal Processing for noise control in ducts and inside a pick up has been presented. The objective is to establish a study on Active Noise Control in different cases with acoustic parameters modification using adaptive digital filtering implementation. The main results are presented and considered according to their use in the development of real applications in closed places using Adaline neural network and real time identification, doing a spectral analysis in noise attenuation. The idea is to provide an initial and useful insight for both designers and students concerned about Active Noise Control focusing on control algorithm and spectral analysis. The authors are continuing with this research, for other configurations and implementations and believe that the present studies should hopefully provide more favourable conditions to the implementation of real time ANC.

10:40-11:00

1459 _____ *contributed*

A NEW ANALYTICAL MODEL FOR THE FXLMS ALGORITHM VERIFIED TROUGH AN ANC EXPERIMENT

Guillaume Barrault ⋆, José C. M. Bermudez, Arcanjo Lenzi

⋆ *LVA-UFSC, Florianópolis, Brazil*

This paper presents a new analytical model for the behavior of the Filtered-X LMS adaptive algorithm when applied to active noise control in a finite duct. The new model is derived using a stochastic differential equation (SDE) approach. The theoretical predictions are verified through experimental results. The system implemented does not require DSP cards; only I/O cards. Automation of the experimental setup allows the practical verification of the theoretical statistical model using Monte Carlo techniques. It is verified that the behavior of the algorithm is accurately predicted by the theoretical model.

11:00-11:20

1917 _____ *contributed*

ACTIVE VIBRATION CONTROL FOR HELICOPTER

Christian Carme

TechnoFirst, Aubagne, France

During the past, TechnoFirst has focused its main activities for conception and commercialisation of active noise and vibration reduction's electronic processings system. TechnoFirst's mission is being a driving link between fundamental research and industrial applications of active control technologies. After the first ANR mass market developed by TechnoFirst for earmuffs since 1990, the strategy of TechnoFirst has been to concentrate its efforts on other industrial market and mass production market. That the reason why, we have decided to investigate markets as HVAC, seats, etc... One very important market has been also to develop exhaust pipe with active noise control (papers already done during the past for InterNoise congress, [1], [2]). These papers presented solutions for trucks, automotive, boats etc... These markets are representing of course mass production market. An other mass production market appeared to us as active vibration control market. That's the reason why we started to study as first issue a problem of engine vibration on Peugeot 307. This paper has been presented last year at InterNoise 2004, the subject was : control of engine vibration transmitted through the elastic dampers to the car cabin. This year, we have decided to present an experiment done for an helicopter company about a large active floor vibration control which intends to control and reduce dramatically acceleration on the floor. This paper will describe the theoritical approach of this work through modelling used for computing the number of transducers used for solving this problem. We will also present all major experiment results get before doing optimization of the number of transducers, the location of them inside the helicopter cabin. The final part of this paper will be the control description and vibration results.

11:20-11:40

1965 _____ *contributed*

RESEARCH PROGRAM OF ON-BLADE ACTIVE TAB FOR HELICOPTER NOISE REDUCTION

Noburu Kobiki ⋆, Shigeru Saito, Takeshi Akasaka, Yasutada Tanabe

⋆ *JAXA, Japan, Chofu, Japan*

JAXA (Japan Aerospace Exploration Agency) and Kawada Industries Inc. have been working to research and develop a new active technique for helicopter noise reduction which is available to all the flight patterns. This new technique is referred as "Active Tab", which is installed in the aft portion of the airfoil and driven back and forth. This paper presents the outline of active tab research program, the idea and the wind tunnel testing activity to evaluate the active tab effect. The active tab is installed in the aft portion of the airfoil and driven back and forth dynamically to reduce BVI noise and the vibration by the blade lift control due to the variable blade area effect. The active tab also can be operated statically, such as the active tab is deployed with some displacement and fixed. This way of operation can increase the blade lift during the whole revolution of the blade so that the rotor speed can be reduced by making use of this lift increment, which has the effect on the climb and fly-over noise reduction. The wind tunnel test was performed to study the noise reduction effect of the active tab by a rotor configuration in the 2.5x2.5m low speed wind tunnel of Kawada Industries, Inc. using a one-bladed rotor system. The final paper includes the details of the active tab wind tunnel testing results and the discussion.

11:40-12:00

2026 _____ *contributed*

ACTIVE STRUCTURAL ACOUSTIC CONTROL OF A HELICOPTER TRIM PANEL

Arnaud Lepage⋆, Frédéric Mortain, Laurent Coste

⋆ *ONERA, Chatillon, France*

The reduction of vibrations and noises is a major concern of air transportation vehicle developments, indeed the interior comfort has become a major competitive component comparable to other performance features. The classical approach is the use of passive treatments and damping materials but this leads to significant mass increase and has a lack of efficiency in the low frequency domain or in the case of multiple frequencies. Active control methods offer a potential without these drawbacks and can be considered as a complementary approach. This work is mainly focussed on the possibility of reducing the noise transmitted to helicopter cabins by actively controlling the side walls vibrations in such a way as to reduce the sound radiation/transmission (Active Structural Acoustic Control). This paper summarizes numerical and experimental works carried out to actively control a helicopter trimmed panel using a feedback method. In this case decentralized control loops were composed of structural actuators (piezoceramic patches) integrated in composite panel, accelerometer sensors and control laws based on an Internal Model Control algorithm. A numerical model updated with the knowledge of the experimental structural modes was used to define control parameters (actuators and sensors locations, parameters of control laws for disturbance rejection). Active control was then experimentally performed with reference to a primary force excitation acting on the panel. Structural or acoustical disturbances were encountered for different types of signals : tonal and broad band perturbations, especially in the case of a diffuse acoustic field. The effectiveness of this approach has been experimentally assessed in terms of vibration levels reductions and attenuations of the sound radiation.

Session AN2: Aircraft Interior Noise and Technology

chairs:

Dominique Collin - *France*

Carlos Grandi - *Brazil*

10:00-11:40 **Room:** Business Master 136

10:00-10:20

2055 _____ *contributed*

TRANSMISSION LOSS AND SOUND ABSORPTION COEFFICIENT OF AIRCRAFT INSULATION PACKAGES: A PARAMETRIC ANALYSIS

Mario Trichês Jr. ⋆, Marcelo Santos, Samir N.Y. Gerges, Julio Cordioli, Francisco Klug, Thiago Zmijevski

⋆ *Embraer, São José dos Campos, Brazil*

In the last decade many research studies have been dedicated to reducing interior noise of aircraft. Noise fields generated by turbofans, propellers and turbulent boundary layer for example, impinge on the exterior of the fuselage and induce large sound levels inside the cabin of aircraft. The internal noise levels of aircrafts have become a major concern for the aerospace industry during the last decades. Noise reduction inside the cabin of a jet is one of the most important requirements for public acceptance of the aircraft. Almost all aircraft make exclusive use of passive methods to control interior noise. The general concept of cabin soundproofing has remained constant over the years, but detailed design changes have occurred, particularly with respect to more efficient treatments. The basic noise control treatment consists of one or more layers of porous material, an intervening sheet of heavy limp material and a covering impervious trim. When an internal acoustic treatment is defined for a specific aircraft, there is a compromise between weight and transmission loss. With the severe weight and space constraints imposed on airplane soundproofing treatments, the emphasis in many cases has been on minimizing the weight and depth of the treatment while maintaining adequate sound attenuation characteristics. The aim of this paper is to analyse the dependency of the transmission loss of several aircraft acoustic treatments regarding the properties of the layers used in their composition, through the Transfer Matrix Method (TMM) and Finite Element Method (FEM). For this purpose, the properties and the geometrical arrange of the materials used to compose these insulations will be varied and the resultant performance in terms of transmission loss will be analysed.

10:20-10:40

1784 _____ *contributed*

A STUDY OF CLOSED LOOP CONTROL LAW FOR BVI NOISE REDUCTION

Mitsuru Kosaka ⋆, Shigeru Saito, Noboru Kobiki, Hajime Fujita

⋆ *Japan, Chofu, Japan*

It is well known that helicopters make very loud noise, which is problematic in spite of their versatility and utility. BVI (Blade/Vortex Interaction) noise can be noted as one of the most annoying noises helicopters generate. The BVI noise is an impulsive noise which is made by a collision between a rotor blade and a tip vortex generated from the blade itself or the other blades. This study is to construct a control law applicable to active techniques for BVI noise reduction?and to evaluate by a wind tunnel test. A numerical simulation is also carried out in order to enhance the control law based on experimental data. A one-bladed rotor system (1m radius) with HHC (Higher Harmonic Control) as an active technique applied to our control law is used in the wind tunnel test in order to investigate the capability of the control law to reduce the noise. Sound pressure measured by microphones installed near the rotor is set as a control performance function for the control law. It is confirmed from the wind tunnel test that a proposed closed loop control law can rapidly and properly converge to the sound level which HHC can achieve as least as possible. The numerical simulation shows that the enhanced control law has the good capability of the convergence as noise reduction. The final paper describes detailed control law structure, the wind tunnel test results and the control law enhancement by the numerical simulation.

10:40-11:00

1908 _____ *contributed*

COUPLING NAH AND GEOMETRICAL ACOUSTICS IN HELICOPTER CABINS

Julien Caillet ⋆, Franck Marrot, François Malburet, Jean-Claude Camona

⋆ *SERAM, Aix-en-Provence, France*

The work presented in this paper settles in the general framework aiming to improve the acoustical comfort in helicopter cabins, including both diagnosis and modelling purposes, by use of passive techniques (insulating, damping, and porous materials). Cabin noise level in helicopters is mainly due to transmission gearbox, rotor, engines and aerodynamic excitation. These sources cover a broad frequency range extending within the range of dBSIL4 (Speech Interference Level, 4-octave average), which is the frequency band at stake here. Disturbances generated by these sources propagate through the airframe and reach into the cabin via airborne and structure-borne energy paths, thus

producing radiated noise by the panels of the cabin. The problem here is to rank these vibrating panels according to their effect on inside noise level and to locate the leaks, in order to propose some efficient noise reduction technique. At the moment, a complete numerical prediction of the cabin interior noise is not available. A complete system combining measurements by means of Nearfield Acoustical Holography (NAH) and simulation with an acoustical ray-tracing method is derived as the most suitable one for a reverberant and noisy environment as an aircraft. NAH aims to solve the inverse problem consisting in rebuilding the acoustical field on the interior surface of the cabin from measurements of the pressure on a handy 2-D microphone antenna. Velocity results are used as an input for the Green Ray Integral Method enabling to rebuild acoustic pressure at the passenger's ears location, and thus to precise the influence of each panel on the noise produced at the passengers ears location. This method offers a good means to combine the advantages of the geometrical methods for acoustical domains and the ability of the integral formalism to precisely couple vibrating surfaces and acoustic volumes. The coupling of these tools is achieved successfully on simple test cases and is assessed for an in-flight measurement on a whole helicopter cabin.

11:00-11:20

2056 _____ *contributed*

NUMERICAL TECHNIQUES FOR SIMULATION OF AIRCRAFT NOISE CONTROL TREATMENTS

Marcelo Santos*, Mario Trichês jr., Thiago Zmijevski, Samir N.Y. Gerges, Julio Cordioli, Francisco Klug

* *Embraer, São José dos Campos, Brazil*

The high noise environment within the cabin of commercial aircraft has long been recognized as a significant problem. Numerous researchers, and many aircraft manufacturing companies, have investigated noise reduction approaches. The methods considered include structural modifications, passive damping, absorption materials and active vibration or noise control. Aircraft damping composites and insulation materials, often in the form of constrained layer damping, insulation blankets and other arrangements, have been used in a number of applications to reduce airplane interior noise. Damping materials are typically applied directly to the aircraft skin to reduce the effects of boundary layer excitation, engine exhaust impingement and engine vibration, where it is effective only at frequencies above the panel fundamental frequency. Absorption materials are almost always used in conjunction with a barrier of some type, since their porous construction permits noise to pass through relatively unaffected. Typical absorption materials for an aircraft are bagged fiberglass or polyimide foam. Combining these absorptive materials with damping materials increases performance by providing increased structural noise control, additional mass and the acoustical absorption of the fiberglass/polyimide. The selection of the most suitable noise control treatment for aircraft applications, however, it is not a simple task. Indeed, sometimes a noise control package is selected based on a large number of flight tests to evaluate the internal noise, which generally is costly and time consuming. In this context, the aim of this paper is to present numerical techniques to model a noise control treatment, composed by an aircraft damping composite and an insulation blanket (combination of acoustic materials). Numerical models using the Finite Element Method are constructed to represent all the components (layers of materials) of the noise package and the results obtained with the simulations are compared with experiments to validate the modelling method.

11:20-11:40

1552 _____ *contributed*

AIRPLANE GALLEY INSERT OVEN ACOUSTICS

Balakrishna Thanedar

The Boeing Company, USA, Seattle, USA

A galley is a structural unit located within the airplane from which food and beverages are served. In conjunction with the airplane food service a large number of galley inserts such as ovens, refrigerators / freezers, air chillers, wine chillers, galley solid waste disposal are housed as a part of the galley system. During operation noise from the ovens can become noticeable and annoying in and around galley work area; necessitating engineering noise control. By applying the modified NCB (balanced noise criterion) method (ANSI S12.2-1995) acoustic characteristics of four pairs of ovens from four oven manufacturers are examined. For a particular oven, depending upon the distribution of its emitted octave band sound pressure level (SPL) values, the oven noise is classified as rumbly, hissy or balanced and engineering solutions are identified.

Session BA6: Building Acoustics

chairs:

Elvira B. Viveiros - *Brazil*

Gustavo Melo - *Brazil*

10:00-12:00 **Room:** Rio 1

10:00-10:20

1396 _____ *contributed*

ACOUSTIC PERFORMANCE OF TIMBER CONCRETE COMPOSITE FLOORS

Matthias Schmid

School of Architecture, Civil and Wood Engineering HSB, Biel/Bienne, Switzerland

Timber concrete composite floors (TCCF) win increasingly in importance and this not only in the field of multi-storey timber constructions. The performance of this system speaks for itself. However the acoustic performance of this construction was described until today only generally and rather in theory. Fact is that for TCCF only few acoustic field measurements exist. No or few technical and supporting documents are available to planners, architects and engineers today. Within the framework of the national program Holz21 in Switzerland field measurements in multi-storey timber constructions with focus on sound protection could be carried out. The comparison of realised constructions built according to the current Swiss standard SIA 181 showed that floor constructions in timber could absolutely fulfil the requirements for multi-storey timber constructions. The quality achieved with respect to sound performance of the construction first of all depends on the quality of the design and the quality of on site work. To offer more confidence to the planners of timber buildings in this respect the results from the field measurements are presented in this paper.

10:20-10:40

1488 _____ *contributed*

TECHNOSTAR: LIGHTWEIGHT VERSUS MASS CONSTRUCTIONS IN CINEMA WALLS

Andrew Koster

Saint-Gobain Isover, Etten-Leur, Netherlands

Technostar: Lightweight versus mass constructions in cinema walls The role and possibilities of lightweight mineral wool is known for quite some years, acting as the spring in a mass spring mass system one can reach high acoustic values. Compared to the massive constructions (e.g. concrete) the use of a mass spring mass construction has also other advantages (e.g. logistic, dimension of foundation and labour costs). Saint-Gobain Isover developed in the nineties a cinema wall system called Technostar. In this construction an optimal mass spring mass construction is created. The theory of mass spring mass systems will shortly come up. All elements of the system are described. The acoustical performance of the Technostar construction is calculated with acoustic software (Stiff) and compared with laboratory measurements; the influence of different parameters on the measured acoustical performance will be shown. The practical use of the Technostar wall will be shown on the basis of two projects, one project made in the Netherlands and one in Bulgaria. For both projects the acoustic requirements, the translation in terms of the wall construction with the specific details will be shown. Also the acoustic in situ measurement results of both cinema complexes are given.

10:40-11:00

1494 _____ *contributed*

ANALYSE OF STRUCTURE BORN SOUND ON SLIM FLOOR SYSTEM OF STEEL CONSTRUCTION TO ATTEND ACCEPTABLE COMFORT

Jackson Costa Machado*, Marco A.M. Vecci

* *USIMINAS, Belo Horizonte, Brazil*

Accoustic comfort in residential environment with the presence of impact sound due to people walking can be achieved by using floating floor systems insulation. In order to evaluate the influence of the floating floor system insulation built of resilient blanket materials with different thicknesses, 5, 10 and 20 mm, some experiments have been carried out using ISO standard measurement procedures. Experimental data results are compared with numerical evaluated values obtained by means of analytical expression available in the literature. Same adjustments on the analytical expression are being proposed in this work in order to obtain better agreement between the experimental results and the analytical predicted values. The adjusted expression generate values that are in good agreement with the experimental values obtained for the acoustical floating floors system studied herein for a large frequency range and different resilient material thicknesses.

11:00-11:20

1537 _____ *contributed*

ROLE OF MINERAL WOOL IN ACOUSTICAL CONSTRUCTIONS

Jürgen Royar

SAINT-GOBAIN ISOVER GH AG, Ladenburg, Germany

Role of mineral wool in acoustical constructions Mineral wool is one of the most efficient and economical materials for the use in acoustically performant constructions. In some of the most common applications,

such as damping of cavities, resilient material in wall linings, new results have been found to give more precision into the forecast of the acoustical performance of such constructions. The paper gives a survey over the state of the art in using mineral wool in acoustical constructions in buildings including new results in this field.

11:20-11:40

1808 _____ *contributed*

ALLEVIATION OF THE COINCIDENCE EFFECT IN DOUBLE-LAYERED PLASTERBOARDS COMPOSING MULTIPLE DRYWALL SYSTEMS

Hiroo Yano ⋆, Hideki Tachibana, Shinichi Sakamoto, Toshio Matsumoto

⋆ *Chiba Institute of Technology, Narashino, Japan*

Double or multiple drywall systems using plasterboards have various advantages and are being widely used, although they have such intrinsic acoustic defects due to mass-air-mass resonance at low frequencies and the coincidence effect at high frequencies. Regarding the latter problem, there is a possibility to prevent the sound insulation deterioration by layering two or more board materials of different physical characteristics and by devising the way of gluing them. In this paper, the results of the experimental investigations on these points are introduced.

11:40-12:00

1589 _____ *contributed*

COMPARISON OF LIGHTWEIGHT PARTITION ASSEMBLIES TYPICAL OF AMERICAN AND EUROPEAN RESIDENTIAL AND COMMERCIAL CONSTRUCTION

Stanley D. Gatland II

CertainTeed Corporation, Valley Forge, USA

Lightweight partition constructions are used extensively throughout the world to control airborne and structureborne sound transmission through walls, floor-ceiling and roof-ceiling assemblies. However, the benefits of high performance acoustical systems can be lost due to improper installation or poor construction details. This paper will describe the commonly specified, standardized test methods and sound control practices, developed by the International Standards Organization (ISO) and the American Society for Testing and Materials (ASTM), used to determine the acoustical performance of lightweight partition constructions. Sound insulation data regarding wall, floor-ceiling and roof-ceiling assemblies typical of North America, South America and Europe will be graphically compared and contrasted. Sound flanking paths, sound leaks and structural short circuits that decrease the effectiveness of sound insulating systems will be identified with solutions presented.

Session CT: Community Noise around Airports: Technical Aspects

chairs:

Jules G. Slama - *Brazil*

Max de Castro Magalhães - *Brazil*

10:00-11:00 **Room:** Copacabana

10:00-10:20

1555 _____ *contributed*

IMPROVING THE ACOUSTICAL QUALITY OF FACADES NEAR AIRPORT IN HUMID CLIMATES

Ludmila Morais⋆, Mônica Viegas, Teo Revoredo, Jules G. Slama, Sam Revoredo

⋆ *Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil*

This paper intends to discuss the matter of buildings acoustical quality near airports and propose noise control strategies that should reflect on lower energy costs. In hot humid climates, natural ventilation is the usual approach for air conditioning although this may become a problem when noise levels are high on the location. The solution generally used to deal with this matter is the improvement of facade isolation by the use of acoustical windows which requires air conditioning. This solution usually implies on greater energy costs once it demands equipment maintenance in addition to the implementation of the isolation. Sound barriers in urban area are one way of decreasing noise levels at certain locations but they have limitations when used on airport surroundings because of the height difference between noise sources due to aircraft approaches and departures and the receivers. We discuss different ways of achieving acoustical isolation of facades associated to mechanical ventilation or to passive cooling systems such as natural ventilation, or thus accomplishing lower energy costs which should be a main concern on countries such as Brasil where blackouts have been a constant worry. One should thus evaluate its application according to the specific context and maybe apply it together with other solutions such as louvres acoustical silencers and quarter-wave filters. Silencers are considered to be used in the improvement of the acoustical quality of buildings facade. They are classical solutions but they should be transformed on architectural ones.

10:20-10:40

1774 _____ *contributed*

IMPLEMENTING THE BALANCED APPROACH FOR AIRPORT NOISE CONTROL IN DEVELOPING COUNTRIES: THE CASE OF BRAZIL.

Rita de Cássia Nogueira*, Jules G. Slama

* *Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil*

The airport noise control is a multidisciplinary subject on which several means of action are possible. The ICAO on the 33rd OACI assembly in October 2001 has defined a philosophy resolution about this matter called "Balanced Approach". Four courses of action are primarily defined: • Noise reduction on the source (aircrafts) • land-use planning and management • operational procedures to limit noise emission • operating restrictions In many countries two important ways of restricting aircraft operations have been taken in order to reduce the airports environmental noise impact. They are: 1) Prohibition of the noisiest aircrafts operation. These noisiest aircraft are called chapter 2 and non-classified aircrafts by the annex 16 to the ICAO Chicago convention. 2) Reduction on the number of night flight. In Brazil, there are still many important flights of chapter 2 and non-certified aircrafts in the major airports especially during the night time. One of the strategies of work carried through by the UFRJ Airport Noise Study Group consists on sensibility studies on which the following analyses are performed: A First Analysis consists in the Study of the relation between the area situated inside the curve LDN=65dB(A) and the number nocturnal and diurnal movements of the diverse categories of airplanes. Calculation of a linear sensitivity coefficient, were performed allowing to classify the movements of aircraft in function of the noise impact. The result of this first sensitivity analysis shows the important weight of the noisy airplanes in the ambient impact sonorous. The Second analysis consisted of, using the coefficients of sensitivity previously determined, studying the influence of the take-off tracks on the form of the noise curve. It was verified that the form of the noise curve is very sensible to the change of route of the noisy airplanes, suggesting that while had not been completely interdicted in the Brazilian airports, it would be important to study selective alternative tracks for these aircraft of form to prevent to pass in the take-off above of regions very populated. .Cases has been developed using INM program to present this strategic approach to the noise control problem.

10:40-11:00

1958 _____ *contributed*

THE AIRCRAFT NOISE ON MAJOR URBAN AREAS IN BRAZIL - INSTITUTIONAL ISSUES

Alexandre Brandão

INFRAERO, Brasília, Brazil

One of the most important environmental issues associated with civil aviation at the airport environs is aircraft noise. On the one hand, the expansion of airport infrastructure presents a set of positive economic benefits, although those are dispersed throughout metropolitan regions and urban areas as a whole. On the other, the negative effects of such expansion possess physical characteristics, which are felt in a more intense manner in the densely occupied areas next to the airport. The predominance of environmental impacts and the differences between spatial scales of the impacts diminish the perception of the positive socio-economic effects and the right balance between costs and benefits. This article intends to present the interfaces between the urban and environmental legislation as well as the civil aviation regulations and then discuss the limits and possibilities of the legal apparatus in the correction and prevention of the most significant effects of the operation and the expansion of Brazilian airports in the main metropolitan regions of the country.

Session GA1: General Acoustics

chairs:

Antoni Sliwinski - *Poland*
Gilles Daigle - *Canada*

10:00-12:00 **Room:** Business Master 145

10:00-10:20

1582 _____ *invited*

DISPERSAL OF ELECTROSTATIC DEPOSITED POWDER BY HIGH INTENSITY LOW FREQUENCY SOUND

Gary Seiffert*, Barry M. Gibbs

* *University of Liverpool, Liverpool, UK*

The work reported is of an investigation of the acoustical removal of powder deposits on charged plates. The results have application to electrostatic precipitators, which are used extensively in the powder manufacture and power generation industries to remove dust particles from extracted gas streams. An excessive accumulation of dust on the plates leads to a loss of filtering efficiency. The dust layers formed therefore are removed periodically, normally by rapping the plate assemblies

using large metal hammers. This can lead to mechanical damage. High intensity low frequency sound offers the possibility of dust removal from the plates where the installed cleaning systems are inexpensive, easy to maintain and operate in parallel with the main process. The investigation was based on an experimental determination of the adhesive forces between electro statically deposited powder layers and metal collection surfaces using a calibrated shaker system. Acoustic forces also are applied to the powders, using a high sound intensity test rig. A catastrophic failure of the adhesion forces between the powder layer and the collection surface are indicated for both vibration and acoustic excitation. The relationship between the onset vibration acceleration levels and the acoustic pressure levels is considered and results are presented of predicted and measured particle adhesion.

RIO 2005 inter-noise ENVIRONMENTAL NOISE CONTROL
The 2005 Congress and Exposition on Noise Control Engineering
07-10 August 2005 - Rio de Janeiro - Brazil

10:20-10:40

1801 _____ *invited*

ACOUSTIC IMPEDANCE AND ABSORPTION COEFFICIENT OF HELMHOLTZ RESONATORS MODIFIED BY GEOMETRICAL CONFIGURATION VARIATIONS OF THE INLET NECK OF TWO PARALLEL PERFORATED LAYERS

Antoni Sliwinski*, Marek Birnbach, Stanislaw Zachara

**birnbach@neostrada.pl*

In some noise absorbing panels covering a wider effective band in low frequencies range (100-350 Hz) required for applications in plant - food processing and pharmaceutical industry [1] Helmholtz resonators of various acoustic properties have been used as unit elements interconnected in integral systems. The acoustic impedance and absorption coefficient of such elements i.e. Helmholtz resonators can be in wide extent varied by modification of the geometrical parameters of their inlet necks, particularly in the case of specially designed ones as two parallel plates having orifices. Due to variations of the distance between the plates and of the mutual distribution of orificies and their geometry one can modify the acoustic characteristics of the resonators [2,3]. In this paper some experimental results of further examinations of Helmholtz resonators extended on more complicated configurations of resonator inlets of two perforated layers in mutual relation among plate distance and size of orifices and their distribution to look for optimal designing of low frequency noise absorbing systems are presented. It has been found that their exists a critical (for a given configuration of orifices) distance between the plates for a maximum acoustic absorption .

10:40-11:00

1462 _____ *invited*

ACOUSTICAL CHARACTERISTIC MODELING METHOD OF HOMOGENOUS ABSORPTIVE MATERIALS

Seishi Meiarashi*, Toshiaki Fujiwara

**Public Works Research Institute, Tsukuba, Japan*

The basic acoustic parameters for the architectural design are normal incident absorption coefficient, oblique incident absorption coefficient, random incident absorption coefficient, and reverberation absorption coefficient. The acoustic impedance and propagation constant are the most essential characteristics of homogeneous materials, by which these parameters could be determined. The authors first proposed a new method to measure the acoustic impedance and propagation constants by using the impedance tube. Secondly, they measured the acoustic impedance and propagation constants of a non-woven fabric material, which is a porous absorptive material widely used for acoustic design of architectures. The quantitative analysis of the measured data gave the relationship between the structural parameters (material density, fiber diameter) and the acoustic ones (specific acoustic impedance, propagation constant and sound propagation speed) of the non-woven fabric material. Based on the analysis result, the authors have finally built up an acoustical characteristic model of the non-woven fiber material with a fiber diameter of 43μm. The model is a function of sound frequency and the material density. The model formulated in the same manner as proposed by the authors, might be applied to all the homogenous absorptive materials and could enables engineers and researchers to indirectly calculate the basic acoustic parameters by only determining the material density.

11:00-11:20

1780 _____ *contributed*

SOUND ABSORPTION OF SISAL FIBER PANELS

Luvercy Azevedo*, Marco Antonio Nabuco de Araujo

**Silentium Engenharia Acústica Ltda., Rio de Janeiro, Brazil*

Mineral wools (glass wool and rock wool) are the most used sound absorption material in construction market. Their popularity is justified, because besides high absorption coefficients, those are light, lasting and thermal insulating materials. Also manufacturers with great production capacity facilitate their general acceptance on this market. Nevertheless those products have some negative points, as health harms to workers involved in production/installation and a very difficult waste process. Those characteristics are more and more unaccepted by society and environmental laws tend towards a more restrictive use of those products.

As alternative some researchers have been studying sound absorption properties of vegetable fibers, easy to waste and harmless materials. This work presents preliminary results of a research on sound absorption of sisal fiber, a cheap and plentiful material in Brazil. Sisal fiber panels have been made and their absorption coefficients measured in a impedance tube, using the Transfer Function Method (two microphones). Fire resistance and effects of fire retardants have been considered on this research stage.

11:20-11:40

1698 _____ *contributed*

THE STUDY OF SOUND ABSORPTION CHARACTERISTIC PREDICTION OF MICRO-PERFORATED PANEL ABSORBER

Bin Zhang*, Zeguang Tao, Hui Ding

* *Beijing Municipal Institute of Labor Protection, Beijing, P. R. China*

The microperforated panel's sound absorbing performance can be predicted by Maa's theory given information about the panel and the cavity depth. However, the absorbing performance predicted by Maa's theory is approximate. This paper presents a new method to predict the microperforated panel's performance precisely. The transfer matrix method is employed to predict the sound-absorbing performance of a single panel or system of panels. It is demonstrated that the suggested approach can predict the performance very accurately.

11:40-12:00

1608 _____ *contributed*

PC NOISE PREDICTION USING A NOISE SYNTHESIS TECHNOLOGY

Roland Sottek*, Christian Buchcik

**HEAD acoustics GmbH, Herzogenrath, Germany*

Based on the results of the European research project NABUCCO, the sound emission of a personal computer is investigated by applying Noise Synthesis Technology (NST). The sources of airborne sound and structure-borne sound (cooling fans and hard disk drive) as well as the sound transmission via coupling elements and housing to various reference points in the far field are identified. Characterization of the airborne sound sources is effected by using the multi-pole method. The transfer functions between the noise sources and the reference points are determined by reciprocal measurements. In order to describe the structure-borne sound transmission via the coupling elements sub-structuring approaches like the four-pole theory may be applied. In addition, the parameters identified are used to develop - with the aim of auralization - an acoustic model of the PC, which allows virtual exchange of components and coupling elements.

Session NU4: Numerical Techniques

chairs:

Allice H.B. Rodrigues - *Brazil*

Phil Shorter - *USA*

10:00-12:00 **Room:** Flamengo 2

10:00-10:20

1596 _____ *contributed*

VIBROACOUSTIC ATTENUATION EFFECT OF SANDWICH DAMPING MATERIAL ON PIPE FLOW NOISE

Wei-Yu Lu*, Wei-Hui Wang, Chih-Kong Weih

**National Taiwan Ocean University, Keelung, Republic of China*

Normally, pipe flow noise is generated by the fluctuation of pipe entrained fluid excited by sources in the fluid such as pumps and the vibration of pipe wall excited by mechanical connections to a vibrating machine. Thus, potentially many different types of wave could exist within a pipe structure and the entrained fluid. To attenuate such kind noise, damping materials, such as rock wool, glass wool, PE (poly ethylene), PU (poly urethane), can be used to sheathe the pipe wall to absorb or isolate the pipe flow noise. For the purpose to raise the effectiveness of noise reduction, a number of sandwich materials like PE+lead sheet, glass wool+aluminum foil etc., are considered. In this paper, comparative study by numerical simulation of the sound field around pipe wall and the vibration of pipe wall are carried out by BEM and FEM. In which, the modeling technique of contact elements between pipe wall and damping material or inter-sandwich materials are explained. Complementary experimental technique based on Fuglsang Nielsen's method for measuring loss factor of damping material are also described. Both analysis and experiment results show that the sandwich damping materials can further reduce the radiated pipe flow noise by an amount of 12-15 dB.

10:20-10:40

2076 _____ *contributed*

ADVANCED VIBRO-ACOUSTIC MODELS OF WELDED JUNCTIONS

Philip J. Shorter*, Y. Gooroochurn, B. Rodewald

**ESI US R&D Inc, San Diego, USA*

A number of advances have been made recently in the development of a Hybrid method for rigorously cou-

pling deterministic (FEM, BEM, IEM) and statistical (SEA) descriptions of the dynamics of a vibro-acoustic system. This paper illustrates how the method can be used to create accurate models of the vibro-acoustic behavior of welded junctions by coupling a welding simulation with a Hybrid FE-SEA simulation. The commercial software package SYSWELD® is used to simulate the detailed material and geometric properties of various welded junctions. The results from the SYSWELD® analysis can be imported into the vibro-acoustic software and used to define the local junction details in a Hybrid FE-SEA analysis. The method provides an efficient way to assess the effects of different welding and heat treatment processes on the vibro-acoustic response of a complex system. The method also has the potential to provide a numerically efficient way to assess the fatigue failure of welded junctions due to broadband vibrational and acoustic loading.

10:40-11:00

1749 _____ *contributed*

APPLICATION OF THE ONERA'S SABRINA SOLVER TO THE NUMERICAL INVESTIGATION OF THE ENGINE NOISE REDUCTION OFFERED BY NEW AIRCRAFT CONCEPTS

Stéphane Redonnet*, Eric Manoha, Owen Kenning

* *ONERA, Chatillon (Paris), France*

The noise environment around airport is a major cause of concern within the world, with many local communities exposed to high levels of aircraft noise; the effective reduction of such a 'noise pollution' represents both a technical and a financial important challenge for the incoming years. The noise generated by an aircraft in approach or take-off configurations has two main contributions; firstly the airframe noise and, secondly the engine noise. If the airframe and engine contributions to the overall aircraft noise are roughly equals at landing, the latter is largely dominant at take-off, due to the fact that the engine thrust is there at its maximum. Since the beginning of modern civilian jet aviation in the early fifties, the sources of this engine noise have been considerably reduced over the years. Additional noise reduction is now expected from the potential acoustic reduction that could be reached through the development of new aircraft concepts. For several years, ONERA has been developing sAbrinA (Solver for Acoustic BRoadband Interaction with Aerodynamics), a multi-purpose integrated CFD / CAA platform in order to perform general aeroacoustics simulations over complex geometries and flows [1,2,3]. Within the framework of engine installation effects, the sAbrinA solver was recently used to perform several numerical investigations devoted to the downstream fan noise propagation - and its potential reduction. These studies implied different 2D or 3D co-axial engines, and were conducted with a constant concern for the correct taking into account of both the reflection and the refraction effects due to the respective solid structures and (highly inhomogeneous) jet flows. One can just remind that such kind of acoustic calculations over realistic nozzles and jet flows were rarely attempted yet, because of the numerical complexity they can lead to. A survey of these particular sAbrinA applications to the engine noise domain will constitute the purpose of the present paper.

11:00-11:20

1621 _____ *contributed*

HYDRO-ACOUSTIC FLOW COMPUTATIONS BASED ON COMPUTATIONAL AERO-ACOUSTICS (CAA) METHODS

Iris A. Pantle*, Franco Magagnato, Martin Gabi

* *University of Karlsruhe, Karlsruhe, Germany*

Environmental noise reduction leads to an increasing importance of numerical noise prediction of hydraulic systems. Avoiding undesired noise sources, resonance and structural excitation does not only reduce environmental stress caused by machinery operated in human vicinity. Additionally optimized flow characteristics in terms of energy loss and system geometry can be obtained. Consequently a noise prediction method is required including a flow simulation with a detailed description of acoustical sources and calculating acoustical propagation in water flows. Although water flows are usually treated by incompressible numerical methods, for most phenomena exciting noise compressible methods are required (e.g. cavitation, water hammer). CAA methods, though developed for air flow acoustics, contain both compressible and incompressible CFD approaches and therefore seem to be a suitable starting point also for water. Typical water flows tend to show high enough Reynolds numbers to prohibit the use of Direct Numerical Simulations, containing both flow and acoustic movement. Since this is also the case for realistic air flow problems, the hybrid CAA methods were developed. Here, the acoustical sources of the unsteady flow are calculated by a less demanding CFD method, such as Large Eddy Simulation. These sources are transferred into the acoustic method, where the acoustic propagation is computed. Within this contribution, the propagation of an acoustical pulse in a channel of water will be investigated. A CAA approach applied to water flow problems will be discussed. For simplification, presently a quiescent liquid is chosen. In liquids, the relations between pressure, density and temperature are different due to different constitutive equations. The CAA approach is a hybrid approach, combining a CFD field method with a second, acoustic field method of a linearized equation system, originally developed for air flows. The assumption of a constitutive equation of (ideal) gas must be replaced by one for water. Simplifications due to the ideal gas assumption must be removed.

11:20-11:40

1914 _____ *contributed*

APPLICATION OF THE FAST MULTIPOLE BEM TO CALCULATION OF SCATTERING COEFFICIENTS OF ARCHITECTURAL SURFACES IN A WIDE RANGE OF FREQUENCIES

Yoshiyuki Kosaka*, Tetsuya Sakuma

* *Japan/The University of Tokyo, Bunkyo-ku, Japan*

A measurement method of scattering coefficients of wall surfaces is being standardized by ISO 17497-1, while we have developed a numerical technique with employing 3-D BEM for calculating the coefficients. If a direct solver is used for the linear systems, the BEM application is efficient to calculate random-incidence scattering coefficients, since a polar pattern for the plane wave incidence from every direction can be simultaneously obtained with the inverse matrix of the systems. However, it has another difficulty in calculation at high frequencies due to memory requirements. On the other hand, if we apply the fast multipole BEM (FMBEM), which enables us to reduce large amounts of memory required for large-scale problems, we will be able to evaluate the scattering coefficients in a wide range of frequencies. In the FMBEM application, it is necessarily to solve linear systems by using an iterative method, which has to be executed for every incidence condition, but it may take so much computational time to calculate random-incidence values in some cases. In this paper, we study on the convergence behavior of some kinds of iterative solvers and on the effect of a few improvement techniques of the convergence, in order to make the utilization of FMBEM more efficiently. Second, the advantage of FMBEM is confirmed in respect of memory requirements and computational time. Finally, the results of a sine shaped surface of finite size with FMBEM are compared with those of an infinite surface up to 4kHz.

11:40-12:00

1876 _____ *contributed*

TRANSLATION OF THE PHYSICAL DESCRIPTION OF MULTI-LAYER TRAIN PANELS INTO SEA PARAMETERS: ASSESSMENT OF SOFTWARE AND METHODS

Gabriel Alarcón*, J. Ignácio Palacios , Jordi Romeu

* *SENER, Barcelona, Spain*

Since noise requirements are becoming stricter, it is critically important to improve vibro-acoustical characteristics of the new designs of trains, cars and aircrafts. In this sense, the SEA method allows the engineers to predict vibro-acoustical behaviour in early stages of design, only requiring a few geometrical and physical characteristics. The description of an actual structural design using a set of SEA elements is the first step in SEA modelling, crucial for a correct prediction. Many criteria, well studied and published in previous works, can be established. Conversely, the second and most difficult step is to convert the physical description (geometrical and physical properties) of each element into SEA (vibro-acoustical) parameters: modal density, internal loss factor and coupling loss factor. In recent times a lot of bibliography concerning SEA method and SEA parameters calculation has been published and a large variety of modal density and coupling loss factor calculation methods have been developed. Furthermore, available commercial SEA software has implemented internal methods for SEA parameter calculation from geometrical and physical description provided by the user. This research aims to establish a procedure for modelling multi-layer configuration panels contrasting results from different commercial software and from test results of several mock-up configurations. Medium and high frequency results from simulation were successfully validated with experimental measurements. Since multi-layer panel configurations are commonly used in railway, automotive and aeronautical applications, the conclusions of this work can be useful in a wide scope of products.

Session RA4: Room Acoustics

chairs:

Sylvio Bistafa - *Brazil*

Roberto A. Tenenbaum - *Brazil*

10:00-12:00 **Room:** Botafogo

10:00-10:20

1481 _____ *invited*

ACOUSTICS OF ROOMS FOR TRADITIONAL KOREAN MUSIC

Daeup Jeong*, Seok-Won Choi, Ji-Young Kim

* *Chonbuk National University, Jeonju, S.Korea*

A large number of studies have investigated required criteria for the good acoustics of rooms for western music for a long time. However little has been done for establishing criteria for the good acoustics of rooms for traditional Korean music. Due to the recent increasing interests in traditional Korean music in Korean local communities, the efforts to provide more dedicated spaces for playing and listening traditional Korean music have been made for the last couple of years. It seems urgent to establish proper disciplines for the acoustic design of such spaces in order to avoid repeated trial and errors. In this study, 10 halls built for traditional Korean music were visited and their acoustic conditions were measured and analyzed. Also, subjective experiments using the method of paired comparisons were carried out to obtain listeners' impression the acoustics of each hall, using binaurally presented stimuli. In

the subjective listening experiment, binaural impulse responses from dummy head recordings for each room were used to auralize an anechoic vocal and ensemble Korean music. Results suggest that treble ratio is an important factor for the good acoustics of rooms for traditional Korean music, while bass ratio plays a significant role in rooms for western music. Any significant difference between musicians' and non-musicians' preferences was not found. Also, the preferred acoustic conditions for vocal music were not significantly different from those for ensemble music.

10:20-10:40

1991 _____ *invited*

EVALUATION OF STAGE ACOUSTICS OF TWO MULTIPURPOSE AUDITORIUMS IN SÃO PAULO BY MEASURING STAGE SUPPORT,ST1.

Lineu Passeri jr.*, Sylvio R. Bistafa

* *University of São Paulo, USP, São Paulo, Brazil*

(Invited) The acoustic conditions for performers are clearly an important aspect in the acoustic design of concert halls, yet there are many issues associated with stage acoustics remaining to be resolved. For the performer it is important to hear his/her own sound and to hear the sound of colleagues in order to maintain ensemble. The acoustic character of the stage surround may well also influence the blend of the orchestral sound for the audience. When performing, the musician hears the direct sound from his or her instrument followed by a sound reflection off the floor. Later, the performer receives direct sound from surrounding performers, as well as reflections off their instruments, chairs, or the floor. Stronger reflections may come from stage walls, the ceiling, or suspended elements. This sequence of reflections is important for the performer to maintain the rhythm, intonation, balance, and timbre of their sound. Stage support, ST1 (Gade), is a parameter often quoted to assess the acoustic quality of stages. This measure is concerned with support of the performer's own sound and assumes that sound returning to the performer delayed between 20 and 100 ms is beneficial. Measured values of ST1 have been found to correspond with musicians' assessments of ease of playing. Though considerable progress has been made on the question of conditions for performers during the last quarter century, many issues remain unresolved. In particular, much more could be known about the implications of the geometrical shape of the stage and its size. The present study is based on measurements of ST1 on empty stages of some concert halls in São Paulo. Comparisons will be made with optimal ranges that have been reported. The effect of the ceiling height and of stage-wall profile will be analysed based on these measurements.

10:40-11:00

1747 _____ *contributed*

QUESTIONNAIRES PROPOSAL TO DETERMINE THE ACOUSTICAL QUALITY OF THEATRES AND CONCERT HALLS.

Daniel Ottobre*, Manuel Recuero López

* *I.N.S.I.A., Universidad Politécnica de Madrid, Madrid, Spain*

Questionnaires proposal to determine the acoustical quality of theatres and concert halls. Daniel Ottobre - Manuel Recuero López The determination of the acoustical quality of theatres and concert halls is an issue in constant evolution, that gradually brings us closer to the true reasons which lead us to the critical judgement of those buildings' acoustics. In that evolution, the questionnaires to people who attend musical representations have played a very important role. In fact, the most recognised papers on this issue were always based on surveys to the audience. This paper proposes two questionnaire models, one for people with some musical knowledge, and a second one for people without it. The questionnaires have been elaborated based on a simple association with acoustic and psychoacoustic known parameters, and with an easy verification. This allows obtaining valid conclusions of the known parameters and extracting information to progress in the parameters under development. In parallel with the surveys, the creation of a web page is proposed, where the interested people can upload their data in a normalized way, enter the data in matrixes, and share their conclusions with other researchers.

11:00-11:20

1884 _____ *contributed*

AUDITORIO IBIRAPUERA ACOUSTICAL DESIGN

Jose Nepomuceno

Acústica & Sônica, São Paulo, Brazil

This paper describes the acoustical design issues for Auditório Ibirapuera build at Parque Ibirapuera in Sao Paulo, Brazil and designed by the worldwide acclaimed brazilian architect Oscar Niemeyer. The first design was prepared in the 50s but was never built due to a lack of financial resources. In 2002 Oscar Niemeyer returns to the project creating a simple and fine auditorium for lectures, dance and lightly amplified music. The author close collaborated with the architect in the acoustical design, stage box and backstage facilities specifications.

11:20-11:40

1996 _____ *invited*

COMPARATIVE STUDY OF MEASURED ACOUSTIC PARAMETERS IN CONCERT HALLS IN THE CITY OF SÃO PAULO

Fábio Leão*, Fernando Iazzetta

* *Universidade de São Paulo/FAPESP, Sao Paulo, Brazil*

During the last two years we have been working in a project at the University of São Paulo, Brazil, devoted to the investigation of acoustic behavior of rooms designed for music performance and music production (AcMus Project). This paper describes some results related to the determination of subjective acoustic parameters for some concert halls in São Paulo. First we describe the implementation of a program for acquiring the impulse response. The system is based on MLS and logarithmic sweep methods and offers tools for estimating different acoustic parameters. Then, we introduce some questions related to subjective acoustic parameters such as liveness, warmth, brilliance, loudness, clarity and definition. These parameters can be related to objective parameters such as reverberation time, energy variation, and ITGD. The last section of this paper deals with comparative results of measurements made in some concert halls in São Paulo. We will show our conclusions about their different acoustic behaviors, and we also discuss the alternative use of a directional source to measure those parameters.

11:40-12:00

1448 _____ *contributed*

INFLUENCE OF THE LISTENER POSITION ON THE MEASUREMENT OF ACOUSTIC PARAMETERS

Ricardo San Martín*, Irantzu Ganuza, Miguel Arana, Antonio Vela, María San Martín, Emilio Aramendia, Sonia Galech, Vanesa Latorre

* *Universidad Publica de Navarra, Pamplona, Spain*

The measurement of different acoustic parameters derived from the impulse response characterizes the acoustic conditions at a receiver point in a room. Definition of such parameters as well as their measurement techniques are described in the Standard ISO 3382. The possible influence of the source position is taken into account in the Standard. However, the possible influence of the listener position-around central position of the seat- is not discussed. The trouble is that if such position modifies the results of the acoustic parameters in a higher quantity to jnd (just noticeable difference) to the corresponding parameter, at least for the acoustic parameters where the jnd is well established. In this work, the effect of the listener position will be showed. For eight near positions round the central position, the results for several parameters (EDT, T30, D, C, LF, LFC and IACC) show deviations below the jnd but higher than the standard error of the measurement. The same conclusion is obtained from three different techniques of emission: MLS, Sweeps and pseudo-impulsive sources. On the other hand, Sweeps emission technique shows the best results as for repetitivity and minimum standard error of the measurements.

Session SQ2: Sound Quality

chairs:

Jan Stepanek - *Czech republic*

Stephan Paul - *Brazil*

10:00-11:20 **Room:** Arpoador

10:00-10:20

1533 _____ *invited*

DESIRABLE ORDER SPECTRUM PATTERN FOR BETTER SOUND QUALITY OF CAR INTERIOR NOISE

Hatano Shigeko*, Takeo Hashimoto

**Seikei University, Musashino, Japan*

In order to see the effect of the engine order spectrum pattern to the perception of sound quality of car interior noise, the order spectrum of the real car interior noise was modified using digital filter techniques. We have conducted subjective experiments for the modified order spectrum sounds, i.e., one for the level reduction of half order level and the other for level increase of the firing order and its harmonics. The results obtained revealed that the reduction of half order level increased the pleasantness and level increase of firing and its harmonics orders increase the powerfulness for a specific subjects group. What was interesting was that we also found the adverse effects for the other subjects group according to the subjects classification by the cluster analysis.

10:20-10:40

1598 _____ *invited*

THE SOUND QUALITY EVALUATION OF AN AUTOMOTIVE HVAC SYSTEM

Sung-Soo Kim*, Yoo Dong-ho, Hwang Dong-Kun, Oh Jae-Eung

* *HYUNDAI MOBIS / APPLIED TECHONOGY RESEARCH DEPT., YONGIN-SHI, Republic Of Korea*

Noise from an automotive heating, ventilating, and air conditioning (HVAC) system is one of the major con-

siderations for the occupant's comfort. In this study, activities of sound source identification and sound quality (SQ) evaluation are performed. The major source of noise is investigated by structural vibration survey tests and sound intensity measurements. The SQ is evaluated by both objective and subjective approach using the semantic differential method (SDM). Correlations between objective indices and measured subjective responses are analyzed and the estimation models are suggested to predict subjective feelings. The validation results of the suggested models show that estimation models have good agreement with measured subjective responses.

10:40-11:00

1444 _____ *contributed*

IMPULSIVE NOISE OF PRINTERS: MEASUREMENT AND CHARACTERIZATION

Terrence W. Baird*, Wade Bray, Norman Otto

* *Hewlett-Packard Co., Boise, USA*

Several methods exist in international standards for measuring the impulsivity of noise. For information technology equipment (ITE), the method for detection of impulsive noise is provided in ECMA-74 and ISO 7779. In recent years there have been a variety of new measurement methods evaluated for impulsive noise for both environmental and machinery noise. These include both traditional methods as well as the application of psychoacoustic methods and statistical levels (Ali and Bray, NoiseCon 2004; Bray, ASA 148th Meeting, 2004) . Other investigation and research (Pedersen, InterNoise 2001) has resulted in new standards such as Nordtest Method NT ACOU 112. In the office and home computing environments, printer impulsive noise has become a significant contributor to user perceived quality or lack thereof, and can affect the user's comfort level and ability to concentrate. Understanding and quantifying meaningful metrics for printer impulsivity is becoming an increasingly important goal for printer manufacturers. There is a general acknowledgement that the current standard method of determining impulsivity by simply measuring A-weighted sound pressure level (SPL) with the impulsive time weighting, I, applied is inadequate to characterize impulsive noise and ultimately to predict user satisfaction and acceptance. This paper reviews several of the available metrics, applies the metrics to several printer impulsive noise sources, and makes an initial assessment of their correlation to the subjective impressions of users.

11:00-11:20

1959 _____ *invited*

NEW DEVELOPMENT OF TWO-DIMENSIONAL SOUND INDEX FOR THE DESIGN OF BRAND SOUND IN THE PASSENGER CARS

Dong-Chul Park*, Sang-Kwon Lee

* *Nam Yang Research Center, Hyunday Mortor Company, Hwasung, Korea*

In automotive engineering, the production sound quilt becomes one of important design requirements. Especially, the brand sound is one of important advantage strategy in a car company. For the design of band sound, the selection of descriptive word for a car sound is one of major works in automotive sound quality research. Among many descriptive words for a car sound, recently both powerfulness and refinement are widely used for the design of brand sound. In the paper, instead of these general words in the production sound quality, the subjective evaluation for booming sound and rumbling sound, which are professional words used by NVH engineers in automotive technology, are adopted. In the stage of development of a car, the trained NVH engineers evaluate the booming sound and rumbling sound subjectively in most of car companies. The sound indexes, which are objective evaluation for booming sound and rumbling sound, are developed in the paper. These indexes are used for the objective evaluation of sound quality for 14 passenger cars, which are samples of famous cars in the world. The results of objective evaluation are expressed in the two-dimensional sound indexes. The brand sounds of famous cars in the world are very well represented in two-dimensional indexes. In the paper, a production car is modified using theses two-dimensional indexes and its sound quality is improved. In future, the two-dimensional sound indexes are very useful for the development of brand sound.

Session SC4: Soundscape and Community Noise

chairs:

Gaetano Licitra - *Italy*

Brigitte Schulte-Fortkamp - *Germany*

10:00-11:40 **Room:** Rio 2

10:00-10:20

1674 _____ *contributed*

NOISE INDICATORS AND HIERARCHICAL CLUSTERING IN SOUNDSCAPES

Gaetano Licitra*, Gianluca Memoli

* *ARPAT (Regional Agency for Environmental Protection of Tuscany), Pisa, Italy*

New indicators to distinguish soundscapes might be crucial for the noise control in existing quiet areas, as prescribed by the 2002/49/EC END, and for the drawing up of cost/effective action plans. The present study will analyze 21 different locations: "noisy" and "quiet" places where selected respectively screening people complaints to local municipalities and asking to the same people where they went for relax; the remaining "mid" areas were randomly chosen. The time history of LAeq was acquired for each site over a continuous period of 24 hours and the power spectrum G(f) was then calculated every T minutes from it. A power function of the frequency was used to fit G(f,T) in the range 0.002¸ 0.2 Hz, giving two new time dependences for the fitting parameters: the exponent B(t,T) and the multiplying factor A(t,T). These two parameters will be discussed in detail in this paper, underlining the effects of the choice of T (T= 15, 30, 60 minutes) and comparing them with similar parameters, calculated from Zwicker's loudness. Comparison with the time-history of rms-squared pressure showed that A(t, T) gave no additional information. Hierarchical clustering was performed over the data, using the complete time history B(t) together with L_{day} and L_{night} (98 parameters with T =15 minutes): the technique was able to distinguish "extremal" locations, according to the people's perception of them. A detailed analysis of the trend for B(t) suggested that a smaller set of parameters, calculated from B(t), could be enough to distinguish different soundscapes. Clustering was then performed using a limited selection of parameters (just four, with this dataset) and previous results were replicated. The final characterization of "mid" sites was compared with the perception of local inhabitants using questionnaires.

10:20-10:40

1825 _____ *contributed*

SOUND POWER LEVELS OF MOTOCROSS COURSES

Jan Granneman*, Frans Schermer, Hans Huizer, Nico Jochemsen

* *Peutz, Zoetermeer, Netherlands*

Noise due to motocross tracks en motorcycle racetracks demands special attention to prevent annoyance in the environment. Prognosis of new initiatives and effect of noise reducing measures demands adequate calculation models with accurate sound power information of different classes of (motocross) bikes. Sound emission of individual motocross bikes is often verified according to FIM regulations. This so-called FIM-method uses the noise level measured near the exhaust opening at fixed r.p.m.. Sometimes also pass-by tests are used to check the noise level due to individual bikes. However, these methods do not relate accurately with sound levels to be predicted in the environment of a motocross track or racetrack. For this reason sound power levels of individual motocross bikes and motorcycles of various classes are determined in an appropriate way. Furthermore the sound power levels of motocross tracks and racetracks as a whole are determined in different situations, taking into account the specific environmental conditions such as local barriers due to sand dunes, forest and other parameters relevant for the sound transmission. From the results of this investigation proposals are made regarding the most appropriate way to model the sound emission of motocross tracks and motorcycle racetracks in relation to specific classes and local conditions.

10:40-11:00

1992 _____ *contributed*

SNOWMOBILE NOISE IN QUEBEC

Chantal Laroche*, Phat Nguyen

* *University of Ottawa, Ottawa, Canada*

Most studies on community noise have examined the effects of transport noise, given that a large number of individuals are exposed to this type of noise. Although very few studies have focused on the effects of noise from leisure activities, increased interest in this field has been recently demonstrated. Canada, and more specifically the province of Quebec, has long been viewed by tourists as a snowmobile haven. Although snowmobiling is a source of great pleasure for some, others are highly annoyed by noise generated by this recreational activity, a fact supported by the increasing number of complaints filed every year. Penalties in excess of 10 million dollars have been recently imposed to compensate approximately 1000 Quebec citizens whom have suffered the consequences of this recreational noise for the past 7 years. This unprecedented judgment is currently being appealed as the government is questioning, among other things, the use of WHO guidelines to portray the hazardous effects of noise on these citizens. The legal battle has generated an impressive number of expert discussions pertaining to the descriptors of noise hazards. The following questions are among those currently being debated: 1) Are day-night LAeq values adequate descriptors in such cases?; 2) Should the concept of repeated isolated noise events (ISO 1996-2), be used when background noise levels within a known quiet environment rise almost instantaneously to levels exceeding 70-90 dBA, 600 times per day?; and 3) Should the concept of emergence advocated in the French regulation, or that of audibility as introduced by the HMMH firm, be also promoted in a Quebec regulation to better predict the

various effects of noise on the health and well being of citizens? To avoid substantial obliterations of the natural sound environments that distinguish Canada from other countries, the government must seriously address such vital questions.

11:00-11:20

1847 _____ *contributed*

SENSITIVITY OF NOISE MAPPING RESULTS TO THE GEOMETRIC INPUT DATA

Fernando A. N. Castro Pinto*, Jules G. Slama, Nicolas Isnard

* *Fed. Univ. Rio de Janeiro / Mech. Eng., Rio de Janeiro, Brazil*

An important factor for the life quality in urban centers is related to the noise levels to which the population is submitted. Noise mapping techniques together with standards for the calculation of noise propagation are powerful tools to aid urban planners in correctly applying noise abatement measures in an economically feasible way. Nevertheless the results of such mappings rely on a great amount of data, location and strength of noise sources, ground geometry, location and geometry of buildings, kind of absorption in walls, etc... This work focuses on the application of the Noise Mapping Technique in a dense populated area in Copacabana, Rio de Janeiro and discusses the sensitivity of the obtained simulated noise levels to the quality and precision of the geometric data available. Actual measurements are made in order to verify the model assumed.

11:20-11:40

1997 _____ *contributed*

AN URBAN NOISE STUDY IN THE CITY OF BAHÍA BLANCA, ARGENTINA

Víctor Hugo Cortínez*, Pablo Girón, Adrián P. Azzurro, Mariano Tonini, Martín Sequeira, Liberto Ercoli

* *Grupo Análisis de Sistemas Mecánicos, Universidad Tecnológica Nacional, Bahía Blanca, Argentina*

Noise pollution constitutes a serious problem in modern cities. The first step to the solution of this problem is the characterization of the urban acoustic conditions. These conditions depend of several factors such as noise levels, type of sources, population density, local habits, kind of activities and architectural aspects . Several studies were developed in order to consider some of these aspects in different cities. The results of the available reports represent an useful source of information for performing new studies in other places. However, it is important to keep in mind that this problem strongly depends on local characteristics. This paper deals with the characterization of the environmental acoustic conditions in the city of Bahía Blanca (Argentina) with particular emphasis in both a mixed residential-industrial area and the commercial centre. The noise levels in the streets of the zone were evaluated for different moments of the day. The corresponding time intervals are associated with different characteristics of the noise. In particular , during the night the traffic flow is very low, for the industrial zone. Accordingly, the measurements characterize the industrial impact on the noise level of the zone. The historic evolution of the noise level is evaluated and comparisons are made with other cities of the world.

Session TY1: Tyre/Road Noise

chairs:

Ulf Sandberg - *Sweden*

Rajendra Singh - *USA*

10:00-12:00 **Room:** Flamengo 1

10:00-10:20

2012 _____ *invited*

VEHICLE AND TYRE/ROAD NOISE DURING INTERRUPTED-FLOW TRAFFIC CONDITIONS

Jerzy Ejsmont*, Grzegorz Ronowski

* *Technical University of Gdansk, Gdansk, Poland*

Traffic noise is one of the most important environmental problems in urban and suburban areas. In order to determine the most effective abatement schemes, it is important to know what noise source that dominates. Overall noise levels of the vehicles can be decomposed into power unit noise and tyre/road noise. Most investigations studying this topic, deal with the steady flow of vehicles traveling at constant speed. In urban areas, however, the traffic is interrupted and composed mostly of non-steady conditions. Acceleration, deceleration, braking and idling constitute the majority of traffic operations in such a case. The paper presents influence of various driving conditions on sound levels from the entire vehicle as well as from tyre/road noise alone, at the distance of 7.5 m from the vehicle. Presented results were obtained either during measurements or via numerical modeling based on the measurements. The influence of acceleration, deceleration and braking on the noise source contribution is presented for a few passenger cars and motorcycles. Some driving scenarios with variable speed are evaluated showing the influence

of interrupted traffic flow on noise emission. A vehicle noise model VENOM, developed by the Technical University of Gdansk together with the Swedish Road and Transport Research Institute is briefly described. The investigations indicate that, even when including interrupted-flow traffic, tyre/road noise dominates over all other vehicle sources in the vast majority of traffic conditions.

10:20-10:40

2083 _____ *invited*

ROLLING NOISE OF 15 HEAVY DUTY VEHICLE TYRES ON 12 DIFFERENT ROAD SURFACES

Gysjan van Blokland*, Erik Vos, Fred Reinink

**M+P, Vught, Netherlands*

The rolling noise properties of truck tyres on surfaces varying in texture and absorption, care basically different from the properties of car tyres. Surfaces exhibiting low noise for cars can be very noisy for trucks. Noise optimization of road surfaces therefore requires insight in the relation between texture, absorption and the resulting rolling noise levels, for both car and truck tyres. An extensive study was carried in the late 90-ties for car tyres. In 2003 this study was repeated for truck tyres. In total 15 tyres, varying in type (traction, steering, trailer) and wear (full thread depth and reduced tread depth) were studied on 16 asphalt concrete surfaces that exhibit varying absorption characteristics and varying texture spectra. Measurements were performed at speeds ranging between 40 and 90 km/h in the far field of the tyre (7,5 m distance, 1,2 m height). The paper will present the results of the noise measurements, total A-weighted levels as function of speed, and spectra distributions. Furthermore the relation between the surface characteristics and the resulting rolling noise levels will be discussed.

10:40-11:00

1642 _____ *invited*

INFLUENCE OF DESIGN FACTORS ON TYRE ACOUSTIC CAVITY NOISE

Gi-Jeon Kim*, Lee Dong-Ha, Kang Young

**Kumho Tire Co., Inc., Gwangju, Korea*

Acoustic cavity resonance between tyre structure and the inside cavity is known to contribute to audible noise in some passenger vehicles. Tyre cavity resonance noise can be amplified when the tyre wall acts like a thin membrane effectively interacting with the air inside of the tyre. The objective of this paper is to analyze and predict the influence of tyre design factors on the tyre cavity resonance noise. For this investigation, FRF analysis has been carried out using finite element modeling to find important design factors affecting cavity resonance, and the effects of these factors are observed from objective noise test. From the FRF analysis and objective noise test, it is confirmed that the structural control of tyre sidewall can reduce cavity resonance noise due to fluid-structure interaction.

11:00-11:20

1940 _____ *invited*

THE POROUS TREAD TIRE – THE QUIETEST PNEUMATIC TIRE MEASURED SO FAR?

Ulf Sandberg*, Björn Kalman, Arthur Roger Williams

**Swedish Road & Transport Research Institute (VTI), Linkoping, Sweden*

This paper reports attempts to build a porous rubber tread on conventional tire carcasses and measurements made on such tires. The tread is made up of rubber granules bound with polyurethane to create a porous structure with interconnecting air voids. The aim was to determine the potential noise reduction of a porous tread tire, as well as the rolling resistance and wet friction characteristics; a first step in the possible development of such a tire for use on automobiles. A small number of shaved high-performance commercial automobile tires of two widths were equipped with a porous tread. The tread was handmade by members of the project team and later vulcanized on tire carcasses in a tire retread workshop. The resulting tires had the deficiencies typical of handmade treads, such as some unevenness and inhomogeneities but some of them were of acceptable quality for the purposes of the project. The tires have been subject to measurements such as: Noise emission, on a laboratory drum facility (with various replica surfaces) Noise emission measured by the CPX method (on actual roads with various textures) Rolling resistance on two surfaces (laboratory drum) Rolling resistance on various road surfaces Wet skid resistance (full friction-versus-slip curve) Results so far indicate that the noise emission was exceptionally low on road surfaces with a texture typical of Swedish highways. In comparison to the two commercial car tires chosen as references, the noise reduction was about 7 dBA for both the narrow and wide tires which is far below any other tire measured. On very smooth surfaces (unsuitable for highways) noise reduction was lower due to low-frequency noise being present as a result of the inhomogeneities in the handmade tread. Rolling resistance was comparable to that of the reference tires (both higher and lower values were measured). Wet friction was poorer than on the high-performance reference tires; explained essentially by the use of waste rubber from truck tire treads and sidewalls as compared to the friction-optimized properties of the rubber compound of the reference tires.

11:20-11:40

1845 _____ *invited*

REDUCTION OF TRAFFIC AND TIRE/PAVEMENT NOISE: INITIAL RESULTS OF THE ARIZONA QUIET PAVEMENT PROGRAM

Paul R. Donavan*, James Reyff, Larry Scofield

**Illingworth & Rodkin, Inc., Petaluma, USA*

The Arizona Quiet Pavement Pilot Program (QP3) began as a $34 million project implemented to reduce highway related traffic noise. This pilot program represents the first time that pavement surface type has been allowed as a noise mitigation strategy on federally funded projects in the United States. The program will overlay most of the Phoenix metropolitan area Portland Cement Concrete Pavement (PCCP) with one inch of an Asphalt Rubber Friction Course (ARFC). As a condition of using pavement type as a noise mitigation strategy, the Arizona Department of Transportation developed a ten-year research program to evaluate the efficacy of using quiet pavement solutions. This research program was designed to evaluate the acoustic changes, through three means: (1) conventional roadside time averaged traffic noise measurements within the roadway corridor; (2) tire/pavement source level measurements using both Close Proximity (CPX) and Sound Intensity (SI) methods; and (3) far field measurements obtained beyond the noise barriers within the surrounding neighborhoods. This paper provides initial results from three of the roadside measurement sites and the corresponding tire/pavement source level data. Depending on the texturing of the initial PCCP and microphone location, reductions in traffic noise level up to 12 dB were measured at the roadside. Similar reductions were measured for the tire/pavement noise. In addition to the effect of pavement on noise level, environmental and propagation effects were also examined. The results are compared to those predicted by the U.S. Federal Highway Administration's Traffic Noise Model.

11:40-12:00

1826 _____ *invited*

NOISE INNOVATION PROGRAM IPG: TWO LAYER POROUS ASPHALT FOR USE ON THE DUTCH MAIN

Rob Hofman*, J.B.m. Van Wieringen , J.C. Visser

**IPG-DWW, Delft, Netherlands*

The Netherlands is a dense populated country with major motorways penetrating urban areas. As a consequence a high number of inhabitants is hindered by traffic noise. Traditional measures like expensive noise barriers are increasingly used but. In 2002 it was estimated that for noise barriers along both the main rail and road network one to two billion Euros should be spent in the next decade to meet legal and political needs. This is a quite substantial load on the annual budget. To lower this a reduction of 50 % on the investment in noise reducing measures is aimed. To meet this high goal the Ministry of Environmental affairs and Ministry of Transport have initiated the Noise Innovation Program (IPG). The main task of IPG is to develop cost effective source oriented noise reducing measures which can be implemented within the next 5 years. Within IPG, two layer porous asphalt is currently studied as the most promising measure to meet this demand. In total TLPA is tested on 32 sections divided over 4 locations. The tested types can be divided into two groups, 4/8graded top layers and 2/6 graded top layers. The 4/8 type has a noise reduction of 5,8 dB(A) and the 2/6 type has a noise reduction of 6,8 dB(A). Both values are measured by the SPB technique and compared to a standard AC 0/16 asphalt layer. The structural lifetime of the 4/8 type is limited to 7 years, while for 2/6 no information is available at this moment. The next years within IPG two layers porous asphalt will be optimized to meet the growing demands for lower costs, higher noise reduction and better mobility.

Session AC2: Active Noise and Vibration Control

chairs:

Eduardo Bauzer Medeiros - *Brazil*

J. Stuart Bolton - *USA*

13:00-15:20 **Room:** Lagoa

13:00-13:20

2077 _____ *contributed*

ACTIVE CONTROL OF THIN PLATE USING PIEZOELECTRIC PATCHES: PRELIMINARY RESULTS

Patrick Magalhães Cardoso⋆, Danuza Santana, Nicolò Bachschmid, Paolo Pennacchi, Ezio Tanzi, Valder Steffen jr., Domingos A. Rade

⋆ *School of Mechanical Engineering, Federal University of Uberlândia, Brazil*

Due to problems caused by noise and vibration in industrial environment and in human daily life, techniques of active noise and vibration control have received increasing attention lately. More recently, the use of piezoelectric elements in noise and vibration control systems has been investigated. The present paper addresses techniques of active control by employing multiple piezoelectric patches bonded to the surface of thin plate with relatively small dimensions suitable for laboratory tests. A fuzzy control is used in active control. The paper brings the development of a finite element model of the system and presents some numerical simulations. Experimental implementation is realized aiming at attenuating the vibration modal amplitudes of the plate.

13:20-13:40

1666 _____ *contributed*

PERFORMANCE OPTIMIZATION OF AN ACTIVE NOISE REDUCTION HEADSET

Jian Zhao⋆, Jian Xu, Xiaodong Li, Jing Tian

⋆ *Institute of Acoustics, Chinese Academy of Sciences, Beijing, P. R. China*

The performance of the Active Noise Reduction (ANR) headset has been optimized with the implementation of digital adaptive filters. The key problem of the successful implementation of the adaptive filter to the ANR headset is the large variation of the transfer function of the plant at different wearing conditions. As the headset worn tightly or loosely, the transfer function of the plant has such large uncertainty that it would lead to the divergence of the adaptive Filtered-X LMS algorithm. This paper presents a hybrid feedback ANR system with both fixed and adaptive digital filters. Besides the broadband noise reduction, the main purpose of the fixed-coefficient digital filter is to reduce the variation of the transfer function of the plant, and therefore stabilize the updating process of the Filtered-X LMS adaptive filter. The fixed-coefficient filter are optimized with the H_2/H_∞ method in accordance with two design objectives, i.e., reducing the variation of the plant transfer function and attenuating the broadband noise. With the optimized fixed-coefficient digital filter, the variation of the transfer function observed by the adaptive system has been reduced greatly when the headset is tightly or loosely worn. The filter to model the secondary path is also optimized by the H_∞ robust control theory to further stabilize the adaptive Filtered-X LMS algorithm. The experiments of an ANR headset have been performed on a real-time DSP platform. The results show that the fixed-coefficient digital filter designed by the H_2/H_∞ method not only makes the headset system more stable but also increases the convergence speed of the adaptive Filtered-X LMS with relatively large updating step size. The proposed ANR headset system works well in both the broadband and periodic noise environments.

13:40-14:00

1980 _____ *contributed*

HEADPHONE WITH ACTIVE NOISE CONTROL USING ANALOG ADAPTIVE FILTERS

Alex Veloso⋆, Vítor Nascimento

⋆*Escola Politécnica da USP, São Paulo, Brazil*

Traditional methods of acoustic noise control are based on materials that absorb sound waves. These methods employ relatively bulky materials, and present some deficiencies that become more important at low frequencies. An active noise control (ANC) system may be used to efficiently reduce noise with frequencies below 500Hz. Most ANC systems for headphones are based on fixed analog controllers with feedback, that usually reduce the noise up to 15dB for frequencies below 500Hz, independently of the noise spectrum. Changes in the environment, in the positioning of the phone, in the ageing of the components, and different users, modify the transfer function of the secondary path, reducing the system performance. Given this limitation, the use of feedback digital adaptive filters has been investigated. The main factor limiting the performance of feedback digital controllers applied to headphones is the group delay of the secondary path. The group delay of an analog system is smaller than that introduced by a digital system (due to the anti-aliasing, reconstruction filters, analog-to-digital and digital-to-analog converters used for digital processing). In order to reduce the contribution of the group delay due to the electrical system and to improve the correlation between the reference signal and the noise, we propose the use of a headphone with active noise control using analog adaptive filters with a FIR-like structure, using instead of a delay line a cascade of gamma filters.

14:00-14:20

1549 _____ *contributed*

ACTIVE NOISE CONTROL IN DUCTS IMPLEMENTED IN A DSP PLATFORM

Leandro Delfino*, Israel Jorge C. Nuñez, Jose Francisco Ribeiro, Patrick Cardoso

* *Universidade Federal de Uberlândia, Uberlandia, Brazil*

Acoustic noises are known as sources of pollution that causes adverse effects in human life. In this way, considerable interest has been shown in Active Noise Control. This paper studies and analyses three algorithms: Feedforward, Feedback and a Hybrid proposal. To evaluate the methodologies, an experimental acoustic duct was mounted, where the algorithms had been implemented in a DSP platform TMS320LF2407A from Texas Instruments. The results are presented considering the optimum design.

RIO 2005 inter-noise ENVIRONMENTAL NOISE CONTROL
The 2005 Congress and Exposition on Noise Control Engineering
07-10 August 2005 - Rio de Janeiro - Brazil

14:20-14:40

1563 _____ *contributed*

ACTIVE CONTROL OF FULLY-COUPLED STRUCTURAL-ACOUSTIC SYSTEMS

Janatul I. Mohammad*, Stephen Elliott

* *ISVR, University of Southampton, Highfield, UK*

The increasing demand for automotive refinement and improved audio quality in cars motivates the need for better techniques to reduce random road noise. One approach that shows promise for substantial reduction of low frequency road noise is active control, which can be integrated into a car audio system for commercial applications. Low frequency road noise is transmitted into the car via a structural path and this research investigates the effectiveness of various types of secondary source for active control. Of particular interest is the effect of full structural-acoustic coupling between the vibration of the car panels and the interior acoustic field. The results from a model problem are presented, which represent an idealised interior space and floor panel, using either a weakly-coupled or strongly-coupled formulation. The predicted reductions due to active sound control are less when the full coupling is accounted for, since the pressure in the enclosure, which otherwise limits the panel vibration before control, is reduced by the active system.

14:40-15:00

1943 _____ *contributed*

COMPARING FEEDFORWARD AND FEEDBACK COMPENSATORS FOR ACTIVE STRUCTURAL ACOUSTIC ISOLATION

Juan F. Camino*, Lazaro Donadon, José R.F. Arruda

* *UNICAMP, Campina, Brazil*

This paper compares the limitations of "optimal" feedforward and feedback strategies for active structural acoustic control, where the emphasis is on controlling structural vibration that is responsible for sound radiation. The aim is to attenuate the sound pressure transmitted through a double panel system filled with absorption material. The controller must attenuate the noise radiated through the back panel when the front panel is excited by an external force that causes structural vibration. The actuators are piezoelectric patches attached to the back panel. We compare distinct "optimal" control strategies. In the feedforward setting, we design in the Linear Matrix Inequality (LMI) framework an H2 and Hoo filter that assume full information of the exogenous disturbance. In the feedback setting, the control laws are designed using an H2/Hoo control problem posed as LMIs, that assumes full information of the state. With little modification, these designs can be made robust to parametric uncertainties.

15:00-15:20

1786 _____ *contributed*

SPEAKING PANELS - A NEW ACTUATORS FOR A ACTIVE NOISE CONTROL

Mathias Winberg*, Sven Johansson, Thomas Lagö

* *Blekinge Institute of Technology, Ronneby, Sweden*

Different actuators have been developed for active noise cancellation. A broadband linear actuator, typically a loudspeaker, is often used. However, this is not an absolute necessity, the important issue is that the performance is "good" in the frequency band where the actuator should work and that the actuator can produce the volume displacement needed. The speaking panels is a light weight actuator, intended for the used in propeller aircrafts where the weight consideration is of grate importance. The actuator is 200x600 mm in dimensions and is based on piezo ceramic materials embedded in a thin carbon fiber plate. This makes the actuator very lightweight and more flexible for trim panel mounting in a aircraft, as compared to a normal loudspeaker. A disadvantage though, is that the actuator shows a nonlinear behaviour, that cannot be overlooked when designing the controller. The sound filed inside the aircraft consists essential of tonal components originating from propellers together with boundary layer noise which has a more broad band characteristic. However it is only the tonal components

that will be targeted by the controller therefore a narrowband controller has been used in this application. With this in mind the nonlinear characteristics are evaluated in terms of frequency response functions and harmonic distortion. An evaluation of the speaking panels (SPs) together with a MIMO complex filtered-X LMS algorithm, is presented. The setup consists of four speaking panels, mounted in a test mock-up, four control microphones and two monitor microphones. The controller is implemented on a Texas Instruments C31 signal processor.

Session AS: Assessment and Strategies for Managing Noise

chairs:

Lawrence S. Finegold - *USA*

Bernard F. Berry - *UK*

13:00-16:40 **Room:** Business Master 136

13:00-13:20

1811 *invited*

A REVIEW OF METHODS FOR QUANTIFYING TONAL AND IMPULSIVE FEATURES IN ENVIRONMENTAL NOISE

Bernard F. Berry⋆, Nicole D. Porter

⋆*BEL - Berry Environmental Ltd, Shepperton, UK*

The UK Government's Department of Trade and Industry, through the National Measurement System Directorate, has been funding a major research project on Environmental Noise. The aims were to improve the quality and face validity of environmental noise measurements, and to contribute to the improvement of British, and International Standards on environmental noise. The project had three related aspects, with a separate work package being organized for each aspect: · A critical review and inter-comparison of methods of quantifying acoustic features in environmental noise, such as tones and impulses – Work Package 1. · Identifying and quantifying sources of uncertainty in environmental noise measurements. – Work Package 2. · Publishing practical guidance on minimizing such uncertainties. Work Package 3. The authors are part of the consortium of consultants undertaking the project and have been responsible for the first work package, on acoustic features. In a paper at Internoise 2004 in Prague , we outlined the background to the project, explained the approach and methods used in the review and summarized the status of the project [Reference 1]. Progress in Work Packages 2 and 3 was reported in another paper at Internoise 2004 [Reference 2]. In the present paper we will briefly summarise the overall Environmental Noise project, in the context of this Special Session on "Assessment, and strategies for managing noise". We will then describe the later phases of our specific part of the project, including; · a detailed review, and synthesis of a large number of previous research publications in which intercomparisons have been documented, of the "performance" of methods of quantifying acoustic features, · a survey of the state of the art on practical implementations of various methods, in commercial instrumentation, and in systems used in research, · some new small-scale intercomparisons involving a selected number of methods. · Our overall Conclusions and Recommendations. References. 1. B F Berry and N D Porter. 2004. A critical review and inter-comparison of methods for quantifying tonal and impulsive features in environmental noise. Proceedings of Internoise 2004. Prague. CDROM 2. A J Bullmore, I H Flindell, N D Porter , and J Adcock. 2004. Recent developments in the UK approach to environmental noise management. Proceedings of Internoise 2004. Prague. CDROM

13:20-13:40

1487 *invited*

ACTIONS IN THE DEVELOPMENT OF A NOISE PLAN FOR THE COMMONWEALTH OF PUERTO RICO

Jose A. Alicea⋆, Olga, Vinas-Curiel

⋆ *Environmental Quality Board of Puerto Rico, San Juan, USA*

For the past three years, the development and implementation of a noise action plan for Puerto Rico has been the main goal for the Noise Control Program of the Environmental Quality Board of Puerto Rico. The Agency is one of various local government agencies, universities and the general public that is participating in these efforts and activities. This presentation covers the main strategies developed and used to actively promote awareness about noise pollution, strengthening compliance with current regulations and laws, and promote local research regarding environmental noise in urban and rural areas of the country. The presentation describes the processes of evaluating the current local noise infrastructure, the development of educational campaigns, the efforts into investigating urban noise levels, the success in the collaboration with state police and municipalities regarding citizens noise control enforcement, and the promoting of a collaboration and exchange of information among other countries and cities in the Caribbean and Latin America regarding each other successes and failures with noise control activities. The ideas used in our plan and the activities accomplished so far are presented in this talk for the benefit of those that are looking into achieving similar goals and for comments and suggestions regarding our plan of action and future goals from others actively working on a nation-wide noise control effort.

13:40-14:00

2095 _____ *invited*

ASSESSMENT OF ENVIRONMENTAL NOISE IMMISSION IN JAPAN

Toshiro Segawa ⋆, Masanori Fujimoto, Teruhio Saito, Osamu Sakagoshi, Hideki Tachibana

⋆ *Ministry of the Environment, Tokyo, Japan*

In Japan, the Basic Environmental Law is in effect to comprehensively promote policies for environmental conservation. This law stipulates the establishment of "environmental quality standards", which are desirable to maintain the protection of human health and the conservation of the living environment. There are four categories of standards: for air pollution, water pollution, soil contamination and noise. Concerning noise, there are three kinds of environmental quality standards, for 1) general noise including road traffic 2) aircraft and 3) super express trains. They include 1) the matrix of area categories and target values, 2) the methods of measurement and evaluation and 3) time tables. Prefectural governments apply the standards to their region in accordance with area categories. The environmental quality standard for general noise, including road traffic noise, was revised in 1999 and its index was changed from L50 to LAeq. The index of the standard for aircraft noise is WECPNL, which was issued in 1973 following the ICAO recommendation. The index for Shinkansen noise is LA,max which was issued in 1975. The Ministry of the Environment is now, in view of change environmental quality standards about noise in the near future, trying to learn more about "annoyance" which represents a human "impact", and "sleep disturbance" which is one of the physiological effects of noise. The Ministry of the Environment, considering the situation in other countries, considers the introduction of an integrated evaluation index to evaluate multiple noises and the fundamental policy of evaluation time according to various noise characteristics.

14:00-14:20

1807 _____ *contributed*

DRAFT FINAL REPORT OF I-INCE TSG ♯ 3 - NOISE POLICES AND REGULATIONS

Hideki Tachibana⋆, William W. Lang

⋆ *Chiba Institute of Technology, Narashino, Japan*

I-INCE Technical Study Group 3 entitled "Noise Policies and Regulations" was set up in 1999. This TSG has been collecting and arranging the legislative regulations/standards regarding environmental noise emission/immission policies in various I-INCE member countries around the world for the discussion of global policy for standardization/harmonization of legislative systems regarding environmental noise problems. The draft Final Report is now being prepared and its outline will be presented in this paper.

14:20-14:40

1952 _____ *contributed*

FOR A PUBLIC POLICY FOR THE NOISE POLLUTION MANAGEMENT IN BRAZIL

Denise S. Sousa ⋆, Jules G. Slama, Emílio Lebre la Rovere

⋆ *Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil*

In Brazil, several legal instruments have been proposed for noise pollution control. In the federal scope, during the nineties, two CONAMA - National Council of Environment - resolutions were promulgated and are considered an important mark. One instituted the National Program of Education and Control of the Pollution - Silence Program - and the other established the adoption of the standard NBR 10.151 of ABNT - Brazilian Association of Technical Standards - as instrument of "Evaluation of the Noise in Inhabited Areas seeking the community's comfort". Later on, other Resolutions were published approaching the subject of transport noise emission and of appliances. Regarding the aeronautical noise, several legal documents from the old "Ministério da Aeronáutica" (Aeronautical Ministry), have been promulgated, aiming to harmonize the Brazilian legislation in what concerns the aircrafts emission and the noise zoning near the airports with the recommendation of ICAO. In the municipal level, several legislations of noise pollution were also promulgated. In spite of the existence of these instruments, it is still verified an inadequacy and, in some cases, a desagreement among them, showing the need of restructuring the juridical-institutional organization of the area, through the formulation and implementation of a Public Policy for the Administration of the noise Pollution in Brazil. This work has as an objective to present an analysis of the current situation and a strategy for the formulation and implementation of this Public Policy, in light of the international experience.

14:40-15:00

1454 _____ *contributed*

NATIONAL AND PROVINCIAL EVOLUTION OF NOISE LEGISLATION IN ARGENTINA

Ana Maria Rizzo La Malfa⋆, Ariel Velis, Nilda Vecchiatti, Federico Iassi, Gustavo Basso, Mario Rene Serra, Federico Rossi, Giulio Pispola

⋆ *Università degli Studi di Perugia - Dipartimento di Ingegneria Industriale, Perugia, Italy*

The Argentine Republic has had until now a poor legislation with respect to noise pollution. This is reflected in some articles included in several national laws and in local decrees that certain Municipalities implemented as means to solve within their jurisdiction specific situations, which were neither explicitly nor deeply

considered in the legislation. In such a context, a first draft appeared in 2001, within the framework of the Senate of the Province of Buenos Aires. The problem was here faced in an innovative way, using a holistic approach and involving all the different aspects of noise pollution. Following this first provincial draft, the need for a national legislation arose. In the meanwhile, new international legislation (in particular in the EC) was developed, introducing innovative definitions, methodologies of evaluation, prevention and control, acoustical parameters and other excellent technical aspects. All of them were taken into consideration during the preparation process of the first national draft. Finally, the provincial law project was adapted to the national one, incorporating these new concepts. At present the first draft of Law presented in the Province of Buenos Aires, is being in discussion at the Senate and in the several Deputies commissions that constitute the Provincial House of Representatives. With respect to the first draft of National Law, it is at the stage of legal discussion before its presentation in the National House of Representatives.

15:00-15:20

1712 _____ *contributed*

THE ENFORCEMENT OF THE DIRECTIVE 2002/49/EG IN AUSTRIA

Werner Talasch

ÖAL - Austrian Noise Abatement Association, Strasshof, Austria

The directive 2002/49/EC of the European Parliament and of the Council of 25 June 2002 relating to the assessment and management of environmental noise was published in the Official Journal of the European Communities on the 18th July 2002 in Volume L 189/12. The enforcement of the directive in Austria made necessary some technical work to ensure a uniform enforcement in the different federal states by the relevant authorities. The main work was done by ForumSchall, an association of members of the authorities of the nine counties of Austria and their main capitals, and the Austrian Noise Abatement Association (ÖAL) – a non-governmental organisation. These two bodies developed technical guidelines to give clear advice for all topics with latitude of the directive. In these technical guidelines there are provisions for the calculation models to be used, the modelling of the different source types, the grid for calculations, the scale and the colours for the presentation of the noise maps and so on. The relevant provisions will be shown in detail. By this work it was possible to implement the directive 2002/49/EG in the Austrian legal system through nine federal state governments and the federal government.

15:20-15:40

2094 _____ *contributed*

I-INCE TSG ♯ 6, COMMUNITY NOISE: ENVIRONMENTAL NOISE IMPACT ASSESSMENT AND MITIGATION

Lawrence S. Finegold

Finegold & So, Consultants, Centerville, USA

This paper reviews the ongoing work of I-INCE Technical Study Group (TSG) 6, Community Noise: Environmental Noise Impact Assessment and Mitigation. The objective of this working group is to produce a report which provides practical guidance to policy makers who are involved with the regulation and control of community noise/environmental noise, excluding the noise generated by neighbors. The proposed Final Report of I-INCE TSG ♯ 6, "Guidelines for Effective Management of Community Noise", will provide information on how to perform an environmental noise impact analysis, the use of land use planning as a noise management tool, the use of existing exposure-response relationships, the use of cost-benefit analysis in considering noise control engineering tradeoffs, and the importance of public involvement, negotiation and consensus-building to achieve effective and balanced environmental noise management strategies. The TSG ♯ 6 Final Report will be aimed primarily at a non-technical audience. It will advocate for a flexible approach to noise management where the positive effects of controlling exposure to community noise are carefully balanced against the costs and technical difficulties of achieving effective noise control. Thus, the report of TSG ♯ 6 should be viewed as supplementing existing and still evolving immission community/environmental noise policies. The current paper describes the general approach and proposed content of the Draft Final Report for TSG ♯ 6.

Coffee Break

16:00-16:20

1882 _____ *contributed*

NOISE AND NURSING SHIFT CHANGES AND/OR MEDICAL ROUNDS IN THE NICU ENVIRONMENT

Sueli M. T. Ichisato⋆, Carmen Scochi, Nelma Zamberlan, Moacyr Costa jr.

⋆ *Escola de Enfermagem de Ribeirão Preto, Ribeirão Preto, Brazil*

Objective: This study aims to evaluate the Leq during nurse shift changes and/or medical rounds at the Neonatal Intensive Care Unit (NICU) of a university hospital in Ribeirão Preto – SP (Brazil). Methods: A descriptive and exploratory structured observational study was developed at the level III NICU of the medical school hospital in Ribeirão Preto, São Paulo - Brazil. Data were collected during one week (2004-May-08 to 14th from 6:45 AM to 7:30 PM) by means

of a noise inventory and the observations were recorded in a check list. Ambient noise levels at the NICU were measured with a Quest 400 dosimeter, located in the central point of a ten-bed room. Results: The Leq intensity varied from 55.2dBA to 75.7dBA, measured during the medical rounds, which were also the lowest and highest Leq observed during the data collection period. Leq during nurse shift changes varied between 55.2dBA and 72.2dBA, while Leq on the occasion of medical shift changes ranged from 57.2dBA to 70.5dBA. Conclusion: Leq at the NICU were intense during the shift changes of all health providers and exceeded the 50dBA level presented in international recommendations, a fact that is also verified in other studies. In order to reduce noise levels at this NICU, activities should be organized in an interdisciplinary and intersectorial mode, with a view to improving both the health staff's work, the clients' therapeutic process and the physical atmosphere. * Study Group on Child and Adolescent Health, sub-group: Neonatal Nursing, University of São Paulo at Ribeirão Preto College of Nursing

16:20-16:40

1890 _____ *contributed*

ARE NOISE LEVELS AT THE NEONATAL ICU EXCESSIVE?

Nelma Zamberlan*, Sueli M. T. Ichisato, Milena D.O. Rodarte, Carmen Scochi

* *Escola de Enfermagem de Ribeirão Preto, Ribeirão Preto, Brazil*

Introduction: Research indicates noise as a source of environmental stress to premature infants at the Neonatal Intensive Care Unit (NICU). Objective: This study aims to explore the maximum noise frequency and describe the noise sources at the NICU of a university hospital in Ribeirão Preto – SP (Brazil). Methods: A descriptive and exploratory structured observational study was developed at the level III NICU of a medical school hospital in Ribeirão Preto-SP, Brazil. Data were collected in two stages: in the first stage, the level of ambient noise in the NICU was observed during three non-consecutive weeks, with a Quest 400 dosimeter, located in the central point of a ten-bed room; in the second stage, a noise inventory was carried out to detect intense noise sources, and observations were recorded in a checklist (2004-May-08 to 14th from 7:00 am to 7:00 pm). Results: Lmax intensity across the data collection period varied from 81.4 to 94.2dBA. In the three weeks, the highest levels observed were 92.5dBA, 89.9dBA and 94.2dBA, respectively. We identified noise sources such as talking in group, air-conditioning, opening or closing of doors, garbage cans, taps and fluorescent lamps that were on. The following pieces of equipment were on: respirator with noisy pumping and others, nasal CPAP device, heated cribs, incubators, cardiorespiratory monitors, pulse oximeter, infusion bombs, phototherapy device, digital scales and extra-nasal catheter. Conclusion: Lmax at the NICU was intense throughout the entire observation period and exceeded the 70dBA presented in international recommendations. Study Group on Child and Adolescent Health, sub-group: Neonatal Nursing, University of São Paulo at Ribeirão Preto College of Nursing

Session BA7: Building Acoustics

chairs:

Elvira B. Viveiros - *Brazil*

Gustavo Melo - *Brazil*

13:00-16:40 **Room:** Rio 1

13:00-13:20

1685 _____ *contributed*

ESTIMATES OF FLANKING PATHS INVOLVING THE WALL-FLOOR JUNCTION IN WOOD FRAMED CONSTRUCTION

David Quirt*, Trevor Nightingale, R. E. Halliwell

* *National Research Council Canada, Ottawa, Canada*

This paper reports findings from a recently completed study of flanking sound transmission involving the wall/floor junction in wood framed buildings. The paper examines how common construction details affect flanking paths between rooms separated vertically by a floor/ceiling assembly. Variables considered include: the mounting conditions and orientation of joists, the framing of the wall assembly, and the mounting and number of layers of gypsum board. Estimates of the apparent sound insulation were obtained by summing the energy transmitted direct path through the floor ceiling assembly and all the flanking paths involving four wall-floor junctions. Results indicate that if there is no floor topping (i.e., the subfloor is bare) then it is quite likely that the apparent sound insulation for both airborne and impact sources will be limited by flanking. Three different toppings are considered as treatment options for the floor, and additional layers of gypsum board and resilient mounting are considered as options for the walls. The effectiveness of each option is considered and discussed.

13:20-13:40

1840 _____ *contributed*

ANALYTICAL AND EXPERIMENTAL STUDY OF WOOD FLOORINGS

Jean-Luc Kouyoumji ⋆, Cathy Guigou-Carter, Michel Villot

⋆ *CTBA, Bordeaux, France*

In this paper, the performance of wood floorings in terms of impact noise is studied both experimentally and analytically. The investigated system consists of wood floorboards glued onto a resilient layer glued onto a concrete support. A prediction model is briefly presented; the system is modeled as an infinite multilayer isotropic system excited by a point force. The dynamic characteristics of each component are deduced from different measurements. The wood floorboard characteristics are obtained by identifying the resonance frequencies from mechanical impedance measurements in free-free beam configuration. The dynamic stiffness of the resilient layer is evaluated from a mass-spring resonance frequency, with and without the presence of glue. The impact noise performance of the system is measured on a small scale system (3.5 m2) and compared to the prediction model. The agreement is shown to be fairly good. The particular effect of the type of glue, resilient layer and wood flooring is especially investigated analytically and experimentally. To further understand the system behavior, input and transfer mobilities are measured in different locations and directions, and compared to the calculated ones. The glue is shown to be of great importance in the system behavior, due to its migration within the resilient layer. The system is found to be quite inhomogeneous because of gluing.

13:40-14:00

2002 _____ *contributed*

SOUND INSULATION OF GYPSUM PLASTERBOARD IN PRACTICE

Marco A.F. Losso⋆, Elvira B. Viveiros

⋆ *UFSC, Florianópolis, Brazil*

The use of gypsum board is a widespread construction method in many countries. In Brazil, the use of this building component is quite recent and its intensive use has less than ten years. Manufactures highlight many of its qualities but users are still reticent and even have some complains, especially concerning sound insulation. This is an important issue: despite the fact that gypsum board has low surface density, it may reach more than reasonable sound insulation performance. It can be even better than masonry walls, when used in multi layers configurations together with infill of fiber materials. Unfortunately, in Brazil, practical limitations downsize their insulation performance and careless execution does not allow their full potential. This paper presents a comparative analysis between theory and practice, concerning the sound insulation of internal gypsum board partitions used in Brazil. Firstly, a theoretical analysis of the sound insulation of the board is presented. Secondly, possible reasons for the failure in their performance are discussed and finally, the in situ conditions are analyzed. Differences of theory and practice are discussed as well.

14:00-14:20

1439 _____ *contributed*

ASSESSING IMPACT SOUND PRESSURE LEVEL OF SINGLE AND MULTILAYER PARTITIONS USING GREEN FUNCTIONS

Andreia Pereira ⋆, António Tadeu, Luís Godinho, Julieta António

⋆ *University of Coimbra, Coimbra, Portugal*

The impact sound pressure level provided by flat partitions, assumed to be infinite along their plane and dividing an infinite acoustic medium, is analyzed using a Green's functions algorithm. In the numerical model, the partitions are simulated as sets of fluid and elastic layers, allowing calculation of the frequency domain responses provided either by single or multilayer systems. The procedure used to calculate the pressure field caused by the presence of the layers is based on knowledge of the solid layer displacement potentials and the pressure potentials arising from the excitation of a spatially varying harmonic line load. All simulations are performed considering point loads that can act in either the vertical or horizontal direction. Material losses are introduced by using complex velocities. Three different acoustic geometries are studied: a single layer, a concrete-screed floating layer and a suspending ceiling. Differences in the sound pressure level provided by variables such as the position of the load, the type of resilient material in the concrete-screed floating layer and the presence of porous material in the air layer of the suspending ceiling are analyzed. To help describe the acoustic phenomena, time domain plots are added by applying a fast Fourier transform to the frequency domain responses.

14:20-14:40

1603 _____ *contributed*

APPLICATION OF THE FINITE ELEMENT METHOD FOR FLOOR IMPACT VIBRATION ANALYSIS IN APARTMENT BUILDINGS

SangHo Seo⋆, Jin Yong Jeon

⋆ *Samsung Electronics, Suwon, South Korea*

The finite element method has been applied to the vibration analysis of a concrete slab system along with measurements in an apartment building. A 2-dimensional finite element model (FEM) that saves both time and money is proposed. Results from both

the measurements and the FEM analyses show that the peak components influencing the overall sound level and the ratings of floor impact sound insulation coincide with natural frequencies of the reinforced concrete slab. It was also shown that there is a linear relationship between the sound pressure level and vibration acceleration level. In addition, the 2-dimensional FEM was sufficient for the vibration analysis of the floor system.

14:40-15:00

1722 _____ *contributed*

NUMERICAL AND EXPERIMENTAL INVESTIGATION OF SOURCE LOCATION EFFECT ON THE SOUND LEVEL DIFFERENCE BETWEEN ADJACENT ROOMS

Gustavo S. V. de Melo*, Newton S. Soeiro, Barry M. Gibbs

* *UFPA, Belém, Brazil*

In the area of sound transmission into and between dwellings, a recent emphasis has been given to the study of audible frequencies below 100 Hz, due to a proliferation of hi-fi systems of high power and enhanced bass response, increased use of domestic mechanical services and devices, and increasing traffic noise break-in. There is a special concern about low frequency noise because of its efficient propagation in air, and the reduced ability of structures such as hearing protectors or separating walls to attenuate sound at these frequencies. It is at such low frequencies that existing theories of room acoustics and the relationships between sound level difference and sound reduction index are most tenuous. Current standards only deal with frequencies above 100 Hz, and despite the introduction of Annex F in ISO 140/3 (1995), for sound insulation measurements at low frequencies, there is still a poor repeatability between measurement results. The wave theory, associated with the finite element method, has shown the strong influence exerted by modal characteristics of the room-wall-room system on their sound transmission properties, indicating the need for an appropriate model of sound absorption in small-furnished rooms at low frequencies, apart from a study of source location and its relation with sound transmission between adjacent rooms. Therefore, in this paper, three different FE models are used to describe the relationship between source location, and the sound transmission characteristics of a room-wall-room system, for the frequency range below 200 Hz. Results indicate reasonable agreement between measurement and prediction allowing the conclusion that source location has little effect on the sound level difference between adjacent rooms at low frequencies.

15:00-15:20

1748 _____ *contributed*

NUMERICAL MODELLING OF THE ACOUSTICAL PERFORMANCE OF A SIMPLE LINED APERTURE IN A THICK WALL

David Oldham*, Jian Kang, Martin Brocklesby

* *University of Liverpool, Liverpool, UK*

The pressure differences that can be used to drive a natural ventilation system are very small and thus large apertures are required to allow sufficient air to enter and leave a building. Large apertures are potential acoustic weak points on a façade and may require some form of acoustic treatment such as absorbent linings, in which case the ventilator is similar to a short section of lined duct. In ducts the performance of absorbent linings increases with the length of lining and the ratio of the length of lined perimeter to the cross sectional area of the duct. Thus, for a duct of a given cross sectional area a lining is most effective for a duct with a high aspect ratio than a square cross section. However, the high aspect ratio cross section will result in greater flow resistance and impede the airflow performance. The effect of different configurations of a lined aperture on the acoustical and ventilation performance are investigated using numerical methods in order to establish the optimum configurations.

15:20-15:40

1814 _____ *contributed*

AN EXPLORATORY STUDY ABOUT TAKING INTO ACCOUNT HETEROGENEITY OF A MATERIAL IN THE CALCULATION OF IT'S SOUND TRANSMISSION LOSS

Jean-Luc Kouyoumji*, Lionel Vernois

* *CTBA, Bordeaux, France*

To compute sound transmission loss of plates, models using homogeneous mass are the more common. This simplification is justified when one is interested in plastic, glass or metal, but it is much harder for reconstituted materials like concrete or panels of wood. In this last field we can find all types of configuration: from MDF (Medium Density Fibre) which is particularly homogeneous to OSB (Oriented Strand Board) which is very heterogeneous and for which the simplification can't be any more applicable. The transmission loss of this type of panel presents a "dilution" of its critical frequency that can't be explained by considering a homogeneous material. The work presented in this article corresponds to an exploratory phase about taking into account heterogeneity in the analytical formulation allowing the calculation of sound transmission loss of the panel. Modelling is preceded by a series of wood reconstituted panels transmission loss measurement showing the acoustical differences between homogeneous and heterogeneous panels. In this

previous phase, we will focus only on heterogeneity introduced through the mass of the panel. Modelling is carried out using the plane wave theory on infinite beam by considering a periodic and 'constant by parts' density. Results are particularly encouraging since they underline the characteristic behaviour measured on heterogeneous panels. It is expected that this study will be re-examined with a thesis work involving all partners of the study (ADEME, CTBA and LRBB) extending this to other characteristics of the material like its stiffness.

Coffee Break

16:00-16:20

1853 *contributed*

INTEGRATED ANALYSIS OF THERMO-ACOUSTIC PANELS

Eduardo B. Medeiros*, Eliana Rodrigues

* *UFMG, Belo Horizonte, Brazil*

A large number of engineering applications employ panels which should hopefully perform reasonably well as thermal, acoustic and structural elements. However it is also common to observe that the efficiency of these panels has been compromised for the lack of an integrated design approach, involving thermal, acoustic and structural considerations. The present work shows how acoustic and thermal considerations can be considered simultaneously in order to obtain a better efficiency and reduced costs. The problem has been modelled considering a typical panel which is intended to provide both acoustic and thermal insulation. Finite element analysis with the help of ANSYS software has been used to solve the model equations, which also uses actual (real) parameters of a typical panel used in engineering (mainly building) applications. Thermal and acoustic conditions are considered for a variety of situations which reflect those often found in real applications. Simplified structural and vibrational considerations have been also taken into account. Finally, the results are used to show how an integrated method can be advantageously used to produce more efficient panels.

16:20-16:40

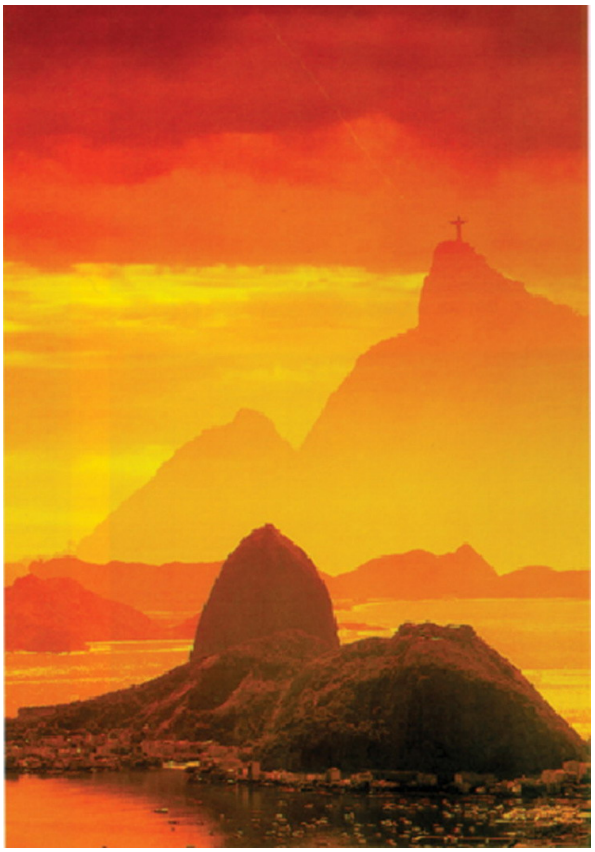
1977 *contributed*

COMPATIBILITY BETWEEN THE CALCULATED AND THE MEASURED SOUND INSULATION OF COMPOSITE BUILDING ELEMENTS

Selma Kurra

Bahcesehir University, Istanbul, Istanbul, Turkey

The computer model prepared for calculation of sound transmission loss of multilayered structures by using the impedance approach presented before, has been revised for the finite-size elements by using the windowing technique. When characteristics of the building materials are concerned, the model was found very sensitive against even the minor change of the parameters such as elasticity modulus, loss factor, flow resistance of porous layer, limiting angle of incidence and size of the element. The effects of these parameters are all frequency-dependent and mostly around the critical frequency of the layers and at the low frequencies near the resonances. In order to provide the verification of the model in terms of insulation values of such composite systems, 28 different element type with varying constructions, materials and sizes were selected and the calculated frequency dependent TL and Rw(C; Ctr) values were compared with the measured results obtained from a laboratory study. The evaluation of the results has revealed that the conformity is very high for the single layered elements at all the frequency range in 1/3 octave bands and for the double layered systems of especially non-similar layer composition and with porous layer between the layers. For the identical layered systems and with a small airgap of say 0.05m, the effects of the above mentioned parameters are more emphasized in the predictions due to the specific frequencies causing nonlinearity on the TL versus frequency curve. The differences in terms of Rw(C;Ctr), are at max 4 units which implying lesser insulation due to the sudden drop at fc if it remains below 5000 Hz which is the upper limit of the rating curve. The statistical results are also given in the paper.



Session CR: Community Response and Exposure Criteria for Complex Environmental Situations

chairs:

Irene Van Kamp - *Netherlands*

Lex A. Brown - *Australia*

13:00-15:40 **Room:** Rio 2

13:00-13:20

1579 _____ *invited*

HYENA - HYPERTENSION AND EXPOSURE TO NOISE NEAR AIRPORTS.A EUROPEAN STUDY ON HEALTH EFFECTS OF AIRCRAFT NOISE

Wolfgang Babisch*, Danny Houthuijs, Jessica Kwekkeboom, Wim Swart, Göran Pershagen, Gösta Bluhm, Jenny Selander, Klea Katsouyanni, Alex Haralambidis, Manolis Velonakis, Panayota Sourtzi, Ennio Cadum, Federicia Vigna-Taglianti, Marie-Louise Dudley, Lars Jarup

* *Federal Environmental Agency, Berlin, Germany*

Epidemiological studies carried out in adults suggest a higher risk of cardiovascular diseases for subjects exposed to high levels of road traffic noise. Less information is known with respect to aircraft noise. A new study has been set up to investigate the associations between aircraft noise, road traffic noise and blood pressure, including hypertension. Clinical blood pressure measurements are carried out in the subjects' homes. Annoyance, type of housing, health status, modifiers of noise exposure and potentially confounding factors, including job condition, smoking and other lifestyle factors, are assessed by questionnaire in a personal interview. To assess the combined effects of both noise factors, the exposures to road and aircraft noise will be modelled with respect to the facades of the dwellings, using available data from the communities (traffic counts, noise maps, etc.) and airport operation data from airport authorities (fleet composition, flight track, etc.). Altogether 6,000 subjects (men and women, 45-70 years of age) will be studied, who live in the vicinity of 6 major European airports. The subjects were randomly selected using existing noise contours around the airports. In a sub-sample, the stress hormone cortisol is analysed in the saliva of the participants. Also, the acute effects of aircraft noise on blood pressure changes are studied in a sub-sample of subjects who live near airports with considerable numbers of night-flights. Air pollution will be modelled for four airports to explore interactions between air pollution and noise. The project is funded by a grant from the European Commission.

13:20-13:40

1636 _____ *contributed*

CHARACTERIZATION OF ZONE ACOUSTIC SATURATED (SAZ) IN THE CITY OF LEON (SPAIN)

Eduardo García Ortiz*, Jesús Cepeda, Marcos Fuentes, Berta Melcón, David Fernández, Mercedes de Barrios

* *University of León, León, Spain*

With date June 25 2003, the Council of León (Spain) law for protection of the Environment against the emission of noises and vibrations was published in the Official Gazette of the León Regional Government. This law ordered, for the first time, the study of the possibilities of implanting Saturated Acoustic Zones in the city of León. The results of the preliminary studies corresponding to the possible implantation of Saturated Acoustic Zones (SAZ) in the city of Leon have implied the obtaining of high data of measurements of level of sonorous pressure in diverse points of a defined affluent zone of this city, for later to confront them with the exigencies that the existing city council legal norm indicates. The values obtained for differents L10, L50, L90, Leq and Lmax, are of special relevance in the nocturnal period, in days of weekend. The conclusions will fundamentally talk about the Leq, like significant parameter. In this paper the Acoustics Laboratory (University of León) displays the results of the preliminary studies corresponding to the possible implantation of SAZ.

13:40-14:00

1976 _____ *contributed*

AN OVERVIEW OF THE COMMUNITY NOISE STUDIES IN TURKEY AND INTRODUCTION TO THE NEW REGULATION CONFORMING TO DIRECTIVE 49/EC

Selma Kurra

Bahcesehir University, Istanbul, Istanbul, Turkey

Noise surveys in Turkey have been conducted in various parts of Istanbul from 1980 up to date, for different noise sources mostly for road traffic noise. The results were presented so as to reveal the dose&response relationships in comparison with the worldwide results. Briefly, it was observed that the annoyance responses above the mid-point of the 5-point scale corresponded to 62 dBA Leq,(18h). Comparison between the annoyance degrees, revealed that the aircraft noise was the most disturbed noise source and the same annoyance responses could be obtained at 2 and 5dBA higher noise levels for road and railway traffic respectively. Surveys in schools for traffic noise have pointed out appalling results from the teacher's standpoint, but the adverse effects on students is still being studied. To investigate the noise pollution in cities, noise mapping, although not very common, have been continuing for specific purposes e.g. in certain residential districts,

near schools, near open-air entertainment centers where noise complaints are seriously high and for designing noise barriers against motorway noise. Such studies have encouraged the legislative work i.e. 8 th 5.Year Development Plan and later the Noise Control Action Plan within the Framework for Environmental Strategies. The existing Noise Control By-Law dealing with various noise sources and control at source, environment and user, came into force in 1986. However, after about 20 years of experience, it was inevitable to highlight some important issues, namely, revising the noise limits, strategic noise mapping, coordinating the greater number of responsible authorities, handling the growing interest into the technical solutions for noise and vibration control, especially for the amplified sounds during touristic season.The structure of the new regulation which was recently prepared with consensus on above subjects, is described briefly in the paper by discussing the adaptability to Directive 2002/49/EC and other EU Norms.

14:00-14:20

1601 _____ *contributed*

COMMUNITY ANNOYANCE FROM CIVIL AIRCRAFT NOISE IN KOREA

Changwoo Lim ⋆, Kim Jaehwan, Hong Jiyong, Sun Hyosung, Lee Soogab

⋆ *Center for Environmental Noise & Vibration Research , Seoul, Republic Of Korea*

Studies of community annoyance caused by civil aircraft noise exposure were carried out in fourteen areas near Gimpo and Gimhae international airports, Korea, to accumulate social survey data in Korea and to assess the relationship between aircraft noise level and degree of annoyance. Aircraft noise levels were measured automatically by airport noise monitoring system, B&K type 3597. A social survey was carried out people living within 100 meters of noise measurement points, as a rule. Questionnaires were only aggregated face-to-face interviews using various questions which concerned with demographic, degree of noise annoyance, interference with daily activities and health-related symptoms. The questions of noise annoyance were answered on an 11-point numerical scale. The respondents, from 18 to 70 years of age, were randomly selected and completed the questionnaire themselves. The total number of respondents for the questionnaires was 554.

14:20-14:40

1611 _____ *contributed*

COMMUNITY RESPONSE TO RAILWAY AND ROAD TRAFFIC NOISE - A REVIEW ON GERMAN FIELD STUDIES

Ulrich Moehler⋆, Lou Marcel Greven

⋆ *Moehler + Partner, Munich, Germany*

In 1995 the German railway company (Deutsche Bahn) initiated seven field studies on special topics in context with the annoyance due to railway noise and -in some cases- in comparison to road traffic noise. The studies were carried out in an interdisciplinary team and were accompanied by an international commission with members from Germany (e.g. UBA) Austria, France and the Netherlands. The studies include especially the quantification of differences in the annoyance between road and railway traffic noise in the night period ("Sleep-Study"), inside and outside of sleeping and living rooms regarding also the position of the windows (open/closed) ("Indoor-Study"), between low and high number of pass bys ("Frequency-Study"), due to passenger trains and freight trains ("Passenger-Freight-Train-Study"), due to the effects of high speed trains ("High-Speed-Study"), the changing of reactions with the time near newly built railways ("Habituation-Study") and the effect of rail grinding on the noise annoyance ("Rail-grinding-Study"). The study designs were planned as field studies in selected areas with noise measurement and questionnaires. The acoustic parameters were determined by noise measurements and calculations, the reactions were measured with questionnaires and actimeters. In each study the number of interviews varied between 1000 and 2000 questionnaires. The studies show different results of the annoyance of railway and road traffic noise in dependence of the considered reactions, the traffic situation and the acoustic parameters. The results of the studies will be presented and discussed

14:40-15:00

1676 _____ *contributed*

ASSESSMENT OF NOISE LEVELS IN TERMINALS AT BUS STATIONS

Frederico Rodrigues ⋆, Carlos Faria, Max D.C. Magalhães

⋆*Universidade Federal de Uberlandia, Uberlândia, Brazil*

At more typical levels of noise in bus stations caused by the rustle and bustle of terminals and noisy vehicles, the acoustic stimulation can have a wide range of effects on people, depending on the level and on the situation in which they are exposed. Hence, it is worthwhile to evaluate the noise levels generated inside the terminals in order to determine whether or not such an environment is unhealthy. In addition, there is a need to improve the available analytical tools for prediction of noise levels considering not only the vehicle sizes but also their engine powers. Therefore, this work was mainly motivated by these reasons and aimed at developing an approach which could address some of the important issues related to noise pollution at bus stations. The main goal of this work is to propose an empirical model in order to establish a relationship between noise levels and bus flow inside terminals. The model is based on linear regression of data obtained experimentally in terms of sound pressure levels. The

measurements were made at Uberlândia bus station, Uberlândia, Brazil. Although the results obtained herein might be useful in assisting the design process of bus stations, no attempt has been made here to develop a general model, as it does not appear to be particular easy to solve or generalize.

15:00-15:20

1688 _____ *contributed*

INTERACTIONS BETWEEN SOUND PERCEPTION AND VISUAL PERCEPTION OF ROAD INFRASTRUCTURE

Patricia Champelovier ⋆, Jacques Lambert, Myriam Hugot, Julien Maillard, Jacques Martin

⋆ *INRETS, Bron, France*

Noise and visual intrusion is most often the main environmental concern of residents living close to road infrastructures. Experiments using sound (wave-field synthesis) and visual (augmented reality video) reproduction were performed in the Environmental Simulation and Assessment Laboratory (ESAL) of INRETS. Sixteen scenarios built by crossing 4 road traffic noise levels and 4 visual intrusion levels of road were presented to 32 participants. Results from the experiments provide noise-annoyance relationships and visual intrusion-annoyance relationships. However the visual intrusion indicator (amount of road visual in the landscape) is not entirely satisfying as it doesn't correlate very well with visual annoyance. Interactions between noise perception and visual intrusion perception are somewhat limited: noise has an influence on visual perception, but only when noise levels are high. Visual intrusion of the road has an influence on noise annoyance only when noise levels are low. Total annoyance from both noise and visual intrusion of the road is largely due to noise annoyance; the influence of visual annoyance within the total annoyance is rather low. No robust relationship between noise and visual intrusion and total annoyance was found.

15:20-15:40

1730 _____ *contributed*

URBAN ENVIRONMENTAL NOISE IN GREECE: A FIELD SURVEY

Chrysanthy Nathanail

Laboratory of Architectural Technology, Thessaloniki, Greece

The new European Directive on Environmental Noise (2002/49/CE) points out the need of relevant research, this is particularly true for countries possessing limited data concerning effects of noise on their population. For this reason, the effects of urban noise were studied in three representative roads of the city of Thessaloniki, in Greece. Questionnaires sent to the neighbouring households included questions about residence, annoyance from noise (semantic and numerical scale), sources of noise, periods of annoyance, sensitivity to noise, activity and sleep disturbances. A total of 168 responses were obtained, response rates varied a lot among the areas, most likely due to inhabitants' expectations concerning the improvement of the environment. Results show the expected dominance of traffic noise in annoyance, validate the choice of the time periods proposed by the Directive for the calculation of Lden and reveal the importance of sensitivity to noise. They also show that disturbances on uses of the residence– and mainly on the use of the balcony and the possibility of keeping the windows open – as well as disturbances on sleep are reliable and, sometimes, more pertinent indicators of noise annoyance than reported annoyance. Thereafter, noise exposure will be determined by calculations realized individually for each of the 168 households and correlations will be established with the different subjective metrics. This analysis will give the opportunity to study at which extend noise exposure is responsible for noise annoyance and will help investigate the other factors that contribute to this judgement. Where possible, comparisons of these results obtained in Greece with those obtained worldwide will be discussed.

Session DP: Ducts and Pipes

chairs:

Jorge P. Arenas - *Chile*

Manohar Munjal - *India*

13:00-15:40 **Room:** Copacabana

13:00-13:20

1821 _____ *contributed*

NUMERICAL OPTIMIZATION OF TRANSMISSION LOSS IN COMPRESSOR MUFFLERS

Melina Lofrano ⋆, José Roberto Arruda,Luis Miguel Lopez

⋆ *Tecumseh do Brasil LTDA, São Carlos, Brazil*

The optimization of the acoustic properties of suction mufflers has become an important research field due to the necessity of reducing compressor noise. The most important parameter for the acoustic optimization of suction mufflers is the Transmission Loss (TL). This property, which is independent of the noise source, is defined as the quotient between the incident power and the power ideally transmitted to an anechoic termination. The most common approach for obtaining the transmission loss is to make the plane wave approximation and use a lumped parameter acoustic model. The incident power is computed from the incident wave pressure amplitude, obtained using the wave decomposition method. In this paper, the TL of mufflers is computed from a finite element acoustic model. The

use of the finite element method allows the prediction at higher frequencies. Results for simple muffler geometry are verified experimentally using the two- load method.

13:20-13:40

1690 _____ *contributed*

DETERMINATION OF THE TRANSMISSION LOSS OF HELMHOLTZ RESONATORS USING THE TWO-LOAD METHOD

Fernando A.N. Castro Pinto*, Walace S. Pacheco

* *Fed. Univ. Rio de Janeiro / Mech. Eng., Rio de Janeiro, Brazil*

Helmholtz resonators are commonly used in noise control. Classical examples are automotive exhaust systems and for the abatement of HVAC wind noise. Usually a Helmholtz resonator is placed in the main duct in order to attenuate a given frequency component, reflecting it back to the source. The acoustic performance of a Helmholtz resonator can be described by the corresponding transmission loss, which may be assessed in an impedance tube. In the present work a study of the transmission loss due to Helmholtz resonators in a duct is accomplished using the two-load method. It allows the determination of the transmission loss, in a reliable way, without the need of an anechoic termination in the duct, besides being of easy application. Different configurations for the resonator and their effect are studied based in the mathematical modelling and in experimental results.

13:40-14:00

1957 _____ *contributed*

DESIGN METHODOLOGY FOR VARIABLE-AREA CONCENTRIC-TUBE-RESONATORMUFFLERS

Trinath Kar*, Manohar Munjal

* *Indian Institute of Science, Bangalore, India*

Variable area Concentric-Tube-Resonator (VCTR) mufflers may be used effectively for reducing the exhaust noise of automobiles, compressors, turbines, etc. However, there is a lack of a systematic methodology for their design and optimization. Here, a concise methodology based on the broad band transmission loss (TL) spectrum is discussed and applied to some of the muffler configurations. VCTR elements may be of several sizes and shapes so as to ensure interaction of waves in the inner and outer or annular ducts so as to produce cancellation effects. The underlying idea is to reproduce the wide-band effectiveness of dissipative ducts without use of any absorptive materials. Research work on these lines has done for the last couple of years resulting in generalized analysis techniques. In particular, an elegant Boundary-Condition-Transfer (BCT) algorithm is made use for the numerical prediction of the TL spectrum. Concepts like the effective length and the corresponding resonance frequency is outlined. Extensive parametric studies have been made to arrive at fairly general design guidelines.

14:00-14:20

1637 _____ *contributed*

DIDACTIC SIMULATION OF ACOUSTIC WAVE BEHAVIOR IN DUCTS AND PLENUMS USING ANSYS.

Jóse Villalobos-Luna *, Fernando Elizondo-Garza, Carlos Lara-Ochoa, Pedro Lopez-Cruz

* *UANL. Acoustics Lab., San Nicolas, Mexico*

This paper discusses the didactic use of the finite element software ANSYS for simulation of the sound waves behavior in ducts-plenum systems. The modeling includes simple three-dimensional geometries of ducts and plenums. Two options are included: (1) acoustical absorbent materials on the internal walls of the ducts and (2) divisions or labyrinths. The analysis allows students to visualize the wave behavior inside duct-plenum systems and to manipulate the parameters of the model to improve the attenuation characteristics.

14:20-14:40

1830 _____ *contributed*

SOUND GENERATION IN CORRUGATED PIPES

Ulf Kristiansen*, Tor Reinen, Geir Atle Wiik

* *Norwegian University of Science and Technology, Trondheim, Norway*

Gas installations in the North Sea experience severe noise and vibration problems due to very high noise levels produced in the export gas pipes. These pipes are corrugated, carry turbulent gas flow, and are several hundred meters long. It was decided to do a series of model experiments using small diameter (2.5 cm) tubing of different corrugation geometries. The experimental set-up included a variable fluid flow velocity generator, anechoic terminations for the pipes, and the possibility to embed the pipes in concrete in order to avoid pipe vibrations. It has been found that also in the model experiments we can generate sound levels of the order of the flow dynamic head. The measurements show that the fluid flow instabilities caused by flow in the vicinity of the corrugations is the primary cause of the sound generation, and that the acoustic field set up in the pipes, i.e. longitudinal standing waves, regularizes the flow field. The longitudinal modal order thus depends on the flow velocity. The ability of a pipe to "sing" or not, seems to depend on sensitive parameters. Parameters that are investigated are detailed geometry of the corrugations, the amount of reflection from a pipe end, a pipe geometry change, and a change in effective sound speed within the pipes. A corrugated pipe having a side wall resonator has also been found to "sing" at the resonator frequencies instead of the

length resonances proper to the pipe. The wall vibrations of the pipe have been found to be part of the damping mechanism of the system, but not to play an important part in the sound generation.

14:40-15:00

1450 _____ *contributed*

EXPERIMENTAL DETERMINATION OF ACOUSTIC REFLECTION COEFFICIENT OF DUCT OPENINGS IN SIMULATED HOT CONDITIONS

Hans Rämmal*, Jüri Lavrentjev

* *Tallinn University of Technology, Tallinn, Estonia*

For a number of practical applications knowledge about the radiation impedance, or alternatively the reflection coefficient, of duct opening exhausting hot gases is essential for effective design of a duct system. Despite of several experimental and theoretical investigations in the field, there is still considerably few experimental data available to validate the existing theory. In this paper the reflection coefficient of a circular duct unflanged termination has been experimentally determined in simulated hot conditions. In order to simulate the acoustical conditions of hot air inside the duct, a helium-air mixture has been used in a test duct as a testing environment. Since the acoustic wavelength in helium is similar to that encountered in high temperature gas a range of temperatures from 0 to 1065 degrees of Celsius have been studied varying helium percentage in the mixture. The measurement method is based on the one-port presentation of the source and the standard two-microphone technique is applied to determine the passive acoustic properties of the source. The measured reflection coefficients are compared with the numerical results obtained from a well-known Munt's theory.

15:00-15:20

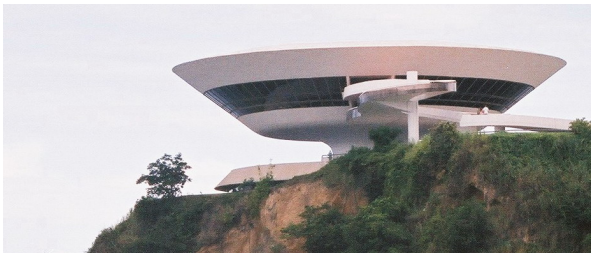
1485 _____ *contributed*

SEARCH OF PHYSICAL LOSSES TROUGH ACOUSTICS METHODS - A SABESP FOCUS

Jorge Luiz Monteiro*, Antônio B. Santos, José Geraldo Querido

* *Sabesp, São José dos Campos, Brazil*

Loss control is a harmonic set of activities carried out by a basic sanitation company with the fixed purpose to reach and maintain the level of its components of losses due to escapes, bursts, overflows, clandestine use of water, wastes, operational uses, special uses, metering inaccuracy and estimated mistakes at the lowest possible level in terms of technical, economical, financial, institutional, political and social viability. Concerns and use of techniques seeking to reduce loss of water are very well known in England where such studies started in the fifties with the participation of Brazilian technicians; particularly in Sabesp – Companhia de Saneamento Básico do Estado de São Paulo, these initiatives were commenced in the late seventies through resources financed by the now extinct BNH – Banco Nacional da Habitação. To achieve these goals strong qualification of available human resources is mandatory, what may be attained through personnel development planning and persistent training in addition to the use of adequate technology, among which acoustic search methods are emphasized along with specifically dedicated equipment. In this way, Sabesp has offered its technicians theoretical and practical qualification to enable them to use acoustic techniques to search physical losses in its supply systems, which is the experience presented in this work.



15:20-15:40

2092 _____ *contributed*

FEW THEORETICAL ASPECTS ON NOISE CONTROL IN A FLOW DUCT

Philippe Destuynder

CNAM, Paris, France

Stability and control of noise in a flow-duct are discussed in this talk, using a numerical simulation. The flow is assumed to be uniform for the steady state and the acoustic waves are modelled by a potential function. The interaction with a flexible part of the duct (the structure), is taken into account by the regular coupling conditions. A control device is located on the structure in order to cancel the acoustic waves which propagate along the duct but using the coupling with the structure. The basic point is that this coupling between the flexible duct and the flow is used in order to improve the control process. Even if the simulation model which is considered in the present study is linear, it enables to perform three fundamental analysis: 1) The critical velocity of the steady flow at which a flutter phenomenon can appear is characterized with respect to the mechanical properties of the flexible flow duct. 2) The pseudo-gyroscopic stabilization effect due to the rotation of the normal to the flexible part of the duct is clearly shown. It enables to delay the flutter mechanism. 3) The robustness of an optimal control is strongly dependent on several geometrical parameters and the sound velocities in the flow and in the structure. If some conditions -which are given in this talk- are not satisfied, then a spill over can appear known as the pillow effect and which disqualify any control system.

Session GA2: General Acoustics

chairs:

Antoni Sliwinski - *Poland*

Ilona Ali Bláhová - *Czech Republic*

13:00-15:40 **Room:** Business Master 145

13:00-13:20

1657 _____ *contributed*

ATTENUATION OF RAYLEIGH WAVE IN EMPTY BOREHOLE DUE TO ITS SCATTERING ON THREE-DIMENSIONAL STATISTICALLY ROUGH WELL SURFACE

Elina Ortega*, German Maximov, Evgeny Pod'yachev

**Facultad de Ingeniería. Universidad Nacional de San Juan, San Juan, Argentina*

The report concerns of the problem on Rayleigh wave propagation and attenuation along empty borehole with three dimensional statistically rough surface. The interest to this problem is appeared because there are the developed techniques for determination of porosity and permeability of surrounding media by attenuation of Stoneley waves along borehole. These techniques takes into account the attenuation of amplitude of Stoneley wave due to dissipation of its energy in porous permeable media. However, there are another mechanism of Stoneley waves attenuation dealt with their scattering on the roughness of a borehole wall. By the reason of unpredictable appearance of this roughness it is generally a statistical random problem with three-dimensional roughness. The problem on attenuation of Rayleigh wave propagating along empty borehole with two-dimensional roughness of a well was considered in the previous work of the authors [see Acoustical Physics 2004, V.50, N 5, p.585-595]. The given report is a generalization of this work for the case of three-dimensional roughness. In comparison with two-dimensional case of roughness with cylindrical symmetry, there are higher helical modes which can be generated by three dimensional roughness and result to additional attenuation. As well as the scattering canal for shear waves with horizontal polarization appears additionally to longitudinal and shear waves with vertical polarization propagating in surrounding elastic medium. The solution for scattered wave field is obtained in the framework of perturbation theory by ratio of roughness heights to the wavelength. The expressions for attenuation coefficient of Rayleigh wave due to Ro→Ro and Ro→Rn processes of scattering as well as for Ro→P, Ro→SV, Ro→SH scattering processes are obtained.

13:20-13:40

1765 _____ *contributed*

LOCALIZING SOUND SOURCES IN 3-D SPACE USING SPHERICAL HARMONIC BEAMFORMING

Peter M. Juhl*, Svend Petersen, Jørgen Hald

**University of Southern Denmark, Odense M, Denmark*

This paper presents a method of localizing sound sources in 3-D space by the use of an array of microphones. In order to obtain a device with uniform characteristics in all directions the positions of the microphones are restricted to a spherical surface. The restriction to a spherical geometry also facilitates an expansion of the sound field impinging on the sphere into spherical harmonics and functions describing the radial dependence of the sound field. The coefficients of the spherical harmonics contain the information of the direction to the sound source. In order to obtain the expansion coefficients needed, the sound pressure must be integrated over the spherical surface. The limited number of microphones poses a limit to the degree of spherical harmonic that can be extracted, and thereby to the angular resolution of the device. It also transforms the surface integral of the sound pressure into a problem of numerical integration. The paper addresses the problem of finding the optimum number and positions of the microphones (integration points). Finally measurements are carried out using a prototype of the array in an anechoic chamber.

13:40-14:00

1867 _____ *contributed*

DEVELOPMENT OF A QUANTITATIVE EVALUATION TECHNIQUE TO ASSESS VIRTUAL AUDIO SYSTEMS ON THEIR SOURCE POSITIONING CAPABILITY

Ki H. Shin*, Youngjin Park

**KAIST, Daejeon, Korea*

The term "Virtualizer" is often used to refer to audio systems that convert multi-channel audio inputs to 2 ch. audio inputs by artificially creating a set of virtual speakers at selected positions around the listener to render a 5.1 ch. (or 7.1 ch.) home theatre system out of just 2 speakers in the front. A virtual speaker is usually generated via convolution with the HRTF (Head-Related-Transfer-Function) corresponding to the azimuth of each surround speaker and appropriate filtering to eliminate cross-talk. Given a virtualizer incorporated in a TV or PC, however, it is difficult to assess if the system effectively places the virtual speakers at desired positions and conclude which algorithm is "better" in terms of positioning capability. A subjective listening test involving many individuals is time consuming and costly. Therefore, it is necessary to devise a quantitative evaluation technique involving a dummy head microphone system rather than a

group of individuals to provide some sort of measure and standard as quick feedbacks to audio engineers who design and revise virtualizers. In this paper, a method to track the azimuth of a virtual speaker from the output signals of a dummy head microphone system is proposed and its tracking performance on each of 3 selected virtualizer algorithms is shown.

14:00-14:20

1874 *contributed*

WAVE NUMBER AND PROPAGATION IN ANISOTROPIC POROUS MEDIA

Jérôme Tran-van*, Olivier Dazel

* *Saint-Gobain Isover, Courbevoire, France*

If porous materials become commonly used, for their acoustical properties of sound absorption and transmission, in aeronautics and automotive, buildings acoustics remain the largest domain where such products are needed. In order to calculate the acoustic performance of absorbing systems (e.g. ceiling) or sound insulating structures (e.g. sandwich panels) it is necessary to understand, and model, the acoustic behaviour, as to say the acoustic and elastic waves, in such materials. Lots of works have been done on the modelling of isotropic porous in the range of wave number and variational formulations. One can cite works of Allard and Atalla et al. Nevertheless most of these works have not been adapted for the case of anisotropic porous materials. Concerning mineral wools for example it is shown that the real structure of the material can be more or less described by the a transverse isotropic modeling. This communication is concerned with the adaptation of the recent works on isotropic materials to the case of anisotropic porous materials and more precisely to the transverse isotropic case. It will particularly be focused on the case of wave numbers and variational formulations.

14:20-14:40

1983 *contributed*

MEASUREMENT OF SECONDARY SOUND FIELD EXCITED BY IMPULSE METHOD

Ilona Ali Bláhová*, Zdenek Kyncl, Jirí Zendulka

* *Faculty of Electrical Engineering CTU in Prague, Prague, Czech Republic*

The impulse method of field excitation has been used in different branches of physics for many years. This method of excitation is also used in acoustics, especially in the field of room acoustics. In this paper, the use of the spark source impulse method of sound field excitation for measurements of secondary sound fields created around differently shaped obstacles was tested. Measurements were performed in an anechoic room, and the spark source impulse was generated by a high-capacity capacitor that with short-time discharge. A response to the impulse was recorded. Measurement at one point can provide the entire frequency spectrum if Fourier transformation is applied to the time slope measured. The secondary sound field around the sphere-shaped obstacle used in previous experiments was measured. We would like to compare the impulse method of sound field excitation to the sound field excitation realized by a speaker (frequency sweep was generated in the first case and separated harmonic frequencies in the second case). The advantages and disadvantages of different methods of sound field excitation and their appropriateness for our experiments concentrating on the description of secondary sound field are also discussed.

14:40-15:00

2088 *contributed*

DESIGN IMPROVEMENT OF POWER SOURCE OF HYDRAULIC ELEVATORS IN ORDER TO REDUCE NOISE EMMISION

Paolo Pennacchi

Dipartimento di Meccanica - Politecnico di Milano, Milano, Italy

Positive displacement pumps are often used as pressure power source in hydraulic elevators. The preferred type is the three-screw pump, while the electric motor is normally asynchronous. Some applications have both the pump and the motor submerged in the oil tank. This solution has the advantage of improving the cooling of the motor and the noise emission is very low. Anyhow, when the size of the pump and the power required to the motor is large, both the pump and the motor are outside the oil tank. With this layout the noise emission of the pump cannot be disregarded, especially if the pump is used in civil building. In this paper first experimental tests on the noise emission of the pump are presented. They were made using on field measurements by means of sound intensity. Some design improvement are also presented with the experimental results. Finally a theoretical study is presented about the possibility of reducing the quasi-impulsive load components, which act on the rotors of the three-screw pumps in the rotational axial direction. These forces can be related to the noise emission of the pump. The analysis is carried out by the systematic variation of one of the design parameters of the rotors, i.e. the semi-amplitude of the threaded zone of the screws, by using the analytical tools previously set-up for the study of the dynamic loads on the standard rotors. Finally, it is shown that a suitable choice of this design parameter on one hand allows to cancel the quasi-impulsive load, on the other hand has a positive effect on the radial loads.

15:00-15:20

1993 _____ *contributed*

STUDY ON THE NOISE GENERATED BY A LARGE STAMPING PRESS

Pérecles Costa Azevedo ⋆, Arcanjo Lenzi, Roberto Jordan

⋆ *Contagem, MG, Brazil*

This work presents the study of the noise produced by a large stamping press. The identification of the main sources, as well the determination of their contributions to the overall noise level, were carried out. Space averaged surface velocity values were measured at the several components, in order to estimate the sound power radiated, using radiation efficiency results obtained from simple geometries. Noise sources thus identified were then used in the estimation of the noise level at the operator position.

15:20-15:40

1512 _____ *contributed*

SOUND INSULATION OF BLOWERS AND COMPRESSORS BY MEANS OF RECYCLING MATERIAL

Karin Künzel⋆, Detlef Schulz, André Siegemund

⋆ *University of Applied Science Mittweida, Mittweida, Germany*

Air blowers for purification plants are delivered usually with a soundproof noise control enclosure. Thereby one is able to reduce the noise emission from the equipment to an allowed degree within the plant and in the environment, that is in many cases in residential areas. Within the scope of a project, promoted by the Deutsche Bundesstiftung Umwelt, it should be investigated how far a new material developed by the Fraunhofer - Institute for Building Physics Stuttgart (Germany) is suitable for application as an absorbent material in enclosures. The material is a sintered swelling glass - granulate consisting of recycling glass. Numerous different samples were measured in a Standing Wave Tube (Kundt's Tube) and in a measuring equipment for determination of the flow resistivity. The absorption coefficients were compared with the results for usual used absorbent materials. The flow resistivity is one of the most important parameters for the calculation of the insertion loss of an enclosure. The porous swelling glass – granulat has the useful property that it's absorption is very effective even in the middle frequency range. This advantage is significant with regard to the emission spectrum of a compressor. Finally, the insertion loss of a noise control enclosure with a sound – absorbing lining consisting of sintered swelling glass – granulate will be shown.

Session IS: Instrumentation and Standards

chairs:

Walter E. Hoffmann - *Brazil*

Ronaldo Dias - *Brazil*

13:00-15:40 **Room:** Flamengo 2

13:00-13:20

1492 _____ *contributed*

HEADSET NOISE EXPOSURE OF CALL CENTER TELEPHONE OPERATORS

Erasmo F. Vergara ⋆, Samir N.Y. Gerges, Robert S. Birch, Moysés Zindeluk

⋆ *UFSC, Florianópolis, Brazil*

Nowadays call centres have a very important role in the daily activities of commerce and providers of services in the public sector. Potentially, one of the risks to the health and safety of the telephone operators is damage to hearing due to the prolonged use of their personal communication headset (i.e., comprising microphone and small speakers fitted the operator's head) and the levels noise that they expose the users to. A headset can be considered as a type noise source such as circum-aural, supra-aural and plug in the ear. Despite telephone equipment having a limited bandwidth, these headsets can generate wideband noise of high quality and fidelity that implies a wide dynamic range. The sound level of the headsets should be sufficiently high to overcome the effects of any background noise in the operator's workspace and is particularly relevant when unilateral and/or supra-aural type of headset are used. However, it appears that there is a lack of national and international standards with agreed methodologies to quantify exposure of telephone headset noise typical of that experienced by operators in call centres. This paper presents a procedure for the assessment of operator exposure to noise from headsets typical of those used in the telemarketing industry. The procedure has been developed by researchers at the Laboratory of Industrial Noise (LARI) of the Federal University of Santa Catarina (UFSC), Brazil. Using a standardized ear simulator and artificial human head, the procedure consists of measuring simultaneously the sound signal that the telephone operator receives and that which ear simulator measures. This method was evaluated using approximately 30 call centre operator subjects in four different workspaces and two different times of the day to represent varying conditions of background noise.

13:20-13:40

2071 _____ *contributed*

INTEGRATED SYSTEM FOR MEASUREMENTS IN ACOUSTICS

Swen Müller

INMETRO, Rio de Janeiro, Brazil

In the past, many measurement tasks in acoustics required dedicated devices. Today, most of these tasks are handled by computer-based systems which do all of the necessary digital signal processing by software. For the data acquisition and simultaneous emission of test signals (ADC and DAC), hard disk recording frontends are a viable and inexpensive option. However, the lack of calibrated gain settings and provisions for laboratory grade transducers often imply the use of an external preamplifier. In measurements involving loudspeakers, such as room acoustics, an additional power amplifier is necessary. The two-channel system presented here combines these three devices in just one box at the size of a laptop computer. It comprises preamplifiers with high SNR and precise 10 dB gain steps, provision for 200 V polarization voltage, phantom power and ICP constant current supply, ADCs and DACs with high dynamic range and low distortion, and a 2x 70 W power amplifier. A built-in universal switched mode power supply with power factor correction (PFC) allow it to operate from any line socket in the world. Connection to a computer is established via a popular and wide-spread interface with available drivers for Windows ASIO, Mac OS-X and Labview. For the latter, a complete "virtual instrument" for remote controlling all functions of the frontend eases the integration in existing measurement setups.

13:40-14:00

1622 _____ *contributed*

PRACTICALLY OBTAINABLE DYNAMIC RANGES OF DATA ACQUISITION SYSTEMS BASED ON 24-BIT TECHNOLOGY

Ole Andersen*, Niels-Jørgen Jacobsen, Svend Gade

**Brüel & Kjaer SVM A/S, Naerum, Denmark*

The linear operating range of high-quality measurement accelerometers and microphones has for many decades been better than that which can be achieved in the following electronics and digital analysis chain. This is despite the fact that today's acquisition hardware is based on AD converters with a designed resolution of 24 bits that is theoretically able to handle signal dynamics of up to 144 dB. In practice, most systems do not realise a useful dynamic range of more than 100dB. This forces the system operator to be very careful in optimising the signal chain dynamics in order to avoid overload and under range situations. This paper looks at what can be achieved with today's state-of-the-art designs to increase the practically realisable dynamic range – all in order to provide the most productive and safest sound and vibration measurements.

14:00-14:20

1653 _____ *contributed*

A NEW SCRIPT-BASED AUTOMATIC TEST SYSTEM FOR SOUND LEVEL METERS AND NOISE DOSEMETERS.

Richard A. Wright

Cirrus Research plc, Hunmanby, UK

Automatic computer-controlled testing has been employed at Cirrus Research plc since the earliest days of readily available computers, and over the last two decades the software and hardware have continuously evolved to make best use of ever-increasing computing power. In 2002 a need was identified to design a completely new software based system to replace the then-existing arrangement. The new system was to be used for electrical testing and exercising the responses of sound level meters and noise dosimeters to a very wide range of input signals in accordance with all the relevant specifications, including the soon to be introduced IEC 61672 and many possible future extensions. The intent being to perform electrical tests as nearly as possible to the 'Pattern Approval' standard in part 2 of IEC 61672. The paper describes the development of this new system: from the initial specification with its ambitious design principles, through the challenges of the design process, to the current state of successful implementation and continuing evolution. The flexibility of the system has led the company to find applications for it that had not been imagined at design stage, including a method for the simultaneous testing of over a hundred individual fixtures.

14:20-14:40

1734 _____ *contributed*

A PRACTICAL GUIDE TO FACTORY ACCEPTANCE TESTING WITH MIL-STD-740-1 AND MIL-STD-740-2 IN A NON-LABORATORY ENVIRONMENT

Nathan S. Jones*, Ronald Dempsey

**Noise Control Engineering, Billerica, USA*

This paper is a practical guide to factory acceptance testing of shipboard equipment for airborne and structureborne noise using MIL-STD-740-1 and MIL-STD-740-2. It discusses the application of these test standards in a shipyard and factory environment. It looks at real world requirements for testing foundations and environmental problems which are encountered. This paper also addresses ranges of background limits and their effect on the testing. These lessons will be valuable as the commercial sector adopts the equivalent ANSI Standard, S2.26-2001.

14:40-15:00

1664 _____ *contributed*

SUBBAND ADAPTIVE NULL-FORMING WITH A DIRECTIONAL MICROPHONE PAIR

Xiaobin Cheng*, Zhaoli Yan, Xiaodong Li, Jing Tian

* *Institute of Acoustics, Chinese Academy of Sciences, Beijing, China*

A small microphone array with two cardioid directional microphones back-to-back based on the subband adaptive null-forming algorithm has been proposed. The array could be used in applications where it is desirable to isolate a voice or sound coming from a single direction, such as hearing-aids devices, hands-free telephones, PDA with speech recognition systems, intercom systems, where the space required for implementation is limited. It has been shown that microphone array is a very effective tool to improve speech intelligibility in automobiles, aircraft, cocktail party-like environments, or any noisy environment where it is desirable to detect speech in an environment with competing undesirable signals. The subband adaptive null-forming scheme makes the null of the combined polar pattern in each subband always towards the direction of the noise sources independently. Comparisons have been made not only between the proposed structure and that of an endfire dual-omnidirectional-microphone array, but also between full-band algorithm and subband algorithm. The discussion covers the frequency range from 300Hz to 3400Hz just as the typical telephone bandwidth. The directional microphone pair requires much smaller scale and lower consistency between two microphones. Furthermore, the subband adaptive null-forming algorithm could make the nulls of each subband towards the noise sources distributed in the frequency rang of each subband.

15:00-15:20

1706 _____ *contributed*

IMPROVED DIRECTIVITY OF SPHERICAL MICROPHONE ARRAYS

Clara Cardoso*, Philip Nelson

**ISVR - University of Southampton, Southampton, UK*

The aim of this research is to create a microphone array on a rigid sphere that could be used for teleconferences and for recording of music with the aim of five-channel loudspeaker surround sound reproduction. Computer simulations have been undertaken, within a MATLAB environment, that test the directivity of circular microphone arrays. The beamformer used in the study is an extension of the "focused beamformer" that attempts to map the distribution of acoustic source strength associated with a given source distribution by changing the Green function vector in accordance with the assumed source position. In the approach used here, it is assumed that multiple sources are present and Tikhonov regularisation is used in order to enable the inversion of the system response. Using an algorithm for the reconstruction of source strength time histories, the improvement in the directivity of the array was achieved by simulating the presence of several sources around the microphone array and then using only the filter corresponding to one of the sources. In that way the directivity is maximum in the source direction and minimum in the directions of the other sources, creating a mainlobe in the main source direction and several dips in response in the directions of the other sources.

15:20-15:40

2067 _____ *contributed*

DETERMINATION OF NOISE EMISSION BY WOODWORKING MACHINES (SOUND POWER LEVELS AND EMISSION SOUND PRESSURE LEVELS) USING THE SOUND PRESSURE: SURVEY METHOD AND ENGINEERING METHOD

Witold Mikulski

Central Institute for Labour Protection - National Research Institute, Warsaw, Poland

Within the framework of unification of Polish and European Union regulations the following Standards for determination of noise emission are applied in Poland: sound power levels PN-EN ISO 3744 and PN-EN ISO 3746, and emission sound pressure levels PN-EN ISO 11201 and PN-EN ISO 11202. These standards are an official translation of European ISO standards: the ISO 3740 series and ISO 11200 series. These series of standards are intended for determining the noise emission of machinery with pressure methods. The methods described in those standards have been used on woodworking machines, which according to directive 98/37/CE are on the top of the list of particularly dangerous machines. The methods and results of measurement of woodworking machines are presented in this article.This paper was created within II stage of National Program entitled "Adjusting the working conditions in Poland to The European Union standards" and other research programs.

Session SP: Sound Power

chairs:

Gerhard Hübner - *Germany*

Honorio Lucatto - *Brazil*

13:00-16:40 **Room:** Botafogo

13:00-13:20

1551 _____ *invited*

THE EVOLUTION OF THE ISO 3740 SERIES OF INTERNATIONAL STANDARDS

William W. Lang*, Roger Higginson

**Noise Control Foundation, Poughkeepsie, USA*

During the 1970s, Working Group 6 of Technical Committee 43 (Acoustics) of Subcommittee 1 (Noise) of the International Organization for Standardization (ISO) prepared a series of basic standards for determining the sound power levels of machinery and equipment: -ISO 3741 Precision methods for broadband sources in reverberation rooms, -ISO 3742 Precision methods for discrete frequency and narrow-band sources in reverb. rooms, -ISO 3743 Engineering methods for special reverberation test rooms, -ISO 3744 Engineering methods for free-field conditions over a reflecting plane, -ISO 3745 Prevision methods for anechoic and semi-anechoic rooms, and -ISO 3746 Survey method. Standardized methods of measurement became important as regulatory agencies were empowered to set upper limits on the noise emissions of sound sources. These methods depend on measurements of the sound pressure levels in the vicinity of sources in specified environments, the sound power being calculated from the theoretical relationship between sound pressure and sound intensity. These are the so-called pressure-squared methods. During the 1980s, equipment was developed for directly measuring the sound intensity at specified positions near a source, the sound power being obtained by approximating the surface integral of the normal component of sound intensity over a surface surrounding the source. In the 1990s, following the recommendation of a study group, a successor to Working Group 6 (WG 28) revised the ISO 3740 Series in parallel with the development, by Working Group 25, of international standards for the intensity method. The revision of the ISO 3740 Series was completed with the publication of ISO 3745 in 2003. For the future, two successive revisions of the ISO 3740 Series are projected, the first a short term revision based on existing knowledge and the second a more comprehensive revision based on future research. Working Group 28 also has responsibility for standards on methods of measurement of sound intensity (ISO 9614 Series), for methods to determine emission sound pressure levels (ISO 11200 Series), for declaring and verifying of noise emission values (ISO 4871), and for rules in drafting a noise test code (ISO 12001).

13:20-13:40

2058 _____ *invited*

SOME FUTURE ASPECTS IN SOUND POWER MEASUREMENTS

Gerhard Hübner

Stuttgart University , Stuttgart, Germany

At present the several international standards (ISO 3740-, ISO 9614-series and ISO 7849) describing procedures for sound power determination of machines and equipment are in a status of a "short term revision" which will be finalised within the next half year for which basic changes are not to be expected. For the sound pressure squared methods using discrete microphone positions a slightly changed microphone array is in discussion only. But fundamental revisions of all sound power measurement standards will follow at least after the next 5 years under the title of a "long term revision". This general revision is initiated mainly by the requirement of GUM (Guide to the Expression of Uncertainty in Measurement) being issued by the Comite' International des Poids et Mesures (CIPM). This Guide must be enforced for any kind of measurement. The core of GUM is to split up the final measurement uncertainty into its several uncertainty components. On the one hand this requires for all sound power measurement procedures substantial investigations. But on the other hand based on the new knowledge the quantified uncertainty components establish its rank order too and so the measurement effort can be reduced by focusing this effort to the components of the greatest influence. Furthermore, the present system of standards is structured by certain uncertainties classes 1,2 or 3 which are defined by different fixed upper limits for the total uncertainty values. Consequently this classification can be designated as a rigid system whereas the new philosophy will lead to a floating system without any fixed uncertainty classes. Furthermore this new uncertainty system has the great advantage to be related to the true actual measurement situation. The paper will present some examples of the to-day and to-morrow praxis of expressing sound power measurement uncertainty declarations.

13:40-14:00

1720 _____ *invited*

MEASUREMENT OF THE EMISSION SOUND PRESSURE LEVEL - REVISION OF THE ISO 11200 SERIES

Wolfgang Probst

ACCON GmbH, Greifenberg, Germany

Experience with the standards of the ISO 11200 series showed some deficiencies and problems that should be solved in the frame of a short term revision. The problems arise because the environmental influence

with machines operating in room depends not only on room characteristics, but also on the directivity index of the radiation at the operators position. This inclusion of the directivity needs generally an additional measurement on a complete enveloping surface similar to ISO 3744. With the proposed revision some simplifications are included from neglecting the correction to an approximate determination up to the mentioned measurement on a complete enveloping surface.

14:00-14:20

1863 _____ *invited*

EUROPEAN NOISE CONTROL POLICY AT WORK PLACES BASED ON DIRECTIVES

Gerhard Hübner*, Patrick Kurtz

**ITSM, University of Stuttgart, Stuttgart, Germany*

European noise control policy at work places based on directives Patrick Kurtz, Federal Institute of Occupational health and Safety, Dortmund Germany To achieve a European Union without trade barriers several directives were prepared by ap-plying the so called New Approach. The basic principle is that the directives are written as a series of legal essential health and safety requirements and leave it to standards describing ways to reach the objectives. As an example the Machinery Directive 98/37/EEC supporting the free trade is stating requirements on noise which require to design machines to lowest lev-els and to provide noise emission values such as the emission sound pressure level and the sound power level. Depending on the magnitude of the emission sound pressure level at the work station of the respective machine at least this value or additionally the sound power level is required to be stated in the instruction manual of the machine. Therefore adequate noise test codes are laid down in so called harmonised machinery safety standards of which almost 400 CEN and CENELEC standards have already been prepared. Their application is the recom-mended way to get presumption of conformity to the Machinery Directive. Concerning health and safety at work, a directive from 1986 protecting workers against noise, only recently has been substituted by a new "Physical Agents, Noise" directive 2003/10/EEC. This directive not only sets exposure limits but also requires choosing comparable quiet machines on the basis of declared noise emission values. The paper to be presented will present the major requirements of the mentioned directives, the general content of the supporting machinery safety standards in respect to the noise emission measurement and declaration and explain why this should finally result in a reduction of noise at work places.

14:20-14:40

1569 _____ *invited*

EUROPEAN LEGISLATION ON OUTDOOR EQUIPMENT - THE USE OF STANDARDS CONCERNING THE DETERMINATION OF SOUND POWER LEVELS

Volker K. P. Irmer

Federal Environmental Agency, Berlin, Germany

The European Directive 2000/14/EC – the Outdoor Directive – contains provisions concerning the noise emission in the environment for some 60 types of equipment. Placing equipment covered by the Directive on the European market manufacturers have to indicate the guaranteed sound power level on each product; in addition for some of the types of equipment permissible sound power levels are given. The Directive lays down measurement methods for each of the types of equipment. In general the sound power levels are determined using the methods describes in EN ISO 3744:1995 and EN ISO 37446:1995. As sometimes the sound power levels of moving equipment, such as loaders or lift trucks, has to be determined the position of the measurement points is slightly changed to allow a drive through measurement; the microphone array has been chosen following the repealed Standard ISO 4872. Wherever possible, operation condition for the different types of equipment are laid down referring to product related European or international Standards. In all other cases operation conditions are given which should allow to determine sound power levels that are characteristic for the normal use of the equipment. Following the process of the adaptation to technical progress the European Commission may amend the Directive by changing the measurements methods and especially may include references to new Standards developed by European or international standardisation bodies. If these new methods have a substantial influence on the sound power level values, the European Parliament and the Council have to be involved. Unfortunately the Directive itself does not regulate the verification of labelled (declared) values, although the relevant Standards would have been available: EN ISO 4871 and the EN 27574 series. This may create problems if the European Member States use different methods of verifying stated sound power levels.

14:40-15:00

1536 _____ *invited*

A CONTRIBUTION TO THE NUMBER OF MEASUREMENT POSITIONS NECESSARY TO DETERMINE THE SOUND POWER WITHIN A CERTAIN SPAN OF UNCERTAINTY.

Gerhard Hübner*, David, Kandelaki

**Stuttgart University , Stuttgart, Germany*

The main quantity to describe the noise emission of

machines and equipment is its radiated sound power. In practise the so called enveloping surface methods are the most common procedures to measure this quantity where the time averaged sound pressure squared or intensity components are to be determined on a limited number N of discrete positions distributed over the measurement surface. From these data the spatial mean value of the pressure squared respectively the spatial mean of the intensity component are to be calculated. The "quality" of these mean values respectively of the yielded sound power described by the its uncertainty depends both on the irregularity of the sound field quantity come across the chosen measurement surface and the number N of measurement positions. For the measurement effort it is an important question how many positions N are necessary to fulfil a certain given accuracy requirement. The ISO Standards 3745, 3744, 3746 using sound pressure and the 9614 Standards using sound intensity measurements offer for this several rules by formulas for the N-determination in function of the expected upper-limit of the uncertainty D and a parameter describing the sound field irregularity. For the same goal the formulas of these standards are different and are based on statistical laws requiring especially non-correlated signals of the measured quantities. The paper presents results from experimental and theoretical correlation investigations, where the objects are sources radiating airborne noise caused by vibrating surfaces and by aerodynamic generations. This investigation is a first step for establishing a rule for the determination of the number N of measurement positions guaranteeing a sound power value within a certain limit of the uncertainty for practical situations.

15:00-15:20

1839 _____ *invited*

EVALUATION OF SOUND POWER MEASUREMENT UNCERTAINTY ASSOCIATED WITH HEMI-ANECHOIC ROOMS QUALIFIED USING THE ISO 3745 INVERSE SQUARE TEST

Daniel J. Simmons

NPL, Teddington, UK

Accurate quantification of sound power level commonly requires the use of a hemi-anechoic room. Such a room is designed with the assumption that sound from the noise source under test is not reflected from boundaries other than the ground plane, thus providing an acoustic environment that is essentially 'free-field' over a reflecting plane. The performance of such facilities however, needs to be assessed in order to validate this assumption. ISO 3745 is a commonly referenced standard for precision grade sound power level determination and includes methods for the assessment of hemi-anechoic room performance stipulating qualification criteria. The standard does not however provide information on how measurement uncertainty associated with sound power level determination is related to the room performance criteria. Users of the standards will therefore not know to what degree their test facility will affect the sound power level determination. Information on values of components of measurement uncertainty are of practical importance since EU Directive 2000/14/EC requires certain machines to display a CE mark stating the guaranteed sound power level. This must include uncertainties due to the applied measurement method. This paper describes an extensive series of measurements, examining the effect of varying the performance of a hemi-anechoic room on sound power determinations for several noise sources. The measurement uncertainty resulting from boundary reflections, for rooms qualified using the ISO 3745 inverse square test, has been evaluated.

15:20-15:40

1588 _____ *contributed*

REQUIREMENTS FOR INFORMATION TECHNOLOGY (IT) EQUIPMENT NOISE

Robert D. Hellweg*, Egons Dunens, Terrence W. Baird

* *Hewlett-Packard, Marlboro, USA*

There are several types of requirements on the acoustical noise emissions from information technology (IT) equipment. The requirements include: international standards for measurement of product noise emission levels; requirements to report product noise emission values; international standard criteria for sound power level; environmental awards based in part on product noise, and purchase specifications. In addition regulations for workplace sound pressure levels imply certain constraints on IT equipment noise emissions which may contribute to the total noise in a workplace. This paper describes recent work of the IT equipment manufacturers' technical committees to improve measurement procedures and reduce noise emissions of IT products in order to produce more acceptable products. The IT committee activities include characterizing prominent discrete tones and impulsive noise, improving sound power measurements, and documenting current product noise emission performance. This paper recommends a process for determining sound power level criteria for IT equipment. Emphasis is placed on determining proper criteria for personal computers (PC) and laptop computers by determining what sound pressure levels are appropriate, by examining customer history and acceptance of PC noise, and by considering technical feasibility. With a concern for differences in proposed acoustical criteria for PCs and laptops from various agencies, the IT technical committees have followed this procedure to develop recommended acoustical criteria. The resulting recommended criteria levels for personal computers and laptops will result in acceptable and non-intrusive noise – the products will be perceived as environmental friendly with respect to acoustics. The recommended levels are achievable without penalties of product size, reliability, complexity, and cost that would be incurred by lower criteria

levels that would not provide further acoustical benefits to users. Considerable progress over the last ten years is shown in the reduction of laser printer and personal computer noise.

Coffee Break

16:00-16:20

1941 _____ *contributed*

INVESTIGATION OF SOUND POWER DETERMINATION METHODS AIMING THE DOMESTIC ELECTRIC DRILL'S STAMPING PROGRAM.

Stelamaris Bertoli⋆, Christian dos Santos

⋆ *UNICAMP - Civil Engineering and Architecture Faculty, Campinas, Brazil*

Sound power radiated by a source is an important parameter to control noise. In Brazil, IBAMA (Instituto Brasileiro do Meio Ambiente e dos Recursos Renováveis) and INMETRO (Instituto Nacional de Metrologia, Normalização e Qualidade Industrial) started a program named "Selo Ruído" that labels the household appliances according to the noise level produced by them. There is a prevision to include the electric tools in this label program. The drill is one of these electric tools that will be included. This work presents tests of drills with different standard methods for determination of the sound power levels. The methods used for the tests were the ones that use reverberation rooms (ISO 3743 – Engineering Methods for Special Reverberations test Rooms and ISO 3741 – Precision Methods for Special Reverberations test Rooms). These methods are referenced by Brazilian standard NBR 13910:1997 – Part 1 – "Diretrizes de ensaios para a determinação de ruído acústico de aparelhos eletrodomésticos e similares". A quantitative analysis from results obtained with different methods applied was performed. The analysis allowed to propose the method to be used in the drill's stamping Brazilian program (Selo ruído)

16:20-16:40

1829 _____ *contributed*

CORRECTIONS IN SOUND POWER LEVEL DETERMINATION USING INTENSITY MEASUREMENTS

Luiz Antonio Brito⋆, Stelamaris Bertoli

⋆ *UNICAMP - Civil Engineering and Architecture Faculty, Campinas, Brazil*

Many Brazilian cities have been facing noise pollution problems. Traffic noise is considered the first annoyance source, followed by civil construction equipments noise. It is paramount to control emission and propagation noise in civil engineering sites to maintain quality of life. Sound power level is an important parameter to predict sound propagation in the environment. The use of intensity measurements makes possible to obtain the sound power level of noise sources in situ, even if other sources are present. With this technique it is not necessary to move the source to reverberation or anechoic chambers. This work studied the efficiency of corrections applied to sound power level determination using intensity measurements. Intensity measuments of electric drills were carried out using a Bruel&Kjaer sound intensity probe. Sound power level was calculated applying corrections suggested in the literature. The results were compared with sound power level measured in special rooms. There was no statistic significant difference between sound power level obtained in special rooms and intensity measurements. With this work the authors intend to spread the intensity measurement technique and use sound power level determination of civil construction equipments to build a support database for environmental noise prediction software.

Session TY2: Tyre/Road Noise

chairs:

Ulf Sandberg - *Sweden*

Rajendra Singh - *USA*

13:00-15:20 **Room:** Flamengo 1

13:00-13:20

1793 _____ *invited*

TWO-LAYER POROUS ASPHALT: AN INTERNATIONAL SURVEY IN THE FRAME OF THE NOISE INNOVATION PROGRAMME (IPG)

Luc Goubert ⋆, Jan Hooghwerff, Peter The, Rob Hofman

⋆ *Belgian Road Research Centre, Sterrebeek, Belgium*

Two-layer porous asphalt is among the quietest types of road surfacing, but has two aspects that could be improved: it is less durable than most conventional road surfacings and its initially excellent acoustic properties tend to deteriorate as it becomes older. In this paper, the results are given from a study in which data available on some 40 Dutch (on secondary and local roads only) and 20 other European sections were studied in order to obtain state-of-the-art information about lifetime and acoustic performance development. Experience with sections of two-layer porous asphalt that served a full life cycle and were consequently removed exists only in The Netherlands. The average lifetime of the sections removed in the past equals 7.0 years. However, indications are found that the lifetime of the more recent laid two-layer porous asphalt might be longer. Dependence of durability on traffic volume will be discussed. It will be shown that the initial noise reduction of sections with only smaller aggregates are,

on average, a little better than that of sections with coarser aggregates. Sufficient data is available from periodic acoustic measurements on several sections in The Netherlands and abroad in order to draw sensible conclusions about the development of the noisiness during the first three years of the lifetime. On the other hand, few data is available on surfacings older than three years.

13:20-13:40

1879 _____ *invited*

TYRE/ROAD NOISE AND ROAD TEXTURE – A COMPARISON STUDY OF MODELLING AND MEASUREMENT RESULTS

Truls Berge*, Svein Adne Storeheier

**SINTEF ICT, Trondheim, Norway*

The texture of the road plays an important role defining the noise emitted from the contact between a tyre and the road surface. To be able to model the contact force between the tyre and the road surface, the road texture profile is an important input parameter. In this project we have utilised an existing hybrid tyre/road noise model. Measurements of tyre/road noise has been performed on different road surfaces. Among these are typical SMA-surfaces in Norway exposed to winter conditions/studded tyres, that are expected to influence the texture of the roads. Rolling noise levels are compared to measurements on an ISO-test track, used for type approval of tyres according to EU-directive 2001/43/EC. The texture profiles on the road surfaces has been recorded and together with the tread pattern of one of the tyres, used as input parameters in the model. The paper will present the results from comparison between the measured differences on the road surfaces and the estimated differences from the model itself. The results will be used to look for improvements of the road surfaces in Norway, to reduce the overall traffic noise levels.

13:40-14:00

1632 _____ *invited*

PREDICTING THE ADDITIONAL BENEFITS OF POROUS ASPHALT WITHIN STREET CANYONS AND CONFINED SPACES

Greg R. Watts*, Phil Morgan

**TRL, Wokingham, UK*

In a street canyon, a road with a full or partial cover or tunnel there will be multiple reflections of sound waves from vehicle noise sources between opposite surfaces and sound waves will propagate over the road surface repeatedly. A highly reflective surface will contribute to the build up of reverberant energy. This sound energy has the potential to cause considerable disturbance and has been the subject of a series of modelling studies. The presence of an absorptive road surface would be expected to have a greater influence on the total sound pressure level than would be the case for free field propagation conditions. Such a surface may also significantly affect the source strength due to reduction in tyre excitation and air pumping etc. The advantage in terms of noise reduction over a reflective surface is therefore expected to be greater under these conditions. The paper describes a study where the effects were quantified using the boundary element method (BEM). The conditions examined were: a single façade, facades on opposite sides of a narrow road and facades with a partial horizontal cover. The results indicate that porous asphalt is more effective in reducing noise levels where the conditions are more reverberant With increasing distance between opposite façades, lower façade heights and where a cover is not present it would be expected that the advantage of the porous surface over the reflective surface would tend toward that of a single façade. Conversely inside tunnels and with narrower roads and closer façades greater improvements than those predicted should be observed. Additional analysisexamined the situation in a confined space behind a noise barrier but in front of a tall building facade and demonstrated that porous asphalt was ineffective in reducing noise levels due to the high effective source position.

14:00-14:20

2087 _____ *contributed*

ROLLING TYRE NOISE EMMISSION ON DIFFERENT ROAD SURFACES

Paolo Pennacchi

Dipartimento di Meccanica - Politecnico di Milano, Milano, Italy

Technical standards and legislation about the control of the noise emission of the road vehicles (ISO 362, ISO 7188 etc.) have the tendency to somewhat emphasize the so called “power train noise”, that is all those sources of noise that presuppose the fact that the engine is supplying power to the system. On the contrary, it is now largely accepted and shown in literature that the rolling (or coasting) noise results a source as remarkable of the traffic noise. However the introduction of acoustic barriers, which are rather effective, are rather pervasive in the urban environment. Therefore, the paper considers the measure and the effect of the rolling noise due to vehicular traffic as function of the different road surfaces. The analysis of the effect of different types of road surfaces is particularly interesting in the Italian urban context in which historic downtowns are preserved and often present middle-age type of road surfaces. The possible improvements that can be obtained in the noise emission control by means of the road surface type are finally analyzed and compared.

14:20-14:40

1951 _____ *contributed*

COMPARATIVE STUDY OF NOISE TRAFFIC MEASUREMENT IN DIFFERENT ASPHALT PAVEMENT

José K. Yshiba*, Paulo Soares, Fernanda Simões

* *Universidade Estadual de Maringá/Departamento de Engenharia Civil, Maringá, Brazil*

Noise traffic is a sound pollution problem in most of urban communities. Trying to solve this problem, some researchers have been developing techniques and new materials which reduce noise production and propagation. One of the most important noise traffic source is the friction between tire and pavement, mainly when the vehicle move in a high speed. Studies have been focus on the effect of the type of pavement in noise level caused by traffic. This paper presents the influence of different asphaltic pavement in traffic noise. Database was obtained by measurement of sound spectrum and noise equivalent level to two cases: noise traffic set and noise from a medium test-vehicle. It was collected in an ascenting part of BR-376 road, between Paranavaí and Alto Paraná cities of Paraná State, Brazil, near the kilometers 116 and 118. The analysis took part in the third lane of the mentioned road and divided in three sections of 195 meters, 416 meters and 530 meters, length consisted of polymeric, CAP 20 and rubber asphaltic concrete respectively. Database was collected using a software installed in a computer that received data from a sound level meter, model SdB+ from the 01dB Company. The traffic database was measured with a microphone set 1,50 meters hight from the pavement level and with 7,50 meters distance from the pavement outboard. The range didn't have any reflexive or obstructive influence of the wave sound. The inside vehicle database was gotten following some parameters like constant speed near than 80 km/h and 100 km/h, tire pressure around 200 kN or 30 psi, dry runway and no obstacles along. The preliminary results indicate the advantage of using rubber asphalt as traffic noise reducer.

14:40-15:00

1609 _____ *contributed*

CORRELATING STATISTICAL PASS-BY (SPB) AND CLOSE-PROXIMITY (CPX) NOISE LEVELS

Phil Abbott*, Greg R. Watts

* *TRL Ltd, Wokingham, UK*

The most significant component of the noise generated by traffic running on high-speed roads result from the interaction between vehicle tyres and the road surface. Efficient methods for assessing the noise from different road surfaces have been developed based on measurements using a microphone in close-proximity to a reference tyre. A particular advantage of this method over the traditional roadside SPB method is that several kilometres of test surface can be assessed in a relatively short period of time. However, an important consideration is the relationship between CPX and SPB noise levels to ensure that noise assessments carried out close to the contact patch can be correlated to roadside noise levels and provide an estimate of the impact on people living in the vicinity. TRL Ltd was commissioned by the Highways Agency to examine this relationship by carrying out a series of measurements on different road surfaces using both measurement methods. The statistical correlation between the data was examined. Seventeen different sites located on thirteen different road sections were included in the measurement programme. The range of surface types included porous asphalt, stone mastic asphalt, hot rolled asphalt, exposed aggregate concrete and brushed concrete. Using TRL's purpose-built vehicle designed for CPX measurements (TRITON), it was possible to examine these correlations for microphone positions in front and to the rear of the reference tyres as well as the mandatory positions at 45°. The aim was to assess whether improvements in the correlation statistics could be achieved using different microphone positions particularly for porous surfaces where propagation is influenced by the absorption properties of the surface. In addition, the correlation between SPB and CPX for each individual reference tyre was also examined. The aim was to establish whether the need for using all four reference tyres was statistically robust particularly as some of the tyre types are now no longer available and existing stocks are diminishing.

15:00-15:20

1477 _____ *contributed*

A CHARACTERIZATION METHOD OF ROAD STIFFNESS FOR TYRE/ROAD NOISE

Julien Cesbron*, Fabienne Anfosso

* *LCPC, Bouguenais cedex, France*

This paper deals with the development of a non destructive method for characterizing the dynamic Young's modulus of the road surface with respect to tyre/road noise. First, the experimental dispersion curve of the pavement was found using a seismic method, called the Multichannel Simulation with One Receiver (MSOR) method. The technique consists in delivering steady impacts on the road surface along a straight-line and in measuring the acceleration response at a fixed surface spot for each impact. Then, the dispersion curve of the road is found by means of a two dimensional fast Fourier transform from space-time field to frequency-phase velocity field. Next, the experimental dispersion curve was interpreted using a "single plate approximation" derived from Lamb's theory. It only took into account the surface layer, which was supposed to be much more rigid than the substratum. Also, the Rayleigh's velocity and the thickness of the surface layer were found from the theoretical Lamb's curve by means of a least mean square method. Finally, the dynamic Young's modu-

lus of the road surface was directly calculated using the Rayleigh's velocity. The characterization method was applied for five bituminous road surfaces of the LCPC reference track in Nantes (France). The findings gave encouraging results, especially for the dense asphalt concrete (BBSG-0-10), which estimated rigidity matched with the one measured in laboratory from core samples of the track. Finally, the findings support the view that the proposed method could be used to study road stiffness influence on tyre/road noise in the future.

Session US: Urban Sound Propagation and Evaluation

chairs:

Jian Kang - *UK*

Tor Kihlman - *Sweden*

13:00-15:40 **Room:** Arpoador

13:00-13:20

1418 _____ *invited*

NOISE-MAPPING: ACCURACY AND STRATEGIC APPLICATION

Jian Kang*, J. Huang

* *University of Sheffield, Sheffield, UK*

While noise-mapping software/techniques have been widely used in practice, there are still debates about their validity. Moreover, practical application of noise-mapping software requires simplification of the 3D models, the level of which may significantly affect the prediction accuracy. Starting with a general comparison between micro- and macro- scale prediction models for urban sound propagation, this paper then examines the validity and simplification in noise-mapping, through a series of calculations with one commonly used piece of noise-mapping software. First, for an idealised urban square, a comparison is made between the noise-mapping software and a program based on the image source method, which is regarded as an accurate model. In the near field the results are similar, but with the increase of source-receiver distance, the noise-mapping software underestimates the sound pressure level (SPL), by 4-8dB. Second, various ways of simplifying pitched roofs and building gaps are examined, which are of great importance in the UK urban areas. It is shown that a pitched roof can be viewed as a flat roof with a suitable height between the eaves and ridge, with an inaccuracy of less than 2dB but a reduction in calculation time of about 70%. The effects of building gaps are significant, and the SPL behind buildings increases proportionally with the building gap width. Third, effects of various calculation parameters are examined. When the refection order is increased from about 4, the change in SPL is negligible but the increase in calculation time is dramatic. Overall, the study again suggests that noise-mapping software/techniques can/should be used for large areas considering general pictures, whereas for individual receivers, the accuracy would be rather low. This is further confirmed by a study of an area of 700m by 400m in Sheffield city centre, with a comparison between calculation and measurement.

13:20-13:40

1540 _____ *invited*

ACOUSTICS AND SUSTAINABILITY IN THE BUILT ENVIRONMENT: AN OVERVIEW AND CASE STUDIES

Chia-Jen Yu*, Jian Kang

* *School of Architecture, University of Sheffield, Sheffield, UK*

Sustainable development has been an important issue in recent decades. The aim of this study is to explore the interrelationships between creating a comfortable acoustic environment and general sustainable development. This paper starts with a systematic discussion of various aspects of acoustics which may affect the sustainability of the built environment: (1) high density urban population and buildings may increase community noise disturbance so that optimal designs for both aspects are essential, including planning strategies as well as self-noise-protection buildings. (2) Some natural means could be used for environmental noise control. For example, in addition to general aesthetic and environmental benefits, vegetation can reduce noise in an urban context due to the effects of multiple reflections. (3) Building envelops can be strategically designed, for example, using window systems which reduce noise but allow natural ventilation and daylighting. It is also important to compare various window and ventilator systems, including single and double glazing, in terms of the acoustic and sustainability benefits. (4) A range of acoustic materials, including sound absorbers, insulators, diffusers and noise barriers, could have similar acoustic performances but significantly different sustainability performances. (5) Some sustainable measures, such as wind farms, may be noisy so that the useable land is reduced and the overall sustainability is negatively affected. (6) More fundamentally, an indoor or outdoor space is more sustainable with a good sound quality. The second part of this paper presents case studies regarding the noise impact of wind turbines on typical residential areas, using a noise-mapping software package. The effects of land form, building type, building arrangement and source height are examined, as well as the effects of some calculation parameters.

13:40-14:00

1667 _____ *invited*

NOISE IMPACT MODELLING OF A ROUNDABOUT

Judicael Picaut*, Michel Bérengier, Eléonore Rousseau

* *LCPC Nantes, Bouguenais Cedex, France*

Whatever for traffic management or for safety reasons, many traffic flowing equipments have been realized in urban areas, like roundabouts, limited speed areas, zig-zag... In many cases, some people have considered that such equipments may produce a noise abatement, while others have observed an increase of noise due to modifications of traffic flow characteristics. In order to evaluate the noise impact of such equipments, a recent study was launched. As a first example, we propose to study roundabouts by coupling an acoustic modelling of passenger cars with a typical kinematics signature and trajectory of the car around the roundabout. The acoustics emission is based on an equivalent source modelling, including acceleration and deceleration phases, while the traffic flow conditions are measured on real roundabouts. Comparisons with measurements for two roundabouts are proposed and show a very good agreement. Moreover, we also show that this simple modelling can be used to estimate the noise impact of a roundabout, in comparison with a straight road.

14:00-14:20

1556 _____ *contributed*

GIPSYNOISE: A GIS TOOL ADAPTED TO THE EUROPEAN DIRECTIVE ON ASSESSMENT AND MANAGEMENT OF ENVIRONMENTAL NOISE 2002/49/CE – DEMONSTRATIVE TOOL

Stéphane Bloquet*, Laurent Faiget, Christine Aujard, Julie Vallet, Poulicos Prastacos, Bruno Vincent, Patricia Champelovier

* *01dB-Metravib, Limonest Cedex, France*

As a European LIFE Environment project, GIpSyNOISE aims at developing an operational decision support tool: · Compliant with European Directive 2002/49/CE of 25/06/2002 relative to the assessment and management of environmental noise in collaboration with European local authorities, · Including requirements of city decision makers/managers, in charge of defining action plans aiming at improving the quality of life and public information, · Simple and user-friendly (designed for operators who are not experts in acoustics/computer science), based on a Geographic Information System (GIS). GIpSyNOISE functions rely on the calculation of actual acoustic situations from European-wide indicators / models and on their representation as noise maps by type of noise source (road, railway, industry, aircraft). Various simulations of noise source changes, in particular for road noise, can then be achieved. Two acoustic situations are compared to generate a conflict map. Automatic crossing of noise/population data is used to work out the map of exposed population. Statistical data are estimated with respect to area, building and population exposure for the entire city. Eventually, action plans can be validated by local decision makers and maps can be communicated to the public. As of now, this tool is being tested by all local authorities-partners in this project (15 European cities and experts) on a pilot site located in Greater Lyon (France) and also by a small sample of citizens.

14:20-14:40

2080 _____ *contributed*

NOISE AND TOWN-PLANNING. THE CASE OF MADRID REGION

Miguel Ángel González García

Infraestruturas, coop. y medio ambiente SA, Madrid, Spain

Evolution of law, town-planning proceedings and the parallel environmental proceedings is analysed (case of Madrid Region). The last includes evaluation of acoustics effects of town-planning on the population. A methodology developed for considering noise in town-planning, which allow Urban Design to reduce acoustics effects is described, based in the following steps: - Prediction of sound levels in mid-time horizon (without urban growths), and description of the restriction these sound levels mean for urban planning (possible uses of the soils according the levels) - Integration of acoustics criteria in the planning of the city (uses, typologies) - Analyse of: o The uses of the soils assigned to different places, and the degree of tolerance to noise (sensitivity) of each one o The origin of new causes of noise in the actual urban model and the forecasts (noise levels), meanings and consequences related. This analyse allow to identify acoustics problems in the future, studying the measures needed. The process ends with dividing into zones the acoustic sensitivity of the territory, permitting to plan different limits of emission. The document present a resumed list of the measures which are usually used for minimizing noise problems, in the Urban design and in existing cities.

14:40-15:00

1634 _____ *contributed*

EVOLUTION OF THE ACOUSTIC CONTAMINATION IN THE CITY OF LEON (SPAIN)

Jesús Cepeda *, Eduardo García, Marcos Fuentes, Berta Melcón, Mercedes de Barrios, David Fernández, Gabriel Búrdalo

* *University of León, León, Spain*

From year 1996, the Group of acoustics of the Physics Department of the University of Leon has made two projects of investigation to determine the space and

temporary evolution of the acoustic contamination in a Spanish middle town: the city of Leon. In this paper we analyzed the results obtained in the study of the acoustic contamination present in the city of Leon in the nocturnal period. The studies were made on a network of 468 grids superposed on the urban plane. all the measures were done in situ, with the goal to obtain the maximum reliability in the most of the representative acoustic levels. To the light of the data we have reflected the zonal distributions based on the urban districts, on the one hand, and in the intervals of sonorous levels, on the other hand. At the same time we have come to make a comparative analysis of the evolution of the acoustic contamination in nocturnal period throughout these years.

15:00-15:20

1399 _____ *contributed*

DEVELOPMENT OF MANAGEMENT SYSTEM FOR MEASUREMENT AND CHARACTERISTIC ANALYSIS, EVALUATION OF ENVIRONMENTAL NOISE BY USING INTERNET NETWORK

Sang Kwon Lee*, Dong-Joon Yu

**INHA UNIVERSITY, Inchon, South Korea*

In these days, the people living in the urban is suffer from the environmental noise because the number of car increase in the city, and a lot of new industrial complex is made in the urban every. But there is no suitable system for measurement and management of environmental noise. Therefore, in this research, a new system for the measurement, characteristic analysis and evaluation, management of environmental noise using Internet communication is developed. The system includes the environmental noise measurement equipment and the controller for the noise measurement, analysis and evaluation, management.

15:20-15:40

1768 _____ *contributed*

ATTENUATION OF ENVIRONMENTAL NOISE: COMPARING THE PREDICTIONS OF ISO 9613-2 AND THEORETICAL MODELS

Gilles Daigle*, Michael Stinson

**National Research Council Canada, Ottawa, Canada*

In recent years, ISO 9613 Part 2 has been in widespread use for calculating the attenuation of sound during propagation outdoors in order to predict the levels of environmental noise at a distance from a variety of sources. The Standard specifies an engineering method to predict sound pressure levels under meteorological conditions favorable to propagation from sources of known sound emission. These conditions are for propagation downwind or propagation under a well-developed moderate ground-based temperature inversion. Three categories of reflecting surface are specified: (1) hard ground - paving, water, ice, concrete and all other ground surfaces having a low porosity, (2) soft ground - ground covered by grass, trees or other vegetation, and all other ground surface suitable for the growth of vegetation, and (3) mixed ground. The Standard specifies that inversion condition over water surfaces are not covered and may result in higher sound pressure levels than predicted. However, the case of snow-covered ground is not implicitly discussed in the Standard. This paper will compare the predictions of ISO 9613-2 with predictions from theoretical models (such as the PE, FFP, etc) for a number of selected cases. In particular, the attenuation is calculated for a number of differing snow covered grounds. Contrary to ISO 9613-2, the theoretical models allow a precise description of the reflecting surface as well as specifying the details of the wind and temperature profiles.

Session CH: Community Noise Around Airports: Human Aspects

chairs:

Michel Vallet - *France*

Ichiro Yamada - *Japan*

16:00-17:20 **Room:** Rio 2

16:00-16:20

1506 _____ *contributed*

COMMUNITY NOISE AROUND LYON SAINT-EXUPERY AIRPORT: MONITORING AND CONTROL 2000 -2004

Michel Vallet*, Jean-Claude Bruyere, Lionel Lassagne, N'dogbia Yombo

* *AEDIFICE-ODESA, Lyon, France*

Lyon-Saint Exupéry airport is a typical euro-regional airport : 120 000 flights in 2004, 6M passengers, 5200 employees on the site. To comply with the French law (1999) a permanent noise monitoring network was installed in 2000, including a microphone station in 6 points around the airport, a mobile van for measurement at other places, and a registration of trajectories. Noise levels are prepared by software as a routine to provide noise levels in Lden and complementary extraction of noise signature by manual-visual analysis, in order to calculate noise Lmax 1sec, per site and per period. Data are published in a quarterly bulletin An mediator is in charge of informing local residents about flight procedures, noise levels, and answering their complaints. The number of complaints has regularly decreased between 2000 and 2004. A scientific council has been created to analyse in depth the huge amount of data, as to provide better conclusion about changes in noise levels, especially at night. This council , named ODESA (Observatoire De l'Environnement Sonore de l'Aéroport Lyon-Saint Exupéry) is independent from the airport, and its administrative board comprises representatives from local residents associations, local and regional authorities . The latter will be invited to help finance the studies decided by the scientific council , and to be carried out under its control.

16:20-16:40

1760 _____ *contributed*

RECENT ISSUES REGARDING AIRPORT NOISE AND STRUGGLING FOR QUIETER AIRPORT ENVIRONMENT IN JAPAN

Ichiro Yamada

AIRPORT ENVIRONMENT IMPROVEMENT FOUNDATION, Ohta-ku, Japan

This paper makes a brief survey of the present noise-related issues as well as efforts towards quieter living environment around airports in Japan. First, it reviews recent airport development and extension at several major international airports including Central Japan, Narita and Tokyo. Next, it reviews recent keen issues related to noise around major airports. It is now needed to cope with issues such as revision of the basic guideline Environment Quality Standard for Airport Noise, evaluation of noise impact due to low level and seasonally uneven noise exposure in areas distant from the airport and so on. When the second interim parallel runway opened at Narita three years ago, noise measurement was carried out to check deterioration in noise situation, but it unexpectedly resulted in a slight decrease of noise exposure at some locations in spite of an increase in aircraft movements. It is now discussed whether the Japanese definition of noise evaluation index WECPNL should be modified as a temporary action to solve the subtle contradiction. Finally, it refers to a strategy we should consider for further mitigation of noise impact.

16:40-17:00

1703 _____ *contributed*

EVALUATION OF AIRCRAFT NOISE PERCEPTION IN SCHOOLS: STUDY IN ZONA I OF PZER OF SALGADO FILHO INTERNATIONAL AIRPORT

Maria Fernanda Nunes*, Miguel Aloysio Sattler

* *Universidade de Caxias do Sul, Caxias do Sul, Brazil*

This paper aims at evaluating aircraft noise in the vicinity of Salgado Filho International Airport, in Porto Alegre, with research done in two schools inside Zona I of Plano Específico de Zoneamento de Ruído - PEZR. It also presents a brief review of studies in order to provide overall understanding about aircraft noise. According to the World Health Organization, children are considered the most vulnerable group regarding the effects of noise. In addition, scientific evidence has proved that school life is harmed. However, school activities inside the most critical noise zones around airports, which are not allowed according to national and municipal legislation, take place in environments with constructive building features unsuitable to the exposure levels. This study aims at evaluating the perception and annoyance of aircraft noise in schools within Zona I of PZER of Salgado Filho International

Airport, based on quantitative and qualitative criteria, with acoustics measurement, surveys, interviews, and observation of behavior and use of school environment. The primary results show a lot of annoyance reported by students and teachers who live in noisy environments. Such results may also indicate possible vocal and auditory problems as a consequence of the need to raise one's voice. Another aspect which has been pointed out was problems in school performance because of the frequent interruption in the communication between teacher and students whenever planes flew over the place.

17:00-17:20

2034 _____ *contributed*

WHAT DO THE LOCATION OF NOISE COMPLAINANTS AND NOISE-CONTOURS TELL US ABOUT THE PATTERN AND LEVEL OF DISTURBANCE AROUND AIRPORTS?

Kenneth I. Hume ⋆, Helen Morley, Marcus Sutcliffe, Graham Smith, Callum Thomas

⋆ *CATE, MMU, Manchester, UK*

Over recent years it has become increasingly apparent that annoyance and complaint about aircraft noise is poorly predicted solely by averaged sound energy levels (Leq) used to create noise contours around airports. The physiological and psychological response to aircraft noise is primarily evoked by individual noise events, particularly aircraft noise which is 'out of the ordinary', not by some mathematical average over many hours. Many other non-auditory factors have been implicated to modify and/or moderate the response to aircraft noise eg. time-of-day, socioeconomic status, fear of crashes. A recent review advocates a new research direction, in which airport authorities make more use of geographical distributions of complaint origin, as an aid to better understand the environmental impact of airports on the local communities. Manchester Airport has a well organized complaint handling system which provides a continuous, free, rapid information/feedback on the general level of tolerance of the local residents around the Airport. At Manchester Airport we have recently studied the geographical distribution of complainants before and after the opening of a new runway. This analysis considered the geographical distribution of complainants in relation to: • Noise contour • Distance from the airport • Position in relation to flight corridors • Take-offs & landings • Wind direction • Patterns of population density • Socio-economic distributions Also, the recent opening of a new runway at Manchester provided the opportunity to explore any geographical shift in the 'mean position of complaint' to reflect the slight shift in the airports operations. Preliminary results indicate that the noise contours are a poor indicator of the pattern and level of complaint generated by the air traffic operations. A full report of these recent analyses will be provided.

Session CB: Costs and Benefits

chairs:

Jacques Lambert - *France*

William W. Lang - *USA*

16:00-17:40 **Room:** Lagoa

16:00-16:20

1832 _____ *invited*

APPLYING STATED PREFERENCE METHODS TO THE VALUATION OF THE ENVIRONMNETAL IMPACTS OF NOISE: LESSONS TO DATE

Mark Wardman⋆, Abigail Bristow, Elisabete Arsenio

⋆ *Institute for Transport Studies, University of Leeds, Leeds, UK*

Few studies have applied stated preference methods to the valuation of noise. This paper draws upon the experiences of three studies which have estimated willingness to pay for reductions in road traffic and aircraft noise. Such valuations can be used in the economic appraisal of infrastructure and operating decisions using social cost benefit analysis. The emphasis is upon methodological issues. In particular, this papers covers: the insights obtained by the three studies into the presentation of noise in a survey setting; whether marginal valuations depend on the size and sign of the change in noise levels and the noise level from which variations occur; the impact of socio-economic variables on valuations; and the comparison of the valuations obtained using stated preference methods with those derived using the contingent valuation method.

16:20-16:40

1687 _____ *invited*

VALUATION OF THE BENEFITS OF TRANSPORTATION NOISE REDUCTION

Jacques Lambert

INRETS, Bron, France

Reducing transportation noise leads to costs but also to benefits. By providing decision-makers with a monetary value to measure the benefits of reducing noise, the impact can be compared easily to reach a decision on the overall interest of noise action plans or policy. Monetary values are now often used in Europe, particularly in cost-benefit analysis of transport projects and, to a less extent, in carrying out cost-benefit analysis of noise reduction measures. A review of these values is presented for selected European countries. These values derived from scientific work using different valuation methods like hedonic pricing (house price depreciation) or contingent valuation (stated preferences), and

based both on analysis of people's willingness to pay as a means of valuing benefits from noise reduction. However these benefits only include perceived effects of noise reduction like decreases in noise annoyance and disturbed activities (conversation, listening, enjoyment of outside space,...), but probably neglect effects not easily perceived such as the impacts of noise on certain aspects of health. So a monetary value based on willingness to pay for the benefits which people perceive is not a complete measure of the benefits to society of noise reduction. As a result, research in valuing health costs of noise should be encouraged.

16:40-17:00

1805 _____ *invited*

VALUATION OF TRAFFIC NOISE - COMPARISON OF WTP FUNCTIONS AMONG DIFFERENT SOUND SOURCES-

Takanori Matsui ⋆, Makoto Morinaga, Soji Aono, Sonoko Kuwano

⋆ *Osaka University, Japan, Suita, Japan*

In this survey the economic value of noise reduction in LAeq of road traffic, railway, aircraft and Shinkansen noises was examined by Contingent Valuation Method using real sounds and a virtual residential environment. The results were that there was a positive correlation between WTP and noise reduction in LAeq, the estimated economic values of road traffic, railway, aircraft and Shinkansen noises were 2,159-3,468. 1,700-2,880, 2,219-3,564 and 2,184[Yen/dB/person/year], respectively, the estimated value of railway was smaller than those of other traffic noises, and Marginal Willingness To Pay could be regarded as constant for each 1dB reduction in the range used in this survey, i.e. between 35 dB and 65 dB.

17:00-17:20

1939 _____ *contributed*

VALUATIONS OF NOISE: THRESHOLD, NON-LINEAR AND INDEX EFFECTS

Mark Wardman⋆, Abigail Bristow

⋆ *Institute for Transport Studies, University of Leeds, Leeds, UK*

Surveys were conducted amongst residents around Manchester and Lyon Airports which aimed to value the annoyance associated with aircraft movements using stated preference techniques. The use of such methods to value aircraft annoyance is comparatively rare and the results presented here make a significant contribution to the body of empirical evidence. However, the main emphasis is the examination of a number of methodological issues. This has involved the examination of how the monetary valuations of aircraft movements vary according to the measured level of noise and whether thresholds and non-linearities in values are present. Models are also reported which test different noise measurement indices.

17:20-17:40

1833 _____ *contributed*

VALUING AIRCRAFT NOISE: INFLUENTIAL VARIABLES

Abigail Bristow⋆, Mark Wardman

⋆ *Loughborough University, Loughborough, UK*

This paper reports stated preference models valuing aircraft noise at Lyon and Manchester airports. It builds on the authors' earlier paper (Bristow and Wardman 2004) and offers the following key developments. Firstly, re-estimation of SP models based on changes in aircraft movements to changes in Leq to give a value for a unit change in Leq. Secondly the testing of a wide range of socio-economic and situational variables to identify any impact on values of noise. A small range of variables were found to modify noise values. The Manchester and Lyon models have a high degree of similarity in that the following variables are significant in both: probability of being at home; annoyance from aircraft noise; household size; income and whether they gave a zero response to the contingent valuation question. Fewer variables were unique to one model.

Author and Chair Index

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Personal Agenda and Contacts

Sunday 7 August 2005

Hour	Ref	Note	Room	see p.
08:00-17:00		Registration at Sofitel Foyer		
09:00-17:00		Course 1: Sound Quality	Lagoa	43
09:00-17:00		Course 2 (in Portuguese): Successful Prevention of Hearing Loss at Work, Leisure and Home; Sucesso na Prevenção de Perdas Auditivas no Trabalho, Lazer e em Casa	Arpoador	43
09:00-17:00		Course 3: Noise Control Materials	Botafogo	44
17:30-19:30		Opening Ceremony and Distinguished Lecture 1: Sustainable Development in an Urbanizing World.-The Noise Issue	Rio 1+2	45
19:30-21:30		Cocktails	Foyer	

Contacts

Name	Phone	Mail	Notes

Monday 8 August 2005

Hour	Ref	Note	Room	see p.
08:30-09:30	DL	Advancements in Hearing Protection: Technology, Applications and Challenges for Performance Testing and Product Labeling	Rio 1+2	49

Coffee Break

10:00-10:20				
10:20-10:40				
10:40-11:00				
11:00-11:20				
11:20-11:40				
11:40-12:00				

Lunch

13:00-14:00	DL	Health Effects of Noise Interactions at Work, Leisure and Home	Rio 1+2	80
14:00-14:20				
14:20-14:40				
14:40-15:00				
15:00-15:20				
15:20-15:40				

Coffee Break

16:00-16:20				
16:20-16:40				
16:40-17:00				
17:00-17:20				
17:20-17:40				
17:40-18:00				
18:00-18:20				
18:20-19:20				

Additional Appointments

Tuesday 9 August 2005

Hour	Ref	Note	Room	see p.
08:30-09:30	DL	Engineering Acoustics meets Annoyance Evaluation	Rio 1+2	125
		Coffee Break		
10:00-10:20				
10:20-10:40				
10:40-11:00				
11:00-11:20				
11:20-11:40				
11:40-12:00				
		Lunch		
13:00-14:00	DL	Predicting the Response Statistics of Uncertain Structures Using Extended Versions of SEA	Rio 1+2	146
14:00-14:20				
14:20-14:40				
14:40-15:00				
15:00-15:20				
15:20-15:40				
		Coffee Break		
16:00-16:20				
16:20-16:40				
16:40-17:00				
17:00-17:20				
17:20-17:40				
17:40-18:00				
18:00-18:20				
		18:30-19:00 h Buses from Sofitel to the Banquet at Porcão Rio Flamengo beach restaurant		
19:00-23:00		Banquet at Porcão Rio Flamengo beach restaurant		3
		Additional Appointments		

Wednesday 10 August 2005

Hour	Ref	Note	Room	see p.
08:30-09:30	DL	Porous Materials for Sound Absorption and Transmission Control	Rio 1+2	185

Coffee Break

10:00-10:20				
10:20-10:40				
10:40-11:00				
11:00-11:20				
11:20-11:40				
11:40-12:00				

Lunch

13:00-13:20				
13:20-13:40				
13:40-14:00				
14:00-14:20				
14:20-14:40				
14:40-15:00				
15:00-15:20				
15:20-15:40				

Coffee Break

16:00-16:20				
16:20-16:40				
16:40-17:00				
17:00-17:20				
17:20-17:40				
18:00		Closing Ceremony	Rio 1+2	

Additional Appointments

Notes

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