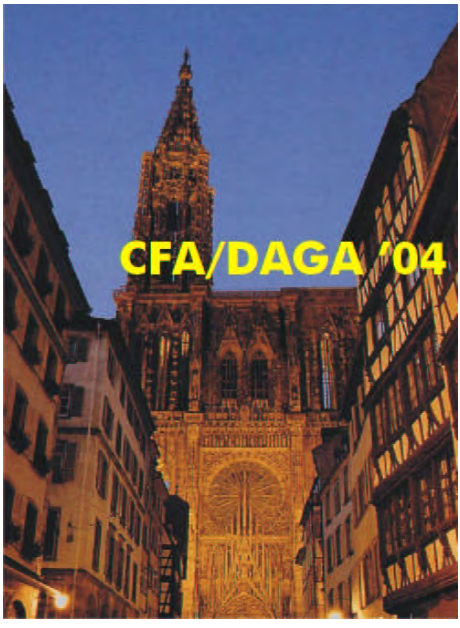

Programme
Programmheft

Congrès Joint / Gemeinschaftstagung

7ème Congrès Français d'Acoustique CFA
30. Deutsche Jahrestagung für Akustik DAGA

Strasbourg, France
Straßburg, Frankreich

22 – 25 mars 2004
22. bis 25. März 2004

7ème Congrès Français d'Acoustique CFA
30. Deutsche Jahrestagung für Akustik DAGA

with support by the Swiss Acoustical Society SFA–SGA
in co-operation with:

- ITG "Informationstechnische Gesellschaft im VDE" (Information Technology Section, ITG, within the German Association for Electrical, Electronic & Information Technologies, VDE),
- NALS "Normenausschuss Akustik, Lärmminderung und Schwingungestechnik" (German Standards Committee Acoustics, Noise Reduction and Vibration) of DIN and VDI
- DPG "Deutsche Physikalische Gesellschaft" (German Physical Society)

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Le mot de bienvenue des présidents du congrès

Chères collègues, chers collègues,
Après avoir vécu pendant 50 ans dans la construction de nombreuses actions et activités communes, c'est aujourd'hui vraiment une première que le rapprochement de nos deux communautés de l'acoustique française et allemande à l'occasion de ce congrès préparé, organisé et vécu ensemble, le CFA/DAGA'04. Les deux pays qui ont déjà réalisé dans le passé des congrès communs avec leurs voisins, souvent parlant la même langue, donnent ici un exemple de bons voisins « s'entendant » par-dessus les barrières linguistiques en organisant ensemble le congrès CFA/DAGA'04 qui est la réunion du « 7ème Congrès Français d'Acoustique (CFA) » et du « 30. Deutsche Jahrestagung für Akustik (DAGA) ».
Il fut évident, même obligatoire, qu'un tel événement dût avoir lieu dans la ville qui représente comme aucune autre nos valeurs communes et ce qui nous lie, les Allemands et les Français, et c'est bien sûr Strasbourg, même si l'on doit y abandonner quelques habitudes, comme par exemple les frais de congrès traditionnellement très bas en Allemagne. Seule la ville de Strasbourg avec son histoire commune franco-allemande et aujourd'hui son rang de métropole européenne peut conférer à ce congrès l'attrait qu'il mérite.
Il était également naturel d'intégrer la Suisse pour contribuer à cette réunion franco-allemande, puisque c'est un pays où les deux langues allemande et française se côtoient dans les discours sur l'acoustique.
D'ores et déjà, lors de l'achèvement de ce livret des résumés, le but est atteint : 697 résumés, dont 384 de l'Allemagne et 197 de la France, 28 de la Suisse, 70 venant de 13 autres pays de l'Europe de l'Est et de l'Ouest ainsi que 18 conférences de 7 pays non-européens. Ces chiffres montrent qu'on a dépassé la somme des résumés habituels des deux congrès nationaux : une réunion dont l'attrait dépasse de beaucoup le cadre des acousticiens allemands et français qui nous invitent à les rencontrer. Le spectre professionnel couvert par le congrès est très large et reflète très bien la grande importance de l'acoustique d'aujourd'hui.
Qu'il s'agisse de la recherche plus fondamentale ou de l'innovation dans des domaines techniques, de la communication acoustique, comme par exemple la transmission du langage ou de la musique, de la conception optimale de salles de conférences, de l'amélioration de la qualité acoustique de notre environnement ou bien qu'il s'agisse de produits construits et utilisés pour nos besoins, dont les propriétés acoustiques sont perçues

de plus en plus consciemment, et qui seront conçus conformément à ces perceptions : l'acoustique, discipline physique classique, s'est encore développée ces dernières années pour devenir encore plus un sujet interdisciplinaire et novateur fondamental dans beaucoup de domaines d'applications physiques et techniques. Les nombreuses conférences du CFA/DAGA'04 font aussi preuve de ce développement.

Vu le grand nombre de conférences, nous avons dû faire des sacrifices, comme par exemple les pré-colloques traditionnels au lieu desquels le congrès lui-même se tiendra lundi après-midi. De même une autre habitude importante – l'utilisation de la langue nationale, ou l'allemand ou le français – sera abandonnée en faveur de l'anglais qui est plus courant pour la plupart des auditeurs. Cependant nous sommes convaincus que de tels sacrifices sont vraiment justifiés par l'union des traditions de congrès allemandes et françaises car cette union représente une plateforme idéale pour connaître mieux l'acoustique, les acousticiens et leur travail dans les pays germanophones et francophones.

Profitez de cette occasion, laissez-vous séduire par un congrès qui met en scène un échange de pensées et d'informations entre les acousticiens parlant allemand et français, laissez vos oreilles entendre – tout en respectant la différence linguistique – la langue que nous avons tous en commun, à savoir l'acoustique, permettez qu'elle devienne notre langue maternelle commune pour trois journées et demi.

Dans ce but, l'équipe responsable de l'organisation et du programme a essayé de travailler de manière optimale en collaboration étroite avec les sociétés nationales, la Société Française d'Acoustique, SFA, et la société allemande, la Deutsche Gesellschaft für Akustik, DEGA. Cette tâche n'a pas toujours été facile à cause des distances qui séparaient les membres de l'équipe d'organisation. Pourtant, ce travail a été possible non seulement grâce aux moyens de communication électroniques modernes mais aussi, dans la même mesure au moins, grâce au grand engagement de tous ceux qui ont participé aux différentes étapes de cette organisation.

Nous aimerions d'ores et déjà exprimer à toute cette équipe nos remerciements les plus cordiaux. Ensemble avec cette équipe organisatrice, nous souhaitons à tous et surtout à vous, visiteurs du CFA/DAGA'04, que ce congrès s'avère satisfaisant et stimulant et qu'il offre à tous les participants un séjour agréable, rempli de connaissances et d'informations dans cette merveilleuse ville influencée par la France et l'Allemagne : la ville de Strasbourg.

Pour le comité d'organisation français/allemand :

Jacques Châtillon	Joachim Scheuren
Président du congrès	Président du congrès

Grußwort der Tagungsleiter

Liebe Kolleginnen und Kollegen,
es ist ein echtes Novum, dass Franzosen und Deutsche, die in den letzten 50 Jahren aus ihrer räumlichen und historischen Nähe zahllose gemeinsame Aktionen und Aktivitäten abgeleitet haben, nun auch „akustisch" zueinander finden: in einer gemeinsam vorbereiteten, veranstalteten und erlebten Tagung, der CFA/DAGA'04. Nachdem beide Länder in der Vergangenheit schon gemeinsame Tagungen mit ihren überwiegend gleichsprachigen Nachbarn veranstaltet haben, setzen sie nun mit dem als CFA/DAGA'04 gemeinschaftlich veranstalteten „7ème Congrès Français d'Acoustique (CFA)" und der „30. Deutschen Jahrestagung für Akustik (DAGA)" über die Sprachbarriere hinweg ein Zeichen für eine gute „akustische" Nachbarschaft.
Es war naheliegend, ja zwingend, ein solches Ereignis in der Stadt, die wie keine andere für das Gemeinsame und Verbindende von Deutschen und Franzosen steht, stattfinden zu lassen: in Straßburg im Herzen des Elsass. Auch wenn dadurch einige Gewohnheiten einschließlich der in Deutschland traditionell sehr niedrigen Tagungsgebühr aufgegeben werden mussten: Nur Straßburg mit seiner wechselvoll bewegten Vergangenheit im deutsch/französischen Grenzgebiet verleiht dieser Tagung den ihr zukommenden Reiz, nur Straßburg hat diese Tagung verdient.
Naheliegend war es auch, die Schweiz, in der Deutsch und Französisch auch in der Akustik eine bedeutende Rolle spielen, unterstützend in eine deutsch/französische Tagung zu integrieren.
Schon jetzt, bei Fertigstellung dieses Programmhefts, kann das Ergebnis sich sehen lassen: 697 Vorträge, davon 384 aus Deutschland und 197 aus Frankreich, 28 aus der Schweiz, 70 aus 13 weiteren ost- und westeuropäischen Ländern sowie 18 Vorträge aus 7 nichteuropäischen Übersee-Ländern zeigen, dass mehr als die Summe zweier nationaler Tagungen erreicht wurde: ein Treffen, dessen Anziehungskraft weit über die einladenden deutschen und französischen Akustiker hinaus wirksam ist. Das dabei eröffnete fachliche Spektrum ist riesig und bildet die große Breite der heutigen Akustik trefflich ab.
Denn ganz gleich ob bei der Erforschung neuer akustischer Effekte in Physik, Technik und Biologie, bei der akustischen Kommunikation, etwa der adäquaten Übermittlung von Sprache oder Musik, bei der optimalen Gestaltung von Hörräumen, bei der Verbesserung der durch wachsenden Lärm gefährdeten akustischen Qualität unserer Umwelt oder bei den immer bewusster registrierten und deshalb auch gestalteten akustischen Eigenschaften der von uns erstellten und benutzten Produkte: die klassische physikalische Disziplin Akustik hat sich gerade in den letzten Jahren zu einer wichtigen interdisziplinären und innovativen Disziplin in vielen physikalischen und technischen Anwendungsbereichen

entwickeln können. Auch davon zeugen die zahlreichen Vorträge der CFA/DAGA'04.
Der Vortragsfülle mussten Opfer gebracht werden, etwa die traditionellen Vorkolloquien der DAGA, an deren Stelle nun die Tagung selbst den Montagnachmittag in Anspruch nimmt. Auch eine andere bedeutende Gewohnheit, die Verwendung der deutschen oder französischen Landessprache, wird in den meisten Fällen der einem größeren Hörerkreis zugänglichen englischen Sprache den Vortritt lassen. Wir sind aber überzeugt, dass solche Opfer sich durch die Verbindung deutscher und französischer Tagungstradition mehr als rechtfertigen. Denn diese bietet eine ideale, einzigartige Plattform, die Akustik, die Akustiker und deren Arbeit in den deutsch- und französischsprachigen Ländern näher kennen zu lernen.
Nutzen Sie diese Gelegenheit, lassen Sie sich ein auf diese Tagung, auf den mit ihr inszenierten Gedanken- und Informationsaustausch zwischen Deutsch und Französisch sprechenden Akustikern, lassen Sie sich – bei aller sprachlichen Verschiedenheit - von der uns allen gemeinsamen Sprache, der Akustik, anstecken, lassen Sie diese für dreieinhalbe Tage unsere gemeinsame Muttersprache werden.
Das Vorbereitungs- und Programmteam hat versucht, dafür in enger Absprache mit den tragenden akustischen Gesellschaften, der Société Française d'Acoustique, SFA, und der Deutschen Gesellschaft für Akustik, DEGA, die bestmöglichen Voraussetzungen zu schaffen. Wegen der weiträumigen Verstreutheit fast aller Beteiligten war dies nicht immer einfach. Dass es dennoch möglich war, liegt nicht nur an den modernen elektronischen Kommunikationsmitteln sondern mindestens in gleichem Maß an dem großen Engagement all derer, die diese Mittel für die notwendige und mitunter mühsame Kommunikation und Abstimmung zu nutzen wussten.
Ihnen allen möchten wir schon hier unseren herzlichen Dank aussprechen. Und mit ihnen gemeinsam wünschen wir uns und Ihnen, den Besuchern der CFA/DAGA'04, dass diese Tagung einen guten und anregenden Verlauf nimmt und allen Teilnehmern eine angenehme, erkenntnis- und informationsreiche Zeit in der wunderbaren, französisch/deutsch geprägten Stadt Straßburg beschert.

Für das deutsch/französische Vorbereitungskomitee:

Joachim Scheuren	Jacques Châtillon
Tagungsleiter	Tagungsleiter

Welcome address of the conference chairs

Dear colleagues,
It's a real novelty that French and Germans, whose proximity and historical vicinity have brought them an endless number of common actions and activities within the last 50 years, now also meet "acoustically": at a jointly prepared, organised and experienced congress, the CFA/DAGA'04. Since both countries in the past already organised congresses with those neighbours, who mainly speak the same language, they now point the way to the future for a good "acoustical" neighbourhood ignoring the language barrier by jointly running the "7ème Congrès Français d'Acoustique (CFA)" and the „30. Deutsche Jahrestagung für Akustik (DAGA)" together as CFA/DAGA'04.
It was obvious and even compelling that such an event takes place in a city, which like no other city represents the association and connection of Germans and French: Strasbourg in the heart of Alsace. Although this meant that some habits had to be given up, including the traditionally very low congress fees in Germany, only Strasbourg with its eventful and exciting past at the French-German border area gives this congress its appropriate attraction, only Strasbourg deserves this congress.
It was obvious again that Switzerland, where German and French are important languages in acoustics too, also supports and participates in this joint French-German congress.
And now already, when finishing the program booklet, an impressive result can be stated: 697 presentations, thereof 384 from Germany and 197 from France, 28 from Switzerland, 70 presentations from 13 Eastern and Western European countries as well as 18 presentations from 7 Non-European overseas countries. This shows that more than just the sum of two national congresses has been achieved: a meeting, which is equally attractive for other nations beyond the inviting German and French acousticians. The technical spectrum emerging from this is enormous and outstandingly reflects the wide range of today's acoustics.
No matter whether we consider the investigation of new acoustic effects in physics, technology and biology, the acoustic communication like adequate transmission of speech or music, the optimal design of listening rooms, the improvement of the acoustical quality of our environment being threatened by growing noise or the more and more noticed and therefore designed acoustic properties of products manufactured and used by us: especially in recent years the classic physical field of acoustics has developed into an important interdisciplinary and innovative discipline in many physical and technical fields of application. Again this is proven and illustrated by the numerous presentations at CFA/DAGA'04.

Because of the great number of presentations sacrifices had to be made like the traditional colloquia of DAGA typically preceding the actual congress. They had to be replaced this time by the congress itself on Monday afternoon. And then, another significant habit, the use of the German or French national language, will give precedence to the English language in most cases as this will be understood by a greater audience. Nevertheless, we are convinced that such sacrifices are more than justified by linking German and French congress traditions. Such a congress offers an ideal, unique platform to mutually improve the acquaintance with acoustics, acousticians and their work in German and French-speaking countries.

Take this opportunity, get involved in this congress, in its exchange of thoughts and information between German- and French-speaking acousticians and - besides all differences in language - get infected by the language we all have in common, by acoustics, and let become this our native language for these three and a half days.

To enable this, the organising and program team tried to establish optimum conditions in close cooperation with the main acoustic societies, the Société Française d'Acoustique, SFA and the Deutsche Gesellschaft für Akustik, DEGA. As nearly all contributors were widely scattered, this was not always easy. But nevertheless it was possible, and this is not only due to the modern electronic means of communication but even more to the strong commitment of all those people who were able to use these means for the necessary and sometimes difficult communication and coordination.

At this point we would like to take the opportunity to thank them all. And, together with them, we would like to wish everyone, all visitors of the CFA/DAGA'04, that this congress runs well and stimulates all participants by a pleasant and informative time in the wonderful city of Strasbourg.

For the German-French organising committee:

Joachim Scheuren	Jacques Châtillon
conference chair	conference chair

Informations générales

CFA/DAGA'04
30. Deutsche Jahrestagung für Akustik
7ème Congrès Français d'Acoustique

Le 7ème Congrès de la Société Française d'Acoustique (CFA) est organisé conjointement avec le 30ème Congrès de la Société Allemande d'Acoustique (DAGA) du 22 au 25 mars 2004 à Strasbourg (France) au Palais des Congrès. Cet évènement a le soutien de la Société Suisse d'Acoustique.

Rendez-vous

Sa situation géographique centrale et son histoire agitée entre l'Allemagne et la France font de Strasbourg un centre européen et un symbole du voisinage et de la coopération entre nations. Strasbourg est l'une des rares villes au monde dont le centre a été déclaré héritage mondial.

Le palais des congrès est situé à environ 10 minutes à pied du centre historique. Les auditoriums très bien équipés, ainsi qu'un grand hall d'exposition, constituent les conditions idéales pour un congrès réussi pour toutes les personnes intéressées par l'acoustique, qu'elles viennent d'Allemagne, de France, de Suisse ou de tout autre pays d'Europe ou hors Europe.

Adresse :
Palais de la musique et du Congrès
Place de Bordeaux – Wacken –
F–67082 Strasbourg Cedex

De plus amples informations sont disponibles à l'adresse suivante :
http ://www.strasbourgmeeting.com

Organisation

Le congrès est organisé conjointement par les Sociétés Française et Allemande d'Acoustique, la SFA et la DEGA, avec le soutien de la Société Suisse d'Acousique, la SGA–SSA, en collaboration avec l'« ITG – Informationstechnische Gesellschaft im VDE »(section technologies d'information de l'association allemande pour les technologies électriques, électronique et d'information), le « NALS – Normenausschuss Akustik, Lärmminderung und Schwingungestechnik »(Comité de normalisation allemand pour l'acoustique, la luttre contre le brut et les vibrations) du DIN et du VDI et la « DPG – Deutsche Physikalische Gesellschaft »(Société Allemande de Physique).

Présidents du congrès et comité d'organisation

Présidents de la conférence

Jacques Châtillon et Joachim Scheuren.

Soutenus par :

Coordination du congrès
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Evelyne Dewayse Regina Condin, Christian Nocke

Salon européen d'acoustique
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Jean Louis Guyader Armin Kohlrausch
Jean Kergomard Wolfgang Kropp
Beat Hohmann (SGA-SSA)

Organisation locale
Guillaume Dutilleux, Catherine Serve Rainer Riedlinger

Coordination technique
Joachim Feldmann

Langues officielles
L'anglais sera la langue privilégiée pendant la conférence ; cependant les langues française et allemande sont également bienvenues.

Programme du congrés

Ce congrès franco-allemand CFA/DAGA'04 abordera tous les thèmes de l'acoustique : acoustique architecturale, acoustique industrielle, acoustique non-linéaire, acoustique physique, acoustique sous-marine, acousto-optique, aéroacoustique, audition, communication parlée, contrôle actif et passif, contrôle non-destructif, design sonore, diffusion, électroacoustique, environnement, hydroacoustique, imagerie, instrumentation, méthodes numériques, métrologie, propagation, thermoacoustique, traitement du signal.

Sessions plénières
Les conférences invitées sont orientées vers des sujets d'intérêt général :

– P. Avan, Faculté de Médecine, Clermont-Ferrand, France
"Auditory distortion : toward a non-invasive dissection of cochlear micromechanics"

– H.-E.Meier, DaimlerChrysler AG, Germany
"Vehicle acoustics : chances for application of research results"
– M. Rossi, Ecole Polytechnique Fédérale de Lausanne, Switzerland
"Engineering issues related to listening areas"
– M. Fink, ESPCI - LOA, Paris, France
"New perspectives on time reversal acoustics"

Sessions spécialisées
Les sessions suivantes sont composées de contributions invitées et ont été organisées par des experts dans leur domaine :
– Active control (A. Jakob)
– Applications of psychoacoustics (H. Fastl, E. Parizet)
– Assessment of noise exposure in the frame of the environmental noise directive (V. Irmer)
– Audiovisual interaction (C. Patsouras)
– Auralisation (M. Vorländer, C. Semidor)
– Benchmarking tests in automobile industry (K. Genuit)
– Car acoustics (1) (U. Widmann)
– Car acoustics (2) (H. E. Meier)
– Car acoustics perception (E. Parizet, M. Lewit)
– Car acoustics physical aspects (E. Parizet, M. Lewit)
– Cavitation (B. Dubus, W. Lauterborn)
– Change detection and repetition detection in hearing (L. Demany, C. Kaernbach)
– Combined noise evaluation (B. Schulte-Fortkamp)
– Concert hall acoustics (S. Weinzierl)
– Environmental noise and machinery noise
– Flow noise (W. Neise)
– Hydroacoustics (A. Homm)
– Integrated micromechanical Si microphones for array applications (G. Sessler,)
– Localization of normal hearing and hearing impaired persons (O. Warusfel, B. U. Seeber
– Low frequency vibrations
– Low noise traffic (B. Griefahn)
– Measuring methods in building acoustics (W. Scholl)
– Medical Acoustics (F. Padilla)
– Noise from leisure activities (B. W. Hohmann)
– Non linear acoustics (V. Gusev)
– Numerical methods in acoustics (O. von Estorff, J.-L. Guyader, M. Ochmann)
– Organ and room (J. Meyer)
– Outdoor sound localisation (B. U. Seeber, P. Naz)
– Outdoor sound propagation (D. Heimann, B. Gauvreau)
– Physical acoustics (1) (W. Lauterborn)

– Physical acoustics (2) (C. Aristegui)
– Picosecond acoustics – laser ultrasonics (A. Devos)
– Psychoacoustical methods in musical acoustics (Gunter Ziegenhals)
– Railway noise (B. W. Hohmann)
– Railway noise (2) (P.-E. Gautier)
– Rating methods in building acoustics (A. Schmitz)
– Recent advances in speech quality modeling (S. Moeller)
– Room acoustics : simulation, measuring techniques and auralisation (H. P. Tennhardt)
– Silencers (U. Kurze)
– Sleep, noise, and health (C. Maschke)
– Sonic boom (P. Blanc-Benon, D. Heimann)
– Soundscapes and community noise (B. Schulte-Fortkamp, C. Marquis-Favre, K. Genuit)
– Sound reinforcement and immission control (W. Ahnert)
– Speech and voice – analysis and synthesis (M. Kob, X. Pelorson)
– Speech in vehicles (H.-W. Gierlich)
– Temporal aspects in the perception of sound and speech quality (A. Raake, S. Meunier)
– Temporal envelope processing in hearing (C. Lorenzi, T. Dau)
– Thermo- and flowacoustics (M. Ochmann, R. Piscoya, P. Költzsch)
– Vibration from railway lines (R. Wettschureck)
– Wave field synthesis (G. Theile)
– Ultrasonics Transducers (G. Feuillard)
– Ultrasonic non destructive testing (A. Lhemery)
– Underwater acoustics (G. Maze)

Salon européen d'acoustique

Le congrès commun CFA/DAGA'04 aura lieu au Palais des Congrès de Strasbourg du 22 au 25 mars 2004. L'exposition réunit tous les fournisseurs importants de produits acoustiques, de services et d'information. L'exposition permettra aux entreprises, aux industries, aux sociétés de service, d'informer les visiteurs de leurs résultats les plus récents dans le domaine de la recherche, du développement, des équipements, leurs méthodes innovatrices, les solutions logicielles, matérielles, les standards, directives et publications.

Des salles de conférence bien équipées et un grand espace d'exposition offrent les conditions parfaites pour la réussite du congrès pour tous ceux qui s'intéressent à l'acoustique en Allemagne, en France et en Suisse ainsi que dans les autres pays européens ou non.

Assemblée générale des membres de la DEGA
Le jeudi 25 mars après-midi, se tiendra l'**assemblée générale 2004 de la DEGA**. Merci de bien vouloir prendre note de cette date si vous souhaitez y participer. La lettre d'invitation officielle et le planning seront publiés dans le prochain numéro de "Sprachrohr"de la DEGA.

Inscription au congrès
Il est vivement préférable de s'inscrire par l'intermédiaire site du Web de la conférence, accessible depuis la page d'accueil

http ://www.cfadaga04.org

Société Française d'Acoustique (SFA)
23 avenue Brunetière
75017 Paris
tél : +33 (0)1 48 88 90 59
fax :+33 (0)1 48 88 90 60
mél : sfa4@wanadoo.fr

Prix d'inscription

Groupe	Adhérent(1)	Etudiant	Retraité(2)	EURO En avance(3)	EURO En retard(4)
1(5)	non	non	non	330,-	360,-
2	non	non	non	320,-	350,-
3	non	non	oui	240,-	270,-
4	oui	non	non	250,-	280,-
5	oui	non	oui	125,-	155,-
6	non	oui	non	100,-	110,-
7	oui	oui	non	50,-	60,-

(1) : Adhérent de la DEGA, SFA, SGA, VDI, DPG, ITG, VdT
(2) : Les tarifs pour les "retraités"s'appliquent également aux personnes sans revenus
(3) : Inscription avant le 31 janvier 2004
(4) : Inscription tardive après le 1er février 2004
(5) : *Lot :* inscription et nouvelle adhésion à la SFA pour l'année 2004

L'**offre spéciale** (groupe 1) réservée aux non-membres de la SFA, inclut les frais d'inscription au congrès, ainsi que le droit

d'adhésion à la SFA pour l'année 2004. Cette offre est très attractive en raison de la faible différence par rapport aux frais d'inscription seuls. Au-delà de 2004, l'adhésion à la SFA sera automatiquement reconduite chaque année, sous réserve de paiement des droits d'adhésion standards. Si vous n'êtes pas intéressé par la poursuite de cette adhésion, un courrier devra être transmis au secrétariat de la SFA début décembre 2004.

Inscription - Exposition européenne d'acoustique :
Pour plus d'informations, veuillez contacter :

Cécile Rodet
01dB Acoustics & Vibration
200 chemin des ormeaux
F-69760 Limonest
Tel. :+33 (0) 472-5247 80
Fax : +33 (0) 472-5247 88

Diana Schreiber
HEAD acoustics GmbH
Postfach 3340
D-52120 Herzogenrath
Tel. : +49 (0) 2407-577 20
Fax : +49 (0) 2407-577 99

e-mail : **exhibition@cfadaga04.org**
http ://www.cfadaga04.org

Actes du congrès
Les manuscrits des contributions (présentations orales et posters) ne seront pas fournis à tous les participants sous forme papier, mais sous forme CD-ROM. Chaque participant inscrit recevra une copie de ce CD-ROM durant l'été 2004 automatiquement.
Une version papier des actes sera disponible pour un montant de 50 EURO, à condition que la commande soit transmise avant la fin du congrès. Au-delà, le montant de la version papier des actes sera de 75 EURO.

Instructions pour les présentations

Il est fortement recommandé que les présentations soient faites en anglais, afin d'accroître au maximum l'audience possible. Néanmoins, les présentations en allemand ou français sont acceptées. Toutes les figures doivent être organisés de façon claire (indépendemment de la langue utilisée).

Posters
Tous les posters seront présentés dans des sessions séparées, parallèlement aux sessions orales. Les auteurs des posters devront être présents au cours de leur session, afin de permettre des discussions avec les personnes intéressées. De même que pour les présentations orales, les sessions posters apparaîtront dans le programme du congrès, avec les résumés correspondants.
Les posters seront accrochés sur des panneaux pleins, de cotes utiles : hauteur : 2,39 m - largeur : 0,94 m. Ils se fixent sur leur

support par du ruban adhésif (non fourni) simple ou double face. Format recommandé pour les posters : A0.
Les emplacements des posters seront identifiés par le n° correspondant aux auteurs / le nom de l'auteur / le titre du poster, placés sur le panneau correspondant.

Présentation orale
Les présentations durent 15 minutes, suivies d'une discussion de 3 minutes. Une coupure de 2 minutes entre les présentations est prévue pour changer de salle.

Equipement audio-visuel
Dans chaque salle seront mis à la disposition des participants :
– un ordinateur portable avec Windows 98 ou version supérieure, Microsoft Power Point 2000, Adobe Acrobat Reader 6.0, OpenOffice 1.1., java run-time environment 1.4,
– un vidéoprojecteur,
– un rétroprojecteur.

La lecture des CD se fera à partir de l'ordinateur portable de la salle qui sera relié à la régie son. Il n'y aura pas de lecteur de CD audio disponible dans les salles.
Aucun projecteur de diapositives classiques, ni aucun système d'enregistrement / lecture sur bande magnétique (audio ou vidéo) ne seront fournis. Au besoin, apportez votre propre appareil et le câblage nécessaire. (Entrées son : XLR) Auquel cas il est absolument nécessaire d'en informer l'organisateur au préalable avant le 1er mars 2004 en indiquant le n° de la session (Mail to : presentation@cfadaga04.org).
Attention : les prises secteur ne sont pas identiques dans tous les pays européens.
Aucune demande d'intervention avec du matériel particulier (même s'il est fourni par le participant) pendant le congrès ne sera prise en compte.
Une salle de Preview avec 2 PC sera mise à disposition des congressistes pour contrôler leur présentation.

Recommandations
Il est très fortement conseillé de venir avec 1 CD Rom ou une disquette contenant la présentation. L'utilisation de USB sticks n'est pas garantie par l'organisateur. La présentation sera chargée sur l'ordinateur avant le début de chaque session.
Si la présentation est faite à partir d'un ordinateur portable, il est recommandé d'imprimer la présentation sur transparents afin de pouvoir faire face à des problèmes techniques.
Il sera possible d'utiliser son propre ordinateur à ses propres risques. L'ordinateur pourra être branché sur le vidéoprojecteur de la salle.

Les participants sont responsables de leur présentation.
Il ne sera pas accordé de temps supplémentaire aux intervenants dont les présentations ne sont pas opérationnelles.

Manuscrits
Le manuscrit final est limité à 2 pages maximum double colonnes, selon un format PDF. Le manuscrit devra être transmis soit avant le congrès, soit sur place pendant la conférence ; dans tous les cas, la date limite est fixée au 25 mars 2004. Des modèles de document aux formats Winword et LaTeX 2$_\varepsilon$ sont disponibles sur :
http ://www.cfadaga04.org/presentation_guide_f.html

Logement
Les participants au congrès sont invités à veiller à leur logement sur place. Vous pouvez contacter l'office de tourisme pour toute assistance dans la recherche d'un logement. De plus amples informations, ainsi que des possibilités de réservation en ligne, sont disponibles à l'adresse suivante :
Office du tourisme de Strasbourg
17 place de la Cathédrale
B.P. 70020
F–67082 Strasbourg cedex
Tel : +33(0)3 88 52 28 28
Fax : +33(0)3 88 52 28 29
http ://www.ot-strasbourg.fr/
ou par l'intermédiaire du palais des congrès : un formulaire des réservation hôtelière hotel.pdf peut être téléchargé sur
http ://www.cfadaga04.org/venue_f.html

Dates importantes pour CFA/DAGA'04
– *Février 2004 :*
  Programme prêt et disponible par Internet, envoi postal de la version papier
– *22 – 25 mars 22 2004 :*
  Congrès CFA/DAGA'04,
  Date limite de soumission des articles sur le site Web du congrès
– *Eté 2004* :
  Envoi des CD-ROM et des actes au format papier

Hinweise zur Tagung

CFA/DAGA'04
30. Deutsche Jahrestagung für Akustik
7ème Congrès Français d'Acoustique

Die 30. Deutsche Jahrestagung für Akustik findet zusammen mit dem 7. Congrès Français d'Acoustique als deutsch/französische Gemeinschaftstagung

vom 22. bis 25. März 2004

in Straßburg (Frankreich) im dortigen Kongresszentrum statt.

Tagungsort
Der Tagungsort ist das Kongresszentrum in Straßburg. Seine zentrale geographische Lage wie auch seine bewegte deutsch/französische Geschichte haben Straßburg zu einem Zentrum Europas und zum Symbol einer freundschaftlichen Nachbarschaft und Kooperation gemacht. Straßburg ist eine der wenigen Städte der Welt, deren vollständiges Zentrum zum Weltkulturerbe erklärt wurde.
Das Kongresszentrum ist in 10 Minuten vom historischen Zentrum zu erreichen. Dort bieten bestens ausgestattete Hörsäle sowie eine ausgedehnte Ausstellungsfläche ideale Voraussetzungen für eine erfolgreiche Begegnung aller an der Akustik Interessierten aus Deutschland, Frankreich und der Schweiz sowie aus anderen europäischen und außereuropäischen Ländern.
Adresse:
Kongresszentrum Straßburg
Place de Bordeaux – Wacken –
F–67082 Strasbourg Cedex
Weitere Information finden Sie unter
http://www.strasbourgmeeting.com

Veranstalter
Veranstalter der Tagung sind die akustischen Gesellschaften Deutschlands und Frankreichs, DEGA und SFA, mit Unterstützung der Schweizerischen Akustischen Gesellschaft SGA–SSA in Zusammenarbeit mit der Informationstechnischen Gesellschaft im VDE (ITG), dem Normenausschuss Akustik, Lärmminderung und Schwingungstechnik (NALS) im DIN und im VDI und der Deutschen Physikalischen Gesellschaft (DPG).

Tagungsleitung und Organisation

Die wissenschaftliche Tagungsleitung liegt bei

Jacques Châtillon und Joachim Scheuren.

Sie werden unterstützt von:

Tagungskoordination

Delphine Noël Alfred Schmitz

Registrierung und Sekretariat

Evelyne Dewayse Regina Condin, Christian Nocke

Europäische Akustik-Ausstellung

Claude Legros (Koordination)

Patrick Luquet, Cécile Rodet Klaus Genuit, Diana Schreiber

Finanzen

Jacques Châtillon Hugo Fastl

Publikation und Internet

Didier Cassereau Malte Kob

Programmausschuss

Armand Dancer (Leitung) Michael Möser
Henri Arbey Heinz-Martin Fischer
Jean Louis Guyader Armin Kohlrausch
Jean Kergomard Wolfgang Kropp
Beat Hohmann (SGA-SSA)

Lokale Unterstützung

Guillaume Dutilleux, Catherine Serve Rainer Riedlinger

Technische Koordination

Joachim Feldmann

Tagungssprachen

Tagungssprachen sind bevorzugt Englisch, aber auch Deutsch und Französisch.

Themen der Tagung

Themen der Tagung sind alle Gebiete der Akustik sowie alle Fachgebiete, die interdisziplinär mit der Akustik verbunden sind, in diesem Jahr insbesondere die folgenden: Audiologische Akustik, Aktive Schallbeeinflussung, Bauakustik, Bioakustik, Elektroakustik, Fahrzeugakustik, Hydro- und Geoakustik, Körperschall, Lärmausbreitung, Lärmschutz, Messtechnik, Musikalische Akustik, Numerische Akustik, Physikalische Akustik, Psychoakustik, Raumakustik, Signalverarbeitung, Sprachverarbeitung, Ultraschall

Plenarvorträge

Eingeladene Vortragende halten Übersichtsvorträge zu aktuellen Themen von allgemeinem Interesse:

- P. Avan, Faculté de Médecine, Clermont-Ferrand, France
  Äuditory distortion: toward a non-invasive dissection of cochlear micromechanics"
- H.-E.Meier, DaimlerChrysler AG, Germany
  "Vehicle acoustics: chances for application of research results"

- M. Rossi, Ecole Polytechnique Fédérale de Lausanne, Switzerland
  Ëngineering issues related to listening areas"
- M. Fink, ESPCI - LOA, Paris, France
  New perspectives on time reversal acoustics"

Strukturierte Sitzungen
Die Strukturierten Sitzungen wurden von fachkundigen Organisatoren aus eingeladenen Beiträgen zusammengesetzt.

- Active control (A. Jakob)
- Applications of psychoacoustics (H. Fastl, E. Parizet)
- Assessment of noise exposure in the frame of the environmental noise directive (V. Irmer)
- Audiovisual interaction (C. Patsouras)
- Auralisation (M. Vorländer, C. Semidor)
- Benchmarking tests in automobile industry (K. Genuit)
- Car acoustics (1) (U. Widmann)
- Car acoustics (2) (H. E. Meier)
- Car acoustics perception (E. Parizet, M. Lewit)
- Car acoustics physical aspects (E. Parizet, M. Lewit)
- Cavitation (B. Dubus, W. Lauterborn)
- Change detection and repetition detection in hearing (L. Demany, C. Kaernbach)
- Combined noise evaluation (B. Schulte-Fortkamp)
- Concert hall acoustics (S. Weinzierl)
- Environmental noise and machinery noise
- Flow noise (W. Neise)
- Hydroacoustics (A. Homm)
- Integrated micromechanical Si microphones for array applications (G. Sessler,)
- Localization of normal hearing and hearing impaired persons (O. Warusfel, B. U. Seeber
- Low frequency vibrations
- Low noise traffic (B. Griefahn)
- Measuring methods in building acoustics (W. Scholl)
- Medical Acoustics (F. Padilla)
- Noise from leisure activities (B. W. Hohmann)
- Non linear acoustics (V. Gusev)
- Numerical methods in acoustics (O. von Estorff, J.-L. Guyader, M. Ochmann)
- Organ and room (J. Meyer)
- Outdoor sound localisation (B. U. Seeber, P. Naz)
- Outdoor sound propagation (D. Heimann, B. Gauvreau)
- Physical acoustics (1) (W. Lauterborn)
- Physical acoustics (2) (C. Aristegui)
- Picosecond acoustics – laser ultrasonics (A. Devos)
- Psychoacoustical methods in musical acoustics (Gunter Ziegenhals)
- Railway noise (B. W. Hohmann)

- Railway noise (2) (P.-E. Gautier)
- Rating methods in building acoustics (A. Schmitz)
- Recent advances in speech quality modeling (S. Moeller)
- Room acoustics: simulation, measuring techniques and auralisation (H. P. Tennhardt)
- Silencers (U. Kurze)
- Sleep, noise, and health (C. Maschke)
- Sonic boom (P. Blanc-Benon, D. Heimann)
- Soundscapes and community noise (B. Schulte-Fortkamp, C. Marquis-Favre, K. Genuit)
- Sound reinforcement and immission control (W. Ahnert)
- Speech and voice – analysis and synthesis (M. Kob, X. Pelorson)
- Speech in vehicles (H.-W. Gierlich)
- Temporal aspects in the perception of sound and speech quality (A. Raake, S. Meunier)
- Temporal envelope processing in hearing (C. Lorenzi, T. Dau)
- Thermo- and flowacoustics (M. Ochmann, R. Piscoya, P. Költzsch)
- Vibration from railway lines (R. Wettschureck)
- Wave field synthesis (G. Theile)
- Ultrasonics Transducers (G. Feuillard)
- Ultrasonic non destructive testing (A. Lhemery)
- Underwater acoustics (G. Maze)

Europäische Akustik Ausstellung
Die Tagung wird von einer großen europäischen Akustik-Ausstellung begleitet, die alle wichtigen Anbieter akustischer Produkte, Dienstleistungen und Informationen vereint. In dieser Ausstellung informieren Firmen, Hersteller, Ingenieurdienstleister, aber auch Forschungs- und Verwaltungseinrichtungen, technisch-wissenschaftliche Vereinigungen und Verlage über neueste Ergebnisse in Forschung und Entwicklung, über Geräte, Verfahren und Softwarelösungen sowie Materialien und Werkstoffe, Normen, Richtlinien und Publikationen.
Die Ausstellung wird abgehalten in den breiten Gängen zwischen den Hörsälen des Konferenzzentrums. Mehr als 1000 Teilnehmer werden die Stände durchqueren, um die Räume zu erreichen.

Abschlussveranstaltung
Im Rahmen der Abschlussveranstaltung der CFA/DAGA'04 wird der Preis für das beste Poster verliehen. Anschliessend findet die DEGA-Mitgliederversammlung statt.

DEGA-Mitgliederversammlung
Am Donnerstagnachmittag, dem 25. März 2004 um 16:30 Uhr, wird die DEGA-Mitgliederversammlung stattfinden. Bitte merken

Sie sich den Termin vor. Die offizielle Einladung und die Tagesordnung gehen den Mitgliedern der DEGA mit dem nächsten Sprachrohr kurz vor der CFA/DAGA'04 zu.

Anmeldung zur Teilnahme

Die Anmeldung zur Teilnahme soll vorzugsweise per Internet unter

http://www.cfadaga04.org

erfolgen. Ein online Anmeldeformular steht auf der Web-Seite zur Verfügung. Für die schriftliche Anmeldung als Teilnehmer benutzen Sie bitte das Anmeldeformular (siehe Seite 487), das ebenfalls von der Webseite herunter geladen oder bei der DEGA-Geschäftsstelle angefordert werden kann.

DEGA Geschäftsstelle
Dr. Christian Nocke
c/o Universität Oldenburg
Physik - Akustik
D-26111 Oldenburg
Tel.: +49 (0) 441 798-3561
Fax: +49 (0)441 798-3698
e-mail: daga@cfadaga04.org
WEB: http://www.cfadaga04.org

Teilnahmegebühren

Die Teilnahmegebühren entnehmen Sie bitte der Tabelle auf Seite 36.

Das **Paketangebot** (Preisgruppe 1) für Nicht–DEGA– Mitglieder umfasst neben der Tagungsteilnahme die volle persönliche Mitgliedschaft in der DEGA inklusive des Mitgliedsbeitrags für 2004. Dieses Paketangebot ist auf Grund der geringen Differenz zur regulären Teilnahmegebühr sehr attraktiv. Nach Ablauf dem Jahr 2004 verlängert sich die Mitgliedschaft automatisch. Es gelten dann die regulären Mitgliedsbeiträge. Sollten Sie an einer weiterführenden Mitgliedschaft nicht interessiert sein, teilen Sie uns dieses bis spätestens vier Wochen vor Ablauf des Jahres schriftlich mit.

Anmeldung – Europäische Akustik Ausstellung

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Fax: +49 (0) 2407-577 99

e-mail: **exhibition@cfadaga04.org**
http://www.cfadaga04.org

Gruppe	Mitglieder[1]	studierend	Rentner[2]	EURO früh[3]	EURO spät[4]
1[5]	nein	nein	nein	330,-	360,-
2	nein	nein	nein	320,-	350,-
3	nein	nein	ja	240,-	270,-
4	ja	nein	nein	250,-	280,-
5	ja	nein	ja	125,-	155,-
6	nein	ja	nein	100,-	110,-
7	ja	ja	nein	50,-	60,-

[1]: Mitglied in DEGA, SFA, SGA–SSA, VDI, DPG, ITG, VdT

[2]: Die Teilnahmegebühren für Rentner"gelten auch für Erwerbslose.

[3]: Gebühr bis einschl. 31. Jan. 2004

[4]: Gebühr ab dem 1. Feb. 2004

[5]: *Paketangebot:* Tagungsteilnahme *plus* Neu-Mitgliedschaft in der DEGA im Jahr 2004

Tagungs-CD und Tagungsband

Die Manuskripte der Beiträge zur Tagung (Vorträge und Poster) werden standardmäßig nicht mehr als gedruckter Tagungsband, sondern als CD-ROM veröffentlicht. *Jeder* registrierte Tagungsteilnehmer erhält diese CD-ROM im Sommer 2004. Eine gedruckte Version des Tagungsbandes ist selbstverständlich weiter erhältlich, allerdings gegen eine Kostenbeteiligung von 50 EURO. Dieser Preis gilt als Subskriptionspreis bei Bestellung vor oder während der Tagung. Nachträgliche Bestellungen des Tagungsbandes sind möglich; der Preis beträgt dann 75 EURO.

Präsentationsformen der Beiträge

Um eine bestmögliche Verständlichkeit für einen größtmöglichen Interessentenkreis zu erreichen, wird empfohlen, die Beiträge in englischer Sprache abzufassen und vorzutragen. Dennoch bleiben auch Beiträge in französischer oder deutscher Sprache zugelassen.

Um für alle Sprachen eine Mindestverständlichkeit zu erreichen, sollen alle Abbildungen und Präsentationsfolien besonders übersichtlich und weitgehend selbsterklärend (von der Sprache unabhängig) gestaltet sowie in englischer Sprache beschriftet werden.

Poster

Alle Poster werden in eigenen Sitzungsperioden parallel zu den Vortragsperioden vorgestellt. Während dieser Sitzungen halten sich die jeweiligen Autoren am Präsentationsort zu Erklärungen und Diskussionen bereit.

Auch im Tagungsprogramm werden Postersitzungen gleichrangig zu den anderen Sitzungen mit einer Kurzfassung aufgeführt.
Für die Posterausstellung werden Stellwände bereitgestellt, an denen die Poster präsentiert werden. Für jedes Poster steht eine Fläche von max. 94 cm (Breite) x 239 cm (Höhe) zur Verfügung. Befestigungsmaterial wird zur Verfügung gestellt. Als Größe der Poster wird A0 empfohlen.

Mündlicher Vortrag
Die Vorträge haben eine Dauer von 15 Minuten. Es schließt sich eine 3-minütige Diskussionszeit an. Da die Konferenzräume alle untereinander gut erreichbar sind, ist eine Pause von nur 2 Minuten für den Raumwechsel ausreichend.

Audio. und Computerpräsentation
In jedem Vortragsraum ist standardmäßig die folgende Aussattung vorhanden

- a laptop mit Betriebssystem Windows 98 oder höher, Microsoft Power Point 2000, Adobe Acrobat Reader 6.0, OpenOffice 1.1 (java run-time environment 1.4 included),
- ein Video-Beamer,
- ein Overhead-Projektor.

CDs (or andere Sounds) werden auf dem Laptop im jeweiligen Raum über die installierte PA-Anlage abgespielt. CD-Spieler sind in den Vortragsräumen nicht vorhanden.
Ebenfalls nicht vorhanden sind 35 mm Diaprojektoren oder Kassetten- und Video-Rekorder.
Sofern benötigt, bringen Sie bitte Ihre eigene Ausstattung mit (XLR-Kabel). Für diesen Fall geben Sie den Organisatoren bitte bis zum 1. März 2004 unter der Angabe der Sitzung Bescheid (e-mail: presentation@cfadaga04.org). **Achtung: Andere Netzstecker in Frankreich.**
Anfragen zu speziellen Anforderungen an die Präsentationstechnik können nach Beginn der Tagung leider nicht mehr berücksichtigt werden, auch wenn der/die Vortragende ein eigenes Gerät mitbringt.
Ein Vorschau-Raum mit 2 PCs steht den Tagungsteilnehmern zum Ausprobieren der eigenen Präsentationen zur Verfügung.

Empfehlungen
Es wird empfohlen die eigenen Präsentation lauffertig auf CD-ROM oder Floppy-Disk (im Format .ppt oder Pack&Go – .pps oder pdf) mitzubringen. Somit können die Präsentationen vor Beginn der jweiligen Sitzungen auf den vorhandenen Laptop überspielt werden.
Die Verwendung von USB-Sticks wird seitens der Tagungsleitung nicht garantiert.
Nutzen Sie die Möglichkeit, Ihre Präsentation vorab auszuprobieren, falls etwas nicht klar erscheint. Sicherheitshalber sollten Sie

gegebenenfalls einen Ausdruck auf Overhead-Folien mitbringen, um eventuelle technische Probleme vermeiden zu können.
Eigene Laptops können in eigener Verantwortung verwendet werden. Prinzipiell ist das Anschliessen eigener Laptops in jedem Vortragsraum möglich.
Generell gilt, dass die Tagungsteilnehmer für die Präsentation selber verantwortlich sind. Bei Verzögerungen durch technische Probleme kann die Vortragsdauer aufgrund des engen Zeitrasters nicht nachgeholt werden.

Manuskripte
Das Manuskript soll eine Länge von zwei Seiten haben und als zweispaltiges pdf-Dokument abgefasst sein. Das Manuskript muss spätestens zur Tagung eingereicht werden (Abgabefrist: 25.03.2004). Eine Vorlage im Word- und LaTeX 2_ε-Format wird bereitgestellt unter:

http://www.cfadaga04.org/presentation_guide_d.html

Autoren ohne Zugang zum Internet wenden sich gerne an die DEGA-Geschäftsstelle, Adrresse siehe Seite 35

Unterkunft
Die Reservierung von Unterkünften bleibt den Tagungsteilnehmern selbst überlassen. Dabei steht es jedem frei, bei der Buchung einer geeigneten Unterkunft auf das örtliche Fremdenverkehrsbüro zurückzugreifen.
Weitere Informationen und online-Buchungsmöglichkeiten finden sich unter: Tourism Office of Strasbourg
17 place de la Cathédrale
B.P. 70020
F–67082 Strasbourg cedex
Tel : +33(0)3 88 52 28 28
Fax : +33(0)3 88 52 28 29
http://www.ot-strasbourg.fr/
oder über das Kongresszentrum: ein Formular zur Hotel-Reservierung hotel.pdf ist unter

http://www.cfadaga04.org/venue_d.html

erhältlich.

Wichtige Termine zur CFA/DAGA'04
- *Februar 2004:* Versand des Programms an die angemeldeten Teilnehmer, Programm im Internet
- *22. März – 25. März 2004:* CFA / DAGA'04-Tagung, Abgabe der druckfertigen Tagungsbeiträge in elektronischer Form als pdf-Datei (vorzugsweise vorab per Internet)
- *Sommer 2004:* Versand der CD-ROM sowie der zusätzlich georderten gedruckten Tagungsbände (kostenpflichtig)

General information

CFA/DAGA'04
30. Deutsche Jahrestagung für Akustik
7ème Congrès Français d'Acoustique

The 30th German Convention on Acoustics (DAGA) takes place together with the 7th Congrès Français d'Acoustique (CFA) as a joint French-German meeting 22.-25 March 2004 in Strasbourg (France).

Conference site
Its central geographic location as well as its turbulent german/french history made Strasbourg a European centre and a symbol of a friendly neighbourhood and cooperation. Strasbourg is one of the few towns of which the centre has been declared a world-heritage.
The congress centre is located 10 minutes walking distance from the historic centre. The well-equipped auditoria and the large exposition area provide ideal conditions for a successful meeting of all people interested in acoustics whether they come from Germany, France, Swiss or other European or Non-European countries.
Address:
Strasbourg Music and Conference Centre
Place de Bordeaux – Wacken –
F–67082 Strasbourg Cedex
Further information is available at:
http://www.strasbourgmeeting.com

Organisers
The congress is jointly organised by the acoustical societies of Germany and France, DEGA and SFA, with support by the Swiss Acoustical Society SGA–SSA in co-operation with the "Informationstechnische Gesellschaft im VDE"(Information Technology Section, ITG, within the German Association for Electrical, Electronic & Information Technologies, VDE), the NALS "Normenausschuss Akustik, Lärmminderung und Schwingungestechnik"(German Standards Committee Acoustics, Noise Reduction and Vibration) of DIN and VDI and the "Deutsche Physikalische Gesellschaft"(German Physical Society, DPG).

Scientific conference chair and organising committee

The congress is chaired by

Jacques Châtillon and Joachim Scheuren.

They are supported by:

Coordination of the congress
Delphine Noël Alfred Schmitz

Registration and secretariat
Evelyne Dewayse Regina Condin, Christian Nocke

European acoustics exhibition
Claude Legros (coordination)
Patrick Luquet, Cécile Rodet Klaus Genuit, Diana Schreiber

Finances
Jacques Châtillon Hugo Fastl

Publication and Internet
Didier Cassereau Malte Kob

Scientific committee
Armand Dancer (session organisers) Michael Möser
Henri Arbey Heinz-Martin Fischer
Jean Louis Guyader Armin Kohlrausch
Jean Kergomard Wolfgang Kropp
Beat Hohmann (SGA-SSA)

Local support
Guillaume Dutilleux, Catherine Serve Rainer Riedlinger

Technical coordination
Joachim Feldmann

Languages
English will be the preferred language of the congress but also German and French are welcome.

Topics of the Congress

Topics of the conference are all areas of acoustics, and all areas which are inter-disciplinarily related to acoustics, in particular the following: audiology, active noise control, building acoustics, bioacoustics, electroacoustics, vehicle acoustics, hydro- and geoacoustics, structure-borne sound, noise propagation, noise control, metrology, musical acoustics, numerical acoustics, physical acoustics, psychoacoustics, room acoustics, signal processing, speech processing and ultrasonics.

Plenary lectures
Invited lectures will focus on hot topics of general interest:

- P. Avan, Faculté de Médecine, Clermont-Ferrand, France
  "Auditory distortion: toward a non-invasive dissection of cochlear micromechanics"
- H.-E.Meier, DaimlerChrysler AG, Germany
  "Vehicle acoustics: chances for application of research results"

- M. Rossi, Ecole Polytechnique Fédérale de Lausanne, Switzerland
  "Engineering issues related to listening areas"
- M. Fink, ESPCI - LOA, Paris, France
  "New perspectives on time reversal acoustics"

Structured sessions

The following structured sessions are composed of invited contributions and have been organised by experts:

- Active control (A. Jakob)
- Applications of psychoacoustics (H. Fastl, E. Parizet)
- Assessment of noise exposure in the frame of the environmental noise directive (V. Irmer)
- Audiovisual interaction (C. Patsouras)
- Auralisation (M. Vorländer, C. Semidor)
- Benchmarking tests in automobile industry (K. Genuit)
- Car acoustics (1) (U. Widmann)
- Car acoustics (2) (H. E. Meier)
- Car acoustics perception (E. Parizet, M. Lewit)
- Car acoustics physical aspects (E. Parizet, M. Lewit)
- Cavitation (B. Dubus, W. Lauterborn)
- Change detection and repetition detection in hearing (L. Demany, C. Kaernbach)
- Combined noise evaluation (B. Schulte-Fortkamp)
- Concert hall acoustics (S. Weinzierl)
- Environmental noise and machinery noise
- Flow noise (W. Neise)
- Hydroacoustics (A. Homm)
- Integrated micromechanical Si microphones for array applications (G. Sessler,)
- Localization of normal hearing and hearing impaired persons (O. Warusfel, B. U. Seeber
- Low frequency vibrations
- Low noise traffic (B. Griefahn)
- Measuring methods in building acoustics (W. Scholl)
- Medical Acoustics (F. Padilla)
- Noise from leisure activities (B. W. Hohmann)
- Non linear acoustics (V. Gusev)
- Numerical methods in acoustics (O. von Estorff, J.-L. Guyader, M. Ochmann)
- Organ and room (J. Meyer)
- Outdoor sound localisation (B. U. Seeber, P. Naz)
- Outdoor sound propagation (D. Heimann, B. Gauvreau)
- Physical acoustics (1) (W. Lauterborn)
- Physical acoustics (2) (C. Aristegui)
- Picosecond acoustics – laser ultrasonics (A. Devos)

- Psychoacoustical methods in musical acoustics (Gunter Ziegenhals)
- Railway noise (B. W. Hohmann)
- Railway noise (2) (P.-E. Gautier)
- Rating methods in building acoustics (A. Schmitz)
- Recent advances in speech quality modeling (S. Moeller)
- Room acoustics: simulation, measuring techniques and auralisation (H. P. Tennhardt)
- Silencers (U. Kurze)
- Sleep, noise, and health (C. Maschke)
- Sonic boom (P. Blanc-Benon, D. Heimann)
- Soundscapes and community noise (B. Schulte-Fortkamp, C. Marquis-Favre, K. Genuit)
- Sound reinforcement and immission control (W. Ahnert)
- Speech and voice – analysis and synthesis (M. Kob, X. Pelorson)
- Speech in vehicles (H.-W. Gierlich)
- Temporal aspects in the perception of sound and speech quality (A. Raake, S. Meunier)
- Temporal envelope processing in hearing (C. Lorenzi, T. Dau)
- Thermo- and flowacoustics (M. Ochmann, R. Piscoya, P. Költzsch)
- Vibration from railway lines (R. Wettschureck)
- Wave field synthesis (G. Theile)
- Ultrasonics Transducers (G. Feuillard)
- Ultrasonic non destructive testing (A. Lhemery)
- Underwater acoustics (G. Maze)

European acoustics exhibition

Parallel to the congress a large European Acoustics exhibition will be held. The exhibition joins all important providers of acoustical products, services and information. At the exhibition companies, manufacturers, engineering services providers, but also research and administrative establishments, technical-scientific associations and publishers inform about the newest results in research and development concerning equipment, technologies and software solutions as well as materials, standards, regulations and publications.

Well equipped lecture rooms and a large exhibition space provides perfect conditions for a successful meeting for everybody interested in acoustics from Germany, France and Switzerland as well as from other European or non-European countries.

DEGA members general assembly

On Thursday afternoon, March 25, the **2004 general assembly of DEGA** will take place. Please note this date if you are interested in participating. The official invitation letter and the agenda will be published in the upcoming "Sprachrohr"newsletter of DEGA.

Conference registration
Preferably, registration should be done via the conference website, which can be reached from the congress homepage

http://www.cfadaga04.org

Alternatively, you can register via a hard copy of the registration form which is added to this brochure (see page 487) or can be found on the website.

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WEB: http://www.cfadaga04.org

Registration fees

group	members[1]	student	pensioner[2]	EURO early[3]	EURO late[4]
1[5]	no	no	no	330,-	360,-
2	no	no	no	320,-	350,-
3	no	no	yes	240,-	270,-
4	yes	no	no	250,-	280,-
5	yes	no	yes	125,-	155,-
6	no	yes	no	100,-	110,-
7	yes	yes	no	50,-	60,-

[1]: Member of DEGA, SFA, SGA–SSA, VDI, DPG, ITG, VdT

[2]: Membership fee "pensioner"is also applicable for unemployed.

[3]: Fee until Jan. 31, 2004

[4]: Fee after Feb. 1, 2004

[5]: *special package:* Participation at conference *plus* new membership of DEGA in 2004, membership stays with extra costs from 2005

The **special package** (group 1) for non-members of DEGA includes the conference fee and the full personal membership fee for 2004. This package is very attractive due to the small difference between the regular fee. After 2004 for the membership will automatically be continued. Then the usual membership fees as personal member of DEGA are due. If being not interested in this membership, a short notice has to be given to DEGA by the beginning of December 2004.

Registration – european acoustics exhibition

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e-mail: **exhibition@cfadaga04.org**
http://www.cfadaga04.org

Congress proceedings

The manuscripts of the contributions (oral and poster presentations) will generally not be published as as printed version but on CD-ROM. Every registered participant will obtain a copy of this CD-ROM during summer 2004 automatically. A printed version of the proceedings will be made available at a rate of 50 EURO- for orders received until the end of the conference. Later orders are possible at a rate of 75 EURO.

Guidelines for presentations

It is highly recommended that presentations be done in English in order to reach as much of the audience as possible. However presentations in German and French are allowed. All figures should be created in a self-explanatory layout, the legends should also be in English. Generally, strange fonts should be avoided.

Poster

All posters will be presented in separate sessions parallel to the oral presentation timetables. The authors of the respective posters will be present during their timetabled poster session and will be prepared for discussions and clarifications. The poster sessions are also printed with an abstract in the congress programme, just like the oral presentations.
Posters will be hooked on full boards with: height: 2,39 m - width: 0,94 m as useful dimensions. They can be fixed on their support with adhesive tape (not provided), simple or double-faced. Recommended size for posters: A0.

Oral Presentation

The presentations last 15 minutes followed by a 3 minutes discussion. A break of 2 minutes in between the presentations is timetabled to change between the rooms.

Audio and video equipment

In each room, following equipment will be available:

- a laptop with windows 98 or upper version, Microsoft Power Point 2000, Adobe Acrobat Reader 6.0, OpenOffice 1.1 (java run-time environment 1.4 included),
- a video projector (beamer),
- an overhead projector.

CDs (or sound) will be played from the room laptop, which will be linked to the room P.A. system. There won't be any CD player available in the session rooms.

No conventional 35 mm slides projector and no recorder/player tape system (audio or video) will be available.

If absolutely necessary, please bring your own device (cables included, sound : XLR) with you. In this case, it's important to inform the organiser before the 1st March 2004 with regard to your session. (mail to : presentation@cfadaga04.org)

Warning : mains sockets can be different within the EU.

Requests for presentation with particular devices during the congress will not be taken into account, even if the attendee brings his/her own device.

A preview room with 2 PC will be available for attendees to check their presentation.

Recommendations

It's highly recommended to come to the performance with a CDROM or a floppy disk containing the presentation (Format .ppt or alternative pack&go or .pdf). If this happens in time the presentation can be downloaded on the laptop before the beginning of each session. The use of USB sticks is not guaranteed by the organiser.

Use the possibility to check the presentation before if something seems to be not clear.

If the presentation is done with a laptop, it is recommended to print out the presentation on overhead transparency sheets in order to cope with potential technical problems.

It will be possible to use one's own laptop one's own risks. In principal it will be feasible to connect an external laptop to the video projector in each room, but the functioning of the presentation technique is guaranteed only by the existing laptop/beamer combination.

The attendees are responsible for their presentation. Presenters whose presentations fail for any reason will not be granted extra time.

Guidelines for preparation of manuscripts

The manuscripts shall have a length of two pages and shall be formatted as a two-column style pdf document. The manuscript

shall be submitted before or during the conference, latest March 25, 2004. A template in Winword or LaTeX 2ε format is available at:

http://www.cfadaga04.org/presentation_guide_e.html

Authors without access to the internet may contact the secreteriat of DEGA, address see page 35

Accomodation

For the reservation and booking of accommodation each participants has to organise for him- or herself.
Further information and online-booking facilities are available at
Tourism Office of Strasbourg
17 place de la Cathédrale
B.P. 70020
F–67082 Strasbourg cedex
Tel : +33(0)3 88 52 28 28
Fax : +33(0)3 88 52 28 29
http://www.ot-strasbourg.fr/
or through the Congress Centre: a hotel.pdf registration form is available at:

http://www.cfadaga04.org/venue_e.html

Important dates for CFA/DAGA'04

- *February 2004:*
  Programme ready and available via internet, printed version being sent
- *March 22 – March 25 2004:*
  CFA/DAGA'04 Congress ,
  Deadline for submission of papers via congress website
- *Sommer 2004:*
  Dispatching of CD-ROM and additionally printed proceedings

CFA/DAGA'04 Jam Session

Tuesday 23 March, from 19:00 hours Jam Session
All participants and guests of CFA/DAGA '04 are cordially invited to join the CFA/DAGA Jam Session during the welcome evening. This traditional DAGA event shall give opportunity to play Jazz standards with colleagues without rehearsing. If you are interested to participate please bring your instrument with you. You will find piano, drum set and PA installed.
Contact :

♭ Malte Kob (mkob@ukaachen.de),
♯ Joel Gilbert(Joel.Gilbert@univ-lemans.fr) ou
♮ Xavier Pelorson (pelorson@icp.inpg.fr)

Opening Ceremony

Mo. 13:30 Schweitzer Opening of CFA/DAGA'04

- Welcome adresses

Plenary lectures

Tu. 14:00 Schweitzer Plenary session 2

An overview of time-reversed acoustics

Mathias Fink
ESPCI - LOA

Time-reversal invariance is a very powerful concept in physics. In the field of acoustics, where time-reversal invariance also occurs, time-reversal experiments may be achieved simply with arrays of transmit-receive transducers, allowing an incident acoustic field to be sampled, recorded, time-reversed, and re-emitted. The time-reversal mirrors (TRMs) are innovative tools in the field of fundamental physics. They may be used to study random media, multiple scattering processes, chaotic scattering, inverse scattering problems, dissipation effects, and diffraction limits. They open the way to new signal processing. An overview of these fields will be presented. Applications of TRMs will also be described, including underwater acoustics, medical applications, telecommunications, as well as nondestructive testing.

We. 11:10 Schweitzer Plenary session 3

Vehicle Acoustics: Chances for Application of Research Results

Heinz-E. Meier
DaimlerChrysler AG

Vehicle acoustics is (almost) not organized as an autonomous branch of research. However, numerous principles and methods of acoustics have been developed by research people regarding vehicle acoustics as one possible field of application. Examples are Signal Analysis (analog and digital), Modal Analysis, Psychoacoustics, Statistical Energy Analysis (SEA), Active Noise Cancellation (ANC), Sound Intensity and many more. Some of these examples have become essential standard tools in vehicle acoustics, some exist on the fringes. The study of their history of application and conversion leads to evidence of success factors which (co-) determine the chances for the application of a scientific idea or development result. It is mandatory for acousticians as well as for automotive engineers to know these factors and to understand their different cultural view from the either partner's side.

We. 11:55 Schweitzer Plenary session 4

Engineering Issues Related to Listening Areas

Mario Rossi
Ecole Polytechnique Fédérale de Lausanne

Through numerous real-life implementations and beyond the expected responses to the various mandates, in terms of adequate solutions, the author has always strived to contribute to the state-of-the-art of acoustical engineering. It should be underlined that the problems posed were out of the ordinary and as such, constituted severe challenges, where the will of the project manager and users was to have multifunctional spaces at their disposal. The latter are designed to host a variety of events ranging from conferences, congresses, classical concerts, operas, drama, variety shows, jazz, pop music, exhibitions, worship, etc. The aim is to guarantee the best possible conditions for the hosting of events and not focus on their more or less successful coexistence. This implies defining and designing specific arrangements and layouts. In most cases, the listening area was already in existence, with both its qualities and faults, and it has to be adapted to new usages. Also, the architectural or environmental constraints are often such that the area does not satisfy the essential acoustic criteria as regards volume and shape. The only possible and fruitful approach liable to succeed in responding to this challenge, is an epistemological approach, where critical scientific thinking underlies rigorous experimental methods. This presentation will show that in acoustics, maybe more than in others fields, there should be no frontier between science and technique.

Th. 11:10 Schweitzer Plenary session 5

Auditory distortion: toward a non-invasive dissection of cochlear micromechanics

Paul Avan
Faculté de Médecine

The discovery of otoacoustic emissions (OAE) by Kemp has been the most groundbreaking step in auditory physiology since Békésy's. In the first place, the existence of OAEs underpinned Gold's 1948 statement that the cochlea must work as a regenerative looped system, with enhanced sensitivity and frequency selectivity as a result. It is now known that the outer hair cells (OHC) house the regenerative loop, although which substructure(s) exactly contribute is unclear. Secondly, OAEs provide evidence that in sharp contrast to most acoustic reproduction systems, the cochlea is essentially nonlinear. So, intermodulation distortion is generated and comes out as an OAE whenever the

cochlea is stimulated by pairs of pure, primary tones with neighboring frequencies. This property has been successfully used for probing OHCs and cochlear function around the place tuned to the primary stimuli, thereby disclosing strong correlations between intermodulation and audiometric performance. However, recent evidence qualifies these correlations by suggesting that, instead of amounting to a sort of "objective" audiometry, OAE distortion measurements probe lower levels of OHC function. They may exhibit tuning of their own, and their integrity is necessary but not sufficient for the OHC loop to be efficient. It may thus be possible to use OAE distortion for splitting the cochlear loop into consecutive steps and probing them separately.

Paper Sessions

Mo. 14:30 Schweitzer Car acoustics I

Automatic Optimization of Acoustic Trims

Volker Schulz, Heiko Andrä
Fraunhofer Institut für Techno- und Wirtschaftsmathematik

By its ongoing improvement the simulation of car acoustics reached the edge to be fully integrated at the design and prototyping stage. The acoustic properties of the materials therefore are becoming more and more important in the material selection process. This selection can be done efficiently by the aid of software tools based on mathematical optimization strategies. Here, we present a software tool which extends the standard SEA software (AutoSEA) in order to find the optimal material properties reaching a desired sound pressure level automatically. The tool also includes a database where measured and simulated material data can be stored. Our software tool has been developed for the optimization of a headliner consisting of PET fiber material. Additional measurements showed that the acoustic properties of the investigated material follow the standard model of Delany and Bazley. The developed optimization provides the flexibility in order to be used for the optimization of other parts of the interior and materials such as foams or layered structures.

Mo. 14:50 Schweitzer Car acoustics I

Sound Radiation of a Gear Box Using Acoustic Transfer Functions

Otto Von Estorff, Marian Markiewicz, Ralf May, Olgierd Zaleski
Novicos GmbH

Measurement techniques combined with numerical methods can be seen as an important step towards an acceleration of the development cycle of vehicles. In particular, by such combinations it

is possible to investigate the future performance of a system and to cor-rect weaknesses in a very early design stage. This paper presents an example for the integrated usage of measurements and simulation techniques in order to improve the sound radiation of a gear box. Although the focus is placed on the numerical procedure, the essential input gained by related measurements will be discussed as well. An advanced BEM formulation, rapid re-meshing tools and newly developed Acoustic Transfer Functions (ATF) are used to improve the acoustic behavior of the gear box. It will be shown that the ATFs provide a very efficient way to compute the sound radiation behavior of a vibrating system when several design alternatives need to be investigated. Moreover, the ATF concept will be employed to access directly those parts of the gear box which are responsible for certain maxima of the sound pressure level.

Mo. 15:10 Schweitzer Car acoustics I

Influence of hoses on the sound field of engine compartments

Tobias Kellert, Daniel Steinbacher
Institute of Technical Acoustics

During the development of new vehicles one cannot underestimate the value of simulations. The goal of the BTPA/BTPS (binaural transfer path analysis/synthesis) is the evaluation of constructive changes of the powertrain in early stages of development and their influence on the interior soundfield. For this purpose it would be desirable that all the acoustic and vibro-acoustic transfer paths from the source to the passenger's ears are known. To accomplish this task, the airborne sound radiation of vibrating panels in engine test benches can be measured, as well as simulated with the help of finite element models. The sound radiation of engines was already analysed in the literature, but some questions about the influence of the engine compartment still remain. For the exact simulation of sound fields, the correct description of the boundary conditions is of major importance. Although the characterisation of the behaviour of the surfaces is well known, the consideration of fluid-filled hoses is not fully understood. In this work, an experimental analysis was made in a built 1:2-model of an engine compartement and the influence of the hoses was analysed. The experimental data was then used as basis for simulations with a finite element model of the engine compartment. In this presentation the comparison between meassurements and simuations will be presented and the results discussed.

Mo. 15:30 Schweitzer Car acoustics I

Use of One Dimensional Gas Dynamic Simulation to Predict "Rasping Noise" in ICE Exhaust Systems

Mondher Ayadi, Robert Maunder
Ricardo Consulting Engineers Ltd

The tone of a noise at the exhaust tail pipe can markedly affect the sound quality inside vehicles. "Rasping Noise" perceived as a metallic and strident tone and characterised by high frequency components in the exhaust orifice noise, can have an adverse effect on the vehicle marketability. A study on the generation mechanism, providing an understanding, of this phenomenon highlighted an acoustical non-linear behaviour due to coupling between resonant modes within the exhaust ducts. WAVE, used to predict performance and noise in vehicle powertrains, provides a one-dimensional non-linear gas computation of gas dynamic behaviour within the intake and exhaust systems. This paper presents the results of a predictive rasping noise computation using this one dimensional dynamic simulation approach. This has been carried out through a critical example of powertrain and exhaust system where rasping noise generation conditions have been experienced.

Mo. 15:50 Schweitzer Car acoustics I

Validations on the acoustic behavior of a passenger car cavity by FE Simulations

Dietmar Jennewein, Oliver Eichelhard, Harald Flötke
Adam Opel AG

The FE modelling of the acoustic behavior of a passenger car cavity was validated. Therefor, acoustic transfer functions from several loudspeakers to a grid of multiple microphones inside a car were measured for different boundary conditions. First all the interior components were removed from a production vehicle. Next single components like seats and interior trimm parts were added. The differences of the measured transfer functions were compared versus FE simulations of corresponded modells. This lead to informations how to modell the acoustic behavior of such components.

Mo. 16:30 Schweitzer Car acoustics I

Efficient Sound Package Design Using Statistical Energy Analysis with Optimisation Through Genetic Algorithm

Jean-Charles Bonnet, Javier Rodriguez-Ahlquist
Rieter Automotive Management AG

Determining the best possible Vehicle Sound Package Design for a set of different acoustic loads is a delicate exercise of balance. Statistical Energy Analysis (SEA) has already proven to be a valuable tool for predicting whole-vehicle acoustic performance at medium and high frequencies. By combining efficient SEA modelling practices together with specially adapted optimisation algorithms, overall lead-times can be substantially reduced, assisting decision-making earlier in the acoustic development process.

Mo. 16:50 Schweitzer Car acoustics I

Prediction of Vehicle Interior Noise in High Frequency Range using Statistical Energy Analysis Hybrid Method

Irena Hauer, Karoly Jalics, Hans Herwig Priebsch, Thorsten Bartosch
Akustikkompetenzzentrum

The application of Statistical Energy Analysis (SEA) in the development process of Vehicles has been intensified during the last years. On one hand, experimental SEA is applyed to investigate improvements of existing design. On the other hand, simulation models of vehicle ensembles and entire vehicles are analysed by means of random properties of a network of coupled subsystems in the high frequency range. However, predictive analyses still require specific experience to extrapolate SEA models of new desing out of existing ones. The specific problem is the efficient and precise adaption of transmission loss factors, as usually, a support by experimental SEA is not possible. To avoid these problems, the Hybrid Approach of SEA can be introduced. FEM models of all parts are used to simulate the SEA tests and provide internal and coupling loss factors to be used in SEA simulation models as a result. The paper describes the procedure applyed for Hybrid SEA. An example of interior noise prediction for a passenger car in the frequency range above 500 Hz is given. Specifically, the validation of the Finite Element Model required for high frequency range is discussed and the validation of the SEA Hybrid model is presented. Finally, the benefits of the methoddology compared to the common SEA approch are shown.

Mo. 17:10 Schweitzer Car acoustics I

Structure-borne Sound in Automotive Structures: High Frequency Boundary Element Method (HFBEM) vs. Statistical Energy Analysis (SEA)

Björn Knöfel, Ennes Sarradj
Institut für Akustik und Sprachkommunikation

At high frequencies, sound radiation and vibration transmission are increasingly difficult to predict. The well known Statistical Energy Analysis has been for years more or less the only method which could be applied for high frequency predictions with a satisfying result. Because of several reasons, it comes with some limitations which are trying to be overcome by some alternative approaches. One out of these approaches, the High Frequency Boundary Element Method (HFBEM) is being tested for its general usability in comparison with measurements on three different typical automotive structures (ripped plate, railway carriage, floor panel of a Van). First HFBEM results will be presented and compared to SEA as well as measurement results.

Mo. 17:30 Schweitzer Car acoustics I

Transmission acoustics in the overall automobile system

Tobias Vöhringer, Axel Mors
ZF Friedrichshafen AG

'If audible at all, the audibility of a transmission inside the vehicle must not be disturbing!' On account of this development goal, the acoustics engineers of transmission suppliers and vehicle manufacturers are again and again faced with new challenges. ZF Friedrichshafen AG, an independent transmission producer, is represented in a variety of vehicles of various vehicle manufacturers with largely similar transmission types, which is due to the company's modular system. Invariably, acoustical optimization in and on the transmission is carried out in the initial stage of development work. Often, the development goal mentioned above needs to be pursued simultaneously for the most diverse installation conditions. At the department for acoustics engineering of ZF Friedrichshafen AG, such necessity gave rise to an efficient tool, which allows the acoustically effective system environment of a transmission to be determined as a vehicle-characteristic variable: airborne-sound sensitivity (LSE). The process involves investigation of the acoustic 'quality' of the automotive body, starting from the interfaces of the drive train and including the passenger compartment. With regard to many noise phenomena, an essential share of noise can be attributed to noise transmission. If, for example, gearing excitation on the transmission end is present across a broad operating-speed range, then audibility

within only narrow speed ranges is due to body-related structural resonance. For the overall system to be optimized in ever shorter development cycles, suppliers and vehicle manufacturers have to cooperate on a very close and trusting basis.Getriebe

Mo. 17:50 Schweitzer Car acoustics I

Microphone Array Measurements of Sound Radiation from Cars

Anders Nordborg
Nordborg Acoustics AB

Traffic noise is the most serious noise source. Although we already know that the noise is generated by tyres, wind, exhaust, and engine, we still do not know exactly when a ceratain source is dominating. Therefore, we also lack certain information about how we should control traffic noise, to achieve maximum benefit. A series of microphone array measurements of noise from cars, fitted with different tyres, passing by at different speeds, reveal for instance when tyre noise is the dominating source, and is the one which should be controlled.

Mo. 18:10 Schweitzer Car acoustics I

Analysis of passed by noise by Near Fielf Acoustic Holography (NAH)

Randolf Arndt, Walter Fließer
Akustikkompetenzzentrum

The Near Field Acoustic holography (NAH) is a method for analyzing noise sources. In acoustic holography the amplitude and the phase of the sound pressure at one plane in the near field of a sound radiating object has to be measured (here: car). This can be realised by scanning the plane at stationary object conditions using one or more microphones (totally: about 800 microphon positions). The method is based upon a two dimensional spatial Fast Fourier transformation of the measured pressure distribution at fixed temporal frequencies. The superposition of the waves in the new plane is done by an inverse two dimensional Fourier transformation and results in a sound pressure distribution in a plane parallel to the measurement plane. Applying this method for a series of parallel planes a three dimensional information of sound pressure and of sound intensity can be achieved. At the conditions of the highest passed by noise the NAH measurements were made at stationary conditions in the Near Field. From this plane the radiated noise will be caclulated at different planes far away from the structure. During these measurements reference microphones were placed close to the different noise sources and another reference microphone is 7,50 meters

away at the passed by measurement position. Correlation measurements between the reference points and the measurement points. The result is a distribution of the different noise sources in the different planes and especially at the measurement point of the passed by noise.

Mo. 18:30 Schweitzer Car acoustics I

Simulated Pass-By in Small Rooms Using Noise Synthesis Technology

Sandro Guidati, Roland Sottek, Klaus Genuit
HEAD acoustics GmbH

Pass-by measurements are a standard test procedure for every new vehicle. The test is performed on a test track with a single microphone at a distance d=7.5 m. Since there are only a few test tracks and the measurements depend on the ambient conditions, an indoor test procedure has been developed at HEAD acoustics. Here the vehicle is placed on a chassis dynamometer. The noise is measured with a linear microphone array at d=7.5 m. A binaural time signal of a simulated pass-by measurement is generated by switching between the microphone signals and applying filtering and smoothing algorithms. This procedure cannot easily be adapted for small rooms ($d<7.5$ m). For this purpose HEAD acoustics has developed a new test procedure based on results of the European research project SVEN. Microphones are placed close to the dominant noise sources of the vehicle. The airborne transfer functions between the source microphones and observer positions in a plane at a distance of 4 m are measured reciprocally. The vehicle noise produced on a chassis dynamometer is subsequently measured with the source microphones. A simulation of a binaural time signal measured at an arbitrary position is synthesized by filtering the source microphone signals with the transfer functions and adding the resulting time signals. In this paper first results of vehicle noise measurements on the new HEAD acoustics four-wheel chassis dynamometer and corresponding simulations will be presented. The described technique can also be used to investigate the contribution of single sources to the exterior noise supporting the sound design process.

Mo. 14:30 Schuman Room acoustics: simulation, . . . I

Medea technique and Sound Systems in Churches

Ernst-Joachim Völker, Wolfgang Teuber
Institut für Akustik und Bauphysik

The paper will deal with the medea technique in churches. Video transmission with access to internet, recordings of services or

of a special speech are increasingly required. Microphone technique and sound reinforcement must be of a high standard to obtain a better intellegibility of words for the congregation present in the church and for the listeners at home, in hospitals or in old people's homes. The installations depend on different activities in the church, when e.g. the choir and soloists are singing, when 6 microphones are required near the altar, additionaly wireless microphones, when services or processions take place in other parts auf the church, when a brass group is playing or a gospel choir would like to perform on one side of the church. The audio und video equitment will be described including the routing of signals, recordings and both life transmission and post production for videos. The access to internet is included.

Mo. 14:50 Schuman Room acoustics: simulation, . . . I

Quadratic Residue Diffusors Scale Model Mesurements

Philippe Woloszyn, Guillaume Rezeau, Bruno Suner
CNRS UMR 1563

This experimental study presents a scale model measurement system destined to allow concert hall acoustical design qualification. The research work aims to validate a mesurement procedure with verifying the adequation between the theoritical Quadratic Residue Diffusors interference model and its diffusion angular measurement on a 1/10 scale model. Defined for a frequency band from 1000Hz to 40kHz, the mesurement procedure takes place in a semi-anechoic room, exploiting an MLS signal through time windowing. At every 2.5 degree incrementation step, a 180 degree polar reference measure has been done on a flat panel in front of the diffusor, before measuring the diffusor itself. Specular and diffuse reflexion modes comparison between the scale model and the reference model (Helmholtz - Kirchhoff equation for infinitely rigid flat panel and boundary elements method for the Quadratic Residue Diffusor) confirms the sharp correlation between scale model measurements and the reference model, except for grazing angles directivity lobes qualification. Generalisation of those results will allow this method to describe the diffusive behaviour of any surface, under the conditions of geometrical continuity for its contributing part.

Mo. 15:10 Schuman Room acoustics: simulation, . . . I

Relevance and treatment of the low frequency domain in room acoustics

Helmut Fuchs, Frank Zickmantel, Constanze Rau
Fraunhofer Institut Bauphysik

Noise in schools, open-plan offices and other communication areas is predomi-nantly self-generated by the respective users.

The lack of sound absorption in traditionally furnished class-rooms or modern office environments forces all oc-cupants to raise their voices, as soon as the necessary communications among them and on the phone sets in. Conventional damping at mid- and high-frequencies by absorptive ceilings, carpets, cur-tains, claddings, sails and furni-ture may reduce the detrimen-tal effect of the room on speech intelligibility and the resulting noise amplification. Current research and consultant activities at IBP have revealed, however, that novel low-frequency and broad-band absorber modules can tackle the problem more efficiently at its roots. Examples show surprising improvements of acous-tic comfort in rooms where mid- and high-frequency absorption measures had failed or were impracticable for one reason or an-other.

Mo. 15:30 Schuman Room acoustics: simulation, . . . I

Loudspeaker positioning in rectangular rooms

Jean-Dominique Polack, Benoît Isabey, Pierre Leroy
c/o Laboratoire d'Acoustique Musicale

The field radiated by a loudspeaker is sensitive to the loud-speaker placement, especially at low frequencies, because the room exerts an acoustical load on the membrane. For rectangu-lar rooms, the image source theory is used to simulate the load, because it takes phases into account. A proper classification of image sources makes it possible to use their lattice distribution to speed up computation by means of perturbation theory. It builds up the coherent part of the point transfer function - or acoustical load - from the lattice of image sources for different source posi-tions and the ratios give the compensation filters. Compared to measurements, the same overall shapes are obtained when point sources are considered. Present developments include taking into account the finite size of the loudspeaker, but not the phase shifts at the reflections on the walls yet.

Mo. 15:50 Schuman Room acoustics: simulation, . . . I

Microphone Array for Soloists

Frédéric Bongard
Ecole Polytechnique Fédérale de Lausanne

A two-dimensional microphone array intended for recording soloists in a very reverberant cathedral is presented. This ar-ray belongs to an electro-acoustical assistance system which im-proves the hearing comfort in the cathedral of Lausanne during choral music concerts. For this particular application, constraints are as follows : a) the array has to be placed quite far from the singers (about 4 m), so its directivity index must be high enough in order to reject the reverberated field ; b) the position of the

singers is not fixed but depends on the musical work, so it must be possible to electronically steer the main lobe. The use of a full two-dimensional array (squaring of microphones) leads to an excessive number of microphones, which is why more reduced geometries have been studied. A cross-shape has finally been retained, i.e. two linear arrays at right angles to each other. The designed array includes 15 hypercardioid microphones arranged on a cross of 2m40 x 1m24 and a digital processing unit (DSP) allowing the implementation of FIR filters. By modifying the properties of these filters, the main lobe can be steered in various directions. The directivity index is about 13 dB and the half power beam width varies between 25° and 55° according to the section considered in the directivity pattern. The nested subarray method made it possible to keep these performances roughly constant over a decade frequency bandwidth (300 Hz to 3 kHz).

Mo. 16:30 Schuman Room acoustics: simulation, . . . I

Computerised planning aid for the design of anechoic chambers

Gerhard Babuke, Xiaoru Zhou, Xueqin Zha
Fraunhofer Institut Bauphysik

A computer program using image sources was developed to aid the design of anechoic rooms. The phase shifting caused by different distances of all image and higher-order image sources and by reflection on each boundary surface are taken into consideration. The calculated sound pressure compares well with "drawaway" measurements. Several parameters which influence the quality of an anechoic room can be investigated by means of this simulation programme. It shows, that the absorption coefficient of the wall linings is by no means the only qualification requirement for an anechoic room. Besides the absorption, the geometry of the room, location and size of the source, the orientation and length of a prescribed measuring path and the respective test signal all affect the acoustical quality of an anechoic room for a given purpose.

Mo. 16:50 Schuman Room acoustics: simulation, . . . I

Time reversal imaging of noise sources inside a reverberant room

Guillemette Ribay, Cedric Roux, Julien De Rosny, Mathias Fink
ESPCI - LOA

In a reverberant room, the multiple reflected echoes make imaging of acoustical random sources difficult. In this talk, we give an original solution based on Time Reversal Principles. Basically, in a first step, the acoustic field due to a noise source is recorded

by a set of microphones. In a second step, all the recorded signals are time-reversed and re-emitted by loudspeakers that now replace the microphones. We observe a strong enhancement of the mean intensity around the initial source position. In a first part, we highlight the formal link between time-reversal of pulsed and noise sources in reverberant media. Especially we deduce that the signal to noise ratio depends only on the number of pairs of microphone/loudspeaker for noise sources. Numerical simulations confirm these predictions. In a second part, we present experimental results performed in a 5*3*3 m and strong reverberant room. The intensity map of noise acoustic sources with a working bandpass of [100 3000] Hz has been performed. The same experiment has been carried out with two coherent or incoherent sources. Moreover, the frequency dependence of the resolution obtained with this technique is studied. Finally, we focus on the SNR with respect to the bandpass and central frequency.

Mo. 17:10 Schuman Room acoustics: simulation, . . . I

A Four-Channel Dynamic Cross-Talk Cancellation System

Tobias Lentz, Christian Renner
Institute of Technical Acoustics

To reproduce a binaural signal using loudspeakers, a cross-talk cancellation system is needed. It is based on the transfer functions from each loudspeaker to each ear. To produce filters for a static cross-talk cancellation system, the four transfer functions are measured with an artificial head. Afterwards the filter is calculated and used to cancel the cross-talk at the point the artificial head was positioned during the measurement. The filter is valid only in this one point and this fact limits the systems applicability significantly. An adaptive cross-talk cancellation for a moving listener requires a system being able to provide a valid filter-set for each position. With the increase of the computation power it is possible to calculate cross-talk cancellation filters online using an HRTF-Database (Head Related Transfer Functions) and a head tracking system to detect the listeners current position. A dynamic cross-talk cancellation system using two speakers is already implemented (see DAGA 2002). Head rotation is possible only within the angle spanned by the loudspeakers. Aim of this work is to implement a dynamic four speaker cross-talk cancellation system to provide a full head rotation. Several approaches of filtering will be tested and compared.

Mo. 17:30 Schuman Room acoustics: simulation, . . . I

Design of Loudspeaker Systems for Reverberant Rooms

Wolfgang Teuber, Ernst-Jo. Voelker
IAB Institut fuer Akustik und Bauphysik

Improvements of speech intelligibility in acoustic difficult rooms with long reverberation times (churches, concert halls) require carefully designed loudspeaker systems. To select adequate speaker systems and their positions in the room acoustic criteria have to be taken into consideration such as sound absorbing areas, listener positions, parallel walls and reflections as well as technical data of loudspeaker systems like frequency response, Q-factor etc. Calculations, computer simulations and results of measurements are presented to show the influence of loudspeaker characteristics to the direct / diffuse sound field and speech intelligibility.

Mo. 17:50 Schuman Room acoustics: simulation, . . . I

Room Acoustical Simulation at Low Frequencies Using the Scattering Element Method (SEM)

Matthias Blau, Andreas Wilde
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Arguably all known room acoustical simulation packages assume geometrical 'ray-like' sound propagation and are thus limited to high frequencies and/or diffuse sound fields (large rooms). In the present work, a wave approach, the so-called scattering element method (SEM), is used to predict room acoustical parameters such as RT, C80, G, Tc at low frequencies for 5 microphone positions in a reverberation room (empty and with 4 plate absorbers). This situation is modeled by 1.) adding a uniform absorption to all boundary (wall) nodes, in order to adjust the reverberation time to the expected statistical value for the empty room, and 2.) by discrete-time implementation of multiple-input-multiple-output (MIMO) reflection coefficient matrices representing the dynamical behavior of the plate absorbers. The simulation, performed in 3rd octave bands, takes about 20 min on an ordinary PC; the predicted values of the room acoustical parameters conincide with measured ones in an acceptable manner.

Mo. 18:10 Schuman Room acoustics: simulation, . . . I

The extended model to simulate the Quetzal echo at the Mayan pyramid of Kukulkan at Chichen Itza in Mexico

Nico Declercq, Joris Degrieck, Rudy Briers, Oswald Leroy

Soete Laboratory, Department of Mechanical Construction and Production, Ghent University

It is well known that a handclap in front of the staircase of the pyramid produces an echo that sounds similar to the chirp of the Quetzal bird. This phenomenon occurs due to diffraction. There exist some publications concerning this phenomenon and even some first attempts are reported to simulate it. Recently, it has been shown [Declercq et al, J. Acoust. Soc. Am. 113(4), 2189, 2003] that it is possible to reproduce the echo by means of a simulation which is based on the theory of the diffraction of plane waves and which takes into account continuity conditions. The latter theory is the building block for a theory that tackles the diffraction of a spherical sound pulse. By means of these principles it is possible to simulate the echo following a handclap in front of the staircase. This paper shows results obtained by means of an extension of this model where also reflections on the ground in front of the staircase are taken into account. These results correspond better to reality than the previous results.

Mo. 18:30 Schuman Room acoustics: simulation, . . . I

Influence of the ears canals location on spherical head model for the individualized interaural time difference estimation

Sylvain Busson, Rozenn Nicol, Olivier Warusfel

France Télécom R&D

The spatialization rendering with binaural synthesis is still limited by the individualization of the spatial filters, which are usually composed of a pure delay for the interaural time difference (ITD) and a minimum-phase filter for the spectral cues. This paper deals with the individualization of the ITD based on physical modeling. Individualized ITDs are well predicted by a spherical-head model with a customized radius derived from an empiric linear combination of three head anthropometric parameters describing the listener's head. However it can be observed that the constant ITD contours computed from the spherical-head model are concentric circles, whereas the constant ITD contours extracted from measured HRTFs show deviations from these circles, especially for azimuths near to the interaural axis. The location of the ears with respect to the center of the head seems to be the main factor to reproduce these deviations. The authors propose to introduce

a parameter governing the ears' shifting, so as to break the symmetry of the spherical-head model. This idea leads to a new formula for the computation of individualized ITDs. The formula is tested by comparison with measured data. The authors also examine to what extent the deviations of the measured ITD along the circles contribute to the individualization. Psycho-acoustical experiments are performed to answer this question.

Mo. 14:30 Tivoli 1 Recent advances in speech . . .

An extension of PESQ for assessing the quality of speech degraded by severe time clipping and linear frequency distortions

John Beerends, Jeroen Vugt
TNO Telecom

PESQ (ITU-T recommendation P.861) has been established as a world standard for assessing speech quality. This paper shows its limitations when it is used for assessing the quality of speech that has been degraded by large amounts of time clipping and linear frequency distortions. For both types of distortion an extension to PESQ has been developed. Two types of extensions were investigated, using a separate indicator for quantifying distortions, and using a modification of the PESQ algorithm without introducing separate quality indicators. A significant improvement in correlation could be obtained with these types of distortions without degrading the PESQ performance on other types of distortion.

Mo. 14:50 Tivoli 1 Recent advances in speech . . .

P.SEAM, a Breakthrough in Single Ended Voice Quality Testing

Christian Schmidmer
OPTICOM Dipl.-Ing. M. Keyhl GmbH

P.SEAM will be the new ITU recommendation for single ended (non-intrusive) voice quality testing. In Sep. 2003 the ITU-T SG12 finished the competitive phase with the selection of the final candidate for the recommendation. All four models which were proposed during the competitive phase proved to be amazingly accurate. The performance was sometimes even better than the performance of previous intrusive measures. The basic principle of P.SEAM is to first detect the dominant distortion by analyzing the output of various distortion detectors. The results of these distortion detectors will then be weighted depending on the dominant distortion, thus leading to the final Mean Opinion Score as in indication of the listening quality. Some of these distortion detectors, being key to the success of P.SEAM will be presented in detail. Furthermore the performance of P.SEAM in various applications will be examined.

Mo. 15:10 Tivoli 1 Recent advances in speech . . .

Predicting speech quality under packet loss: Extension of the E-model

Alexander Raake
Institut für Kommunikationsakustik (Web: www.rub.de/ika)

Network planning models allow the quality of a network to be predicted before it has been set up. The model currently recommended by the ITU-T for this purpose is the so-called E-model. It was designed for the planning of traditional wireline, circuit-switched telephone networks. In today's networks, however, packet-based transmission techniques are typically applied. Packet-based transmission shows new types of impairments like packet loss and jitter, which were not included in the original version of the E-model. In this paper, the extension of the E-model to predicting speech quality under packet loss as one example of time-varying degradations is presented. Different aspects of packet loss distributions will be addressed: In the first part, a formula will be presented for quality prediction under random loss, which can be regarded as the simplest case of loss distributions. In a second step, the formula will be extended to the prediction of burst loss, i.e. packet loss for which the loss of a particular packet depends on whether or not the previous packet was lost. During one telephone conversation, the rate of lost packets may vary considerably also on a more macroscopic level, leading to longer periods of very high and longer periods of very low quality. Both long-term variations and short-term variations will be addressed in this paper, and quantitative approaches will be suggested for the prediction of speech quality in these cases.

Mo. 15:30 Tivoli 1 Recent advances in speech . . .

Recent standardization work on non-intrusive evaluation of voice quality in IP environments

Vincent Barriac
France Télécom R&D

This presentation begins with a short overview of the existing standardisation bodies involved in this topic (definition of metrics and description of measurement methods) and the document already issued by these bodies.. Then, the work of Q.16/12 of the ITU-T (whose rapporteur is making this presentation) is addressed more in detail. In particular, we will address the update of existing ITU-T recommendation on INMDs (P.561 in 2002, P.562 to come), to take into account new type of connection for the measurement probes and new parameters related to transit on IP network (most of them being taken from IETF RFCs). But most of the presentation will be devoted to the on-going competition for

the selection of a future standard model for the evaluation of voice quality in VoIP services based on protocol information (known as P.VTQ, 2 candidates in competition), supposed to address a large variety of network and terminal conditions. The concept, terms of reference, basic characteristics, advantages and limitations of P.VTQ will be presented and discussed.

Mo. 15:50 Tivoli 1 Recent advances in speech . . .

Supervision of perceived quality in VoIP telephony services
Jean-Yves Le Saout
France Télécom R&D

The supervision of the quality of new telephony services is a real challenge for telecommunication operators. Currently, different methods and tools are used, whose advantages and drawbacks will be briefly discussed. As far as Voice over IP is concerned, the fact that packet and signal are processed by the terminal makes it necessary to measure the end to end (from mouth to ear) quality, not only network QoS, and thus to take into account the terminal behaviours. The installation of probes on the end point terminals allows such an evaluation and makes it possible to apprehend the real quality perceived by the user by taking into account other parameters than networks metrics such as jitter or packet loss ratio.. In this presentation, we will describe an original operational solution to the problems of supervision of the quality of VoIP telephony services based on this concept. This solution is based on a soft probe installed on the VoIP terminal of the user (PC with soft phone or IPphone). During communications, and without interfering or disturbing the conversation, such a probe can determine parameters characterizing the perceived quality, based on the analysis of the speech signal (e.g. : P.56, P.561, P.SEAM) or of the protocol (e.g. Y.1540, P.VTQ). At the end of each communication the probe uploads the measurement results to a central server from where actions of supervision or correction can be performed.

Mo. 16:30 Tivoli 1 Recent advances in speech . . .

Speech Quality "Quick Check" for VoIP Terminals
Frank Kettler, Frank Rosenberger, Hans Wilhelm Gierlich
HEAD acoustics GmbH

VoIP terminals need to be carefully designed in order to guarantee a high speech quality for the user of this communication scenario. Some of the parameters which have to be considered are comparable to traditional telephonometry like frequency responses, distortions or loudness ratings of the handset. Other parameters have to be adjusted differently due to the IP specific transmission characteristics. One example is the echo delay in IP

scenarios which may be significantly higher compared to the traditional telephone network. Consequently the terminals need to provide a higher echo attenuation expressed e.g. by the parameter terminal coupling loss (TCLw). Current standards like the TIA-810 require an echo attenuation of 55 dB instead of 46 dB which is required for ISDN phones. A comparison test was carried out with 5 different VoIP terminals (handsets). The most important parameters were measured ("Quick Check") and are discussed here. These results demonstrate different implementation strategies of manufacturers and the current quality differences of VoIP terminals.

Mo. 16:50 Tivoli 1 Recent advances in speech . . .

Speech Quality - a Multidimensional Problem: An Approach to Combine Different Quality Parameters

Hans Wilhelm Gierlich, Frank Kettler
HEAD acoustics GmbH

The evaluation and/or prediction of speech quality in modern telecommunication scenarios is getting increasingly complex. Due to a variety of non-linear and time variant signal processing in terminals as well as in networks the description of the perceived speech quality by a single number is a challenging topic. Established procedures like the E-model or the perceptual evaluation of speech quality (PESQ) are either not suitable for non-linear and time variant systems or describe just a part of the overall speech quality. The presentation will give an overview of the different parameters influencing the speech quality in modern telecommunications systems and their relationship. Approaches how to combine the different values to a single number will be discussed.

Mo. 17:10 Tivoli 1 Recent advances in speech . . .

Comparative Speech Quality Evaluation of Mobile Phones Using Advanced Testing Methods

Frank Kettler, Frank Rosenberger, Hans Wilhelm Gierlich
HEAD acoustics GmbH

The complexity of signal processing implemented in mobile phones has grown continuously over the past years. Echo cancellation, comfort noise injection, noise reduction or dynamic level controlling typically found in hands-free devices are now implemented in mobiles. Therefore the traditional testing methods are no longer sufficient in order to reflect conversational speech quality. More complex testing is necessary. Conventional measurements like frequency responses can be made more realistic by using an artificial head equipped with a more realistic artificial

ear which shows the pressure force dependent acoustical leakage comparable to the human ear. This measurement also guarantees more realistic results when determining objective listening quality scores (MOS-LQO according to ITU-T-Recommendation P.800.1). Furthermore the implemented signal processing significantly influences the double talk behavior and the quality of background noise transmission. Consequently appropriate tests and analyses are necessary. This presentation introduces advanced testing methods which offer a high efficiency in gaining a complete picture of the conversational quality of a mobile phone. Comparative results of different mobiles are discussed.

Mo. 17:30 Tivoli 1 Recent advances in speech . . .

Quality Prediction Models for Telephone-Based Spoken Dialogue Systems

Sebastian Möller

Institut für Kommunikationsakustik (Web: www.rub.de/ika)

The spoken interaction between a human user and an application based on speech technology (e.g. for information or transaction tasks, like railway information or telephone banking) gains ground in modern telephone networks. In order to estimate the overall quality a user of such a service will experience, quality prediction models have been set up. They calculate an index related to user satisfaction on the basis of parameters which can be logged during the interaction, either automatically or with the help of an expert transcription. The most popular modelling approach is the PARADISE framework developed by Walker et al. at AT&T. In the talk, an overview is given about the modelling principles as well as the prediction accuracy which can be reached for human-machine interaction (HMI). Starting from a taxonomy of quality aspects which have demonstrated relevance for the HMI situation, it is shown that the PARADISE approach is still very limited both with respect to the predicted quality indices as well as with respect to the amount of subjective judgement variance covered by the model. The correlation to subjective judgements is considerably lower than for speech transmission quality models. A new proposal for predicting individual quality aspects is made in order to obtain more generic quality estimations.

Mo. 17:50 Tivoli 1 Recent advances in speech . . .

STIPA - The Golden Mean Between Full STI and RASTI

Ole-Herman Bjor

Norsonic AS

The Speech Transfer Index (STI) as developed by TNO in Holland during the last thirty years, has proven to be one of the

most reliable objective indicators for speech intelligibility prediction. However, as the measurement time of a full STI requires about 15 minutes, it is often necessary to use an approximation to the STI-value, which may be measured in shorter time. For that purpose the Room Acoustics Speech Transmission Index (RASTI) was developed in 1979. Through its use, it has been noted that unreliable indications in some situations as measurement of PA-systems may be obtained. A more reliable indicator STIPA, developed for measurement of PA-systems, has recently been standardized by IEC. This paper describes how the measurement of STIPA may be implemented in a modern digital sound level meter.

Mo. 14:30 Tivoli 2 Active control I

A course on active noise control held at the Technical University of Berlin

André Jakob
Institut für Technische Akustik , Technische Universität Berlin

During summer semester 2002 a course on active noise and vibration control was held at the Institute of Technical Acoustics of the Technical University of Berlin, and was repeated in winter semester 2002/2003. The course was designed for students of acoustics. It introduced the physical basics of active control as well as the control strategies, i.e. feedforward, feedback, and the adaptive digital filters, which are commonly used for control. The presentation will give an overview of what was taught the students, keywords are: overview of state of the art, necessary degree of exactness of the secondary signal, Hermitian Quadratic Form, one-dimensional ANC, ANC in free-fields, ANC in enclosures, AVC of a plate strip, ASAC of plate strip, manual control, digital signal processing, transformations, digital filters, adaptive filters, LMS algorithm, system identification, filtered-x LMS algorithm, multiple error LMS algorithm, adaptive algorithm for feedback control, digital signal processors (DSPs), case study of active control of a double-glazed window. The analytical calculations, performed for the students, were illustrated with computer simulations and animations. These will be shown in the presentation.

Mo. 14:50 Tivoli 2 Active control I

Causality Constraints in Multi-channel Active Control of Random Noise

Emmanuel Friot
LMA CNRS

Active noise control over large areas often requires large sets of actuators and sensors. In the single-channel case and for random noise, the causality of active control can be easily checked from the transducer locations; for example to stop low-frequency noise propagation in a duct a detection sensor must be set up upstream the secondary source. In the multi-channel case, causality is more difficult to be enforced; in this paper it is indeed shown that in some pathological cases optimal noise control can require control filters which include an infinite non-causal part, simply because of the multiplicity of error sensors. This may explain the difficulties encountered when implementing random noise control in large cavities. In other cases the single-channel result generalizes: perfect feedforward control can be achieved if a reference sensor detects the incoming noise with a time advance larger than the overall delay in the longer secondary path between a secondary source and an error sensor. In the paper simple cases with two loudspeakers and two microphones in free-field are considered to derive these results; optimal non-causal control is derived analytically while causally-constrained control is approximated by Finite Impulse Response filtering computed via a Filtered-reference Least Mean Square adaptive algorithm. Guidelines to prevent a loss of causality due to the multiplicity of channels are also given for more complex cases.

Mo. 15:10 Tivoli 2 Active control I

Active Noise Control Description by Using the Direct Finite Element Method (DFEM)

Gerhard Hübner, Max Kraus
Universität Stuttgart

As known, the DFEM is a very appropriate method to describe the sound power radiated by technical sound sources. The main advantage of this method is the short, direct way for calculating the main sound emission quantity (the sound power), by using the source outer surface quantities (normal vibration components, its phase relationship and the belonging to geometrical quantities) directly without calculating airborne sound field quantities (sound pressure, sound velocity, sound intensity) "in between". The method determines the totally radiated sound power by a sum of partial sound powers individually generated by all single monopoles replacing the machine's outer surface radiation and additionally by the sum of all interaction sound powers generated

by the combination of all monopole pairs. Especially the effect of the monopole pairing gives the important contribution to the final sound radiation behaviour of the different types of sources, including the increasing and decreasing of the radiated sound power. In so far the monopole pair may be regarded as the "elementary stone" for any active noise control description, too. The paper deals with the sound power effects of several combinations of monopole systems different in amplitude and phase relationships and discusses the conditions for noise reduction in general and especially regards questions of active noise control. This issue is a first step of an investigation to describe general principles of active noise control by using the DFEM.

Mo. 15:30 Tivoli 2 Active control I

Considerations on the Realtime Realisation of a 2D-Feedforward-ANC-System Part 1: Aspects to the Software

Detlef Krahé, Mattias Trimpop
University of Wuppertal

The algorithm presented in former papers realises the approach in the space-frequency domain by the FFT. This solution results in the disadvantage of a block-wise processing causing a long processing delay alone by collecting the data for each block. So in addition with the time for other processing steps the maximum allowed delay of about 1 ms is exceeded. Therefore another solution is developed working directly in the time domain and avoiding the block-wise processing. This solution is presented and discussed.

Mo. 15:50 Tivoli 2 Active control I

Considerations on the Realtime Realisation of a 2D-Feedforward-ANC-System Part 2: Aspects to the Hardware

Mattias Trimpop, Detlef Krahé
Institut for noise control

An experimental assembly for a 2D-feedforward-ANC-system containing 24 microphones and 12 loudspeakers should be prepared for real time processing. Up to now experiments were done in an off-line-modus. This means a stimulated source (primary source) was recorded, the signals were processed off-line and then the fields of the secondary sources driven by the processed signals and the primary source are generated simultaneously and superposed. The on-line-modus (realtime) requires special conditiones for the hardware as well as for the software. These are a small processing delay by the several components (e.g. ADC and DAC) and a sufficient signal processing power needed to realise 24x12=288 transfer functions. This paper presents a multiprocessor system that can fulfill the needed specifications.

Mo. 16:30 Tivoli 2 Active control I

Improved shielding effect of noise screens by means of actively controlled headpieces

Hyo-In Koh, Michael Möser

Institut für Technische Akustik , Technische Universität Berlin

On the basis of theoretical studies on the effect of the cylinders attached to acoustical screens, a numerical study of actively controlled headpieces of noise screens has been presented last year. According to the theoretical investigations the tangential sound power-transport parallel to the surface of the attached cylinder is crucial in the shielding effect. In the last numerical study, the surface impedance of the headpiece was actively controlled to minimize the power transport along the headpiece as much as possible, i.e. the sound field on the surface was locally minimized. The calculation on the basis of a two dimensional model showed that a deflection of the incident sound was possible by means of a secondary sound field. The acoustical shadow region was more pronounced in both near- and far-field compared to the passive case with rigid surface. For a relatively wide frequency range it was also possible to find optimal positions for the secondary sources and for the error microphones. In the present study the system was investigated experimentally. The physical principle from the theoretical study could be realized practically by means of active control. The optimal configurations, which were found in the numerical analysis were also proven to be effective in the experiment.

Mo. 16:50 Tivoli 2 Active control I

Active control of sound travelling through a bogie-shrouds-barriers-combination

Carsten Spehr, Michael Möser

Institut für Technische Akustik , Technische Universität Berlin

The combination of bogie shrouds and small barriers is promising method in the abatement of railway noise. In order to reduce the noise transmission through the gap between the bogie shroud (on the train) and the small barrier the gap should be as small as possible. However, for security raisons the Bahn AG defined a minimum distance between bogie and shroud, through this the noise travels unhindered and limits the noise reduction of the method. The aim of this project is to develop a method to active reduction of the sound travelling through the bogie shroud-barrier interspace. A brief introduction in the theoretical work will be given, with the main focus at the following points. · The sound propagation from the primary source through the shroud-barrier

interspace in order to determine the possibilities for an improvement of the insertion loss. Shroud and barrier are modelled as overlapping cylinder segments (two-dimensional) to examine the effects of different positions of the bogie and the barrier as well as of the acoustic sources. · In the second part we consider an active feedback system. Thus the influence of a finite impedance at the secondary loudspeaker (with mass-, spring-, or absorption characteristic) or a deviation from the ideal transfer function on the insertion losses with active control could be examined. · In order to examine the possibilities from two independent feedback loops too, the model was extended by a further secondary loudspeaker. Based on this a test rig was developed. Results of this will be presented.

Mo. 17:10 Tivoli 2 Active control I

Control of low frequency enclosed, harmonic sound fields with active absorbers

Stefan Zimmermann, Phil Joseph, Philip Leistner
Privat

This paper describes an active absorber for the control of low frequency enclosed, harmonic sound fields. The active absorber consists of a microphone located immediately adjacent to a loudspeaker. The microphone signal is used to drive the loudspeaker via a high-gain inverting power amplifier thereby causing the pressure at the microphone to be driven close to zero. By analogy with passive absorbers, the behaviour of the active absorber is completely described by its input impedance. It is shown that a single active absorber can produce significant reductions in the total acoustic potential energy of the sound field at low frequencies when correctly positioned in a rigid room. The relationship between absorbed sound power and the feedback gain of the active absorber is derived, and hence a criterion is established for the optimal gain that maximises sound power absorption. The use of multiple active absorbers is also investigated. It is shown that mutual interaction between active absorbers, but also the presence of passive absorption greatly affect control performance. Further significant reductions in total acoustic potential energy in the room are obtained by increasing the total number of active absorbers uniformly distributed over one surface of the room. Above a critical number of absorbers, however, the effectiveness per unit absorber begins to decrease. Measurements of the total acoustic potential energy before and after control are presented for four and nine active absorbers, for varying amounts of passive absorption treatment in the room. The results are shown to match predictions in reasonable limits.

Mo. 17:30 Tivoli 2 Active control I

Reduction of sound immission in buildings by sound insulation using active facades

Lothar Kurtze, Torsten Back, Rainer Nordmann
Department of Mechatronics and Machine Acoustics, Darmstadt University of Technology

Low sound immissions into rooms have become more and more important for the construction of large buildings such as hotels, hospitals, or conference centres. Particularly near airports, major roads, or railway lines, the acoustic shielding of ambient noise is, in many cases, difficult to handle with classical passive methods. The reasons lie mainly in the physical and financial limitations of the construction. In modern architecture, facades serve as the outer skin of a building and so have to fulfil the demand of static strength. However, if facades are planned in a suitable way, they can act as a barrier for incident sound fields (for example by the use of active noise control). The investigation of the possibilities for a reduction of structure borne sound using active techniques is the object of a research project initiated by the German Ministry of Education and Research. One of the central questions so far addressed by the project is the investigation and the experimental detection of the lower natural frequencies and eigenmodes on a reference facade composed of several frame elements. The mode shapes were then compared with the results of numerical FEM calculation. The next step is to find an actuator design for generating anti-vibrations. After that, suitable positions for the actuators and an appropriate control system must be determined. At the conference, the results of the first year of research will be presented. This will include a report on the experiment conducted at the facade test facility and the calculations to determine the natural frequencies and the mode shapes of the reference facade.

Mo. 17:50 Tivoli 2 Active control I

Are electromagnetic Receivers suitable for ANR Earplugs?

Karl Buck, Véronique Zimpfer-Jost, Armand Dancer, Pascal Hamery, Philippe Herzog
I.S.L. : Institut franco-allemand de Recherche de Saint Louis

Crew members working close to modern fighter aircraft are exposed to very high level continuous noise in the mid-frequency range. Presently available hearing protectors cannot cope with such high levels. A possible improvement would be an ANR earplug with an effective bandwidth extended to frequencies exceeding 1 kHz. Taking into account the dimensions that are involved, and the bandwidth of the transducers, this goal should not be impossible to obtain. However, measurements

of electro-acoustical transfer functions of configurations using electro-magnetic (hearing-aid type) receivers seem to show a delay of about 20 μs added to the "minimal" phase behaviour. Out of these 20 μs, only a maximum of 6 μs could be accounted for the distance between the receiver's membrane and the microphone. The paper presents different approaches that were used in order to determine the source of the unexplained 15 μs. It also explains the difficulty to decide whether we are confronted to a delay or whether the effect is due to the phase shift of some "hidden" pole. It also presents the performance of ANR earplugs using digital filtering, and the difference in efficiency of an (close to ideal) ANR system when using two different transducer technologies: electro-magnetic (hearing aid type), or reversed condenser microphones (B&K 1/4").

Mo. 18:10 Tivoli 2 Active control I

A preliminary study of an isodynamic transducer for use as active acoustic materials

Hervé Lissek, Xavier Meynial
Ecole Polytechnique Fédérale de Lausanne

Active control of the acoustic impedance of walls in rooms allows fine control of reverberation in auditoria. Such active materials may use locally reacting cells comprising a transducer connected to an electronic control circuit. The feedback circuit is based on a linear combination of the pressure at the transducer diaphragm and its velocity, and allows making the active material absorbing (absorption coefficient alpha close to 1), but also reflecting (alpha close to 0), and even 'super-reflecting' (alpha$<$0 !). Most of the characteristics of an ideal transducer for use as active material seem to be reached by isodynamic transducers, for their acoustical performances as well as for manufacturing costs considerations. We present results from simulations involving a finite element model of such a transducer, which predict a good control over two frequency decades. Preliminary experimental results obtained with a basic prototype of isodynamic transducer are encouraging. It is likely that better results can be obtained (especially in the 'super-reflecting' case) with closer control over the various mechanical parameters. Future work will also address the optimisation of the magnet geometry and the assembly of the diaphragm.

Mo. 18:30 Tivoli 2 Active control I

Design of a dedicated PVDF microphone for active noise control in high levels environment

Hervé Lissek
Ecole Polytechnique Fédérale de Lausanne

With the aim of lowering noise disturbances within high sound pressure levels environments, active strategies have been developed. Specifications for a dedicated microphone have been drawn, with respect to the acoustical signature and the levels of the noise source. The investigations on a dedicated transducer, able to reach the compliance specifications as well as to support the noise levels generated by the source without distortion, led to develop a PVDF-based microphone, compliant with the extreme environmental conditions. We present the technological solutions considered to reach the acoustical specifications, on the basis of an electroacoustical model used for numeric simulations in a first part, and then show experimental results obtained with a prototype. We then conclude with the perspectives provided by this kind of transducer used within rough sound fields.

Mo. 14:30 Gutenberg Musical acoustics

Influence of decorations on the sound of church bells

Jochen Bauer, Lothar Schmidt, Benno Kotterba
md-pro GmbH

The first casted bells for the Dresdner Frauenkirche had a discord. Particularly the beat of the prime caused that six of the seven bells didn't pass the sound test. So a further casting had to be done. Experts agreed that the decorations had caused the problem. But they didn't agree which part of the decoration had the biggest influence on the affected sound components. By simulating a bell model with variations of decoration the cause of the beat was identified. By accompanying measurements of the real bells the transferability of simulation results to real bells was proved. The disturbing acoustic effects of simulation and real bells did comply. The use of simulation for bell development is evident. The harmony of the bell sound can be predicted and also the risk of discording bell sounds caused by decorations can be estimated. Variations of bell models allow optimizing the sound without producing prototypes. Optimization and development of new splines are accelerated.

Mo. 14:50 Gutenberg Musical acoustics

Acoustic analysis of sonority and discord of church bells
Lothar Schmidt, Jochen Bauer, Benno Kotterba
md-pro GmbH

The sound of bells enchants us. By faulty manufacture and disadvantageous figuration of decorations a discord can be caused. Ageing and cracks initiation affect the sound. The metrological analysis of the bell sound is used to document the result of the bell casting process. Continuous control measurements allow detecting changes in material and bell structure precociously. By analysing the time domain behaviour of the bells single tones a musical fingerprint can be generated. It comprises the measured harmony, the maximum sound level, attach and decay as well as the beat of single bell tones. The approach to the musical fingerprint is demonstrated with one bell for the Dresdner Frauenkirche. Because the first casting result wasn't accepted because of a discord and the second casting result was accepted, we can compare two bells of the same spline. One with a discord and one with a good sound. The differences of the fingerprint data help us to identify the cause of the discord. Together with simulation results or modal analysis the fingerprint enables us to locate causes of discords or longtime changing effects. These methods can also be used for product testing in industrial production environments. The use of acoustic resonance analysis for product testing is well established in many applications.

Mo. 15:10 Gutenberg Musical acoustics

Monopole Breathing of the Organ Pipe Body
Steffen Bergweiler
APKM, Physik, Universität Potsdam

Using a new sensor method we investigated the organ pipes body. The area of investigation was the oscillation of the pipe resonators cross-section. We found that, additionally to quadrupole oscillation, it also shows a monopole oscillation. The results are based on measurements of four groups of nominally equal pipes. They differ in two properties: the choice of material and the profile of the tube resonators wall. A total number of 40 pipes being investigated, make the obtained results statistically very safe. The results are discussed with respect to the relationship between air-column and pipe-body oscillations. Differences due to the influence of material and the resonators wall profile will also be considered.

Mo. 15:30 Gutenberg Musical acoustics

An experimental study of the acoustic radiation of a concert harp using Nearfield Acoustic Holography

Nicolas Dauchez, Jean-Hugh Thomas, François Gautier, Jean-Claude Pascal
LAUM

Planar Nearfield Acoustic Holography (NAH) [1] is used to provide acoustic features of the radiation of a concert harp [2]. The acoustic pressure fields are measured from two planes in the nearfield of the soundboard and the soundbox holes while a stationary mechanical excitation is placed at one string location. NAH provides a reconstruction of the pressure field and the normal velocity on the source planes by solving an inverse problem. Acoustic intensity vectors are computed from the measurements. A detailed description of the acoustic intensity field radiated by the sounboard surface and the soundbox holes is performed. Calculations of acoustic power radiated by the two sources allow us to quantify their relative importance. In three frequency ranges, it is shown that soundbox holes radiate more than the soundboard. In the first range, it is suggested that the acoustic radiation of the instrument can be described by two monopoles implying that in this range the harp acts as an equivalent elastic Helmholtz resonator. [1] J. D. Maynard, E.G. Williams and Y.Lee, Nearfield Acoustic Holography: I. Theory of generalized holography and the development of NAH, J. Acoust. Soc. Amer. 78, 1395-1413 (1985) [2] F. Gautier, N. Dauchez, Acoustic intensity measurement of the sound field radiated by a concert harp, submitted to Applied Acoustics, (2003)

Mo. 15:50 Gutenberg Musical acoustics

Noise Control and Professional Musicians - 87 dB(A) Exposure Level Limit

Georg Brockt
Bundesanstalt für Arbeitsschutz und Arbeitsmedizin

The EU-Directive 2003/10/EC on the requirements of health and security of workers to the risks arising from physical agents (noise) demands the adherence of a limit value for the weekly noise exposure level of 87 dB(A) for all employees, taking into account the attenuation of hearing protectors. Professional musicians and employees in entertainment industry are explicitly stated within the Directive. In the case of musicians, there appear substantial difficulties on the conversion of this Directive. A noise reduction at the source is hardly possible, while carrying hearing protection can affect the making of music or even prevent it at all. However, the average sound pressure levels in orchestras

are in the range of 80-100 dB(A). Options of noise control for musicians are means of employment organization, room acoustical improvements and the reasonable application of hearing protection. But obviously no simple general solution exists, which limits the sound exposure without affecting the artistic liberty. This contribution gives a survey on the requirements of the EU-Directive, typical sound exposures and potential noise control measures for orchestras.

Mo. 16:30 Gutenberg Musical acoustics

Acoustic impedance measurement of the clarinet players'airway

Claudia Fritz, Joe Wolfe
IRCAM

Understanding of the playing regimes of the clarinet requires measurements of the acoustical impedance spectra of the player's airway, as well as that of the instrument and knowledge of the mechanics of the reed. Previous measurements of the airway (Hoekje, Wilson) are not fully exploitable or applicable because they either were not necessarily performed in playing conditions, lack phase information, or contain high levels of background noise. We report experiments to measure the impedance for conditions close to those used in playing. The impedance spectrometer used, originally developed by Smith and Wolfe, has been modified by the integration of the measurement head in a clarinet mouthpiece. A highly damped parallel leak, with low acoustic admittance, enables the musicians to blow air into the 'instrument'. Mounted on a tube with appropriately placed rings under the fingers, this convincingly simulates, for the player, the feeling of holding a clarinet ready to play. Impedance spectra (magnitude and phase) were measured for a range of simulated playing conditions with a group of professional clarinettists. The reproducibility of the measurements is high, probably because accomplished musicians have a 'muscle memory' that enables them to reproduce with high precision the vocal tract and tongue configurations required for particular playing conditions. The significance of these spectra will be discussed in terms of models of the playing regimes of clarinets, and also in terms of players'statements about the role of the vocal tract in different registers and conditions, and their intentions when preparing to play.

Mo. 16:50 Gutenberg Musical acoustics

Spectral sources of basic perceptual dimensions of violin timbre

Jan Stepanek
Academy of Performing Arts in Prague

Dissimilarity in timbre was assessed in five sets of violin tones (pitch B3, F#4, C5, G5, D6) by twenty experienced listeners - violin players. The results of five listening tests (individual dissimilarity matrices) were separately processed using latent class approach (CLASCAL). This approach yielded to perceptual spaces of common dimensions shared with all listeners and in each studied pitch to the division of listeners into two classes. Classes of listeners were clarified by exclusion of outstanding listeners. Perceptual spaces of groups (clarified classes) exhibit more stable dimensions. Moreover, the second group (with significantly higher dissimilarities) has optimal model of higher dimensionality in pitches B3, F#4 and C5. Spectral sources of individual dimensions for both groups were calculated and compared. The first dimension is significantly correlated with spectral centre of gravity (positively), with levels of high frequency harmonics (positively), and with the level of the first harmonic (negatively) for pitches B3 (in both listener groups), F#4 (second group) and C5 (both groups). In both groups of the pitch G5 the first dimension correlated with spectral centre of gravity (positively) and with the level of the first harmonic (negatively), but levels of high frequency harmonics correlated with the second dimension together with the level of the second harmonic (the same sign). In both groups of the pitch D6 the first dimension is correlated with spectral centre of gravity and with levels of high frequency harmonics (the same sign), but the level of the first harmonic correlated with the second dimension.

Mo. 17:10 Gutenberg Musical acoustics

Physical Characterisation of musical instruments

Mathieu Paquier, Benjamin Robin, Théophane Foggia, Jean-Christophe Béra
Université de Brest

We used time cues, spectral cues, and spectro-temporal cues for musical instrument differentiation from recordings. Twenty notes had been played on thirty instruments by one or, sometimes several players for a same instrument. These notes had been selected by each musician as being the most representative of his instrument (various attacks, intensities, decays, crescendo/decrescendo,oe.). Then, for each of these notes, we

calculated the different cues, e.g. spectral centroïd, peak factor, harmonics synchronisation, attack- and decay-duration, oe.. The means and standard deviations of the different cues allowed a tree-structure-based classification of the instruments. For example, one cue differentiated the instrument families (e.g. brass from rubbed strings). Then, an other cue differentiated an instrument from an other in a given family (e.g. the violin, the cello, or the double bass within the rubbed strings family). The main application of such a classification is the automatic recognition of instruments for audio signal indexing and automatic musical transcription.

Mo. 17:30 Gutenberg Musical acoustics

Réponses impulsionnelles d'un jet de flûte à bec

Hagop Ohanessian, Jean Perrigot
Institut National des Sciences Appliquées de Lyon

New methods are proposed for important steps of real time computing for jet displacements generated by pipe sounds. The Fletcher formula for 2-dimensional laminar jets as revisited by Verge and coll., taking the jet viscosity into account, and requiring a solution of free jet perturbation, is used . To perceive the formula hypothesis, a simple channel exit model (a little cylindrical area replacing each edge) is presented which links the Fletcher formula to Euler equations for uncompressible fluids and the foundations of the Rayleigh equation are reviewed . The channel immobility generates a displacement term sensitive to sound frequency and jet speed. To compute easily its contribution, only the unit impulse response Fref(t) for a defined jet speed, the "reference" one, is put in computer's memory. This unit impulse implements our choices (approximations discarded, amplitudes and phases computed together) and solves problems of sampling's unwanted periodicities, accuracy of samples of Fref(t). Actual jet speed is taken into account by calculated memory access: Fref(t) becomes a big array in which are calculated the address and a level correction of the wanted sample according to a proposed formula. In this way, the actual unit speed impulse response F(t) is obtained. The computing of jet displacements uses a convolution: s(t)=v(t)*F(t); v(t) is the speed of the acoustic field near the channel exit and F(t) the unit speed impulse response; these speeds are easier to calculate than displacements. Applications: sounds simulation, study, adjustment software.

Mo. 17:50 Gutenberg Musical acoustics

Ondes mobiles et résonateur conique des flûtes à bec

Hagop Ohanessian, Jean Perrigot
Institut National des Sciences Appliquées de Lyon

. Baroque recorders exhibit a slightly tapering conical pipe, which is easy to adjust by use of specific reamers. The musical notes are played by opening finger holes on the pipe. So, we think the pipe as a fictitious set of incomplete conical segments, such as any localized impedance (mouth, finger hole, end of the pipe, joints between recorder's constructional parts) stands at the a segment's beginning or end . For each segment, we define two characteristic impedances: for progressive (to the end) and regressive (to the mouth) waves, one input impedance and two reflection ratios: for pressure and flow. These parameters may be calculated from the end segment to the mouth one. The Bergeron method formulates the pressure and flow variations seen, between two consecutive points of reflection, by fictitious observers respectively 'linked ' to the progressive and the regressive wave. Of course we establish a formulation for tapering pipes, and we obtain time-dependent linear discrete equations between pressures or flows on the segment faces. The results are applied to the simulation of the pressures near mouth and first finger hole. The mouth pressure computing requires the equations and the reflection function of the first segment. But the finger hole pressure may be calculated without convolution, and is taken into account to obtain a realistic spatial pressure.

Mo. 18:10 Gutenberg Musical acoustics

Audiotactile simultaneity perception of musical-produced whole-body vibrations

Michael Daub, M. Ercan Altinsoy
"Institute of Communication Acoustics, Ruhr-Universität Bochum; jetzt: VISATON GmbH & Co. KG"

In many situations, presentation of music causes whole-body vibrations (such as classical music concert in a concert hall, organ music concert in a church, or in a popular music concert). In literature, most studies have concentrated upon the annoyance or discomfort of whole-body vibrations. However, the whole-body vibrations which are generated by musical excitations (stimulations) have pleasant and informative sensations on listeners. This study concerns the interaction between whole-body vibrations and auditory stimulation which are generated by musical events. For this purpose, the characteristics of the "musical" whole-body vibrations have been investigated through measurements. In this

sense, the correlation of cross-modal perception has been explored with psychophysical tests. Using statistical methods and discussing the results, indicators for mechanisms of cross-modal perception could be found. In this talk, investigations which are related with temporal aspects of musical auditory-tactile interaction will be presented.

Mo. 18:30 Gutenberg Musical acoustics

Period doubling on cylindrical reed instruments

Jean Kergomard, Jean-Pierre Dalmont, Joel Gilbert, Philippe Guillemain
LMA CNRS

Period doubling phenomena are expected to be possible on self-sustained instruments, at least since the famous paper by Mc Intyre et al (1983). Some theoretical papers have been written concerning cylindrical reed (i.e. clarinet-like) instruments, discussing the possibility of period doubling. In 1995 Kergomard has shown that for the simple model based upon the Bernoulli equation, ignoring losses in the resonator, period doubling, triplingoe can occur, depending on the dimensionless parameter characterising the fit between reed and resonator. On the experimental point of view, if such a behaviour has been observed on a bassoon, it is difficult to obtain for cylindrical reed instruments. Nevertheless, using a crumhorn with a soft plastic reed, Gibiat and Castellengo (2000) got period doubling. The first aim of this paper is to extend the theoretical analysis when resonator losses are taken into account : analytical calculation when losses are independent of the frequency shows that the range of parameters for which period doubling occurs is small. Above a rather small value of the loss parameter the phenomenon disappears. This fact can explain the difficulty to observe the phenomenon on a clarinet. The second aim is to confirm the previous result by using a real time synthesis method (Guillemain et al, 2003). Moreover synthesis allows to listen sounds and transitions with values of the parameters which are non common in practice : in certain cases even chaos can occur. Auditory examples will be given.

Mo. 14:30 Kleber Thermo- and flowacoustics

Numerical Simulation of the Noise Generation at the Outlet Section of Combustion Chambers

Christoph Schemel, Frank Thiele
Technische Universitaet Berlin, Hermann-Foettinger-Institut fuer Stroemungsmechanik

Combustion noise has become an increasingly important component of total aero-engine noise, especially during the landing approach of modern aircraft. In this flight regime, the reduction

of combustion noise has become a particular goal of efforts to optimize sound emission. Combustion noise is understood to be a conglomerate of direct and indirect noise. The indirect combustion noise, addressed by a numerical method here, is radiated from an acceleration zone downstream of the combustion chamber. A change in state together with a fluctuation in entropy is identified as the source mechanism for this indirect noise. This change in state is brought about by the acceleration of an entropy fluctuation through a nozzle flow. The relationship between direct and indirect combustion noise, however, is outside the scope of this work. The approach for the simulation of radiation and propagation of indirect combustion noise is based on the linearized Euler equations coupled with a Computational Aeroacoustics (CAA)-method. The numerical method employing the 4th order DRP scheme is first verified by comparison to a compact theory from literature. The CAA method is applied to internal subsonic nozzle flows with non-compact entropy wave propagation. The sound pressure level (SPL) in the numerical examples given grows with increasing contraction ratio of the nozzle.

Mo. 14:50 Kleber Thermo- and flowacoustics

Strategies for Coupling Large-Eddy Simulations with Computational Aeroacoustics

Felix Flemming, Amsini Sadiki, Johannes Janicka

Institute for Energy and Powerplant Technology, TU Darmstadt

To describe the noise generation in turbulent combustion systems, it is important to capture the fluctuating density which acts as a volume source of sound - the volume of the flame fluctuates with the reciprocal of the density. In the reactive case and for small Mach numbers, the main cause for the density fluctuations are fluctuations in the heat release by the chemical reactions in the flamefront. This heat release can be related to the acoustical pressure fluctuations. The main issue is then to get an accurate description of the fluctuating heat release. Following a conserved scalar approach, the latter can be expressed as a function of the mixture fraction. While large-eddy simulations (LES) of the reactive flowfield enable a time dependent description of the heat release, acoustic approaches in the frame of computational aeroacoustics (CAA) determine the acoustical field. Here, methods like the acoustic perturbation equations (APE), the boundary element method (BEM) or the equivalent source method (ESM) utilize the time dependent heat release and its influence on the flowfield to predict the propagation of the noise into the far sound field. To combine the two fields - fluid dynamics/combustion and acoustics - with its individual approaches enables a detailed description of the combustion noise. For this purpose one needs

to define common interfaces, on which the exchange of data is based. In this contribution the coupling strategies for the data supplied by means of the LES with the CAA approaches are addressed.

Mo. 15:10 Kleber Thermo- and flowacoustics

Modelling of the Combustion Noise by means of the Equivalent Sources Method

Rafael Piscoya, Martin Ochmann, Haike Brick, Peter Költzsch
Technische Fachhochschule Berlin

The present work shows the advances in the development of the Equivalent Sources Method (ESM) to predict the noise produced by aerothermic sources, particularly the noise from a free flame. This method, which has been applied with very good results to the description of noise from vibrating bodies, can be well coupled with a Computational Fluid Dynamics (CFD) technique to describe the noise from combustion processes. A CFD code is used for solving the complicated non-linear equations that govern the processes in the interior and near surroundings of the flame. However, such a CFD method is inappropriate for farfield noise determination. Instead, the ESM can easily be used to calculate the sound radiated into the far field from data of sound pressure or sound velocity on a control surface that contains the source. The original source is replaced with elementary sources (monopole, dipoles, etc.) that produce the same field at the control surface as the flame itself. The surface must contain the zone with turbulence or non-uniform flow in order to obtain reasonable results. The sound power and radiation patterns from a free diffusion flame are presented. The nearfield turbulent flow was solved using a Large Eddy Simulation (LES) code. The acoustic quantities were calculated by using ten concentric cylinders with increasing radius as control surfaces in order to see how the results depend on the distance between the flame and enclosing surfaces. The agreement of the results with corresponding BEM calculations is very good.

Mo. 15:30 Kleber Thermo- and flowacoustics

A Hybrid Approach to analyze the Acoustic Field based on Aeroacoustic and Thermoacoustic Effects

Thanh Bui, Wolfgang Schröder, Matthias Meinke
Aerodynamisches Institut Aachen

A hybrid LES/CAA approach to simulate sound fields generated by aeroacoustic and thermoacoustic effects will be presented. Acoustic perturbation equations are used, which are capable to describe acoustic wave propagation in a non-uniform mean flow such that the computational domain of the flow simulation has

to comprise only the significant acoustic source region. The input data to evaluate the acoustic source terms are generated by an LES computation in a flow region that contains all major acoustic sources. Special care is taken on Combustion Noise in which a sound field of an unbounded flame is simulated. Besides a fourth-order DRP-Scheme (Dispersion Relation Preserving) for spatial discretization a LDDRK-Scheme (Low Dissipation and Low Dispersion Runge Kutta) is used for time integration. By analyzing the sound radiation into unbounded space the need arises due to the limitation of computational resources to introduce artificial boundaries to make the computational domain finite, such as PML (Perfect Machted Layer) or Sponge Layer, to avoid unphysical numerical reflections into the computational domain.

Mo. 15:50 Kleber Thermo- and flowacoustics

Investigation of combustion noise by real time laser measurement techniques

Anton Winkler, Johann Wäsle, Thomas Sattelmayer
Technical University of Munich

In open turbulent premixed flames the volume of the reaction zone is time dependent. This leads to a temporal fluctuation of the heat release resulting in noise production. As long as the combustion process proceeds in the flamelet-regime there is a strong coupling between the local reaction rate and the flame surface. Consequently, the noise production of the flame becomes finally accessible by determination of the surface fluctuation. Unfortunately most measuring methods integrate along the optical axis, which leads to the loss of local information. Thus, there are set up light sheet techniques to visualize the flame fronts with high temporal and spatial resolution. One of the procedures is based on the laser induced fluorescence of OH-molecules, which indicates the edge of the reaction zone. In addition a second procedure was developed, feeding an evaporating tracer in the gas. The reaction zone is estimated from the absence of this tracer. Due to the different physical effects their qualification for the image post processing and their application for the noise production of open turbulent premixed flames has to be checked.

Mo. 16:30 Kleber Thermo- and flowacoustics

Non-stationary Phenomena at the Firing of a Small Thruster

Jean Varnier
ONERA

Non-stationary phenomena at the firing of a small thruster (thema : Aeroacoustics) In the framework of Ariane 5 program supported by CNES, the ONERA has carried out experimental studies of the

blast wave which occurs at the ignition of solid-propellant rocket engines. A thruster is a small rocket of very short combustion time, that allows to isolate the non-stationary phenomena occurring at its ignition. The thruster is horizontally fixed above a reflecting ground. The sound field is measured along a linear microphone array aimed towards the nozzle, and along a large-radius nozzle-centered microphone arc. It is interesting to notice that two successive shock waves are recorded in fact: the first one corresponds to the breaking of the nozzle shutter during the rise of the chamber pressure; the second one, more important, occurs during the short stationary phase of the pressure. The latter phenomenon was rather unexpected and has been studied more particularly. It is established from three different methods (time shift between the microphones, time lag of the reflected wave, spatial correlation functions) that the second shock-front comes from a point located at about one meter downstream from the nozzle. Thus, the origin of this wave is not the nozzle but the 'fireball' formed in the air by the gaseous combustion products.

Mo. 16:50 Kleber Thermo- and flowacoustics

Numerical Sound Prediction of Open Rotors: Methods, Results and Perspectives

Iris Pantle, Esra Sorgüven, Franco Magagnato, Martin Gabi
Fachgbiet Strömungsmaschinen, Geb. 10.91, 2. OG., Universität Karlsruhe

The numerical sound prediction of open rotors underlies special requirements due to the complexity of their geometry and flow. As far as one aims to find an overall valid numerical prediction method for aero-acoustics without relying on empirical or semi-empirical data the classical Computational Fluid Dynamics (CFD) approach suggests similar methods tailored to acoustical problems. Presently within the field of the so-called Computational Aero-Acoustics (CAA) there are several methods available. Basically these extract unsteady acoustic sources out of a flow computation and proceed with the computation of the acoustical wave propagation through a fluid. In respect of applying the method to subsonic open rotors such as fans a combination of unsteady Reynolds Averaged Navier-Stokes (URANS) computations or Large Eddy Simulation (LES) together with a form of Acoustic Analogy, preferably the Ffowcs Williams and Hawkings Analogy (FWHA), does not only produce reasonable results but also shows appropriate but nevertheless feasible demand of computing resources. Within this presentation a brief overview of the functionality of the acoustic module implemented in the in-house CFD solver and using FWHA will be shown. There will be presented three case studies, realized by using LES and the

FWHA, including a 3-dimensional flow around a circular cylinder, a flow around a combination of a cylinder and an airfoil and a flow through a simple, but completely 3-dimensional, subsonic propeller. The configurations follow experimental settings for the reason of comparing numerical and experimental results and validating this approach.

Mo. 17:10 Kleber Thermo- and flowacoustics

Computation of Trailing Edge Noise with Turbulence in Linearized Euler Equations

Marcus Bauer, Andreas Zeibig
Institut für Akustik und Sprachkommunikation

Airframe noise plays a very important role in road traffic, rail traffic and air traffic. Its direct computation, however, can hardly be accomplished with presently available computers and hence is not applicable for industrial design. This research attempts to compute broadband trailing edge noise as a special case of airframe noise using a cost-saving hybrid method. In the first step the time-averaged mean-flow field around the object is computed by solving the RANS-equations (Reynolds Averaged Navier Stokes) and in the second step the time dependent noise is obtained by solving a modified form of the LEE (Linearized Euler Equations) with a source term. The latter is driven by a synthetic turbulence field and is used to excite turbulence in the LEE. Results of the computed trailing edge noise of a profile and a flat plate are presented. In both cases good agreement with solutions obtained by other researchers is found. The computations are validated with measurements in the institute's own aeroacoustic wind tunnel. Single and triple sensor hot-wire probes are employed for the aerodynamic measurements while single microphones and a microphone array, respectively, are used for the acoustic measurements. The method seems to be suitable to compute and to investigate trailing edge noise, but additional research is required concerning the excitation of turbulence in the LEE.

Mo. 17:30 Kleber Thermo- and flowacoustics

Control of Pipe Flow Resistance by Sound

Matthias Jüschke, Dirk Ronneberger
Drittes Physikalisches Institut Göttingen

We have investigated the sound propagation through a rigid walled circular flow duct with a short section having yielding walls (lambda/4-resonators). We have observed strong amplification of sound waves that travel downstream at frequencies slightly above the resonant frequency. The energy of the amplified wave

is taken from the mean flow. Thus the flow resistance of the yielding duct section increases depending on the amplitude of the incident sound [Brandes, Ronneberger, DAGA 95,96], i.e. the yielding duct section acts as a fast reacting sound-controlled valve. This includes, among others, the possibility to generate sound at abitrary low frequencies [Lange, Ronneberger, DAGA 99]. In such applications of the effect, the amplified control sound is unwelcome. Therefore we searched for higher order modes which are evanescent in the rigid duct but are strongly amplified in the yielding duct. A rectangular cross section of the yielding duct was chosen for this purpose. Surprisingly we found a spectrum of instabilities quite different from the circular duct. In particular the outstanding instability which was responsible for the flow control in the circular duct has no correspondence in the rectangular one. Possible reasons for this will be discussed.

Mo. 17:50 Kleber Thermo- and flowacoustics

Transient Behaviour of a Thermoacoustic Refrigerator : model and experiments

Gaelle Poignand, Pierrick Lotton, Philippe Blanc-Benon, Michel Bruneau, Vitali Gusev
LAUM

Nowadays, the expression of the temperature difference across the stack of a thermoacoustic refrigerator can easily be obtained in steady states, but models for analysing the transient process are still in progress. More precisely, previous models used to describe the behaviour of thermoacoustic devices usually assume several approximations preventing us from describing the transient behaviour of the temperature field. Particularly, heating due to viscous effects at the interfaces between the walls and the fluid in the thermoacoustic stack and thermal losses are usually neglected. Therefore, the parameters which govern the transient response, its shape and its characteristic stabilisation time are not fully identified. Thus, the aim of the present work is to investigate more deeply, analytically, the transient behaviour of the thermoacoustic refrigerator, using a revisited description for the temperature variations in the stack due to thermoacoustic process, by introducing new features as heat losses through the thermoacoustic system and viscous heating in the boundary layers near the walls. The phenomena has been modelled in terms of a system of a coupled differential equations, including both a non-homogeneous linear second order partial derivative equation reduced to an equation with constant coefficients and a set of differential equations, derived from the given physical situation, corresponding to initial and boundary conditions. Apart from numerical methods which can provide the behaviour of the transient

to interpret the experimental results recently available, the goal is to obtain approximate analytical solution to interpret the physical phenomena which underlie the viscous and thermal phenomena coupled together.

Mo. 18:10 Kleber Thermo- and flowacoustics

Transient nonlinear processes in annular thermoacoustic engines

Guillaume Penelet, Vitali Gusev, Pierrick Lotton, Michel Bruneau
LAUM

An annular thermoacoustic prime-mover transform thermal energy into acoustical energy using the thermoacoustic interaction between an inhomogeneously heated stack of solid plates (placed in an annular waveguide) and resonant gas oscillations. In such a device, the saturation of the acoustic wave amplitude leading to the stationnary regime is linked not only to classical nonlinear phenomena such as cascade process of higher harmonic generation and minor losses, but also to nonlinear processes influencing the temperature distribution in the inhomogeously heated parts of the system such as acoustically enhanced thermal conductivity and acoustic streaming. The present study aims at describing the own contribution of each one of those nonlinear processes by means of experimental observation and analytical description of the transient regime. Experimental observations of the transient regime are briefly reported. The obtained results show various regimes, demonstrating the possibility for the engine to turn on and off spontaneously and periodically, the possibility for an overshoot of the acoustic wave amplitude before its final stabilization, or the possibility for a double-threshold process during the amplification regime. A simplified theoretical model is then presented, where the one-dimensional heat transfer equation is coupled to the acoustic problem by taking into account the forced convection due to acoustic streaming and the acoustically induced thermal conductivity. Thermoacoustic amplification depends in its turn on the temperature distribution along the stack and the waveguide. The obtained results notably provide a qualitative explanation for the double-threshold phenomenon.

Mo. 18:30 Kleber Thermo- and flowacoustics

Concepts and Realization of Acoustical Tomography

Peter Holstein, Armin Raabe, Roland Müller, Manuela Barth, David Mackenzie, Eric Starke
SINUS Messtechnik GmbH

Tomographic techniques are powerful tools for obtaining insight into physical or chemical properties of areas and volumes. There

is also a trend to develop these procedures for non-stationary conditions. We present the realization of a prototype version of a tomographic system for industrial and scientific applications. It includes conceptual work on several levels. Firstly, the hardware of the system should consist, as far as possible, of an existing product - a multi-channel system with active output. The hardware solution can be applied under a variety of conditions (scalable areas/volumes, adaptive frequencies appropriate to the target and to the physical problem, resilience to background noise etc.). This will be discussed in the technical part of the talk. Secondly, a general software concept (including several layers of real-time and near-real-time algorithms, inversion techniques and the user interfaces) will be presented and applied to the tomographic system. MATLAB toolboxes for control, algorithms and presentation form the core of the numerical tomography concept. It will be demonstrated that the concept can be applied to tomographic problems of various sizes (scalability). Two examples are given which demonstrate the scalability of the concept. A small-scale model-size experiment (for educational purpose) of about 1 square meter and an example indoor climate investigation (for a sports hall) are presented. It is intended to use the tomographic system for educational purposes as well as for the training, preparation and realization phases of expensive measurement campaigns.

Mo. 14:30 Oberlin Physical acoustics I

Numerical Simulation of Bounded Acoustic Beams by the Fourier Integral Method

Philippe Gatignol

Laboratoire Roberval, CNRS, Université de Technologie de Compiègne

A bounded acoustic beam, such as the one generated by a finite transducer, may be classically described by plane wave superposition. In the monochromatic case, the pressure field is then obtained in the form of a spatial Fourier integral. Analytical expressions of such integrals are out of reach in general and only asymptotic or numerical evaluations are available. The numerical evaluation of Fourier integrals is usually performed by the FFT algorithm. This procedure requires to introduce a regular discretization of the integration variables and a corresponding set of values of the conjugate variables. The pressure field is thus obtained for a particular set of points in the space. Moreover, the regular discretization results in an artificial periodization of the solution. A direct numerical evaluation of Fourier integrals by classical methods such as Lagrange method avoids to prescribe

specific positions of the points in the physical space, but the periodization phenomenon is not overcome. We propose a method based on partial exponential integration of the Fourier integrals. The acoustic beam is then obtained in any point of the physical space without any periodic artefact. This kind of numerical simulation of a bounded acoustic beam is relevant of those problems where the beam interacts with a multilayered structure, with long range propagation effects, in particular when a modal wave is generated in the structure.

Mo. 14:50 Oberlin Physical acoustics I

Surface Acoustic Wave Propagation on Spheres and Cylinders Using Laser Ultrasonics : Analysis and Experiments

Dominique Clorennec, Daniel Royer
ESPCI - LOA

We have observed that a short Rayleigh wave pulse propagating on a cylinder or on a sphere was reversed during its first half-turn of propagation. Experiments were performed on steel and duraluminium samples with transient surface acoustic waves (SAW) launched by a pulsed YAG laser focused along a line. The radial component of the displacement was measured by a heterodyne optical interferometer. The waveforms recorded versus the angle between the source and the detection points shows that the Rayleigh pulse, which is for example monopolar (positive) near the source, becomes bipolar at an angle equal to 45°, monopolar (negative) at 90° and monopolar (positive) at 180°. In the case of a cylinder, we demonstrated that this unexpected phenomenon could be ascribed to the dispersion effect on the high frequency components of the laser-generated acoustic pulse. We analysed the variation of the inversion angle versus the material Poisson's ratio and we show that for large cylinder radius the diffraction effects must be taken into account. In the case of a sphere, the curvature along the line source compensated the diffraction effects. Then the inversion angle does not depend on the sample diameter. In the last experiment, we replaced the line by a point source and we studied the focalisation effect of SAW in the vicinity of the opposite point.

Mo. 15:10 Oberlin Physical acoustics I

Sound Field Modelling in a Narrow Street by the Transport Theory

Thierry Le Pollès, Judicaël Picaut, Michel Bérengier
LCPC

In this paper, we present an original approach for the diffuse sound field modelling in a narrow street. Using the concept of

sound particles, we show that the temporal and spatial distribution of sound energy in a street may be solution of a transport equation, where the boundary conditions are defined for mixed specular-diffuse reflections. In order to apply this model, an asymptotic solution is detailed. In this case, we show that the transport equation may be reduced to a diffusion equation for the sound energy, where the diffusion coefficient depends only on the street width, the ratio of specular and diffuse reflections, and the diffuse reflection law. In order to validate the model, measurements have been carried out in a narrow street and compared with the solution of the diffusion equation. The results show that a good agreement is obtained, both for the sound levels and the reverberation times in the street.

Mo. 15:30 Oberlin Physical acoustics I

Radiation of Directional Seismic Sources within a Layered Half Space

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Institut d'Electronique de Microélectronique et de Nanotechologie, UMR 8520 CNRS, département ISEN

The aim of 4D-surveying, a recent development in seismic, is to monitor the changes in the subsurface in time. Thus, measurements are continuously repeated with the same space configuration : reliability and repeatability of the acquisition footprint are key requirements for 4D surveys. The Weathered Zone (WZ) is the main cause of source signal fluctuations, polluting the signal coming from reservoir variations. This zone is directly located beneath the surface and its mechanical properties vary with weather. To eliminate this perturbation, a directional source, buried under the WZ and radiating downwards, is analyzed here. Two models are developed considering that the source size to wavelength ratio is small. Firstly, Green's tensor for the half space is derived using the Cagniard De Hoop's method (CDHM, [1]). Two signals are used to compute synthetic seismograms for the directional source : a quasi harmonic excitation, which provides radiation patterns of the source, and a Ricker signal (gaussian in the frequency domain) which is a typical seismic signal. Secondly, a source buried in a half space covered by a layer (the WZ) is considered. As the CDHM, would be intricate in this case, the Green's tensor in a layer is computed using the Discrete WaveNumber Method (DWNM, [2]). The solution is then propagated using the reflectivity method. Seismograms are computed for different WZ properties to validate the directional source concept. References [1] Johnson, L. R., 1974. Geophys., J., R., astr., Soc., 37, 99-131. [2] Bouchon, M., 1981. Bull., Seism., Soc., Am., 71, 4, 959-971.

Mo. 15:50 Oberlin Physical acoustics I

Propagation of Lamb waves in anisotropic rough plates

Catherine Potel, Claude Depollier, Damien Leduc, Bruno Morvan, Pascal Pareige, Jean-Louis Izbicki
LAUM

In this paper, the propagation of Lamb waves in a plate of anisotropic solid with a randomly rough surface is studied. The profile of the surface is described by its statistical properties: its mean value and the mean square deviation of the surface from the flatness. In the small roughness limit, the dispersion relation of the Lamb waves is derived from an effective boundary condition by a perturbation method. In this model, the roughness of the stress-free boundary induces a small complex perturbation of the dispersion relation: the real and imaginary parts of which are related respectively to the shift frequency and to the attenuation of the wave. Analytical and numerical results are presented for both the shift and the attenuation of the waves, showing that two mechanisms contribute to the decay of a Lamb mode: its decay into bulk elastic waves and its decay into other Lamb modes. Experimental results are presented in glass plates and duralumin plates are compared to the theoretical results.

Mo. 16:30 Oberlin Physical acoustics I

Acoustic waves generated by a pulsed laser in anisotropic semiconductors

Bertrand Audoin, Hinde Meri, Clément Rossignol
Laboratoire de Mécanique Physique, Université Bordeaux 1

When a laser pulse is focused at the surface of a material, the transient heating of the semi-transparent material induces ultrasound. The subsequent acoustic generation and propagation has been extensively described even when the material behaviour shows anisotropy and viscosity. However, when a 1064 nm laser pulse is focused at the surface of silicon, it has been observed that the material contracts whereas heating should produce expansion. In addition to the usual thermal acoustic source, a non thermal sound excitation results of photo excitation of electron-hole pairs. Therefore, to describe the optoacoustic effect in semiconductors it is necessary to account for thermoelastic and other deformation sources simultaneously. In this presentation, a model is implemented that accounts for the diffusive character of charge carrier motion and heat conduction. Relevant differential equations are coupled together and with the wave motion equation. Three sets of equations are linearised in a 2D

Fourier domain and solutions are found with an appeal to convenient boundary conditions. Signals are calculated for off epicentre positions at the rear side of the anisotropic semiconductor. Experiments are performed on a 5 mm thick silicon plate with a Nd:Yag laser that delivers 20 ns pulses. Signals are measured for epicentre and off epicentre positions. Very good agreement is obtained with calculated signals for both positions demonstrating that both sound generation mechanism and anisotropy are accurately taken into account.

Mo. 16:50 Oberlin Physical acoustics I

Laser-induced thermoelastic excitation of plane shear acoustic pulses

Denis Mounier, Moussa Hazmoune, Nicolay Chigarev, Thomas Pézeril, Pascal Picart, Samuel Gougeon, Jean-Marc Breteau, Vitali Gusev

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A simple theory is developed and numerical estimates are presented to demonstrate the possibility of directly exciting plane shear acoustic pulses by distributed laser-induced thermoelastic stresses. It should be mentioned that in the most of the experiments conducted until now shear waves are excited not directly through thermoelastic effect but through the mode conversion at the surfaces and interfaces of the longitudinal acoustic pulses (excited due to thermal expansion). The direct excitation of shear waves through thermoelasticity is possible due to anisotropy of the crystal thermal expansion. To use this anisotropy the orientation of the laser-irradiated surface relative to the crystal symmetry axis should be optimised. We analysed in details the case of the hexagonal crystals, where the efficiency of the thermoelastic excitation of the plane quasi-shear, and of the plane quasi-longitudinal waves (launched normally to the irradiated surface) depends on the orientation of the surface relative to the crystal axis. The preliminary results of the experiments in Zn single crystals, where the laser interferometry is used for the detection of the nanosecond shear acoustic pulses thermoelastically excited by nanosecond laser pulses, are also reported.

Mo. 17:10 Oberlin Physical acoustics I

Elaboration of a scattering matrix measurement procedure for higher order acoustic duct modes propagation conditions.

Azzedine Sitel, Jean-Michel Ville
Laboratoire Roberval, CNRS, Université de Technologie de Compiègne

A method for measuring the scattering-matrix of duct discontinuities for higher order acoustic modes propagation conditions is being developed and progress is presented in this paper. The technique, as this previously used for measuring transmission and reflection matrices, is based on measurement of acoustic pressure in two closed cross sections which separate incident and reflected modes after a modal decomposition by Fourier-Lommel's transform for N linearly independent pressure source distributions on N cut-on modes. Following works already achieved for plane wave propagation conditions, the determination of the scattering matrix coefficients is deduced after repeating all the experiment for two inlet charges which create the conditions for solving the system of equations. The experimental set-up, the signal processing and the data treatment process are described. Experimental results of the scattering matrix coefficients of a hard wall duct test section without any discontinuity for pressure distributed on the first three cut-on modes (0, 0); (1, 0); (-1, 0) are discussed.

Mo. 17:30 Oberlin Physical acoustics I

Variation in Time and Spread of Quantiles (Percentiles) of Stochastically Fluctuating RMS Sound Pressure

Alois Heiß
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In sound measurement besides the level Leq and other descriptors also the quantile of type 'N percent exceedance level' is used. Within the measurement techniques standardized until now these quantiles are determined by counting the population of sound pressure level classes. But by this procedure no use is made of statistical structural data additionally embedded within the stochastic fluctuations in time althoug these data are relevant for the uncertainty of the measurement. This deficiency is to be eliminated for sake of adequately taking into account all contributions which determine significantly the quality of sound impact assessments. The quantile's dependance on time can be concluded from the quantile definition applied onto the primary continuous, usually stochastically fluctuating rms sound signal.

From this follows that also the quantile varies stochastically. After a sufficient number of fluctuations the quantile variation can be linearized and the spreads can be extracted directly as for the quantile as for the exceedance relative to a fixed quantile level. The resulting relations are calculable by the outcome of measurement itself. Thus also the confidence limits (c. l.) of quantiles are determinable in real time by measurement. For the Leq, the associated c. l. are calculable by integration of the quantile c. l. over the exceedance variable space, i. e. from 0 to 1. Main features and possible applications of these relations are presented, already available for the every days measurement practice by a commercial measurement software for online sound level quality control.

Mo. 17:50 Oberlin Physical acoustics I

Vibroacoustic Testing of Technical Plastics Components

Andreas Franck, Jürgen Graf
Institute of Technical Acoustics

Due to their often small stiffness and their associated affinity to vibration, plastics components contribute much to sound radiation in many technical systems. An acoustics-aware design of this components is therefore of special importance. Computer simulations of the vibration behaviour only supply a first approximation of the real performance, because complicated material models with often unknown or hard to obtain parameters are necessary to describe the material properties over an acoustically relevant frequency range. For the vibroacoustic analysis, a 3D laser vibrometry scanner has been combined with a correlation measurement system, providing the mechanical excitation with a shaker. Systematic measurement errors of the setup are compensated with a special calibration approach. An automated data transfer between CAD models, laser vibrometry and post processing applications provides fast adaption to different part geometries. A matching of the simulation models with the real behaviour therefore requires a vibroacoustic testing of the plastics components. This paper discusses the vibroacoustic testing of several technical plastics components. The necessary steps for a methodically founded comparison between simulation and measurement results are presented. Finally, possible approaches for both the subjective and objective interpretation of simulations, measurements and the acoustical reality are shown.

Mo. 18:10 Oberlin Physical acoustics I

A simple method of determining the sound absorption coefficient at oblique incidence

Xiaoru Zhou, Xueqin Zha
Fraunhofer Institut Bauphysik

This paper proposes a simple method for estimating the sound absorption coef-ficient at oblique incidence in an anechoic environment. The frequency de-pendent sound pressure (direct sound) is first measured at one microphone po-sition without any reflecting plane. In a second step a reflecting/absorbing ma-terial is inserted and the sound pressure measured again. The direct sound and the reflected sound cause interference at the microphone position. The pattern of interference depends on the absorption characteristics of the material to be tested. By analysing the interference pattern the absorption coefficient of the test object at oblique incidence can be calculated. This method can do without any complicated instruments and calculation procedures. More specifically, it yields a fast and precise estimate of the absorption ability of larger acoustic modules and linings.

Mo. 18:30 Oberlin Physical acoustics I

Interpolation of complex frequency response curves

Joerg Panzer, Charalampos Ferekidis
Consultant - R&D Team

The interpolation between two complex frequency response curves, such as obtained from turntable directivity measurements is investigated. The direct application of interpolation algorithms to response data, either in frequency or time domain, may cause interference patterns and, due to this, does not yield the expected result. This paper demonstrates the problem and offers a solution, which takes into account the multi-valued property of the exponential function of the phase term.

Mo. 14:30 Arp 1 Measuring methods in building acoustics I

Evaluation of procedures to determine uncertainties in building acoustic measurements

Hans Goydke
Technische Universität Braunschweig

In order to determine uncertainty values according to the GUM of single number quantities being the final results of several building acoustic measurement procedures two basic tasks excist. The one is to establish procedures for the determination of the uncertainty of the single number from the uncertainties of the measurement results in the third-octave or octave-bands from which the single number is dereived. The other is the evaluation of procedures to establish the uncertainty budgets for every measurement result in the different frequency bands. Solving the first task it occures that the Monte-Carlo method is well suited to be used with "shifting reference curve procedures" as they are related besides others to the airborne sound insulation index Rw. For the quantities to be used as European harmonized ones (f.i. RA,1 = Rw + C) a much simpler "linear calculation method" can be applied as well as the Monte-Carlo procedure. In order to find solutions for the second task results from several international Round Robins and also from national comparison measurements are gathered and analyzed. First results will be shown.

Mo. 14:50 Arp 1 Measuring methods in building acoustics I

Some remarks on the uncertainties associated with the laboratory measurement of noise from waste water installations

Volker Wittstock
Physikalisch Technische Bundesanstalt, FB 1.6 Schall

Laboratory measurements of noise from waste water installations are mainly carried out for two purposes. The first one is to assign individual values to different types of waste water installations with a view to comparing their acoustic properties, and the second one is to predict the noise from such systems as early as at the design stage of a building. The measurement procedure described in prEN 14366 was developed to reach these two purposes. The measurement is carried out in a usual test suite and the waste water system is mounted in the sending room on the wall between sending and receiving room. One measurement result is the sound pressure level in the sending room which mainly is a result of direct radiation from the waste water system; another result is the sound pressure level in the receiving room which is assumed to be a measure of the ability of the source to emit structure-borne sound into the building. To obtain comparable results for the latter, the structural sensitivity of the mounting

wall is normalized to a standardized sensitivity. The paper deals with several assumptions for this measurement procedure. One of these is that the structural sensitivity at the two mounting positions is averaged, whereas a detailed analysis reveals that this averaging is valid only in some special cases. Another assumption is that the source acts as a force source and the amount of vibratory energy emitted into the mounting wall solely depends on the properties of this wall and not on those of the source.

Mo. 15:10 Arp 1 Measuring methods in building acoustics I

Describing Noise of Water Appliances by ISO 3822: What happens really?

Heinz-Martin Fischer
Fachhochschule Stuttgart - Hochschule für Technik

At the moment the acoustical behaviour of valves and water taps has to be characterized by the standard ISO 3822. The present contribution describes the principles of the actual measurement method. Mainly the role of the so called INS (installation noise standard) and the understanding of the underlying reference source procedure will be outlined. It can be shown by basic considerations that the physical assumptions of this approach inevitably will result in shortcomings which considerably can influence the comparability of test results gained in different test facilities. Beyond that it can be shown that the Lap ( ) as the final result of this standardized measurement in many cases will not give a sufficient description of the real acoustic behaviour under in-situ conditions. In consequence the Lap can not be considered as a reliable basis for predictions of the appliance noise in the field (this will be of importance for the new prediction models of EN 12354-5). Thus it is recommended to revise the complete measurement procedure of ISO 3822 by means of methods related to the emitted water and structure borne sound power (see contribution of Alber et al at CFA/DAGA 2004).

Mo. 15:30 Arp 1 Measuring methods in building acoustics I

Characterization of valves as sound sources

Thomas Alber, Michael Yankonis, Heinz-Martin Fischer, Barry Gibbs
Fachhochschule Stuttgart - Hochschule für Technik

Commonly valves, especially water taps, are regarded exclusively as fluid-borne sound sources. Based on this assumption, an ISO standard 3822 has been established, which has led to considerable improvements regarding fluid-borne sound emission of valves. However the reduction in fluid-borne sound in part contributed to the finding, that structure-borne sound cannot be neglected a priori. In practice valves like water taps

are sources of air-, structure- and fluid-borne sound simultaneously. Generally measurements of airborne sound power are relatively straightforward and can be conducted using standardized methods. However the procedures are more complicated if structure- and fluid-borne sound power are to be considered, as a means to predict the acoustical performance of valves in-situ. A current research project, at the Fachhochschule Stuttgart in co-operation with the University of Liverpool, is concerned with the sound emission of valves on a power basis, including fluid- and structure-borne sound. Preliminary results of this research project are presented.

Mo. 15:50 Arp 1 Measuring methods in building acoustics I

Measurement of installation noise and service equipment in buildings

Alfred Schmitz
TAC Technical Acoustics Consult

During the last years new methods for measuring installation noise and noise from service equipment in buildings on a unit European level have been developed (EN 10052 and EN 16032). EN 10052 contains a method for survey measurements, EN 16032 deals with the corresponding engineering method. The development of these two standards has taken a long time, because many technical and 'political' problems had to be discussed and solved. First of all, the estimation of the reverberation time using a prepared table for reverberation correction is one of the points which has been discussed intensively in the working group. In particular the categories of the room types and the estimation precision have been of importance for some countries. In addition to that the attention has been focused on the introduction of a "weighted" corner position in the receiving room for measurement of the sound pressure level. Last but not least the definition of consistent operating conditions for installations and service equipment has been a main task. However, a "European" compromise had been found and the standards will become official soon. The paper summarizes the discussion of the technical and 'political' points, and explains the most important issues in more detail.

Mo. 16:30 Arp 1 Measuring methods in building acoustics I

Sound insulation test facilities yielding deviating measurement results although conforming to ISO 140

Werner Scholl
Physikalisch Technische Bundesanstalt, FB 1.6 Schall

For many years, the Physikalisch-Technische Bundesanstalt in Braunschweig (PTB) has been carrying out interlaboratory tests

in the field of sound insulation. One test of that type started in 1998, with a heavy-weight masonry wall of 24 cm calcium silicate bricks being the test object. The interlaboratory test is still going on, and participation of all laboratories wishing to obtain an official approval as a laboratory for building acoustics in Germany is required. Basic regulations for the construction of test rigs for sound insulation measurements are given in ISO 140-1. Although laboratories asking for an approval usually comply with this standard, it happens once in a while that the measurement results deviate from the mean values of the interlaboratory test to an extent which cannot be explained by the typical variance of the measurement. In one case, where the deviation was about 15 dB around 100 Hz, PTB got the opportunity to investigate the reasons. Extensive measurements were carried out, e.g. narrowband analysis of the sound reduction index, modal analyses of the airborne and structure-borne sound fields, and measurement of the total loss factor. In addition, the boundary conditions of the wall under test were changed. In the paper it will be documented in which way the geometrical configuration influences the measured sound insulation and proposals be given how the measurement can be improved.

Mo. 16:50 Arp 1 Measuring methods in building acoustics I

Experimental Investigations into Attenuation in the field of Building Acoustics

Christoph Kling

Physikalisch Technische Bundesanstalt, FB 1.6 Schall

The Applied Acoustics Department of the Physikalisch-Technische Bundesanstalt (PTB) Braunschweig, in cooperation with the Applied Mechanics Institute (InfAM) of the Civil Engineering Department of Braunschweig Technical University, is at present implementing a DFG project to investigate attenuation influences in building acoustics. It is the objective of this research project to analyze the effect of attenuation mechanisms on sound transmission in building construction. In particular, the influence on the measurement of sound reduction in the test stand will be investigated and a differentiation into properties of test object and test stand will be made. The project is subdivided into a numerical and an experimental part. At the InfAM a simulation of a test stand by combined FE and BE methods will be realized. At the PTB, the predictions from the simulation will be experimentally checked and investigated in more detail. This combination will ultimately serve to develop an instrument to predict the attenuation in the test stand and in the building and on the other hand to optimize the acoustic insulation of partitions. First of all, however,

the simulation results must be verified to substantiate the numerical predictions. For this purpose, the PTB carries out comparison measurements on scaled models and determines various material parameters by both, conventional and modified methods. The lecture presents the project and deals with the current state of the investigations. It will describe the realization of the structure-borne and of the airborne sound fields true to scale for the dimensioning of the model, the requirements resulting for the model material, and the measurement of the material characteristics.

Mo. 17:10 Arp 1 Measuring methods in building acoustics I

Measurement of Structure-borne Sound Power of Mechanical Installations

Moritz Späh, Heinz-Martin Fischer, Barry Gibbs
Fachhochschule Stuttgart - Hochschule für Technik

The standard EN 12354 Part 5 is being developed to allow prediction of the sound generated by active building components found in mechanical services in buildings. It is recognised that much of the noise generated by vibrating components transmits as structure-borne sound before radiating as perceived noise in other rooms. However, there are not yet available appropriate laboratory test methods for sources of structure-borne sound and therefore there is not reliable input data for the predictive models being developed. The structure-borne power of a source can be calculated by considering the mobilities of the source, the receiver and the free velocity or blocked force of the source at the contact points. This requires a great amount of data which cannot be obtained for most mechanical installations sources. A reception plate method is investigated as a way of reducing the required data set and simplifying data acquisition. As installations can introduce structure-borne sound into more than one surface simultaneously, a test rig is proposed with three resiliently supported mutually perpendicular plates. The structure-borne power into each plate can be measured separately. The validity of this approach is investigated by comparison of the test-rig results with predicted powers obtained by mobility methods. A case study of a whirlpool bath is presented.

Mo. 17:30 Arp 1 Measuring methods in building acoustics I

About the Measurement of Flanking Sound Transmission between Adjacent Rooms through Lightweight Walls

Stefan Schoenwald, Heiko Martin, Eddy Gerretsen
Eindhoven University of Technology - Department of Architecture, Building and Planning - Laboratory for Acoustics

The EN 12354 is a valuable tool to predict the flanking transmission of air-borne and structure-borne sound between adjacent rooms. Regarding "heavy", monolithic structures the model is in-between commonly used in building acoustics, since a lot of data is already available for the vibration reduction index Kij that describes the strength of coupling of two building elements, due to the easy applicable measurement methods that are described in the prEN ISO 10484. The Kij can be determined either by air-borne sound measurements or by vibration measurements that can be applied in the laboratory as well as in-situ. However, besides monolithic structures also lightweight, double leaf building elements exists. Unfortunately, in this case the above-mentioned prediction model is not successfully introduced yet mainly due to a lack of available data for the Kij. This is caused by the fact that mostly the indirect measurement procedure with airborne sound (prEN ISO 10484-3) was used successfully so far, which can only be applied in special test facilities for flanking sound transmission. This is a great disadvantage compared to the direct method with structure borne sound measurements. Therefore to get a better understanding of the problem a review of the CEN-model, the measurement methods for the Kij and current research work regarding the flanking sound transmission through lightweight building elements will be presented and examples for the application of the model to lightweight building elements will be given.

Mo. 17:50 Arp 1 Measuring methods in building acoustics I

Comparison of Different Methods for the Determination of the Structure-borne Noise Reverberation Time

Heinrich Bietz
Physikalisch Technische Bundesanstalt, FB 1.6 Schall

Due to the implementation of new measurement standards in building acoustics (ISO 140 series, EN 12354 etc.), measurement of the structure-borne noise reverberation time has become necessary for the determination of some measurands of building acoustics. Compared to the determination of the airborne noise reverberation time, a couple of additional problems occur. Decay processes are extremely short and the curve for the decay process is difficult to evaluate because of the lack of diffusivity

of the structure-borne noise fields. Different methods for excitation (shaker, hammer) are available, which unfortunately often lead to different results. This may probably be due to the interactions between excitation mechanism and test object. When using a shaker for excitation, correlation signals will generally have to be employed because of poor measurement dynamics, which requires quite intricate signal processing and extensive user knowledge. But the impulse response measured with a hammer, too, can be evaluated correctly only after applying the inverse integration. Numerous tests with a heavy-weight wall to investigate these problems were conducted in the past within the scope of an intercomparison at PTB. Experience gathered and results gained in current tests will be reported. Different measurement methods will be introduced and their applicability discussed.

Mo. 18:10 Arp 1 Measuring methods in building acoustics I

The effect of airborne sound transmission using the standard tapping machine as structure borne sound for lightweight stairs - problems and possible solutions

Thomas Möck, Jochen Scheck
Schalltechnisches Treppen-, Entwicklungs- und Prüfinstitut (STEP) GmbH

Within the scope of an acoustical research and development project about the sound transmission through lightweight stairs structural improvements considering the sound transmission were investigated. The investigations were carried out at our test facility for stairs measuring the total sound pressure level which is the energetic sum of airborne and structure borne sound transmission. Using the tapping machine as structure borne sound source we found that airborne sound transmission was dominant compared to the structure borne sound transmission when testing effective improvements. Therefore the correction of the airborne sound transmission according to DIN 52210 ("Luftschallkorrektur") was not possible (the actual standard DIN EN ISO 140-7 doesn't even offer a possibility for this correction). This could be considered as a principal problem when we're looking at the structure borne sound transmission of lightweight stairs which also often occurs when measuring the sound transmission of stairs in top floors. In the presentation possible solutions of this problem are discussed.

Mo. 18:30 Arp 1 Measuring methods in building acoustics I

Alternative Determination of Dynamic Stiffness of Thick Insulating Layers

Philip Leistner, Hartmut Schröder, Bettina Richter
Fraunhofer Institut Bauphysik

The dynamic stiffness of insulating layers is a decisive parameter for the sound insulation of multi-layer building parts such as floating floors, additional linings and external thermal insulation systems. With restriction to (mostly thin) layers of insulating materials used under floating floors a measurement procedure its regulated in the standard DIN EN 29053. Due to this restriction a reliable procedure for insulating layers in other applications is still needed. Especially the stiffness of very thick layers of external thermal insulation systems is hard to analyse. The mounting conditions strongly influence the results and the measurement uncertainty is generally high. These problems can be avoided by an alternative procedure which should also be as practical as possible. In comparison with the standard shaker excitation, which is far from reality of thermal insulation systems, an airborne sound excitation shows several advantages. In this sense the impedance tube can be used. The measured sound absorption curve clearly shows the resonance behaviour of a mass (plaster) - spring (insulating layer) system. With the known mass the dynamic stiffness can be easily derived. Further practical conditions are ensured by horizontal orientation of the multi-layer system and by well-defined lateral terminations. Even the influences of different support systems, e.g. plugs or frames, can be investigated in impedance tubes with bigger cross-sections (> 1 m^2). A number of tests will be presented and compared with other results including results of sound insulation measurements.

Mo. 14:30 Arp 2 Global reduction of transportation noise

The 'Research Network Quiet Traffic' - A Global Approach to Reduce Transportation Noise

Dietmar Wurzel
DLR

Traffic noise has become a severe environmental problem. Noise negatively affects the physical, psychic and social well-being. Consequently, noise reduction will improve the quality of life and is an essential element of health protection. The global attenuation of noise from road, rail and air traffic is an ambitious goal. Mobility and thereby economical progress must be guaranteed while transportation noise is reduced despite increasing traffic density. To provide an enabling and interdisciplinary approach

for the coordination of all noise abatement efforts across traffic branches, the research network 'Quiet Traffic' was founded in Germany in 1999. 70 partners from academia, research institutions, manufacturers, operators, and government agencies have joined the network to develop noise reduction methods at the source, quiet traffic routes, and operational procedures; to recommend new noise rules and standards; and to improve traffic management and control. Beneficiaries will be residents affected by traffic as well as industry, which, by achieving specific knowledge in noise abatement technology, will gain a competitive advantage. Current activities: - Low-noise road traffic - tire-road interaction, noise at expansion joints - Low-noise trains and tracks - wheel-rail interaction, propulsion noise - Low-noise transport aircraft - engine and airframe noise - Common technologies and methodologies - noise source location, propagation, and immission prognoses. A special feature is the inclusion of research on the effects of noise on humans to formulate reliable specific noise criteria and limit values and to suggest effective ways to lower the effects from noise exposure. Although some activities extend to 2006, first results have already been achieved.

Mo. 14:50 Arp 2 Global reduction of transportation noise

Protecting people against transportation noise - overview over the section 'Noise effects' within the 'Research Network Quiet Traffic'

Barbara Griefahn
Institut für Arbeisphysiologie an der Universität Dortmund

Within the Research Network 'Quiet Traffic' the section 'Noise Effects' a variable number of partners focus their activities on the solution of four problems: 1) Diurnally varying noise sensitivity. One partner studies residents either exposed to rail or to road noise. Noise levels and acute annoyance are recorded during the day to quantify the temporal responsiveness. Another partner determines the reactions to both noises during sleep. The results are applicable for traffic management. 2) Assessment of frequency spectra. Noise attenuation reduces the level but alters the spectra towards lower frequencies and the temporal structure towards intermittency which both cause stronger effects even during deep sleep. Five partners evaluate the significance of lower frequencies for communication, performance, and sleep. The results are useful for the construction of vehicles. 3) Assessment of noise sources. All partners study the effects of rail and of road noise on various psychophysiological functions. The comparison reveals whether the rail bonus is valid for various activities. 4) Assessment of combined noise sources: It is as yet not possible to evaluate noise emitted from more than one source.

Four partners study annoyance while combining systematically various road and rail noises and will develop an appropriate prediction model.

Mo. 15:10 Arp 2 Global reduction of transportation noise

Multidimensional scaling of road and railway noise in a 5.1-surround situation

Rudolf Bisping
SASS acoustic research & design GmbH

The effect of combined road and railway noises on the human listener is one of the topics of the BMBF-project Leiser Verkehr. Currently a joint study is performed by three laboratories (IfADo, SASS, Universität Eichstätt-Ingolstadt) to find out wether the combination of these noise has some specific interactive effect on the listener or not. Beside annoyance other perceptual cues such as timbre, powerfulness, impulsiveness, etc., are assumed to be relevant, too. For this reason subjects where asked to scale these attributes using a multidimensional categorical technique. The experimental noises were presented in an ITU 5.1-surround situation which proved to reproduce quite naturally the quality of the original sources. Factor analysis of the data showed that indeed the perception of the noises is related to a hierarchically organized pattern of several cues rather than just on annoyance. The data not only help to better understand the human perception of traffic sounds and to improve the scaling procedure in the current joint study but are used as a psychometric guideline for the set up of a systematic library of road and railway noises, too.

Mo. 15:30 Arp 2 Global reduction of transportation noise

Evaluation of traffic noise by quality of speech communication

Charlotte A. Sust, Hans Lazarus, Rita Steckel, Marko Kulka
ABoVe GmbH

Evaluation of traffic noise by quality of speech communication by Ch. A. Sust1, H. Lazarus2, R. Steckel2, M. Kulka2 1Above GmbH; 2BAuA (Federal Institute of Occupational Safety and Health) Speech is the most important medium of communication. Disturbing communication by noise influ-ences the quality of dwellings, leisure areas, and workplaces. The quality of speech communica-tion is mainly influenced by speech intelligibility, which is used as an important instrument for dis-criminating the effects of different noises. High signal-to-noise-ratios result in a relative high speech intelligibility which is defined with defined speech material as a percentage of recognised speech items (0 to 100 %). But a high speech intelligibility does not mean automatically a high quality of speech communication, which is also

influenced f.e. by necessity of concentration, of coping strategies, etc. In two experiments speech communication will be simulated under defined conditions, which al-lows an effective evaluation of different - concerning frequency and time structure - traffic noises. That means defined speech material - monosyllables and semantically contextfree, but grammati-call correct sentences - has been recorded from different speakers (male, female, native and non-native speakers) and is presented under six different signal-to-noise-ratios (from -15 to +20 dB) of traffic noises to subjects, who have to repeat the monosyllables and the sentences. After present-ing three items subjects have to evaluate the quality with a rating scale which includes aspects of subjective speech intelligibility, concentration, annoyance and coping strategies. Results of the first experiments, where noises varying in frequency (RR, road and train traffic noise) are used, are presented.

Mo. 15:50 Arp 2 Global reduction of transportation noise

Detrimental Effects of Traffic Noise on Basic Cognitive Performance in Adults

Alexandra Schmid, Jürgen Hellbrück
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Noise is one of the most serious environmental problems. Especially traffic noise has been permanently increasing in the last decade, and is expected to grow dramatically in the near future. Particularly at working places such as bureaus or schools, which are situated nearby highly frequented routes, traffic noise is becoming more and more a reason for complaints. The results of preliminary experiments investigating basic cognitive functions, which are important in mental work, like attention, encoding or memory, are reported. These cognitive functions show differential sensitivity toward certain aspects of traffic noise, especially its loudness and spectral-temporal structure. The findings are interpreted in relation to the well examined influence of speech-based noise on such tasks. So far, it can be shown that the crucial parameter of traffic noise contrary to background speech is first of all its sound pressure level, but also its temporal structure. Additionally, the impact of traffic noise depends on the nature of the cognitive requirements. Especially tasks that demand more central executive functions seem to be sensitive for interferences caused by traffic noise. These results are discussed with respect to deductions for noise abatement.

Mo. 16:30 Arp 2 Global reduction of transportation noise

"Leiser Verkehr" (Quiet Traffic), Project 2222: Effects of traffic noise on speech intelligibility and cognitive performance in children, Part 1: Effects of different kinds of traffic noise on reading and attention performance in elementary school children

Helga Sukowski, Maria Klatte, Markus Meis, August Schick
Universität Oldenburg, Institut für Psychologie, Abteilung Umwelt und Kultur

In the context of the sub-project "Effects of traffic noise on speech intelligibility and cognitive performance in children" the first test module examined attention performance (arithmetic test) and reading performance (reading test) in children under the influence of traffic noise. In addition, the perceived annoyance due to presented noise stimuli was surveyed. The implemented sounds varied in traffic density and frequency spectrum. A total of 103 children from elementary schools in Oldenburg with ages ranging from 8-10 years at the time of participation took part in the experiment. The results from the arithmetic test show a general negative influence of the noise conditions compared to the control condition as well as significant differences between particular noise conditions. In both the arithmetic and reading tests, negative effects due to traffic noise were especially detected in children with high performance levels. An analysis of the judgments on annoyance primarily revealed an influence of traffic density. In total, negative effects of general noise conditions as well as of particular noise stimuli were confirmed. The results additionally indicate that the influence of noise stimuli cannot only be predicted by acoustical parameters. Moreover, other factors such as individual performance ability also influence whether and to what extent an effect due to noise is detectable.

Mo. 16:50 Arp 2 Global reduction of transportation noise

"Leiser Verkehr" (Quiet Traffic), Project 2222: Effects of traffic noise on speech intelligibility and cognitive performance in children, Part 2: Effects of different kinds of traffic noise on children's speech perception and phonological short-term memory

Maria Klatte, Helga Sukowski, Markus Meis, August Schick
Universität Oldenburg, Institut für Psychologie, Abteilung Umwelt und Kultur

The ability to analyze, store and process heard speech plays a fundamental role in social and cognitive development. Since children have much more difficulties to understand speech in noise than adults, noise reduction should be a primary goal in order to

achieve acoustical environments supportive for children's learning. In a current study, we investigate the effects of traffic and speech noises on performance in listening tasks in children aged six to seven years. The tasks include phoneme discrimination, phonological short-term memory, and sentence comprehension. The traffic sounds vary with respect to temporal and spectral characteristics. The aim of this study is (a) to explore the effects of moderate-level environmental noise on children's learning and (b) to explore which qualities of traffic sounds affect the disruption of children's speech perception. Such findings could provide reasonable guidelines for the technical development of low-noise means of transport.

Mo. 17:10 Arp 2 Global reduction of transportation noise

Acute Annoyance caused by Noise emitted from Rail and Road Traffic

Edna Leue, Martin Schütte, Barbara Griefahn
Institute for Occupational Physiology

Objectives: The study aims at the determination of dose-response-curves for separately occurring train and road traffic noise in the laboratory. It is supposed that acute annoyance depends on the particular activity a person actually performs. The main question to be answered is, how the dose-response relation is influenced by actually exerted activity. Method: 24 healthy male and female subjects, 20 to 30 years of age listen to a total of 16 sounds while sitting in a sound proof room. Each sound lasts 3 minutes, the sound pressure levels of road and rail traffic noise are varied from 40 to 82 dB (A) in steps of 6 db(A). The subjects are requested to imagine to be at home. Following each presentation they have to rate the resulting acute annoyance as well as loudness, pitch, dynamics, impulsiveness and pleasantness. Additionally, they rate the annoyance that they expect while performing six different home activities. Results: Annoyance obtained for the condition "to be at home" will be compared with annoyance supposed in case of different home activities. The study is in progress and will be finished at the end of the year 2003.

Mo. 17:30 Arp 2 Global reduction of transportation noise

Statistical modelling of exposure-response relationships in the analysis of multiple transportation noises

Sonja Kuhnt, Christoph Schürmann
Fachbereich Statistik

Transportation noise from diverse sources results in different subjectively felt loudness and annoyance. To assess this relationship quantitatively one wants to have exposure-response models. We

consider data from experiments, which expose subjects to multiple transportation noises consisting of different levels of road and rail traffic noise. When analysing the effect of noises, rating scales are often used such that subjects can record their individual perceptions quite precisely. In these cases the assumption of a Normal distribution for the ratings underlying the classical linear model is usually not appropriate. So-called generalised linear models extend the linear model in two ways: data are not necessarily assumed to be normally distributed but have a distribution from an exponential family and the mean is not necessarily modelled as a linear combination of certain covariates but some function of the mean is. We show how this model class can be used to derive a prediction model for annoyance resulting from multiple transportation noise. We use a dataset from an experimental setup where subjects have had to accomplish grammatical reasoning tasks under certain surrounding noise scenarios. The effect of noise on the subject is measured mainly by the subjectively felt annoyance and loudness. Further covariates like daytime of exposure, sex, laboratory and difficulty of the task are also considered.

Mo. 17:50 Arp 2 Global reduction of transportation noise

Sleep disturbances caused by transportation noise - part 1: alterations on the polysomnogram

Anke Marks, Barbara Griefahn
Institut für Arbeisphysiologie an der Universität Dortmund

,Leiser Verkehr" (Quiet Traffic), Project 2311: Sleep disturbances caused by transportation noise - part 1: alterations on the polysomnogram Anke Marks & Barbara Griefahn Institute for Occupational Physiology at the University of Dortmund Objectives: Noises from road, rail, and air traffic are compared concerning sleep disturbances and after effects to derive adequate "Bonus-Malus"-regulations. Methods: 32 healthy and normal hearing students (16 male, 16 female, 18 - 30 years) sleep ever 4 nights of three consecutive weeks in the laboratory while exposed to the randomly presented noises. Each set of four nights consists of a control night and 3 nights with Lmax of 62, 68, and 74 dB(A). The same Leq for the 3 noises is achieved by varying the number of events. Dependent variables are the polysomnogram (EEG, EOG, EMG, ECG), subjective assessment, and performance (switch task, go/no-go task, random generation of numbers). Results: Concerning the polysomnogram, latency, total sleep time, total time spent awake and in deep sleep were evaluated. First analyses of few subjects revealed that irrespective of the type of noise the time awake increases and deep sleep decreases with the sound pressure level. The strongest difference

exists between the quiet condition (32 dB(A)) and the maximum noise load (74 dB(A)). Concerning noise quality, the strongest effects in terms of increased time awake were evoked by rail traffic noise. A more detailed evaluation will be presented at the congress.

Mo. 18:10 Arp 2 Global reduction of transportation noise

Sleep disturbance by traffic noise: after-effects on brain activity

Sergei Schapkin, Barbara Griefahn

Institute for Occupational Physiology

This study examined the influence of sleep disturbances caused by traffic noise on inhibitory processes underlying the action planning and implementing. Fourteen undergraduates completed both simple and complex Go/Nogo tasks to visual word stimuli after sleep in quiet and after sleep under the influence of aircraft and road traffic noise with Lmax = 74 dB(A). The difference in event-related brain potentials (ERPs) between Nogo and Go trials served as an index of inhibition. After quiet nights, the N2d and P3d components with a maximum over fronto-central brain areas were smaller in amplitude and longer in latency in complex than in simple task, which suggests that they reflect the amount of resources available for inhibition of an intended action and hence for effective regulation of behaviour. In contrast, after noisy nights the clear-cut decrease of the N2d and P3d amplitudes and (to a lesser extent) prolonged latencies were obtained. This effect was greater in the complex task than in the simple one and after sleep disturbance induced by road traffic noise than by aircraft noise. The result suggest that traffic noise can exert its negative effect on brain processes indirectly, through shortening of cognitive resources by sleep disturbance.

Mo. 18:30 Arp 2 Global reduction of transportation noise

Low Noise Road Traffic - Results from test site B56

Wolfram Bartolomaeus

Bundesanstalt für Straßenwesen

The project "low noise road traffic" was part of the integrated project "low noise traffic". It was finished for the most part end of 2003. During the project together with our 15 partners from industry, institutes and universities we developed new road surfaces, new tires, a new wheel housing and new bridge crossings. On our test site, B56 near Düren, 10 different surfaces were build. Results from both controlled pass-by and statistical pass-by measurements over two years from these sections are shown.

Mo. 14:30 Arp 3 Localization of normal hearing . . .

Binaural rendering assessment in the context of augmented reality

Olivier Warusfel, Olivier Delerue, Isabelle Viaud-Delmon
IRCAM

The paper presents recent work undertaken on binaural rendering in the context of the European project LISTEN, dedicated to augmented reality (AR) and museum applications. Thanks to wireless technology applied to audio transmission and tracking systems, binaural synthesis, up to now confined to laboratory contexts, may be applied to create large scale immersive and interactive virtual sound scenes. In these applications, the visitor, equipped with motion-tracked wireless headphones, explores a real space seamlessly augmented by an interactive audio content. The virtual sound scene, composed of sound sources disseminated in the space and of associated room effects, is rendered using binaural synthesis, the only technique allowing fully controlled localization cues. The paper reminds the different implementation approaches for binaural rendering and the remaining issues often commented in the litterature, such as the front-back localization ambiguity and the need for an individual morphological adaptation. However, the introduction of the 3D sound modality in augmented environments highlights the need for a better understanding of multi-sensorial integration mechanisms, since the context involves user's navigation and perception-action mechanisms linked to auditory versus idiothetic interactions. Moreover, augmented reality also allows the use of non physical or realistic laws, when modelling distance effects, auditory perception field or room reflexions. Therefore, conventional localization performance tests, usually applied for assessing binaural rendering quality, should be replaced in a multimodal scheme focusing on the congruence of the virtual world and on the user's ability to fulfil a navigation task or to build a cognitive spatial map of the proposed world.

Mo. 14:50 Arp 3 Localization of normal hearing . . .

Localization of Auditory Sources in Virtual Reality

Isabelle Viaud-Delmon, Ludivine Sarlat, Olivier Warusfel
CNRS UMR7593

Virtual reality (VR) represents a set of computer technologies, which allow users to interact with a three-dimensional, computer-generated environment in real time. VR is starting to be used in psychophysics experiments as well as in psychological therapy around the world. VR provides a way to immerse a user in an environment in which the interaction between different sensory

modalities can be controlled. Therefore VR represents an interesting tool to study the integration of space-related multisensory information in human and its disorders. Incorporating real-time updated 3-D sound to virtual reality technologies addresses several issues. If there seems to be a consensus on the fact that 'presence' is improved by 3-D sound, little is known about how an auditory virtual environment (VE) should be designed so that it does not interfere with the visual VE. It is well known that discrepancies in the location of synchronized auditory and visual events can lead to mislocalizations of the auditory source, so-called ventriloquism. In two experiments, we tested whether such cross-modal influences on auditory localization could be observed after an immersion in a VE. Auditory stimuli were presented via headphones (HRTFs) and were presented in synchrony with virtual visual events. We observed that the association of virtual auditory and visual stimuli could lead to a 'complete' remapping of auditory space, including stimulus locations not presented during the VR immersion. It is therefore possible to induce a ventriloquist effect with VR, which can not be interpreted in terms of a simple visual biasing of auditory localization.

Mo. 15:10 Arp 3 Localization of normal hearing . . .

Learning to Judge Distance of Nearby Sounds in Reverberant and Anechoic Environments

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Boston University Hearing Research Center

Previous studies have shown that accuracy of distance judgments for nearby sources improves over time when the listener is in a reverberant environment, but not in an anechoic space. The improvement observed in rooms may be the result of the listener learning (through experience) how to interpret reverberation cues and map these cues to different distances in a particular room. The present study evaluates whether such "room learning" is disrupted when reverberation cues vary over the course of the experiment. Results of two auditory distance perception experiments are reported. In the first study, perceived distance was measured for listeners whose position in a real room was varied from session to session. In the second study, distance perception was studied using virtual auditory space (VAS) techniques to simulate sounds for different listener locations in a reverberant room and in anechoic space. In the real room, listeners appeared to get better at judging source distance despite the fact that their location in the room varied from session to session. However, in the VAS study, intermingling sounds simulated in a room with sounds simulated in anechoic space led to a dramatic reduction in performance overall as well as a reduction in the amount of

improvement observed with experience. In the limit, when the simulated room was varied on a trial-by-trial basis, no learning was observed. These results suggest that listeners can generalize "room learning" across different listener locations within a single room, but not across dramatically different acoustic environments.

Mo. 15:30 Arp 3 Localization of normal hearing . . .

Modeling the Precedence Effect for Noise Bursts of Different Durations

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Recently, a number of binaural models have been applied to explain the precedence effect for experiments using click pairs without the need of contralateral-inhibition elements as was proposed by Lindemann in 1986. These findings raised the question of to what extent those types of models are able to explain experiments for lead-lag pairs with longer durations. The simulation revealed that models which simulate the precedence effect by using the special characteristics of the auditory periphery (Hartung and Trahiotis, 2001) or by focusing on the spectral-dominance region (Tollin, 1998) fail when stimuli of longer duration than clicks are used, while a modified Lindemann model still shows satisfactory results. In principle, the modification consisted of alternating the combined algorithm to process interaural level differences and interaural time differences into two separate ones. In the model simulation, it was unnecessary to consider cross-frequency-band interaction like the second coincidence weighting of Stern et al. (1988), and it was sufficient to estimate the average of the outputs of the frequency bands involved. However in order to simulate the data for the ongoing (non-impulsive) stimuli, the degree of inhibition, which was originally adjusted to simulate the precedence effect for click pairs, had to be increased considerably. These findings indicate that the degree of inhibition increases dynamically with the exposure time of the stimulus.

Mo. 15:50 Arp 3 Localization of normal hearing . . .

Sensitivity to Interaural Time Delay in Stimulus Fine Structure and Envelope of Bilateral Cochlear Implant Listeners

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Acoustics Research Institute, Austrian Academy of Sciences

Recent studies on the sensitivity of bilateral cochlear implant (CI) listeners to interaural time delay revealed JNDs in the order of 100 μs. There are indications that sensitivity is restricted to stimuli containing low rate signal information in either the carrier or the envelope. This has been inferred from JNDs for ITD applied

either to the entire stimulus (interaural waveform delay, IWD) or to the envelope only (interaural envelope delay, IED) [R. van Hoesel and R. Tyler, 2003]. This study investigates the sensitivity of bilateral CI listeners to IWD, IED and, as a newly tested condition, delay in the fine-structure only (interaural fine-structure delay, IFSD), as a function of pulse rate. Two different stimuli are tested: stimulus A is a sequence of four equal-amplitude pulses. Sensitivity to IWD, IED and IFSD is tested by interaurally delaying all 4 pulses, pulses 1+4 only, or pulses 2+3 only, respectively. Stimulus B is a pulse sequence shaped with a trapezoid function. Here, IWD, IED and IFSD refer to an interaural delay in the entire stimulus, the envelope only or the pulse timing only, respectively. The experiments are also performed with normal hearing subjects listening to simulations of CI stimulation. With these experiments we hope to get more insight into the relative potencies of interaural envelope- and fine-structure delay at different electrical pulse rates. Moreover, the results should provide information on the relevance of interaural synchronization in pulse timing. Results of these experiments, which are currently underway, will be presented.

Mo. 16:30 Arp 3 Localization of normal hearing . . .

Localization cues with bilateral cochlear implants investigated in virtual space - a case study

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Cochlear implants stimulate spiral ganglion cells in few, wide areas using discrete, amplitude-quantized pulses. This results in reduced spectral, temporal, and amplitude resolution. Nevertheless, several studies could show outstanding localization ability with selected bilateral cochlear implant subjects. A previous free-field study showed that interaural time differences could not be evaluated for localization with low-frequency carriers (Seeber et al., DAGA 2003). As the relative weighting of interaural temporal and level cues for localization can not be tested for high-frequency carriers in the free-field, a study using virtual sound presentation was conducted. Interaural level cues (ILDs) were calculated from test stimuli, which incorporated the compressive pre-processing of the cochlear implant. Interaural temporal cues (ITDs) were deduced from directional transfer functions of the speech processor when being placed on a head. The ILD and ITD cues of the test stimuli were then independently modified. A localization test using these modified virtual stimuli showed high spacial sensitivity to changes in ILDs, but no or small sensitivity to ITD changes, even for high frequency carriers. It can thus be

followed that interaural temporal cues are not used by this subject for localization. In opposite to normal hearing, localization is entirely based on monaural spectral cues and interaural level cues for our cochlear implant subject.

Mo. 16:50 Arp 3 Microphones and loudspeakers

Design refinement of high order ambisonics microphones - Experiments with a 4th order prototype

Jérôme Daniel, Sébastien Moreau
France Télécom R&D

Ambisonics is a very flexible sound spatialisation technology based on the spherical harmonic decomposition of a sound field. It has known an increasing interest during the past years thanks to studies that have extended the theory (and to a less extent, its application) from first to higher order. This paper deals with the theory, design and implementation of high order ambisonic microphones. High order ambisonic pickup is a technology based on the spherical harmonic decomposition of a sound field. The goal is to record the spherical harmonic components that describe the sound field at a chosen point of the referential and in the vicinity of it. The area of reproduction depends on the numbers of considered components and signals frequency. The estimation of the spherical harmonic components is in fact distorted due to the aliasing effect that appears when a finite number of sensors is used. The importance of this artefact depends on both spherical array radius (and thus the angular gap between sensors) and frequency. The implementation of an ambisonic microphone comes up against another problem. If we consider the near field recording, the equalization has an infinite bass amplification for low frequencies and high spherical harmonics components. Compromises must be introduced to make practicable application possible. A prototype of a high order ambisonic microphone capable of recording the sound field up to the 4th order has been realized. This prototype consists of 32 sensors arranged on the surface of a rigid sphere associated with a signal-processing unit.

Mo. 17:10 Arp 3 Microphones and loudspeakers

An Alternative Concept for the Realization of a Digital Condenser Microphone with high-range Dynamcics

Roland Müller, Peter Holstein
SINUS Messtechnik GmbH

A concept has been recently presented for high-frequency condenser microphones (DAGA 2003. Especially, it is appropriate for high-quality microphones for measurement purposes. In this connection, the capacity of the microphone capsule dominates the frequency behaviour of a LC-generator. The non-linearity,

which is a results of Thomson's relationship, can be compensated to a large extent. This results in large range of dynamics. In this contribution, an approach will be discussed for adequate demodulation and digitization. The proposed procedure are characterized by low noise and extremely small non-linear distortions, as well. Simulations and experimental results are compared.

Mo. 17:30 Arp 3 Microphones and loudspeakers

Study of a PVDF dome shaped loudspeaker

Bruno Gazengel
LAUM

This work studies the acoustic radiation of a dome shaped PVDF loudspeaker. The PVDF loudspeaker consists of a circular PVDF thin film, clamped around, dome shaped by means of a static pressure which is applied at the back. A time variable voltage applied between the two faces of the film enables to produce a acoustic pressure by means of the piezoelectric effect. The first part of the study focuses on the static behaviour of the speaker. The static deformation is calculated using models found in literature and is measured by means of a displacement sensor. Results enable to estimate the Young modulus of the PVDF material used in the experiment. The second part focuses on the dynamic behaviour of the speaker. At first, analytical models found in the literature are used for predicting the acoustic pressure radiated. Secondly, a finite elements model is used for calculating the acoustic pressure radiated in the near field of the speaker. Finally, an experiment is conducted for measuring the pressure response of the speaker. Results show that results obtained by means of finite elements and experimental results agree well. However, the analytical model does not enable to estimate the acoustic radiated pressure. This difference is explained by the fact that the analytical model does not take into account the coupling between the film and the air.

Mo. 17:50 Arp 3 Microphones and loudspeakers

Electro acoustic coupling in closed space

Pierre-Jean Rene
Ecole Polytechnique Fédérale de Lausanne

The design of loudspeaker systems is usually undertaken under the assumption that load impedance is a radiation impedance into 2 or 4p sr. This is not valid when the wave lengths at the frequencies used by the loudspeaker are of the same order of magnitude as the dimensions of confined space, for example for the low-frequency sounds in a room, control room, or in a technical volume in which active noise control is being carried out (engine nacelle), etc. The loudspeaker cannot be compared any more to

a source of constant volume throughput: the flow depends not only on the system excitation but also on the source and load impedances. This requires better modelling of the electro acoustic coupling between the loudspeaker and room in which it radiates, particularly below the Schroeder frequency, where there are no or only few excited modes. The calculation of the transfer function between the voltage at loudspeaker connectors and the acoustic pressure at any point of the closed space can be made using this model.

Mo. 18:10 Arp 3 Microphones and loudspeakers

Characterisation of Non-Linearities

Delphine Bard
Ecole Polytechnique Fédérale de Lausanne

Characterisation of non-linearities The characterisation of a weakly non-linear electroacoustic device with classical methods of measurement (THD, intermodulation) does not illustrate the non-linearities themselves, but only some of their effects. Device linearisation can be achieved by applying the inverse non-linearity upstream of the device, under the condition that the non-linearity law is known in detail. This paper presents the first stage of transducer non-linearity compensation, namely an experimental method of weak non-linearity characterisation, based on the Volterra series and the analysis of the device response to 'multitone' excitation signals. A careful choice of the number, magnitude and phase of the excitation components allows an easy and effective extraction of Volterra kernels at their different orders. When expressed in the frequency domain, the latter constitute a generalisation of transfer functions at orders greater than one. The algorithm corresponding to the presented method has been developed and implemented as software, handling both the generation of excitation signals and the analysis of their response in terms of Volterra kernels, with the support of '.wav' files. It is thereby possible to rebuild the response of the non-linear system from the kernels and to compare it to experimental results.

Mo. 18:30 Arp 3 Microphones and loudspeakers

Realization of a Dynamic Equalizer for Audio Signals using Linear Phase IIR Digital Filters

Dieter Leckschat, Oliver Luedecke
University of Applied Sciences

Equalizers with signal-dependant filter characteristics have a wide application field in audio restauration, sound reinforcement, mastering, sound design and others. Moreover it is desirable for many applications that the filters are phase linear. In the literature a method has been introduced to realize phase linear digital

filters of the IIR type using local time reversal. We report on two implementations of an algorithm which supports the linear phase IIR method and the real time morphing of filter coefficients in dependance of the signal level. One solution works as a native plug-in which can easily be integrated in most audio processing programs while the other one is a 48-Bit DSP software used on dedicated signal processing cards. - Processing power and memory considerations will be discussed as well as performance aspects.

Tu. 8:30 Schweitzer Car acoustics II

Road Noise Analysis Using A Binaural Time Domain Approach

Christian Nettelbeck, Daniel Riemann, Philipp Sellerbeck
HEAD acoustics GmbH

As the noise from the power train is continuously reduced, road and tire induced airborne and structure-borne noise shares become more and more important for the overall sound quality. Two independent road noise mechanisms have to be taken into account: tire noise on plain or coarse road and noise from single bumps. Starting from a binaural vehicle interior noise recording, a method based on multiple coherence analysis is introduced that enables the user to distinguish between the noise shares of single axis, wheels or even between airborne and structure-borne noise contributions. Due to the fact that the method works in the time domain it includes the advantage to binaurally listen to single contributions. Furthermore, it is possible to verify the influence of component transfer behaviour or vibroacoustic body transfer functions on the single noise contributions, while source signals and transfer paths can be addressed individually. The auralization of synthetic modifications of single input signals and/or transfer paths provides helpful information for troubleshooting and sound design.

Tu. 8:50 Schweitzer Car acoustics II

Binaural Auralisation of Vibrating Surfaces - Laser Scanning Vibrometry Combined with Binaural Transfer Path Analysis

Oliver Wolff, Sandro Guidati, Roland Sottek, Heinrich Steger
HEAD acoustics GmbH

Laser Scanning Vibrometry has become a well-established working tool for vibration analysis in different areas of automotive industry and research. Apart from statics and strength a lot of applications are increasingly concerned with acoustics. The knowledge of vibration behaviour alone is usually not sufficient to fully describe the acoustical behaviour, since the sound radiation factor, the transmission of the sound to the drivers's ears (airborne

transfer functions) as well as the structural pattern of the sound itself (psychoacoustic perception) have not been adequately taken into account so far. A new method is presented combining laser scanning vibrometer measurements with binaural transfer path analysis. Airborne noise transfer functions between driver's ears and the vibrating surfaces are measured with a binaural sound source by making use of the reciprocity principle. Thus visual representation of structural vibrations is not limited to e.g. the amplitude of a certain vibration, but is numerically weighted with the binaural airborne noise transfer function instead. This new type of representation is a measure for the acoustic relevance of the structure and points to single areas responsible for the noise at the driver's ears. This procedure allows the binaural auralisation of acoustical contributions from different areas of a vibrating structure. Measured acoustic transfer functions can also be used as filters for time data visualisation. This provides additional access to non-stationary investigations as well (e.g. run-ups). Experimental results gained from a model structure that has been built up for investigation purposes as well as first results on a test vehicle will be presented.

Tu. 9:10 Schweitzer Car acoustics II

Binaural Panel Noise Contribution Analysis - An Alternative to the Conventional Window Method

Oliver Wolff, Roland Sottek
HEAD acoustics GmbH

When designing the interior noise of a vehicle it is often interesting to know the noise contributions from single surface areas to the total interior noise. The conventional "window method", sometimes also called "subtractive procedure", requires the partial or full encapsulation of the passenger compartment with a proper sound insulation package. This vehicle condition serves as a reference. The sound level of the reference condition is related to the measured sound level for sound insulation packages where insulation material has been selectively removed from the individual surfaces of interest (windows). The level difference is used as a measure for the acoustical surface contribution to the total sound level. Unfortunately, test drives on roads are hard to realise due to safety reasons. The weight of the sound insulation package alters the structure of the vehicle and the absorption behaviour of the cabin is changed, too. Additionally, the preparation of the sound insulation package is generally time consuming and expensive. However, HEAD acoustics is able to present a new procedure, the binaural panel noise contribution analysis. By using a special sensor array which is applied to the surface under

investigation, it is possible to perform measurements while driving on the road. Vehicle structure and absorption behaviour are not changed by the array. In addition to significant time- and cost-saving-effects, this new procedure offers a wide range of analysis possibilities. Room acoustics is taken into account and enables users to listen binaurally to the noise contributions of individual surface areas. The described procedure has been successfully tested on several vehicles.

Tu. 9:30 Schweitzer Car acoustics II

Psychoacoustic investigation on sport sound of automotive tailpipe noise

Jan Krüger, Frank Castor, Alexander Müller
J. Eberspächer GmbH & Co. KG

In addition to technical and economical aspects, the emotional component of modern cars gains more and more importance. The sound of the exhaust system is one of these emotional components. Due to the legislative limitation of the pass-by-noise level, it is not possible to emphasise the sportiness by simply increasing the SPL. Therefore, the first part of this investigation dealt with the characterisation of sport sound of automotive tailpipe at comparable noise levels. For this purpose, physical measurement categories and psychoacoustic parameters were compared with subjective evaluations. In the course of a Jury Evaluation, 101 test persons assessed several Artificial Head Recordings of different tailpipe noises. Furthermore, some of the original recordings were modified according to rules of other works published ear-lier on. Five pairs of adjectives were used to describe the subjective sound impres-sion. These five pairs of adjectives could be summarised in the two factors sportiness and comfort by means of the statistical method of factor analysis. In the second part, the influence of individual properties such as age, sex, annual kilometres travelled on the subjective sound evaluation was determined.

Tu. 9:50 Schweitzer Car acoustics II

Acoustic Quality Control of Drum Brake Shoes

Michael Haverkamp, Norbert Koopmann
Ford Werke AG Köln

Recent investigations of brake noise phenomena show that natural frequencies and damping of brake components play an important role regarding the propensity of noise excitation. While works are on-going to include requirements of those parameters into international standardization (e.g. ISO) of disc brakes, there is lack of knowledge regarding drum brake noise. Torsional modes of drum brake shoes are a main contributor to squeal phenomena,

because they provide coupling of backing-plate bending modes to axial drum resonances. Therefore natural frequencies, damping and variability of physical properties of the shoes are main parameters, which have to be assessed. Vehicle tests have shown that in various cases a strong increase of the torsional stiffness of drum brake shoes can eliminate squeal phenomena. First, the presentation provides an overview of methods appropriate for excitation and measurement of the vibrational modes. Secondly, a quick test is recommended that avoids complicated fixture of exciting structures and measurement pickups. This method works cost-efficiently and allows fully automated operation. Test results are presented and compared with those of various methods of vibrational analysis.

Tu. 10:10 Schweitzer Car acoustics II

Sound quality design by passive measures in the underbody and the closer engine area

Dimitrios Patsouras, Klaus Pfaffelhuber, Christine Patsouras
AKsys GmbH

Several passive measures in a vehicles' underbody area (encapsulation with various membrane absorbers or microperforated absorbers) as well as in the motor compartment were realized. The recorded outdoor idling noises of the vehicle equipped with those different passive measures were presented to subjects in psychoacoustic experiments. The subjects' judgments allowed to draw clear conclusions about the efficiency and the quality of the respective absorbing system and showed thus the large potential reachable by passive measures in the engine compartment.

Tu. 14:50 Schweitzer Car acoustics III

Subjective and objective characterisation of tonal components in tyre/road noise

Sandra Buss, Reinhard Weber
Carl von Ossietzky Universität Oldenburg

An important factor for the generation of tyre/road noise is the geometry of the tread pattern. The pattern noise is a tonal component of the tyre/road noise with speed dependent frequency. A perceivable tyre/road noise leads to a decreased quality rating in a subjective evaluation of tyre/road noise. In order to find an objective measure for the subjectively perceived pattern noise, tyre/road noises are evaluated in a paired comparison test. The set of tyre road noises consists of one tyre/road noise and modifications of this signal with systematically varied spectra. The subjective evaluation of pattern noise can be referred to objective parameters calculated from the signal. Also an aurally adequate signal analysis is performed and compared to the subjective evaluation of the tyre/road noises.

Tu. 15:10 Schweitzer Car acoustics III

The effect of Road Absorption on Tyre-Road Horn effect

Fabienne Anfosso-Ledee
LCPC

Horn effect is an amplification phenomenon of the tyre-road noise generated at the contact patch, due to multiple reflections between the tyre belt and the road surface. This effect can be drastically reduced when the pavement is sound absorbing, which is the case for porous pavements. A 2D BEM model was used to predict this effect in which a non local absorption condition was introduced to take into account the effect of porous road surfaces. An experimental validation was made on porous and non-porous real pavements, using the principle of reciprocity. The 2D tyre was simulated by a long concrete tube. The impulse response was measured between a point source located in front of the tube and a microphone located flush on the tube surface, near the contact with the road surface. The amplification effect was evaluated with reference to semi-free field condition above the road surface. In parallel, the amplification was calculated. The physical parameters of the porous road introduced in the model were deduced from in situ measurements of sound absorption. A good agreement was found between measurements and predictions, both for reflecting and absorbing road surfaces. Subsequently, an estimation of the influence of the horn effect on close proximity tyre-road noise measurements is proposed. The difference observed between the noise radiated behind and sideways of the tyre can be explained by this horn effect.

Tu. 15:30 Schweitzer Car acoustics III

Vibration Field on a rolling tyre - results from a simulation model

Wolfgang Kropp, Ulrich Saemann
Department of Applied Acoustics

Tyre road noise is the dominant source for traffic noise at driving speeds above 30 km/h. In order to achieve a substantial reduction of tyre/road noise a sound understanding of the noise generation mechanisms is required. At the Department of Applied Acoustics, Chalmers University of Technology, a simulation model for tyre/road noise generation is under development. With this model it is possible to calculate the vibration field on the tyre structure for a tyre rolling as a function of tyre properties such as tyre design, tread pattern and road parameters (i.e. road texture). The simulation model is used to predict the vibration field for different tyres at different rolling speeds. A qualitative comparison is made between simulation results and results from near field holography.

Tu. 15:50 Schweitzer Car acoustics III

Road impedance optimisation using an efficient 2D model for the tyre radiation

F-X. Becot
INRETS - LTE (Transport and Environment Laboratory)

Because of the extension of the transportation network, an increasing number of people declare to be annoyed by traffic noise. Under normal driving conditions, the main contribution to overall noise levels is the noise induced by the tyre / road contact. In order to control the noise source and to contribute to the noise reduction offered by noise barriers for instance, accurate numerical tools are needed for the prediction of tyre / road noise including the effect of the pavement absorption. The work presented in this paper contributes to this effort by proposing a model for the tyre radiation over arbitrary impedance surfaces. This two-dimensional model, developed on the basis of the equivalent sources method, has been validated by comparisons with measurements of horn effect amplifications over arbitrary impedance surfaces. Due to its numerical efficiency compared to 3D models, it is an adapted tool for performing parametrical studies concerning the tyre / road interface properties. In particular, the model can be used to predict the optimal value of the surface acoustical impedance. Results show that this latter value is very sensitive to a number of parameters, among others the frequency of interest, the position of the noise source inside the horn and the length of the contact zone. However, in all cases, the model predicts an impedance value which is physically realisable. Therefore, the next step is to add road design constraints to elaborate a realistic solution for the construction of low-noise pavements.

Tu. 16:10 Schweitzer Car acoustics III

Twin wheels horn effect and pass-by noise

F-X. Becot, J-M. Clairet
INRETS - LTE (Transport and Environment Laboratory)

With a view for traffic noise reduction, a large research effort concerns the appraisal of traffic noise levels. While procedures for measuring noise levels from light vehicles have been developed for several years, the assessment of noise levels for trucks has been intitiated rather recently. Because of the decrease of the powertrain contribution, tyre noise becomes the limiting factor of a noise reduction at driving speeds above 70 km/h for trucks. An important parameter for the tyre radiation, as for light vehicles, is the so-called horn effet, which modifies the distribution of sound in both the space and frequency spectrum. Besides different dimensions and characteristics, truck tyres differ from vehicles tyres in that they can be mounted as twin wheels. This is

expected to have a significant influence on the radiation of noise, but it is has not been clearly qualified. In this respect, this paper presents measurements of horn amplifications measured in a horizontal plane around twin wheels. The contribution of each tyre of the twin wheel system is identified and compared to the case of a single wheel system. Finally, an attempt for simulating the resulting contribution to the pass-by noise including the Doppler effect is proposed and the consequences concerning the emission of truck tyres are discussed.

Tu. 16:50 Schweitzer Car acoustics III

Study of Crossbar Tyres in Rolling Conditions

Frédéric Wullens, Wolfgang Kropp
Department of Applied Acoustics

A correct description of the contact between a tyre and a road is a crucial step towards the understanding and the prediction of tyre/road noise using deterministic models. The present work is about the study of crossbar tyres of the passenger car type in rolling conditions. Measurements were made on a crossbar tyre loaded on a rotating drum and acceleration signals were recorded on the tyre structure for both the tangential and normal directions. The measurement situation was also modelled using a deterministic three-dimensional contact model. Comparisons between measurements and calculations show satisfactory results when it comes to pitching frequencies and global shapes of the acceleration signals. Another result is that it can be seen that moment excitation of the tyre structure by each block hitting the road at the leading edge is an important generation mechanism to include in models.

Tu. 17:10 Schweitzer Car acoustics III

Acoustic Behaviour of an Automotive Radiator

Christoph Roentgen, Jens Prager, Bjoern Petersson
Institut für Technische Akustik , Technische Universität Berlin

One of the major contributions to the pass-by noise emitted by cars is that propagated through the radiator. Essential, therefore, are the characteristics of the radiator, seen as an acoustic element. To describe the acoustic behaviour of the radiator, the theoretical model for a porous absorber, proposed by Lord Rayleigh is used. In this contribution, the results from such a model will be compared with those of experiments.

Tu. 17:30 Schweitzer Car acoustics III

Influence of Geometry on the Acoustics of Lateral Open Cavities

Jianrun Zhang, Jens Prager, Bjoern Petersson
Institut für Technische Akustik , Technische Universität Berlin

Most of the sound fields in realistic build-up systems can be seen as sound fields in partially open enclosures. Due to these partially open sides of the cavity and the resulting complex wall impedances, the analytic description of the sound field becomes difficult in particular the determination of the eigenvalues. However, the influence of an irregular cavity shape on the sound field becomes weaker duo to the high apparent absorption. In this contribution, a simple and alternative method is proposed to describe the sound field in a laterally open, rectangular cavity adopting a cylindrical model to avoid the complex eigenvalue problem. The approach is applied to simulate the sound field in an underneath car cavity. The theoretical results will be compared with those of experiments.

Tu. 17:50 Schweitzer Car acoustics III

About the connection between measurements in the alpha-cabin and the theoretically reachable differences in level of absorbing materials

Klaus Pfaffelhuber, Christine Patsouras, Dimitrios Patsouras, Alexander Bosch
AKsys GmbH

The equivalent absorbing area of several absorbing materials (foams, various membrane absorbers, microperforated absorbers) was measured in an alpha-cabin. Additionally, the level differences which can be obtained by those materials were measures in an anechoic chamber. For this a spherical sound source emitting white noise was covered by a square barrier whereas the ground was spread with the respective absorber. The resulting sound pressure levels were measured in varying distance to the sound source and by means of varying aperture degree of the barrier. The in this way obtained level differences of the various absorbing materials were compared to the absorption coefficients measured in the alpha-cabin. An excellent agreement appeared between the effective range measured in the alpha-cabin and the level difference obtained by the respective absorbing material.

Tu. 18:10 Schweitzer Car acoustics III

Measurement and simulation of the acoustical impedance of an internal combustion engine exhaust

Rene Boonen, Paul Sas
Department of Mechanical Engineering, K.U.Leuven

In this investigation, the acoustical impedance of an internal combustion engine is measured and simulated. The measurements are based on the two microphone transfer function method, which is described in the standard ISO/FDIS 10543-2. The method uses the transfer function between two microphones positioned on a waveguide connected to the impedance to be measured. Some improvements are proposed to this procedure, concerning the calibration of the measurement setup. New corrections are proposed to eliminate the speed of sound, the microphone locations and the the deviation between the microphone responses. The method is applied to measure the acoustical impedance of an engine. The reflection coefficient at the engine exhaust is measured. From the reflection coefficient, the acoustical impedance is determined. To prevent the engine to disturb the reflection coefficient during the measurements, the engine is run with an electric motor and the intake is sealed. The simulations are carried out using electrical analog circuits. The circuits are built by analyzing the engine parts contributing to the acoustical impedance. The electrical analog components are determined using the geometrical data of the engine and the exhaust manifold. The simulation results correlate well with the measured impedances . Also, some special cases are simulated, to determine the engine components which contribute primarily to the acoustical impedance.

Tu. 18:30 Schweitzer Car acoustics III

Valves in exhaust-systems

Helmut Venghaus
ArvinMeritor A6ET-Group Zeuna Stärker GmbH Augsburg

For controlling the acoustics or for sounddesign in exhaust-systems today valves are increasingly used. The modes of operation of valves are very specific. On one hand they can be operated by an external steering-system to react on special engine conditions. The other valves are driven by the engine massflow. They can be activated by backpressure or the impact of the exhaust gas. This presentation will give an overview on different types of valves and their modes of operation. The influence on sound and on backpressure will be discussed.

Tu. 18:50 Schweitzer Car acoustics III

Low Noise Urban Truck Project

Ludovic Greverie, Bernard Favre
Manufacture Française des Pneumatiques Michelin

As regards environment, the reduction of noise in urban areas is one of the major concerns of the European Union, and in particular of France.
Michelin, in partnership with Renault Trucks, INSA and Marmonier propose within the framework of a PREDIT project to work on noise reduction of urban trucks.
The objective is to obtain, under urban use conditions, noise characteristics improved from at least 50% compared to existing situation. The originality of this project is on the one hand the wish to treat all the sources (driving, idle, tailgate, tailboard, shocks of handling, refrigerating unit...) and on the other hand to be interested not only in the regulation levels but also in the quality of perceived sound by the residents. This project should end up in 3 years.
Within the framework of this conference, a presentation of the first results, specially regarding the tire, will be made.

Tu. 8:30 Schuman Room acoustics : simulation, . . . II

Evaluation of room acoustical simulation software

Ingolf Bork
Physikalisch Technische Bundesanstalt, FB 1.6 Schall

For comparing room acoustical simulation programs several aspects have to be considered: on the one hand the accuracy of calculations of room acoustical parameters can be checked with prescribed input data as done in the three round robin tests which have been carried out until now. On the other hand, quality criteria for such programs are also: the features for displaying results, auralisations (online/offline) and the usability. The methods used during the round robins will be discussed. The influence of the applied calculation algorithms on the results cannot be derived from this comparison; deviations from measured values can be referred to inaccuracies in measurements or to the limits of geometrical acoustics at low frequencies. It also revealed that only skilled software users are able to get correct results even for simple models.

Tu. 8:50 Schuman Room acoustics : simulation, . . . II

Numerical Sound Field Modelling in Room Acoustics and Workshops using Sound Particles

Judicaël Picaut
LCPC

Most of sound field modelling in room acoustics are based on classical methods like ray tracing or the image-sources theory. Considering the large number of practical applications, these classical methods have been also extended or modified in order to take into account, as well as possible, the room shape (cubic rooms, corridors, low roomsoe), wall absorption and diffusion, atmospheric attenuation, the effect of fitting in workshopsoe following several and various approaches. However, one can remark that lot of mathematical, empirical and numerical models have been proposed including such-and-such phenomena or room property, but practically none including all effects for all shapes. In this paper, we propose to use the concept of sound particles for the numerical sound field modelling whatever the room configuration. Using probabilistic approaches, we show that such method allow to predict the sound field in rooms, including wall absorption and diffusion, atmospheric attenuation, scattering objectsoe with a good accuracy. An algorithm is detailed, and the statistical approach is described. Many numerical results (sound level and reverberation time) for cubic spaces, rectangular rooms and workshops, corridors are given and compared with experimental data.

Tu. 9:10 Schuman Room acoustics : simulation, . . . II

About the influence of the reflection coefficient on simulation in room acoustics

Roman Stumpner, Sebastian Goossens
Institut für Rundfunktechnik

In order to assess the acoustical characteristics of studios (broadcast production rooms) being planned it is very useful to make them audible by simulation. Therefore you need a high-quality-auralization of the sound field at a time when the rooms are still being planned and actually do not exist yet. Besides the geometrical room dimensions the properties of sound absorbers determine the room acoustics. Especially in studios an extensive use of sound absorbers is typical. The efficiency of a sound absorber depends on both, the external sound field on its surface and the internal sound field characterized by its impedance. In order to describe the non-diffuse sound field of a studio (according to our aim of the room acoustical simulation) the reflection

coefficient itself should not contain information about the external sound field. Hence the use of the reflection coefficient based on diffuse field measurements is unsatisfactory. A better way is to use the complex reflection coefficient which depends on the angle of the sound incidence. Extensive absorber catalogues based on complex measurements are not required. Instead of that the theory of sound absorbers is used to solve the problem. With this method a lot of absorber types and all variations of these can be calculated with sufficient accuracy. The influence of the reflection coefficient on simulation in room acoustics is shown at theoretical calculations and measurements in practice.

Tu. 9:30 Schuman Room acoustics : simulation, . . . II

Comparison of investigations using a mathematical and a physical model with results of measurements in the original room

Thomas Behr, Hans-Peter Tennhardt
IEMB e. V. an der TU Berlin

It will be presented the results of investigations of soundfield properties of a room in the design state, obtained using a mathematical model (computer simulation) and a physical model (scaled model). These results will be compared with the results of measurements in the ready-made original room. The occuring differences are evaluated by means of the limens of just perceptible differences.

Tu. 9:50 Schuman Room acoustics : simulation, . . . II

Analytical Derivation of the Reduction of Computation Time by the Voxel Crossing Technique

Uwe Stephenson
University for Applied Sciences Hamburg

Practical application of room acoustical simulation techniques still suffers from high computation times. Different algorithms to reduce the time consuming search for ray-wall-intersections have been tested, mainly, as known from computer graphics, basing on spatial subdivision. For room acoustics, where the number of surface polygons (walls) is not so high, the voxel technique appears suitable, however its performance was not yet investigated up to now. Voxels are small cubes by which the space is subdivided. Only if a voxel intersects a wall (which is once checked and stored before simulation) the intersection point needs to be computed. The advantage: most voxels are empty. In this paper, by estimating the propabilities of such intersections, an analytical formula is derived, by which the optimum factor of spatial subdivision and the factor of acceleration of the algorithm can be forecasted. It turns out, that the computation time increases only

with the square-root of K0 instead with K0 (the number of polygons of the room). Thus, on modern PCs, computation time for a full room acoustical simulation (impulse responses up to about 10th order of reflection, level accuracy in the order of 0.3dB) even for highly complicated rooms (1000 polygons) may be reduced by a factor of 100, i.e. to a few seconds.

Tu. 10:10 Schuman Room acoustics : simulation, . . . II

Equalization and fidelity of a sound environment simulator

Benoit Gauduin, Patrick Boussard
Genesis

The aim of a sound environment simulator is to reproduce, in a studio, all the acoustical elements of a "real environment". The fidelity of such system may be seen through the ability of reproducing: · the spatialisation / localisation of sounds · the loudness of sounds · the spectral content of sounds Nowadays, there is no perfect way to record and reproduce all these elements: microphones and loudspeakers may degrade some of them. Hence, special treatments must be applied to the recorded signal in order to achieve the best compromise at the reproduction. We will discuss about the way to deal with the three points of fidelity listed previously. · The reproduction of spatialisation and localisation of sounds is linked to the method used by the simulator: Binaural, Transaural, Stereo Dipole, Ambisonicsoe · The loudness reproduction of sounds can be corrected by a gain factor in the simulator · The reproduction of the spectral content of sounds can be corrected by filters which will decrease the coloration introduced by the microphones and the loudspeakers. In order to obtain the gain factor and filters that have to be applied, two methods are at disposal: · The coupled equalization consider the microphones and loudspeakers as a whole system. · The decoupled equalization consider the microphones and loudspeakers as separate systems. Measurement sessions have to be conducted. They can significantly improve the fidelity of the sound environment simulator.

Tu. 14:50 Schuman Room acoustics : simulation, . . . II

Designtool Auralisation

Christoph Moldrzyk
TU Berlin, FSP-PV/PRZ

A dummy head measurement based auralisation method and a workflow for acoustical design of rooms with simulation software will be presented. The use of binaural impulse responses based on the measurement of a dummy head with rotating head towards the torso together with low latency head-tracking allows realistic auralisation. Simulation software based auralisation, dummy

head measurement based auralisation and acoustical situation in reality are compared. The results and implications like necessity of visual aid will be discussed.

Tu. 15:10 Schuman Room acoustics : simulation, . . . II

Difference limen for early lateral energy fraction and late lateral level

Ingo Witew, Gottfried Behler
Institute of Technical Acoustics

The subjective perception of spatial impression in room acoustics is strongly related to early and late sound energy that reaches the listener from lateral directions. Recent investigations indicate that most parameters vary severely from one listening position to another in the same sound field, even at very short distance. Although these variations have been shown in both, artificial and real sound fields, the question if these variation are audible and if and how this is perceived by the listener is not fully clarified. In this study the difference limens for single number parameters relating to the two aspects of spatial impression, namely apparent source width (ASW) and listener envelopment (LEV) have been investigated. In this respect synthesized sound fields have often been used for subjective tests. Typically, however, these are much less complex in regard to the density and spatial distribution of the reflections. This may cause unwanted and unrealistic effects. In order to avoid the aseptic nature of such sound fields, measurements in four different concert halls and auditoriums were taken. In a first step these measurements were conducted with suitable microphones to derive single number parameters that describe the binaural impulse responses which were recorded in a second step with a dummy head at the same position. In subsequent listening tests volunteers were then asked whether they can identify the member of an audio pair that inheres the greater sensation of ASW and LEV. These statements are used to derive the difference limen for the corresponding parameters.

Tu. 15:30 Schuman Concert hall acoustics

CARMEN: a physical approach for Room Acoustic Enhancement System

Isabelle Schmich, Jean-Paul Vian
CSTB

It is very common that the acoustic of ancient performing halls or musical spaces cannot be improved by refurbishment works, because of the high cost or because of the registered building. Even for high standing performing halls, demand of multipurpose halls,

which require variable acoustic, is also growing. A new Acoustic Enhancement System has been developed and experienced in several halls. The physical statements on which CARMEN is based are presented, as well as objective and subjective assessment of the enhanced acoustics.

Tu. 15:50 Schuman Concert hall acoustics

Roomacoustical Conditions for the Landau Festival Hall, Germany

Ernst-Joachim Völker, Wolfgang Teuber
Institut für Akustik und Bauphysik

The 850 seats concert hall has been totally rebuild during the last years and was reopened on February 12, 2003 with a concert of the Rheinland Pfalz Philharmonic Orchestra. The great evening was an another milestone in the long history of the hall, now again in the glamour of the former Fugendstil when the hall was build in 1908. In the fifties, more direct sound was prefered with a reverberation time of around 1,5 seconds and 800 seats, unoccupied. Furtwängler conducted the Berlin Philharmonic Orchestra in 1956 and was enthusiastic about the great acoustics. For the authors, the acoustical design was a judge challenge. The hall should again sound bigger with mutch more reverberation. But, what about theater, musicals, jazz and pop-music, rock-bands and congresses? The achievements will be presented including model studies and first experiences.

Tu. 16:10 Schuman Concert hall acoustics

Room Shape and Sound Shape

Hans-Peter Tennhardt
IEMB e. V. an der TU Berlin

It will be given a view of the potential inter-relation of room and sound shape. The ground plan with the classical rectangular and the polygonal shape is the central feature of the room that will be considered. Differences and similarities of sound colouration, reverberation time and reverberation energy will be explained by typical examples.

Tu. 16:50 Schuman Concert hall acoustics

Acoustic Design of the National Grand Theatre of China

Jean-Paul Vian
CSTB

When designing a new opera or concert hall, the architectural requirements for excellence are most of the times conflicting with the similar acoustic requirements for excellence. Good compromises have to be sought; with the well known difficulty that seeing mostly predominates over hearing. The National Grand Theatre of China, Beijing, under construction is composed of three large performing halls: the Opera (2400 seats), the Concert Hall (2000 seats), the Theatre (1500 seats). During the design of the Opera, the architect became unhappy with the layout proposed for the international competition providing optimal first lateral reflections to the public. Series of curved walls were desired by the architect from architectural points of view that create a lot of acoustic shortcomings. Decision has been made to dissociate the visible walls made acoustically transparent from the acoustic ones. The acoustic design of the opera, including computer modelling is presented.

Tu. 17:10 Schuman Concert hall acoustics

Heineken Music Hall - Design of and validation measurements in a great pop music hall

Klaus Lorenz, Rob Metkemeijer, Yves Dekeyrel
Peutz GmbH

"Heineken Music Hall - Design of and validation measurements in a great pop music hall" Abstract This lecture deals with an extraordinary hall: the Heineken Music Hall in Amsterdam. This hall was designed for the main purpose of high-quality pop concerts for an audience of up to 5500 persons and its acoustic properties have become widely admired since its opening. Because most of the events planned in the hall make use of PA systems, a low reverberation level and low reverberation time in all frequencies, even the lowest, was required as well as sufficient diffusion. The design used a certain philosophy: to create an acoustic environment close to free field conditions. This requires extreme measures to control the absorption, diffusion and reverberation properties especially at low frequencies. Thus special absorption and diffusion elements for the walls and the ceiling had to be designed. Measurements of the designed absorber construction were performed during the construction of the hall. After its completion impulse response and reverberation measurements were taken in the hall to evaluate the acoustic properties. It proves that the design requirements were met, such as an almost free-field decay (-5.5dB/ 2r) ; a remarkably short reverberation time of 1.3

seconds was measured in the empty hall with a volume of 48000 m3.

Tu. 17:30 Schuman Concert hall acoustics

Room acoustics for 4 uses - Großes Haus Staatstheater Mainz

Xueqin Zha, Helmut Fuchs, Horst Drotleff, Xiaoru Zhou
Fraunhofer Institut Bauphysik

Since different uses of auditoria, such as concert, opera, theatre and ballet, need a distinctive room acoustic environment, high-quality auditoria normally serve only one or, at most, two uses, e.g. concert and opera. On the other hand, the management of a cultural site usually desires a multi-purpose thea-tre, in order to react flexibly to customers demands. Acousticians are some-times tempted to design fairly cost-intensive and sometimes almost impractica-ble "variable acoustics". The "Großes Haus" of the Staatstheater in Mainz has been redeveloped from ground. This opportunity was taken and the "house" was given a new room acoustic design which serves four uses in one. This was based on smoothing the room response over the whole frequency range in the auditorium and the coupled stage. By an enlargement of the volume of the auditorium and the invisible installation of novel sound absorbers, which effec-tively work at low frequencies only, this goal has been achieved. The useful acoustic energy from the stage and the orchestra pit is directed onto the audi-ence by means of reflectors. Detrimental reflections are focussed away from the spectators. The feedback from spectators, musicians and conductor regard-ing the acoustics for all uses is positive.

Tu. 17:50 Schuman Concert hall acoustics

Acoustic improvements of the working conditions for musicians in orchestra pits

Horst Drotleff, Xueqin Zha, Helmut Fuchs, Michael Leistner
Fraunhofer Institut Bauphysik

Musicians in orchestra pits suffer from extremely high sound pressure levels and have to perform their jobs under severe difficulties concerning the hearing of the sound of their own instrument as well as that of all other members of an ensemble. Factory workers, who are exposed to weighted noise levels exceeding 90 dB(A), are regularly forced to wear ear plugs in order to protect them-selves. In orchestra pits the "noise level" often reaches 110 dB(A) and more. Highly qualified and artistically motivated musicians however, refuse to wear ear plugs of any kind since these deteriorate the necessary communication among them. Instead, the installation of novel compact low- and

mid-frequency absorber modules on the walls and overhang of the pits will be shown to tackle the problem of poor music intelligibility at its roots. This concept of improving the acoustic working conditions has been realised successfully in eight orches-tra pits to the full satisfaction of the musicians and equally important their con-ductors without affecting the transmission of the sound from the pit into the auditorium.

Tu. 18:10 Schuman Environmental & machinery noise I

Underwater noise emissions from offshore wind turbines

Klaus Betke, Manfred Schultz, Rainer Matuschek
Institut für technische und angewandte Physik GmbH

In areas with an extensive use of wind energy, it has become difficult to find appropriate sites for new wind turbines. This is one of the reasons for establishing an offshore wind energy industry. Moreover, it is assumed that the stronger and steadier flows of electricity from sea winds will make up for the extra expense of building turbines offshore. Numerous wind farms are planned or proposed to be raised in the German parts of the North Sea and the Baltic, with a total of more than 5000 turbines of 2.5 to 5 MW each. During construction, pile driving operations can produce maximum underwater sound pressures of several kPa at 1 km, which might be harmful to the sea fauna, in particular to mammals like harbour porpoises or seals. Wind turbines in operation may also emit gearbox and generator noise into the water. In this paper, we will present various hydroacoustic measurements made at various distances from offshore pile drivers. Furthermore, underwater noise radiated from a 2 MW class turbine has been measured over a 4-week period. Results, sound radiation mechanisms and ecological implications will be discussed.

Tu. 18:30 Schuman Environmental & machinery noise I

Schallimmission auf der Deutschen Antarktisexpedition 2002

Peter Fürst, Volker Warnecke
cdf Schallschutz Dresden

Während der XXII. überwinterungskampagne auf der deutschen Antarktisstation ‚Alfred Neumayer" des Alfred-Wegener-Institut für Polar- und Meeresforschung wurde während der überfahrt mit dem Forschungsschiff ‚Polarstern" und während der überwinterung in der unter dem Eis befindlichen Forschungsstation Schalldruckpegel gemessen. Die Messungen erfolgten in den Mannschaftsräumen und Schlafräumen der Forscher. Sowohl auf dem Schiff (Antriebsdiesel) als auch in der Station (Energieversorgung mit ständig laufendem Dieselmotor) sind

neben Klimageräuschen insbesondere die Körperschalleintragung der Motoren immissionsprägend. Daneben sind in den Laboren Schalldruckpegel durch Messgeräte und Computer auffällig. Innerhalb oberirdischer Stationen treten teilweise sehr erhebliche Windgeräusche auf. Die Schallimmissionen sind je nach Beobachtungsstandort sehr unterschiedlich. Es treten deutliche tieffrequente Anteile hervor. Außenmessungen sind wegen der Temperaturen im zweistelligen Minusbereich nicht möglich. Die Messergebnisse innen der Schalldruckpegel und Frequenzanalysen werden vorgestellt.

Tu. 18:50 Schuman Environmental & machinery noise I

Das deutsche Berechnungsverfahren für Lärmbelastung durch den Straßenverkehr

Wolfram Bartolomaeus
Bundesanstalt für Straßenwesen

Am 16. August 2003 veröffentlichte die EU-Kommission eine Empfehlung über den ‚Leitfaden für die geänderten vorläufigen Berechnungsmethoden für Industrie-, Flug-, Straßenverkehrs- und Eisenbahnlärm und diesbezügliche Emissionsdaten". Darin werden die notwendigen Anpassungen der französischen Berechnungsmethode ‚NMPB-Routes-96 (SETRA-CERTU-LCPC-CSTB)" an die EU-Richtlinie 2000/49/EG dargestellt. Die Aufgabe bestand nun darin, aus dem deutschen Lärmprognoseverfahren, den ‚Richtlinien für den Lärmschutz an Straßen" (RLS-90), eine geeignetes Interimsver-fahren für die Ziele der EU-Richtlinie (Lärmkartierung und Aktionspläne) zu entwi-ckeln. In diesem Beitrag werden die änderungen der angepassten RLS gegenüber der ur-sprünglichen Version dargestellt. Anhand von ausgewählten Rechenbeispielen wer-den die Auswirkungen dieser änderungen auf die Ermittlung der Immissionsschallpegel auch im Vergleich zur angepassten Interimsmethode der EU-Kommission auf-gezeigt.

Tu. 8:30 Tivoli 1 Temporal aspects in the perception . . .

Ear-catching features of time-variant speech

Ute Jekosch
Institut für Kommunikationsakustik (Web: www.rub.de/ika)

In modern speech communication systems such as mobile phones or VoIP, time-variant distortions can be perceived quite often. For system design it is essentially important to know which distortions are acceptable and which ones will not be tolerated by the user in the end. As a matter of fact, two different perspectives can be taken to capture listener reactions: one focuses on invariance and the other on variation. What invariance is concerned, the question is why individual perceptual behaviour with regard

to objects of perception and resulting quality judgements is comparable even accross a huge number of subjects; with regard to variability research goes into the question of why subjects do not react and judge differently although signal characteristics of perceived speech vary significantly. As a matter of fact, speech perception is a process of selection, organization, coordination and structuring. These processes are ruled to a certain degree. Human beings have so-called 'schemas' at their disposal perceptual processes are based on. When investigating schemas more analytically, one very soon comes across the theory of 'Gestalt' perception. In this paper ear-catching features of speech sounds will be discussed. The perspective taken is the one of ruling schemas in the context of the following questions: How does the human listener manage to select certain characteristic features of the auditory event and take them as information carrying units? What are invariant types of behaviour as opposed to individual or spontaneous ones? What is the role of the context? What are basic signal characteristics which stimulate a specific type of behaviour?

Tu. 8:50 Tivoli 1 Temporal aspects in the perception . . .

Comparaison between four methods of loudness estimation for stationary and non-stationary sounds

Isabelle Boullet
LMA CNRS

This research is part of a study designed to propose a new model of loudness estimation for impulsive sounds. The purpose of this research was to compare different methods to measure the loudness of various kind of sounds. The aims were to determine: 1) the inter-individual variability of each of the four methods of loudness estimation, 2) whether this variability depends on the temporal features of the stimuli (stationary sounds, impulsive sounds, repeated impulsives sounds). The four psychoacoustical tests of loudness estimation (either in sones or in phons) studied in the present research were the magnitude estimation without reference, the method of adjustment, an adaptive method (2 down-1 up and 1 down-2 up) and a multiple-tracking adaptive method. I will first describe the different stimuli used in the study and then the four psychoacoustical tests. I will present the advantages and drawbacks of each method. The study showed that the method of adjustment gives a good precision/duration ratio. Moreover, we examined the loudness function at 1 kHz from which the relationship between sones and phons is deduced. Then, I will describe the limitations of the mathematical relationship between sones and phons. I wil conclude that it is necessary to be very careful

when comparing values of loudness obtained in sones with those obtained in phons.

Tu. 9:10 Tivoli 1 Temporal aspects in the perception . . .

Loudness of impulsive sounds: measurements versus models

Isabelle Boullet, Sabine Meunier, Alexander Raake, Sebastian Möller, Ute Jekosch, Georges Canevet
LMA CNRS

Loudness measurements are essential for evaluating environmental impact and annoyance of noises. But environmental noises are mostly non-stationnary, or even impulsive, and there is no standard procedure to measure their loudness; models to calculate it are also missing, in contrast with the case of stationnary sounds. The purpose of this study was to undertake a new series of experiments to measure loudness of impulsive sounds, and hopefully to build algorithms that would yield a reliable estimate of this loudness. Previously, we have shown that the loudness of both environmental and synthetic impulsive sounds can be expressed as a product of two power functions, of energy and of decay time, each with its own exponent. This finding that loudness is a power function of decay time is new, and further tests were run to exactly determine the exponent of this function. It was found that the exponent also depends on signal energy and spectrum, in a way that will be described in the presentation. Finally, an experiment was run, in which loudness of different kinds of impulsive sounds (pure tones, environmental sounds, trains of impulsive sounds) was evaluated by magnitude estimation, with German and French listeners. Loudness was also calculated using different criteria: (i) N4, N5, N10 with Zwicker's model and (ii) our new model for impulsive sounds, and compared to experimental results. We will discuss how loudness models can be improved to apply to impulsive sounds as well.

Tu. 9:30 Tivoli 1 Temporal aspects in the perception . . .

Temporal asymmetry in loudness

Patrick Susini, Stephen Mcadams
IRCAM

A study by Canévet and Scharf (1990) showed that sounds that are continuously decreasing in level are perceived to decrease in loudness more than two sounds presented successively with the same difference in level. The authors explained this difference by an inherent auditory asymmetry which they called auditory 'decruitement'. Using the same kind of stimuli, Neuhoff (1998) showed that loudness change is judged greater for a continuously increasing than for a continuously decreasing sound

with the same change in level. Neuhoff explained this difference by an 'ecological' point of view that human beings are more aware of increasing signals. More recently, using short- duration stimuli ($<$250 ms), Stecker and Hafter (2000) compared sounds with opposite attack/decay characteristics; F-S (fast-slow) and S-F (slow-fast). The results showed that S-F stimuli were louder than F-S stimuli having the same energy. The authors explained their results by a mechanism of 'decay suppression'. The present paper presents the different arguments that explain the effect of temporal asymmetry on loudness. Then, a set of loudness evaluations obtained using increasing and decreasing ramps of identical duration shows the same asymmetric phenomenon. We show, however, that it can be explained by a short memory effect called the 'recency effect'.

Tu. 9:50 Tivoli 1 Temporal aspects in the perception . . .

Continuous evaluation of noise comfort in a bus

Etienne Parizet, Nacer Hamzaoui, Lionel Segaud, Jean-René Koch
Lab. Vibrations Acoustique, INSA Lyon - Bât. 303

The goal of this study was to use the 'continuous analog category scale' method for the evaluation of comfort in a bus. A long recording (162 s) was realised in a bus driving in a typical way (including acceleration and coast-down, opening and closing of doors, etc.). A modified version of that recording was created by digitally modifying some particular events. About fifty listeners continuously evaluated the auditory comfort of these two sequences, by moving a cursor sliding along a categorical scale; they also evaluated the overall comfort of each sequence. When considering the overall comfort evaluation, the panel could be divided in three groups (listeners who preferred the modified sound, those who preferred the original one and those who evaluated the two stimuli as equally comfortable). The continuous evaluations averaged over these three groups were different, which can be an indication that listeners really evaluated comfort and not loudness. Nevertheless, instantaneous evaluation was less accurate than the overall one, which indicates that more work is needed to improve the method.

Tu. 10:10 Tivoli 1 Temporal aspects in the perception . . .

Perceptive qualification of the engine sound character

Vincent Roussarie, Florent Richard
PSA Peugeot Citroën

For over 2 years PSA has been studying the sound identity of 4 cylinders vehicles. Using free sorting experiences we observed that the sound of vehicles in dynamic situations such as full load

acceleration can be sorted at least in 4 categories. One category for which sound identity is pregnant in consumer's choice is the so called 'sporty class'. Thus we focused on the link between signal and perceptive attributes of this category through specific experiments using synthetic sounds. The aim is to qualify sporty identity using objective signal criteria. HARTIS, the sound design software we developed using IRCAM's jMax programming environment, allowed us to prepare re-synthesis car sounds for three main experiments :
- Influence of high engine orders on the perception of roughness,
- Influence of booming noise on the gene caused by engine sound,
- Influence of booming noise and roughness on the perception of sporty identity.
The results of those experiments highlight that roughness and booming noise can influence perception of sporty identity in different ways. Indeed we emphasized subject classes with different representation of a sporty car sound. In addition, we now have signal keys to explain the perception of different roughnesses and the annoyance caused by booming noise. Those experiments highlighted the fact that different sporty identities exist, and emphasized important signal criteria for each sporty class observed.

The Bouncing of Balls: Influence of Temporal and Spectral Changes on Perception

Christophe Stoelinga, Hubertus Peeters, Ines Lopez
Eindhoven university of technology

This contribution is concerned with physical modeling for the design of perception tests of non-speech sounds. The restitution coefficient of a ball bouncing on a plate can be calculated from Hertz' contact theory, Newton's second law and the response of the plate. We adapted this method by calculating the plate response from the point impedance of the plate. We calculated the restitution coefficient both in the middle of the plate and at the edges, where the restitution coefficient is three times lower. Measurements showed good resemblance between predicted and measured restitution coefficients in the middle and near the edges. Using the same theory we calculated the spectral content of the sound produced by each individual bounce. We believe that the restitution coefficient and the spectral content are the two most important cues for the listener to detect the size of the bouncing ball. Therefore, we recorded the sounds of three bouncing balls of different sizes. Since the restitution coefficient is directly related to the temporal distances between successive

bouncing events, we realized seven different values of the restitution coefficient by changing the length of the silent gaps between the individual bounces. In a perception experiment we asked listeners to determine the most natural sound, and we asked for the largest ball. Two groups of test persons could be distinguised: when asked for the most natural sound the first group chose the sounds with the lowest restitution coefficient while the other group recognized the original unaltered sounds.

Tu. 15:10 Tivoli 1 Temporal aspects in the perception . . .

The influence of non-stationary vibrations on the quality of non-stationary product sounds

M. Ercan Altinsoy, Ute Jekosch
Institut für Kommunikationsakustik (Web: www.rub.de/ika)

Mechanical vibrations of different products generate usually noise and additionally tactile information. In most cases, these auditory and tactile information are non-stationary signals. In the present study, a psychophysical experiment was conducted to investigate the influence of non-stationary vibrations on the quality of non-stationary product sounds. In this experiment, non-stationary drill noise and vibrations were presented to the subjects via headphones and through a force-feedback mouse simultaneously. The influence of non-stationary vibrations on the quality of non-stationary product sounds will be discussed on the basis of the results of the psychophysical experiment.

Tu. 15:30 Tivoli 1 Temporal aspects in the perception . . .

How do users perceive speech quality under combined "stationary" and non-stationary degradations?

Alexander Raake
Institut für Kommunikationsakustik (Web: www.rub.de/ika)

With the advent of packet-based transmission, telephone users are increasingly confronted with new types of speech quality impairments. The main feature of these impairments is that they are time-varying. In this paper, the question is addressed, how subjects rate the speech quality of a telephone line which is impaired by both "stationary" degradations known from traditional telephone networks and highly "non-stationary" degradations, e.g. due to time-varying packet loss. To this aim, a series of three conversation tests was conducted. In each of the tests, burst packet loss was presented in combination with one "stationary" degradation type known from traditional wireline networks (noise of different levels; different transmission delays; talker echo of different echo attenuations). The study is complementary to that presented at the DAGA03. Instead of random packet loss, burst packet loss was used as the non-stationary degradation type. In

principle, it is known from past tests, how subjects integrate over the instantaneous quality of a link under time-varying packet loss and establish a percept of overall quality. It is also known, how subjects judge the speech quality of a link in case that one of the PSTN-typical "stationary" degradations is present on the line. This paper investigates, whether the subjects' overall quality ratings for combined impairments reflect an instantaneous weighting of "stationary" and non-stationary degradations, followed by an integration over the resulting instantaneous quality, or whether the different types of impairments are evaluated instantaneously but independently, and the percept of overall quality results from a weighting of overall features.

Tu. 15:50 Tivoli 1 Temporal aspects in the perception . . .

Temporal Aspects in the Prediction of Perceived Audio Quality Differences

Rainer Huber, Birger Kollmeier
Medizinische Physik

This talk presents a new computational method for the prediction of perceived overall audio quality differences using an auditory processing model. The method represents an expansion of the speech quality measure qc of Hansen and Kollmeier (2000). It employs a quantitative model of the ‚effective" signal processing in the auditory system by Dau et al. (1997). This model particularly accounts for the processing of non-stationary sounds and was validated by a number of psychoacoustical masking experiments. In the framework of the quality assessment method, it is employed to provide internal representations of a given pair of reference and test signal whose quality difference is to be assessed. The cross correlation between these internal representations serves as a measure for the perceptual similarity and therefore for the quality of the test signal relative to the reference signal. In order to become capable of predicting perceived quality differences for any kind of audio signals and distortions, the relationship between the time varying instantaneous and the overall audio quality had to be modeled as well. The optimum estimate of the perceived overall audio quality difference was found to be the 5%-quantile of the ‚loudness"-weighted sequence of short-time (10 ms) cross correlation coefficients. The method was tested using a large database of subjectively rated audio signals. This talk will focus on the influence of model parameters concerning temporal aspects of the quality assessment on the prediction performance.

Tu. 16:10 Tivoli 1 Temporal aspects in the perception . . .

An Approach for Instrumental Evaluation of Time-varying Speech Quality in an IP-testbed

Florian Hammer
Telecommunications Research Center Vienna (ftw.)

Non-stationary cross-traffic in the underlying IP network causes impairments of voice over IP (VoIP) transport which result in a time-varying degradation of the speech quality as perceived by the user. Subjective testing of the perceived speech quality is hardly feasible due to the huge amount of speech data resulting from various network conditions. Thus, we strongly favor an instrumental quality assessment approach based on an IP testbed which provides the possibility of emulating realistic Internet cross-traffic. Moreover, the provision of various QoS mechanisms in the testbed allows to shape the traffic and thus to improve speech quality. This paper introduces a quality measurement method that facilitates intrusive instrumental speech quality assessment. The relation of realistic Internet cross-traffic, the respective packet statistics and the corresponding quality variation are explored in detail. Furthermore, we investigate also the influence of the speech sample length on the results of the instrumental speech quality estimates.

Tu. 16:50 Tivoli 1 Outdoor sound localization

Source Detection and Localization using Widely Separated Special Arrays : Theoretical Study and Experimental Results

Sébastien Hengy, Pierre Naz, Patrick Gounon
I.S.L. : Institut franco-allemand de Recherche de Saint Louis

In order to improve the soldier's protection and efficiency in hostile environments, the French German Institute of Saint Louis has developed an original array: a head equipment (HE) fitted with one or more microphones, a GPS receiver and a magnetometer. Each man wearing this HE can then be considered as a part of a large global array. Using this kind of array involves several constraints: - the global array has never the same shape due to the movements of the soldiers, - perturbations due to the inaccurate knowledge of the location of the constituting elements must be met, - the "acoustic shadow" generated by the HE has to be compensated. First, we studied the behaviour of a large array with sensors spread randomly on a 10,000 square meters surface. In this case, high resolution localization methods like MUSIC are applied using a spherical wave approximation. This allows for the estimation of the Direction Of Arrival (DOA), as well as for the estimation of the exact position of the acoustic source. Then, using numerical simulations, we measured the consequences of

an inaccurate knowledge of the microphones location. Measurements in an anechoic room confirmed the results obtained by the simulations. Finally, open field measurements using a large array made up of 2 HE arrays and one classical triangular antenna took place in October 2003. Synthesized vehicule noises (generated by speakers) and actual rifle shots were recorded. The results of the estimation of the localization of the sources are here presented.

Tu. 17:10 Tivoli 1 Outdoor sound localization

Basic Investigations of Microphone Arrays

Christian Schulze, Andreas Zeibig, Dietmar Richter
Institut für Akustik und Sprachkommunikation

In order to localize and separate sound sources at structures in air flows a microphone array was developed. In advance basic investigations about the generation of directional characteristics of microphone arrays were carried out. The knowledge obtained during these investigations illustrated on the example of a line array will be the content of this presentation. A specifically developed computer simulation allowed the calculation of the transfer functions of different microphone distributions as well as examinations of the influences of array geometry, signal parameters and evaluation algorithms on the directional characteristic of the microphone array. On the basis of the simulation results an appropriate microphone array for the detection of the aeroacoustic sources mentioned before was found. The application of a frequency band filter algorithm corresponding to the transition from single-frequent to band limited sound source detection provided considerable improvements in the directional characteristic. The obtained simulation results are to be discussed and compared with practical measurements.

Tu. 17:30 Tivoli 1 Outdoor sound localization

PILAR Acoustic Gunshot Detection & Localization system : Principles of acoustic localization of small caliber gunshots

François Magand, Alain Donzier, Frédéric Molliex
01dB Acoustics & Vibration

Acoustic devices have been used on the battlefield since the World War 1 for the localization of Artillery. Localization principle was based on the measurement of time of arrival of the sound generated by the muzzle blast at different locations. The technique may be extended to the localization of supersonic shots of small arms' fire. Localization is based on the measurement of two distinct transient sounds : the shock wave generated by the supersonic bullet and the muzzle blast generated by the rapid discharge of propellant of the weapon. Depending on the deployed

configuration (one or two acoustic arrays) and on the miss distance, localization gives the direction (azimuth & elevation) and range of the origin of fire, the bullet trajectory as well as information on the bullet speed and identification (caliber class). In this paper, the basic principles of the PILAR localization principles are exposed and discussed. A special consideration is paid to the analysis of difficult localization cases, such as application in urban areas for which background noise, reverberation and multiple echoes are of concerns, or burst shots where a correct identification of wave type is often more difficult. Some experimental results are also presented and commented. PILAR system is an acoustic devices dedicated to the detection and localization of small caliber gunshots. It is composed of one (or two) acoustic arrays, a compact Digital Signal Processing unit, and a laptop unit for the display of results. The system and the embedded algorithms are the results of more than 10 years of experience at METRAVIB RDS.

Tu. 17:50 Tivoli 1 Outdoor sound localization

Detection and Localization with Encapsulated Microphones
Pascal Hamery, Pierre Naz
I.S.L. : Institut franco-allemand de Recherche de Saint Louis

Detection and localization of gun noises with microphones have been known for several decades and efficient devices are now produced. However, for the detection and localization of snipers it is difficult to conciliate the measurement of signals of high (Mach wave of the projectile) and low (muzzle wave at a distance) level in a given background noise environment. To work out this problem we propose to put two microphones in a same macro-sensor. The characteristics of the first microphone are chosen to fit the parameters of the high level shock wave (Mach wave of the projectile), those of the second microphone to fit the parameters of the low level wave (muzzle wave at a distance). These microphones are enclosed in cavities which are design to have frequency characteristics corresponding to the frequency domain of the two interesting signals. This macro-sensor allow, while having a low sampling rate, to assess the physical characteristics of the two waves (peak pressure, wave duration). Furthermore, the microphones being encapsulated in a cavity with very little openings, they are protected from external agents. A prototype has been made in order to validate the principle. Experimental results are compared to those obtained with a classical antenna.

Tu. 18:10 Tivoli 1 Outdoor sound localization

Large eddy simulation of acoustical propagation in turbulent channel flow

Marie Haberkorn, Vincent Pagneux, Gilles Bouchet, Yves Auregan, Pierre Comte
IMFS UMR7507 - ULP/CNRS

Velocity fluctuations, caused either by imposing sound on a turbulent channel flow or by pulsating the flow, generate a shear wave at the wall. This shear propagates into the boundary layer and decays within the turbulent counterpart of the laminar Stokes length. Ronneberger & Ahrens (1977) determined in these two ways the damping of sound by turbulence in experimental investigation of the wall shear stress: at high driving frequencies the damping is not influenced by turbulence, for low driving frequencies turbulence increases the sound attenuation and for a range of driving frequencies, the damping is surprisingly reduced by turbulence. This was recovered in Large Eddy Simulation of a pulsating channel (Scotti & Piomelli, 2001), but at too a high a forcing amplitude to be relevant to acoustical propagation. We perform analogous LES in which the pulsation is applied to a passive scalar, so that retroaction on the turbulent flow is suppressed. Different forcing frequencies and diffusivity of the scalar are considered. The trends mentioned above are recovered for high and low frequencies, but the reduced attenuation (with respect to that in laminar flow) at intermediate frequencies is no longer observed. The time evolution of the spatial organization of the scalar field is investigated. Références : Ronneberger D. and Ahrens C.D., 1977, Wall shear stress caused by small amplitude perturbations of turbulent boundary-layer flow: an experimental investigation, J. Fluid Mech., 83, 433–464. Scotti A. and Piomelli U., 2001, Numerical simulation of pulsating turbulent channel flow, Phys. Fluids, 13(5), 1367–1384.

Tu. 8:30 Tivoli 2 Active control II

Mode Structure and Adaptive Control of the Jet-Edge-Flow

Arno Ickler, Dirk Ronneberger
Drittes Physikalisches Institut Göttingen

The stabilisation of the plane laminar jet-edge-flow is studied with the general objective to gain experience in flow control. The convective instability of the jet combined with the feedback of pressure oscillations from the edge to the nozzle results in a global instability leading to various modes (stages) of jet oscillations depending on the distance between nozzle and edge. A feedback control system shall be added such that the flow becomes stable. The jet deflection measured by a realtime image processing system is fed back to an actuator imposing a pressure gradient

on the flow. One of the main differences between the jet-edge-system and most mechanical and electrical feedback systems is besides the inherently high number of degrees of freedom the fact that an exact equivalent open loop system cannot be realized. The relevant system dynamics is identified by an adaptive controller, which needs a small-amplitude broad-band test signal, in order to synthesize a stabilising feedback filter. For small distances between the nozzle and the edge the mode of jet oscillation is not changed by the control action and a good supression of the oscillation is achieved. However by increasing the nozzle-edge-distance, the system becomes more sensitive to the parameters of the controller and finally escapes into another destabilized mode of oscillation. These destabilized modes resemble the higher natural modes of the uncontrolled jet-edge-system. Surprisingly these modes may persist for a long time. The relation between the mode structure and the controllability of the jet-edge-system will be presented.

Tu. 8:50 Tivoli 2 Active control II

Active Resonance Control at the Audi aero-acoustic wind tunnel (AAWT)

Fabian Evert, Hans Miehling
Müller-BBM GmbH

A well-known problem associated with open-jet wind tunnels is the occurrence of low frequency pressure and velocity fluctuations. This so-called 'wind tunnel buffeting' negatively affects the flow parameters and thus the quality of both aerodynamic and aeroacoustic measurements. The observed disturbances mainly originate from a periodic vortex shedding at the nozzle, which supports resonant modes of the tunnel duct. In principle, the destruction of large-scale vortices by passive means leads to a disturbances attenuation. However, due to the additional higher frequency noise generated by such devices, these methods are inapplicable to aero-acoustic wind tunnels. Therefore an active control scheme for the suppression of wind tunnel buffeting has been developed and tested at the Audi aero-acoustic wind tunnel facility. This control system, termed Active Resonance Control (ARC) utilizes a global control of the resonant duct modes in order to suppress the generation of disturbance. Both the underlying theory of disturbance generation and compensation, as well as operational experiences with the ARC-system will be presented.

Tu. 9:10 Tivoli 2 Active control II

Experimental Investigation of Active Control of the Tonal Noise Components of Axial Turbomachinery with Flow Control

Jan Schulz, Wolfgang Neise, Michael Möser
Technische Universität Berlin, Sonderforschungsbereich 557

The aim of the project is to reduce the tonal noise components of axial turbomachines using active noise control. While conventional methods use loudspeakers, the secondary sound field is generated by flow control in this study. The flow conditions near the blade tips are disturbed by blowing air into the blade tip region through nozzles (vortex generator jets), which are installed in the fan casing wall. Piezo elements are used as alternative actuators to disturb the flow. In this way, additional periodic forces are set up which result in aeroacoustic secondary sources. They can be controlled such that a noise reduction of the tonal components is achieved. Furthermore the influence of the flow control on the aerodynamic behaviour of the test object is observed. Results using steady blowing will be presented. The physical background of the generation and superposition of the secondary sound field as well as the influence of different parameters will be discussed. The results will be interpreted with regard to the reduction of the blade passage frequency level, dominant azimuthal mode and overall noise level. In the experiments the blade passage frequency level was reduced up to 20dB, where the overall noise level dropped by 12dB. In certain cases it was possible to reduce the dominant azimuthal mode of the order m=2 by 40dB. Intermediate results of the continuative experiments with unsteady blowing, synchronised with the impeller at blade passage frequency, will also be presented. This study was supported by the Deutsche Forschungsgemeinschaft (German Science Foundation).

Tu. 9:30 Tivoli 2 Active control II

Adaptive and Robust Control for the Reduction of Tonal Noise Components of Axial Turbomachinery with Flow Control

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This paper presents results of a research project using robust and adaptive feedback control algorithms for the reduction of tonal noise components of an axial fan by flow control. The active noise control is achieved by specific distortions of the flow conditions near the impeller blade tips which results in an aeroacoustic secondary field. This can be realised by blowing air into the blade tip

region through nozzles in the casing wall. An extremum-seeking controller is used to find the optimal mass flux, which determines the amplitude of the secondary sources. The phase was controlled by geometrical parameters. The experimental investigations demonstrate the performance of the proposed controller for higher order mode sound fields. To investigate the robustness of the closed-loop disturbances such as changing operating points, non-uniform inflow conditions and a 33% deviation of the revolution of the fan were simulated. In all cases the controller reacted on the changed operating conditions and determined the optimal mass flux, achieving a blade passage frequency level reduction of 15dB for the tested configuration. The radiated sound of the tonal noise components in the far field is mainly determined by the dominant azimuthal duct modes generated by the rotor-stator interaction. Therefore a robust H_∞-controller based on black-box modelling of the non-linear process dynamics was synthesised additionally, to suppress the dominant mode. Further experiments will focus on a controller including the adaptation of both, amplitude and phase of the aeroacoustic secondary field. This study was supported by the Deutsche Forschungsgemeinschaft (German Science Foundation).

Tu. 9:50 Tivoli 2 Active control II

Design of an active exhaust attenuating valve for internal combustion engines

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An active silencer to attenuate internal combustion engine exhaust noise is developed. The silencer consists of an electrically controlled valve connected to a buffer volume. The pulsating flow from the engine is buffered in the volume and the valve resistance is continuously controlled such that only the mean flow passes to the atmosphere. This flow is free of fluctuations and consequently free of sound. The design of the active silencer is carried out using electrical analog circuits. First, the interaction between the active silencer and the engine will be studied using an analog circuit including the combustion engine and a linearized active silencer. Then, a detailed valve model is built in a separate electrical analog circuit. It includes the electrical, the mechanical and the flow-dynamic properties of the actuator valve. The actuator valve concept is then simulated, from which a prototype can be constructed. The active silencer has been tested on a cold engine simulator. This device generates realistic exhaust noise with the associated gas flow using compressed air. The silencer can attenuate pulsations from engines at very low revolution speed, without passive elements preconnected between the engine and

the active silencer. This is not possible using loudspeaker based active silencers.

Tu. 10:10 Tivoli 2 Active control II

Active Structural Acoustic Control of Repetitive Impact Noise

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Industrial machines, which generate structure-borne impact noise, often produce noise levels exceeding the limiting levels, demanded by the regulations for noise emission. Until today, the research on active control focuses on harmonic noise. This paper presents the possibilities of active structural acoustic control of transient noise, produced by an impact excitation. The presented research focuses on the development of feedback control algorithms. A linear time-invariant feedback controller was developed to drive the structural actuator. The performance of this time-invariant controller is limited for several reasons: time-variance of the controlled system, limited controller bandwidth, non-linearities,... However, when the transient noise consists of successive impacts that exhibit a repetitive character, it is possible to extend the developed time-invariant feedback controller with a learning behaviour, based on the additional information about the repetitiveness. As test case, a thick plate, excited by a hammer, is considered. The goal of the research is to reduce the structural transient noise, generated by a hammer impact on the plate, by applying control forces on the plate. An accelerometer measures the generated plate vibrations. This signal is sent to the input of the controller, which drives a structural actuator. At each impact, the residual vibrations measured by the accelerometer, which cannot be controlled despite the action of the feedback controller, are measured and stored in memory. At the next impact, the control signal for the structural actuator is adapted on the basis of the residual error at the previous impacts, such that the radiated noise is reduced.

Tu. 14:50 Tivoli 2 Active control II

Design Optimisation of Active Constrained Layers

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Department of Applied Acoustics

In Active Constrained Layer (ACL) treatments, a layer of viscoelastic material is bonded to the host structure and constrained by an actuator. Several mechanisms simultaneously damp vibrations in ACL treatments, and an approach to quantify these damping mechanisms has been proposed [1]. A simple model of a beam treated with ACL, which allows analytical investigations

of the damping mechanisms of ACL treatment, has also been developed recently [2]. The objective of this paper is to understand how to optimise the design of ACL treatments, using the tools mentioned above. The influence of the shear modulus of the viscoelastic layer on the amplitude of the control voltage and on the robustness of the control is investigated. A comparison between the conventional ACL configuration and the separated active-passive configuration, where an actuator and a passive constrained layer are separately bonded to the beam, is carried out. A control law optimising the efficiency of the ACL treatment is proposed. [1] H. Illaire and W. Kropp, Quantification of damping mechanisms of active constrained layer treatments, to be published in the Journal of Sound and Vibration. [2] H. Illaire, W. Kropp and B. Mace, A phenomenological model of active constrained layers, in preparation.

Tu. 15:10 Tivoli 2 Active control II

Vibration Reduction of a Car Component by a Semi-Passive Piezoelectric Concept

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Lightweight structural design is often accompanied with a reduction in structural stiffness. This can result in an increase of structural vibrations. Viscoelastic damping layers can be efficiently applied to reduce these unwanted vibrations. However, such a measure adds significant mass per area to the structure. Alternatively, a semi-passive concept, realized by piezoceramics with an impedance in parallel, can be employed. This measure is also known as 'shunted piezo technique'. The paper at hand investigates the implementation of the semi-passive technique to a hood of a car. Piezoceramic patches (PZT) are applied at positions, which yield high strain energy. A passive electrical network (PEN) is implemented and connected to the electrodes of all PZT components. The resulting damping capability is similar to that of viscoelastic material. Thus, the generated electrical energy is partially dissipated as heat. By shifting the resistor value of the PEN the dissipated energy can be maximized. The modal parameters of the car structure are determined from experimental modal analysis. Cubic splines are used to interpolate the resulting eigenforms to allow for continuous differentiation in order to determine the strain distribution. The positions of the PZTs are optimized by taking into account the ratio of strain energy of all PZTs to the total strain energy. Finally, experiments are conducted to investigate this concept; structural response with semi-passive damping is compared to the response without.

Tu. 15:30 Tivoli 2 Active control II

Developing a Guideline on Active Vibration Isolation
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Müller-BBM GmbH

Active Vibration Isolation moved onwards from a laboratory curiosity to state of the art technology during the last years. Today it is used mainly for demanding applications where appropriate isolation is difficult to achieve by passive means. In addition, broader applications are under investigation and a common interest in the technology from an application point of view can be found. While there are guidelines and standards on passive vibration isolation (e.g. DIN EN 1299, VDI 2062), there are currently no such documents for active systems. This lead to efforts to support designers, manufactureres and users of active vibration isolation systems by a VDI guideline. This guideline should give a basic understanding of active vibration isolation and define some coherent terminology. It should give practical advice for the design of active vibration isolation. To support co-operation and information exchange, it should give hints for necessary information for the specification of an active vibration isolation system and its components and also for test and measurement procedures. The current state of the comittee work will be presented. A special focus will be with the specification and test and measurement procedure topics.

Tu. 15:50 Tivoli 2 Non linear acoustics

Elastic Nonlinearity of Soft Solids Using Transient Elastography
Stefan Catheline, Jean-Luc Gennisson, Xavier Jacob, Christophe Barriere, Daniel Royer, Mathias Fink
ESPCI - LOA

If nonlinearity has long been studied in metals, crystals or rocks, almost no experimental works is found in the literature concerning soft tissues. Thanks to the ultrafast scanner, we present in this paper an overview of three transient elastography experiments that quantify the nonlinear behavior of a soft tissue phantom. In the first one, a static stress is applied on a phantom. The change on the shear wave speed characterizes the nonlinear elastic Landau moduli. The surprising difference found between these constants are thought to be closely related to the huge difference between the linear Lamé coefficients ($l >> \mu$). It is the acoustoelasticity experiment. In the second one, we present the first experimental observation of a shock shear wave. The very weak Young's modulus of the tissue phantom allows one to generate plane shear wave with a Mach number as high as unity. In this

extreme configuration, the agreement with the theoretical prediction of the modified Burgers equation is remarkable. It is the finite-amplitude shear wave experiment. At last, the interaction between two plane transverse waves with frequencies w1 and w2 is carefully studied. Harmonics are created during the propagation at the frequencies (3w1, 3w2, w1+2w2, w1-2w2, w2+2w1, w2-2w1). It is the parametric interaction experiment. This set of three experiments involves plane transverse waves. The feasibility of measuring the nonlinear elastic coefficient with non plane shear wave is discussed in the last section.

Tu. 16:50 Tivoli 2 Non linear acoustics

Stationary and quasi-stationary solutions of the Burgers-type equations

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Nonlinear acoustic models based on the Burgers-type evolution equations have been widely used in medical applications, geophysics, and nonlinear diagnostics. Various frequency dependence of absorption, typical for media with complex internal structure, has a strong effect on nonlinear wave propagation. Artificial absorption is also used in numerical simulations of shock waves and may result in nonphysical effects. An exact solution in the form of the stationary shock wave or quasi-stationary periodic wave can be obtained for the Burgers equation or nonlinear evolution equation with a relaxation term. However, in most cases numerical simulations are necessary. The solutions of the Burgers type equations with the absorption governed by the second, forth, or sixth order derivatives, are considered in this work for an initially step-like signal or harmonic wave. Stationary solutions in the form of the shock wave and quasi-stationary solutions in the form of the periodic sawtooth-like wave are obtained numerically. Nonlinear waveform and spectrum evolution, shock formation, as well as the intensity and total energy absorption are investigated for the periodic wave. Shock front fine structure is studied and compared for various absorption terms. It is shown that in contrast to the smooth hyperbolic tangent shape of the shock front in case of the classical Burgers equation, oscillatory behavior beyond the shock is observed for the modified absorption governed by the forth or sixth order derivatives. Specific values of the dimensionless absorption coefficient are found, that corresponds to the equal width of the shock front in all three cases.

Tu. 17:10 Tivoli 2 Non linear acoustics

Symmetry of Nonlinear Acoustics Equations Using Group Theoretic Methods : a Signal Processing Tool for Extracting Judicious Physical Variables

Serge Dos Santos
GIP Ultrasons/ LUSSI

The concept of symmetry of differential equation seems to become a powerful tool for the understanding of nonlinear equations. It is already used in various fields such as optics (Nonlinear Schrödinger Equation) and fluid mechanics (Burgers). Symmetries of nonlinear equations can induce transformations of these equations into simpler ones introducing judicious variables implicitly related to physical invariants. In Acoustics, KZK equation is used for diffracted fields modelization propagating in nonlinear and attenuating media: hydroacoustics, medicine, biological tissue characterization and NDT. When attenuation is neglected, KZK becomes KZ for which Tjotta has found, using judicious transformations, a class of exact solutions[1]. In order to find (and to generalize to whatever nonlinear problem) the physical origin of transformations proposed by Tjotta, we have applied a one-parameter Lie group transformation to the KZ equation in order to extract symmetries. We propose to describe the method and present the extracted properties: existence of implicit solutions, explicit dependence versus the axial coordinate which is the consequence of the far field diffraction, and the contribution of the 'nonlinear retarded time'. Already done in acoustic diffusion, the use of symmetries related to Lie groups leads to a simplification of nonlinear problems. One of the signal processing fruitful applications consists in building some particular initial conditions of excitation (related to well defined symmetries) leading to solutions easily measurable using suitable nonlinear acoustics experiments. [1] J.N. Tjotta. A class of exact solutions of the Khokhlov-Zabolotskaya equation. Acoust. Phys.,39(5):507-508, 1993.

Tu. 17:30 Tivoli 2 Non linear acoustics

Quantitative Measurements of Ultrasonic Shock Waves Using a Standard Optical Interferometer

Christophe Barriere, Gabriel Montaldo, Daniel Royer, Mathias Fink
ESPCI - LOA

In order to measure acoustic shock waves generating pressures of some tens of MPa in water, an ideal sensor has to be calibrated, wide-band and sufficiently robust to support acoustic cavitation. We measure high intensity ultrasonic displacements and

shock waves in water, using the phase modulation of an optical beam reflected from a thin immersed membrane materialising moving particles. With a digital demodulation process, a 4.5-μm ultrasonic transient displacement (corresponding to a 21.5-MPa acoustic pressure in water) has been measured with a standard heterodyne interferometer. Results are in good agreement with those given by an hydrophone designed to measure high pressure wave. This sensitive optical method provides absolute measurements with a 50-μm lateral resolution, in a large bandwidth (from 20 kHz to 50 MHz). If the low cost membrane used in the experimental set-up is damaged by the acoustic cavitation, it can be replaced very easily, without changing the calibration factor of the interferometer. The maximum measurable displacement is limited by the frequency bandwidth of the instrument. Since the photodiode cuts off frequencies higher than 120 MHz, the interferometer is able to measure 22-MPa peak acoustic pressures in water. This performance can be improved by increasing the Bragg cell frequency, to obtain a wider bandwidth. We are now conceiving an interferometer working at 140-MHz carrier frequency, to measure pressures up to 45 MPa.

Tu. 17:50 Tivoli 2 Non linear acoustics

Luxemburg-Gorky Effect in a Granular Medium: Probing Perturbations of the Material State via Cross-Modulation of Elastic Waves

Vladimir Zaitsev, Veniamin Nazarov, Vincent Tournat, Vitali Gusev, Bernard Castagnède
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The nonlinear effect of amplitude modulation of a weaker sinusoidal seismo-acoustic wave under the action of another stronger step-wise modulated wave was reported in [1] for a sandy soil. Recently a related effect of transfer of the modulation spectrum from an intensive elastic wave to a probe one with different carrier frequency was observed in resonant-type experiments in solid samples containing cracks [2]. This nonlinear effect is a close elastic-wave analog of the similar phenomenon known as the Luxemburg-Gorky effect for cross-modulation of radio-waves in ionosphere. We report here observations of acoustic effects (self-action and cross-modulation) in a granular medium, which demonstrates the universality of the phenomena. Amplitude dependencies for the fundumental and induced modulation sidelobes of the probe wave have been studied. Furthermore, we observed complementary variability of the sidelobes and the probe wave amplitude at the fundamental frequency under the action

on the medium of short "seismic events" produced by an additional shaker. The resultant transient variations in the amplitude of the modulation sidelobes exceeded normally by an order of magnitude the complementary variations in the signal amplitude at the fundamental frequency (the latter variations being often hardly noticeable). The revealed high sensitivity of the cross-modulation sidelobes to slight variations in the stress state of the material opens possibilities for efficient diagnostic applications of the effect in laboratory and in field conditions. 1. A.L. Bagmet, V.E. Nazarov, et al., Doklady Earth Sciences, 346 (1996) 135. 2. V. Zaitsev, V. Gusev, B.Castagnede, Phys. Rev. Lett., 89 (2002), 105502.

Tu. 18:10 Tivoli 2 Non linear acoustics

Damage Characterisation and Structural Health Monitoring by Means of Nonlinear Acoustics

Mourad Bentahar, Rachid Elguerjouma, Thomas Monnier, Lucien Deville, Jean Claude Baboux
Insa de Lyon- Gemppm

This work is devoted to damage characterisation and structural health monitoring of polymer composites and concrete. For cylindrical concrete bars damaged in compression and thin composite plates damaged in three points bending, we have used a nonlinear ultrasonic method based on the change of a resonance mode frequency. Compared with their initial states, damaged materials are characterised by a resonance frequency shift as function of the excitation level. For a given value of the excitation level we have performed upward and downward frequency sweepings and have seen hysteresis loops that did not exist in the intact state. We have also submitted the material to a high excitation level and have followed the forced variation of the frequency versus time "fast dynamics" as well as the frequency recovery "slow dynamics" that changes as the logarithm of time. Fast and slow dynamics are correlated to the deterioration state of the material and are found to be very sensitive damage indicators. In order to monitor the material's health along the damage process, the frequency shift is compared to mechanical damage parameters and acoustic emission. A good correlation has been found. Our results confirm the efficacy of the nonlinear acoustical approach that could enrich materials nondestructive testing field.

Tu. 18:30 Tivoli 2 Non linear acoustics

Nonlinear Scholte Waves

Andreas Mayer, Alexander Kovalev
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Nonlinear acoustic waves are considered that are guided at the interface between a solid and a fluid with a compressibility much higher than that of the solid. It is shown that their waveform evolution in the fluid is governed by the two-dimensional Zabolotskaya-Khokhlov (ZK) equation with a linear boundary condition determined by the acoustic mismatch between fluid and solid. Two evolution equations used for the interpretation of recent experiments are derived as two different limiting cases of the ZK equation with the corresponding boundary condition at the interface. The existence of solitary waves is predicted for the case of Scholte waves becoming dispersive due to inhomogeneity of the solid. The depth profiles of such solitary interface waves and of corresponding stationary periodic waves are investigated.

Tu. 18:50 Tivoli 2 Non linear acoustics

Interaction of counter-propagating waves in resonant rods composed of materials with hysteretic quadratic nonlinearity

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An ordinary integro-differential equation for the profile of the acoustic wave in a resonant rode, composed of a material with hysteretic quadratic nonlinearity, is derived. It explicitly takes into account the interaction of the counter-propagating acoustic waves. It is demonstrated that in contradiction with simple-minded intuition this interaction suppresses the nonlinear phenomena. In particular the maximum vibration amplitude predicted by this theory is higher and the shift of the resonance peak is smaller in comparison with the case when the interaction of the counter-propagating waves is neglected. The interaction due to hysteretic quadratic nonlinearity amplifies both counter-propagating waves and also suppresses to some extent softening of the material with increasing wave amplitude.

Tu. 8:30 Gutenberg Numerical methods in acoustics I

On the Velocity Distribution at the Interface of Horn Driver and Horn

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For numerical simulations (boundary element method) of horns, the distribution of velocity or pressure at the horn throat is required as boundary condition. For frequencies below the first higher order mode, a plane wave approach is assumed as correct. Usually, the plane wave approach is also used for the higher frequencies as the shape of the wave front radiated by the horn driver is not known. This can cause an error in simulation results, e.g. the simulated directivity may deviate from a measured directivity. To improve the accuracy of numerical simulations, a specific distribution of velocity has to be used. To achieve more information about the required pressure and velocity conditions, the pressure distribution of different horn driver/horn combinations is measured at the interface between horn driver and horn. It is investigated if a wave front can be synthesized from these measurements that allows a more precise description of the interface horn driver/horn. Measurements and simulations using different velocity distributions are compared in order to verify this method.

Tu. 8:50 Gutenberg Numerical methods in acoustics I

Speeding-up acoustic predictions

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Finite element and especially boundary element methods for acoustic and vibro-acoustic predictions bring many benefits, in particular accuracy of the predictions, but they have traditionally suffered the penalty of long calculation times and large computing resource requirements, to achieve these results. This paper presents several recent developments which speed up the solution of finite element and boundary element acoustic models, with particular emphasis on BE models for acoustic radiation. The methods are based on Acoustic Transfer Vectors, Padé methods, domain decomposition and iterative solvers. These technologies make accurate acoustic predictions timely and effective: calculations can be accelerated by one or even two orders of magnitude. They tackle a wide range of applications ranging from engine acoustics to interior acoustics and enable the users to design practical solutions and effectively reduce time-to-market and development costs. The paper explains the methodologies and their implementation in practical software, and presents the results of several case studies and benchmarks.

Tu. 9:10 Gutenberg Numerical methods in acoustics I

Patch Transfer Function (PTF): a substructuring approach for linear acoustics

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For industrial structures, large acoustics problems like noise radiated by cars are very difficult to solve using classical methods like full BEM, because of the complexity of the structure. The PTF approach considers several acoustic subsystems, which are analyzed separately, considering each coupling area as a rigid surface, which is divided in elements called patches. For these calculations, any available method (FEM, BEMoe) can be used in order to build a database of transfer functions between sources and patches, which are acoustic impedance transfer functions. Then, continuity relations can be written on the interface in order to couple the subdomains: this approach is close to the mobility and impedance concepts which are widely used in mechanics. After the description of the method, some results concerning the convergence of the method are shown, concerning in particular the interface mesh size, which should be smaller than the half wavelength. Then, some results on an automotive structure are presented: the noise emitted by an engine through apertures of a car is estimated and compared with experiments.

Tu. 9:30 Gutenberg Numerical methods in acoustics I

Numerical Calculation of Acoustic Scattering From Simple Structures Using the Multiparametric Gradient Method

Edgar Schmidtke

Forschungsanstalt der Bundeswehr für Wasserschall und Geophysik

Under certain circumstances the Kirchhoff-Helmholtz-integral equation for submerged scatterers can be formulated as a Fredholm-equation of the second kind. If the scatterer is modeled as a polyhedron and all functions are assumed to be constant on every facet, the Fredholm-equation can be written as a system of linear equations with dimension D equal to the number of facets. It is planned to calculate structures up to D=10^ 4...10^ 6, so a very fast solver is necessary. The new multiparametric gradient method [1] will be presented as an extension to already established gradient methods. Calculations of scattering from spheres with surface impedance and from a 'Cat's Eye' will be compared with analytical solutions and with results of other numerical methods (FIELD [2]) with respect to accuracy and speed. [1] I. Nissen, Multiparametrische Gradientenverfahren, Ph.D. Thesis, Kiel,

1997 [2] M. Ochmann, A. Homm and J. Ehrlich, Numerical Calculation of Acoustic Scattering from a Finite Cylinder with Locally Varying Surface Impedance, A. Acustica 89, 14-20 (2003)

Tu. 9:50 Gutenberg Numerical methods in acoustics I

A boundary element simulation tool for exterior acoustical problems

Martin Ochmann, Alexander Osetrov
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The numerical prediction of sound fields radiated or scattered from complex shaped structures into the three-dimensional space can be used as a basis for the optimization of noise reduction methods. Especially, the boundary element method (BEM) combined with iterative solvers is a very efficient tool for performing such numerical simulations. For this reason, a simulation tool based on the boundary element method is developed for the analysis of acoustical radiation as well as of scattering problems. For the solution of the corresponding system of linear equations direct and iterative solvers are implemented. To overcome the computational difficulties at the "forbidden" frequencies, two methods are used: the combined integral equation formulation (CHIEF) and the combination with the differentiated integral equation (Burton and Miller formulation). The efficiency of both regularization methods are investigated depending on the frequency range considered. The capacity of the BE simulation tool will be demonstrated by applying it to the calculation of sound radiation from specially selected vibrating structures. In addition, the scattering from point sources located between an idealized tyre and a road surface is calculated for modelling the so-called horn effect.

Tu. 10:10 Gutenberg Numerical methods in acoustics I

Fast BEM-FEM Coupling for the Simulation of Acoustic-Structure Interaction

Matthias Fischer, Lothar Gaul
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BEM-FEM coupling is widely used for the simulation of the interaction between structural vibrations and radiated acoustic fields. Employing the FEM for the structure and the BEM for the acoustic field, exploits the specific advantages of the two methods. However, the efficiency of BEM-FEM simulations suffers from the fully populated BEM matrices. In recent years, fast algorithms have been developed that allow a sparse representation of the BEM systems. In the presented paper, the fast multipole BEM is outlined and a coupling scheme is developed that accounts for the properties of the fast BEM. The coupling algorithm is based on

Lagrange multipliers and provides high flexibility in the choice of discretizations. For the solution of the resulting saddle point problem, an approximate Uzawa algorithm is employed. Simulations in the medium frequency range require an adapted preconditioning of the system. Numerical examples show the performance of a multilevel preconditioner as well as of the entire coupling algorithm.

Tu. 14:50 Gutenberg Numerical methods in acoustics I

Representing Outdoor Sound Propagation Effects with a BEM Model

Sebastian Hampel, Sabine Langer, Heinz Antes
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Outdoor sound propagation is influenced by numerous different factors. Among these the most important are: Geometric damping, absorption of sound energy in the air and on the ground, acoustic shadow and diffraction effects and meteorological conditions such as wind and temperature conditions. To receive an applicable prediction of the sound field or sound immission at certain receiver positions without undertaking time-consuming and expensive experiments, it is necessary to include those propagation effects in a numerical simulation model. In acoustics, for infinite domains in particular, the Boundary Element Method (BEM) has established as a suitable and powerful numerical method. Therefore, it is shown how the important effects can be included in a BEM model. Furthermore, the ability or possible limits to represent these phenomena with BEM are investigated. Finally, BEM solutions for selected example problems are compared to either analytical solution or other reference values.

Tu. 15:10 Gutenberg Numerical methods in acoustics I

Efficient Simulation of Sound Insulation in Architectural Acoustics

Dirk Clasen, Sabine Langer, Martin Schanz
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So far, damping mechanisms have not been used systematically in architectural acoustics and, thus, a great potential in improvement of sound insulation is lost. Due to this fact it is important to analyze different damping mechanisms and their effects on sound transmission in buildings. To study them, beside measurements, numerical simulation techniques for sound transmission are available. To numerically predict the sound insulation of a building a tool based on Finite Element and Boundary Element Method has been developed. Real world problems result in very large systems which need an optimized implementation with respect to storage and numerical efficiency. This is realized

using freely available numerical libraries which provide efficient routines to treat sparse matrices and large scale linear equation systems. They have been integrated to the program to reduce memory usage and to speed up equation system solving. Hence, enormously larger problems can be handled now. Another advantage is that theses libraries are extensively tested and provide almost error free code.

Tu. 15:30 Gutenberg Numerical methods in acoustics I

Combining Finite Element and SEA Approch in Vibroacoustic Analysis

Gerard Borello
InterAC

Statistical Energy Analysis (SEA) is a powerful approach for predicting vibracoustic trends in the high frequency domain. This method is nevertheless limited by the extensive use of analytical representation for computing SEA parameters and fails to provide accurate results when structural complexity increases (car bodies, stiffer parts of structures...). Finite Element modelling (FE) can be involved in the predicting SEA scheme to provide more realistic SEA parameters. Using inverse SEA techniques applied to FE forced solutions, SEA model can be built from FE data and provide accurate models for structure borne sound. This virtual SEA methodology will be demonstrated on examples taken for automotive and aerospace industries.

Tu. 15:50 Gutenberg Numerical methods in acoustics I

Practical considerations of the acoustic FEM for higher frequencies

Steffen Petersen, Daniel Dreyer, Otto Von Estorff
AUDI AG

The Finite Element Method (FEM) is an indispensable tool in today's simulation tasks. It is at the core of any concept that attempts to reduce time-to-market and/or enforces virtual prototyping in almost every engineering field. However, when simulating time harmonic acoustics using the FEM, an efficient tool for bridging the 'mid-frequency gap' is still missing. The lower frequency range is well covered through element-based methods, like domain- or boundary-integral based formulations. The higher frequency range, in turn, benefits from the development of energy averaging methods. However in between, the mode density is too low to render the high-frequency methods effective, and the FEM suffers with increasing wave number from the so-called pollution effect. Several approaches exist, that attempt to extend the element-based methods to the mid-frequency range. These generally rely on knowledge-based concepts, i.e. incorporating

a-priori-knowledge of the solution into the numerical method itself. However, these concepts appear to still lack sufficient maturity for reliable and stable simulations. In this contribution, a more straightforward approach to tackle the pollution effect is suggested, namely through still relying on the conventional FEM, but including the latest developments and most efficient tools currently available. Studies concerning the best combination of several polynomial shape function families, efficient solvers, and means to suppress pollution are presented.

Tu. 16:10 Gutenberg Numerical methods in acoustics I

A component study of the vibroacoustic damping of a non-baffled free plate partially covered with elastomer patches

Lionel Zoghaib, Pierre-Olivier Mattei

LMA CNRS

This work deals with a vibroacoustic numerical and experimental study of a suspended free thin plate which has been partially covered with polymer patches. The aim of the investigation is to develop a model of the acoustical and mechanical damping components for an optimization of the patches location for noise reduction purposes. The patches are thin double-layer elastomer/aluminum laminae whose dissipative influence has been studied in different locations of the aluminum plate. The analysis is based on a viscoelastic incompressible 3D finite element formulation of the rubber layer together with a Kirchhoff-Love plate element model of the metal layers. The differential system of equations that governs both the displacement of the structure and the acoustic pressure is transformed into one single integro-differential equation of the displacement. The acoustic Green function of the spatial configuration is computed by a direct BEM using a double-layer potential. The solution is expressed as a series of the resonance modes. The resonance modes are computed using a perturbation expansion with respect to a small parameter associated to the light fluid approximation. The numerical model clearly distinguishes the viscoelastic damping from the damping associated to the fluid-structure coupling. In addition modal analysis with a non-contacting method is achieved by means of a loudspeaker and a laser-beam measurement apparatus. Comparisons between the numerical computations of the damping and the corresponding measured one show the efficiency of the method.

Tu. 16:50 Gutenberg Numerical methods in acoustics I

On the use of a novel Wave Based Method for the Dynamic Analysis of Flat Plate Assemblies

Caroline Vanmaele, Bert Pluymers, Wim Desmet, Dirk Vandepitte, Paul Sas
Department of Mechanical Engineering, K.U.Leuven

In recent years, the vibro-acoustic behaviour of a product has become a design criterion of growing importance. This behaviour is mainly determined by the steady-state dynamic deformations in the mechanical structure of the product. Commonly, the finite element method is used to predict the dynamic behaviour of structures. This method expands the dynamic field variables, within each element, in terms of local, non-exact shape functions. As a result, the size of the model becomes prohibitively large for increasing frequencies, thereby leading to a practical frequency limit. The newly developed wave based prediction technique, based on the indirect Trefftz method, expands the field variables in terms of global wave function expansions, which exactly satisfy the governing dynamic equations. The wave based method shows to be computationally more efficient, and will consequently be applicable also for higher frequencies. Although the structural-dynamic calculations are computationally the most demanding part in a vibro-acoustic problem, until now the research focused mostly on acoustic systems. Current research extends the applicability of the wave base method towards three-dimensional structural-dynamic applications. This paper discusses the development of the wave based method for analysing the behaviour of an assembly of flat plates, coupled at arbitrary angles. Numerical validations confirm that the wave based method achieves a high accuracy with substantially smaller models in comparison with the finite element method.

Tu. 17:10 Gutenberg Numerical methods in acoustics I

Application of a Novel Wave Based Prediction Technique for Acoustic Cavity Analysis

Bert Pluymers, Caroline Vanmaele, Ravish Masti, Wim Desmet, Dirk Vandepitte, Paul Sas, Eike Brechlin
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Vehicle interior acoustics has become an important design criterion. Both legal restrictions and the growing demand for comfort, force car manufacturers to optimize the vibro-acoustic behavior of their products. The tendency to minimize the number of physical prototypes and to reduce the overall development cost and time, as well as the high performance of modern computer resources, clear the path for numerical prediction techniques to drive the

noise, vibration and harshness optimization. The most commonly used numerical prediction techniques for vibro-acoustics are element based methods, such as the finite element method and the boundary element method, and the statistical energy analysis method. However, element based methods are only applicable in the lower frequency range and the statistical energy analysis method in the higher frequency range, leaving a frequency band, which is called the mid-frequency gap, for which no effective prediction technique is available at this moment. The wave based prediction technique is one of the techniques that exhibit potential to narrow this frequency gap. Like the element based methods, the wave based prediction technique is a deterministic technique, which is however computationally more efficient and thus suited for the mid-frequency range. This paper discusses the application of the wave based prediction technique for the three-dimensional acoustic analysis of a car-like cavity. A comparison with corresponding finite element discretizations as well as an experimental validation are presented with special focus on the convergence rate and computational efforts involved with the novel technique.

Tu. 17:30 Gutenberg Numerical methods in acoustics I

Transient Sound Generation of a Plate Coupled to an Acoustic Cavity

Pierre-Olivier Mattei, Ulf Kristiansen
LMA CNRS

The sound radiated into a cavity by the surrounding walls depends on several factors. The signal type, wall construction, cavity geometry and damping are of the most important. In this paper results that illustrate many of the basic features of vibro-acoustic coupling in the transient regime are presented. One of the aims is to describe the response of the fluid-loaded plate coupled to a rigid cavity when it is excited by a Ricker wavelet and to see the influence of the excitation on the response of system. An other goal is to compare results given by two calculation methods. The first uses an explicit finite difference scheme to discretize the governing equations in space and time. The other uses an analytic technique based on a series expansion into resonance modes. These modes, here computed using perturbation expansion to account for small damping and loading, correspond to the free oscillations of the plate-cavity system. The results from the two models are in good correspondence. Both models show that the efficiency by which the plate radiates sound into the room can in general qualitatively be explained by the speed of the Fourier frequency components of the impulse type signal. Subsonic phase

velocities generate a near acoustic field, and only transfer acoustic energy to the room from the region close to the plate boundaries. For supersonic bending wave speeds energy is transferred to the room all along the trajectory.

Tu. 17:50 Gutenberg Numerical methods in acoustics I

Comparison of a Deterministic and a Genetic Algorithm applied to Structural Acoustic Optimization

Joachim Bös
Fraunhofer Institute for Structural Durability LBF

Both a deterministic (local) and a stochastic (global) optimization algorithm are used to optimize the wall thickness distribution of a model structure such that the difference between two specified natural frequencies is maximized, subject to the following constraints: Neither the vibrational level nor the structural mass are allowed to increase. Powell's COBYLA algorithm, which is a sequential trust-region method that employs linear approximations to the objective and constraint functions, is used as the deterministic algorithm. A specific implementation of a genetic algorithm, namely Charbonneau's PIKAIA algorithm, serves as the stochastic algorithm. The model structure consists of two rectangular steel plates with an initial wall thickness of 4 mm, joined at an angle of 90 degrees. The structure is excited by a harmonic force (0-3000 Hz). For the initial configuration, the difference between the two natural frequencies under consideration is 19 Hz. COBYLA takes about 11000 function evaluations to meet its convergence criterion, and the final design shows an increased frequency difference of 485 Hz (+2450%). PIKAIA has no convergence criterion and is therefore stopped after 50000 function evaluations. At this point, the frequency difference is increased to 547 Hz (+2779%). Obviously, COBYLA finds only a local optimum, whereas PIKAIA locates the global one or at least a significantly better local optimum. However, PIKAIA takes almost four times more function evaluations to obtain the final design.

Tu. 18:10 Gutenberg Numerical methods in acoustics I

Energy residuals for localization of structural areas inducing hypersensitive behavior

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This paper describes a method allowing one to localize structural areas inducing hypersensitive vibrating behavior: with a very low calculation cost, the use of energy residual in fem post processing can be very efficient to detect the zones in which small changes can induce large dispersions on responses. The principle of the method is presented here, including a comparison

between some energy residuals, in term of efficiency and localization properties.

Tu. 18:30 Gutenberg Numerical methods in acoustics I

Power Transmission Coefficients for Generic Structural Junctions

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Gesellschaft fuer Akustikforschung Dresden m.b.H.

A number of numerical methods exist for the prediction of high-frequency structure-borne sound. In particular statistical energy analysis, energy finite element methods and smooth energy methods are used. In all these methods, the transmission across structural junctions is characterised by power transmission coefficients. Thus, the results of the calculation depend on the exact prediction of these coefficients. In the paper, a generic approach for the calculation of power transmission coefficients is presented. Included in this approach are several types of connections: line-connected plates, point-connected beams, point-connected-plates and point connections between beams and line-connected plates. The theory and numerical procedure applied for these connection types is outlined and some example results are shown.

Tu. 18:50 Gutenberg Numerical methods in acoustics I

Acoustical energy diffracted around a building

Emeline Reboul, Joël Perret-Liaudet, Alain Le Bot
Ecole Centrale de Lyon

Acoustical diffraction is a current phenomena which occurs when sound waves hit obstacles: this phenomenon brings acoustical energy into shadow areas that are prevented from direct incidence. It has been widely studied, in particular by means of the Geometrical Theory of Diffraction (GTD) developped by Keller. This theory extends geometrical acoustics to diffraction phenomena and proposes frequency-domain formulations for diffracted rays, asymptotically valid at high frequencies. This paper concerns the study of diffraction by means of an original method based on energy considerations. This method relies on the equation of the energy radiative transfer, and is well-suited for high frequency applications. This method has given rise to the development of a specific software called CeReS. In the proposed approach, diffraction phenomena is treated by introducing diffraction sources whose amplitudes are calculated by applying the power balance between all acoustical sources. It appears to be particularly well-suited for multiple diffraction case as all orders of diffraction are simultaneously taken into account. The method is applied in the case of diffraction around a building near a road.

In this context, diffraction is a major phenomena responsible for noise in the backyard of the building. Results obtained with the method are compared to reference one: enough good agreement on sound pressure level is observed all around the building.

Tu. 8:30 Kleber Hydroacoustics, underwater acoustics

Enhanced Simulation of Hydroacoustics in Flexible Structures by Substructuring and Model Reduction

Matthias Maess, Lothar Gaul
Institut A für Mechanik, Universität Stuttgart

The paper discusses aspects of simulating hydroacoustic vibrations and wave propagation of compressible fluids enclosed in flexible containers such as pipe assemblies or tanks. The two-field simulation models are coupled at fluid-structure interfaces. A coupled finite element model of substructure segments containing the fluid is used for modal and transient analysis. The dynamic equations using the acoustic pressure as field variable in the fluid render both non-symmetric mass and stiffness matrices due to the FSI-coupling. However it is possible to achieve a symmetric representation by introducing the velocity potential as field variable. The existing matrices are transformed into a symmetric system representing the coupling by a damping-like matrix. Based on these two formulations, model reduction and component mode synthesis are performed for FSI-coupled substructures. Hereby, the coupling interface between substructures does not only represent a structural interface but also contains a hydroacoustical partition. Therefore, implicit scleronomic constraints hold for both the nodal displacements and the nodal pressures at the interface, and they are used to generate transformation matrices for the coupling. The substructures are reduced with respect to their interface degrees of freedom mainly to guarantee sufficient accuracy for the coupled model. The model reduction bases for the coupled system are obtained from the uncoupled fluid and structure domains (indirect model reduction). Results for vibrations and wave propagation in composed FSI-coupled piping systems are presented.

Tu. 8:50 Kleber Hydroacoustics, underwater acoustics

Hydrodynamic Pressure on Multiple Vertical Cylinders in a Compressible Fluid

Otto Von Estorff, Marian Markiewicz, Olgierd Zaleski
Technische Universität Hamburg-Harburg

The numerical study of the acoustic interaction among several obstacles in a compressible fluid is a challenging task, especially if the amount of interacting bodies is given by a two-digit number. Typical examples of such systems include the tube bundles

in heat exchangers, underwater pipelines, arrays of cylinders in seabed offshore structures, and mega-float structures. Due to the complexity of these systems, the standard Finite Element or Boundary Element codes are practically inapplicable. The acoustic pressure and the associated forces on such structure assemblies can effectively be predicted by using the so-called "exact algebraic method". The methodology belongs to the group of numerical-analytical methods. The numerical part includes the computation of the so-called diffraction matrices for all members of the assembly and it can be accomplished by using any commercial FE or BE code. The kernel of the method is the solution of the interaction problem which is formulated analytically using an expansion of the wave fields radiated and scattered by each system member into elementary incoming wave components. The total incoming wave and the radiated wave by each member are then combined using diffraction matrices. This yields the final system of linear algebraic equations for the unknown expansion coefficients of the total interaction problem. After a general presentation of the method, some computational examples for the arrays of vertical cylinders in water of constant depth will be presented.

Tu. 9:10 Kleber Hydroacoustics, underwater acoustics

Benchmark solutions for scattering problems in acoustics

Bernhard Schwarz-Röhr
Carl von Ossietzky Universität Oldenburg

Numerical solutions for scattering in acoustics are usually obtained by methods of finite element or boundary element type. Beeing quite versatile on the hand, these methods do not provide estimates for the accuracy of the solution. Thus analytical solutions for not to simple testcases are of major importance. In this paper, the scattering by a hollow sphere with thin, rigid walls and a hole linking inner and outer space is considered. Solutions based on eigenfunction expansions are presented, the stability and accuracy of these solutions is discussed.

Tu. 9:30 Kleber Hydroacoustics, underwater acoustics

Transform methods for horizontally layered isotropic and anisotropic media with obstacles

Holger Waubke
Institut für Schallforschung, öAW

The transform method has shown its advantages for media with regular boundaries. As long as the boundaries are parallel, an analytic evaluation for every layer is possible in the transformed domain. This model was already used to calculate Scholte waves at the boundary between a water layer and an isotropic random,

or an orthotropic soil layer or a half space. Compatibility between the boundaries leads to a matrix equation that is solved numerically. Back transform is also done by numerically using a fast Fourier transform instead of a Fourier integral transform. An extension to randomly varying material behaviour by means of Parseval's theorem and transformed finite elements was already explained in prior presentations. This method can be used for obstacles also, but the idea is suited to global variations. A different approach is the derivation of Green's functions. This normally needs a particular solution for an impact within a layer. This solution can be derived from the homogenous solution, if an addition boundary in variable depth is introduced into the model. Impact loads for the generation of test functions are added at the variable interface as external stresses. In an isotropic or anisotropic medium, dipole solutions with a well defined direction are needed. This is done using impact loads with horizontal and vertical direction. The method is presented and possible reductions in the numerical efforts are explained.

Tu. 9:50 Kleber Hydroacoustics, underwater acoustics

Detection of objects buried in the seafloor with an Experimental Sediment Sonar

Dieter Brecht, Harald Peine
FWG Kiel

With the demonstrator system EXSESO (Experimental Sediment Sonar) FWG investigates the detection and classification of objects buried in the seafloor under realistic conditions. The test sites are located in the Baltic Sea near Kiel. Spheres and cylinders filled with concrete were used as targets. Most of them were equipped with water jet facilities. These help the divers to bury the targets and keep the disturbed sediment volume rather small. Some of the objects are equipped with a transponder system, allowing to check the target position with high accuracy. Experimental Results of the Sea Trials are presented. This includes detection results, display concepts, the fusion of high and low frequency information and the related signal processing tools.

Tu. 14:50 Kleber Hydroacoustics, underwater acoustics

Hydro acoustical range facilities in Germany

Stefan Schael
WTD 71, Akustikzentrum

DAGA 2004 Military requirements demand special properties of their equipment. Therefore the navy works out operational scenarios to derive the possibly threat of their mission and ships. In respect to this prerequisite we define feasible maximum signature levels of naval ships and boats placed in contracts agreed

by the ship yard. WTD 71 provides hydro acoustical ranges to perform measurements for investigating the acoustical behavior of naval ships and boats and to control the fulfillment of the contracts. This talk will describe the underwater installation for deep water and also for shallow water measurements, the procedures of the performance and the analysis of the data processing. Besides measuring the target level it is also mandatory to verify the generating noise source. A brief overview will show results received by · a phase array · narrow band analysis · DEMON · LOFAR The range facilities is constantly improved by the requirement of new projects. U 212 will give an idea of how to prepare the acceptance test.

Tu. 15:10 Kleber Hydroacoustics, underwater acoustics

Freefield Measurements of Radiated and Structure Borne Sound of a Ship

Volkmar Nejedl, Jan Ehrlich, Christian Kubaczyk
FWG Kiel

The radiated underwater sound of technical structures into the far field is of widespread interest, especially for naval ships. A part of the radiated field is caused by structure borne sound excited by the ship's vibrational sources (engines, pumps etc). Actually, there is no reliable physical model that describes the relation between source properties inside the ship and the radiated sound into the far field. Therefore a concept for the identification and quantification of the essential effects is needed. The paper describes the investigation concept and the experimental configuration for the simultaneous measurement of both, the structure borne sound and the radiated sound of a ship. The trials were carried out with the research vessel 'PLANET' in the Celtic Sea. The structure borne sound was measured using up to 18 accelerometers placed on several aggregates and frames along the ship. For the measurement of the radiated sound field an autonomous, buoyant vertical line array was used. In addition to the ships sound sources, defined signals were generated by two self mounted shakers. The evaluation of the experimental data focusses on the identification of the dominating sound sources and their relations to the radiated field. Selected results as well as essential problems will be discussed.

Tu. 15:30 Kleber Hydroacoustics, underwater acoustics

Predicting Very Low Frequency Underwater Radiated Noise from Full-Scale Ships

Layton Gilroy
DRDC Atlantic

Methods for predicting fluid-structure interaction and underwater radiated noise have been under development for a number of years. For very low frequencies, a combined finite element and boundary element technique is often used and such a system (AVAST) is available at DRDC Atlantic. While a variety of structures have been examined, the complete analysis of a full-scale vessel is still relatively rare. There is also a renewed concern to minimize the underwater radiated noise from commercial vessels and, in particular, fisheries research vessels. The International Council for the Exploration of the Sea (ICES) has issued recommendations for maximum radiated noise levels over a broad spectrum. This includes very low frequency (less than 50 Hz) narrowband noise, which is not amenable to prediction with energy-based or empirical methods. This paper will demonstrate the procedure for predicting the very low frequency radiated noise from a generic ship model with excitation provided by sample vibrations measured on engine mounts. The analysis will proceed from a coarse MAESTRO model of the vessel, through to a finite element model where the loads will be applied and the natural frequencies calculated, to a radiated noise prediction using the AVAST software. The resulting prediction will be compared to the ICES recommendations up to a frequency of about 50 Hz. The paper will also discuss the difficulties encountered in such analyses and make recommendations as to an appropriate way ahead.

Tu. 15:50 Kleber Hydroacoustics, underwater acoustics

Acoustic Tomography Experiment in the Lake of Geneva

Xavier Falourd
Ecole Polytechnique Fédérale de Lausanne

Physical limnology in lake Geneva tries to identify the dominant processes of transport and mixing which influence the water quality of the lake. In order to achieve this, a nearly continuous observation of the movements of the water masses and the development of the thermal stratification is required. By measuring the difference in sound travel times in two directions between arrays of hydrophones, placed at the boundary of the lake, we can infer, using tomography inversions techniques, the stratification and hydrodynamic state at lake basin scale. The paper presents the results of an experimentation carried out during the autumn 2003

in lake Geneva, between two linear arrays of four hydrophones at thirteen-kilometre range. Binary Phase Shift Key signals (centered 20 kHz) are examined every five minutes during a long-term period. Detected ray paths are discriminated in time and angle using the MUSICAL method. From the two-way transmission, we derive the thermal stratification and the current velocity component during the experimentation. Finally, we derive from raw hydrodynamic data the influence of the stratification perturbations on the acoustic propagation. The analysis of travel time perturbations shows the variability of the propagation path induced by internal waves and other currents within the field of study during the experimentation.

Tu. 16:10 Kleber Hydroacoustics, underwater acoustics

Heterodyne and Time-gated Time-delay Spectrometry for Amplitude and Phase Calibration of Hydrophones up to 50 MHz

Christian Koch, Volker Wilkens
Physikalisch Technische Bundesanstalt, FB 1.6 Schall

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. Two methods based on the principles of time-delay spectrometry (TDS) are presented providing the complex hydrophone sensitivity up to 50 MHz. 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). To show the performance of the methods, several hydrophones of membrane and needle type were investigated in different frequency ranges. The two reference hydrophones used were calibrated before by a primary interferometry-based calibration technique yielding the amplitude of the sensitivity. As a phase standard an optical multilayer hydrophone was successfully employed showing an extremely flat amplitude and phase response. Thus, absolute amplitude and phase values are obtained from the TDS-technique in a wide frequency range. To validate the new method, results were compared with those of interferometric calibration, of a pulse calibration technique recently developed for hydrophones with small diameters and optical techniques, and of a hydrophone

model. The agreement is excellent in most cases and the data provide a basis for deconvolution correction procedures.

Tu. 16:50 Kleber Noise from leisure activities

Tendencies in the Worsening of Hearing Thresholds of Pupils with Regard to Leisure Noise

Detlef Schulz, Karin Künzel
Hochschule Mittweida (FH)

There has been considerable literature over the past decade ascertaining a worsening of the hearing capability of young persons. Within the scope of a long-term-investigation we performed annual audiometric testing of pupils of 7th - 10th classes during 3-4 years (longitudinal hearing study). This testing was supplemented by a questionnaire regarding noise - relevant aspects of the behaviour in the leisure time (e.g. hobbies) and of the state of health. Apart from an increase in attending discotheques no strong alterations of the behaviour could be detected. Comparing especially pupils of 8th - 10th and 9th - 10th classes of the same samples a worsening of the hearing thresholds was found. The average hearing thresholds of these samples increased significantly in the frequency range of 1 - 6 kHz and 14 - 16 kHz. Hints for specific patterns of hearing impairments and correlations with noisy activities are discussed.

Tu. 17:10 Kleber Noise from leisure activities

Untersuchungen zur Schallemission von Freizeitaktivitäten

Hans-Jörg Ederer
Akustik Bureau Dresden

Das Sächsische Landesamt für Umwelt und Geologie hat 2001/2002 ein Forschungs- und Entwicklungsprojekt unter dem Thema 'Sächsische Freizeitlärmstudie' initiiert. Im Rahmen dieser Studie waren Untersuchungen der Geräuschemissionen ausgewählter Freizeiteinrichtungen und Freizeitaktivitäten durchzuführen, sowie Berechnungsverfahren zur schalltechnischen Prognose der daraus resultierenden Geräuschimmissionen in der Nachbarschaft zu erarbeiten. Neben Freiluftkonzerten, Rummelplätzen und Volksfesten wurden unter anderem Anlagen für Modellfahrzeuge und -flugzeuge, Hundedressurplätze, Abenteuerspielplätze, ortsfeste Wasser skianlagen sowie Sommerrodelbahnen untersucht. In dem Vortrag soll sowohl eine übersicht über die gewonnenen Meßergebnisse ausgewählter Anlagen gegeben als auch über die Probleme bei der Verifizierung berichtet werden.

Tu. 17:30 Kleber Noise from leisure activities

Noise Exposure in Kindergartens

Reimer Paulsen
BIA - Berufsgenossenschaftliches Institut für Arbeitsschutz

Rating levels between 80 and 85 dB(A) (LAeq, 8h) are not uncommon at kindergarten workplaces. Such levels were approved by measurements of the BIA. Peak levels up to 120 dB(C) were measured and, additionally a lot of impulsive noises (caused by children's shouting or wooden furniture falling down) were observed. Especially when acoustic conditions are adverse (e.g. cause of absent acoustic ceilings) such high noise exposure can be measured. Presenting these results the focus should be directed to the exigence of an adequate acoustic design of kindergartens. Maybe the implementation of the new EC directive to protect employees at the workplace will produce the breakthrough. If the action levels of this directive are implemented, suitable hearing protectors must be provided for kindergarten teachers.

Tu. 17:50 Kleber Noise from leisure activities

Impact of acoustic quality in schools : from measurement to perceptive evaluation

Aline Barlet, Emmanuel Mérida
EAPBx -GRECO

This paper deals with the evaluation of the acoustic quality of nursery schools. These premises are rarely considered in terms of environment, particularly in acoustic terms. Nevertheless, during their stay, all the users, adults and children, could be confronted with unpleasant acoustical conditions. However, nursery school environments play an important role in the young children's development of knowledge and sociability. In order to know more about the relation between the children's comportment, the adults' evaluation and the environment, it seems essential to analyse the impact of acoustic on their reactions, notably by modifying the spaces. So, we realized a study in five nursery schools in Bordeaux, which represent a large architectural diversity. We chose to work in particular spaces: the classroom and the activity room [Louwerse C., Barlet A., Sémidor C., 2002]. Although the initial methodological approach was more global, in this article we want to focus our attention only on two phases. These phases were separated by a modification of acoustical characteristics: a decrease of reverberation time. Each phase was constituted of the following elements: measurements, "subjective" survey with closed questionnaires (only with adults) and observations (children's typical comportments). We

also analyzed the correlation between the evaluation of acoustic comfort before and after the modifications. We will demonstrate that, in this case, the decrease of reverberation time is not systematically correlated with a decrease of the produced noise level and with the comfort degree of adults. These results will be corroborated by the analysis of children's comportment in both phases.

Tu. 18:10 Kleber Noise from leisure activities

Schalltechnische Prognoseverfahren für Freizeitlärm

Johannes Herhold
Sächsisches Landesamt für Umwelt und Geologie

Freizeitanlagen und Freizeitaktivitäten erlangen in unserer Zeit eine immer größere Verbreitung. Ihre Nutzung ist häufig mit Geräuschemissionen verbunden und kann zu nachbarschaftlichen Konflikten führen. Zuverlässige schalltechnische Prognosen sind für die Planung und Genehmigung erforderlich. In der Praxis sind jedoch gegenwärtig für zahlreiche vorkommende Arten von Freizeitanlagen bzw. Freizeitaktivitäten aussagefähige Daten über Emissionskenngrößen sowie Berechnungshilfen für die schalltechnische Prognose nur unzureichend verfügbar. Berichtet wird über die Konzeption eines bausteinartig aufgebauten Systems. Ziel war es, eine zuverlässige Bestimmung der Emissionskenngrößen auf der Grundlage von einfach zu ermittelnden nichtakustischen Kenngrößen der Anlage, z.B. bei Beschallungsanlagen die Flächengröße, die maximale Hörentfernung oder die elektrische Anschlussleistung der Beschallungsanlage, vorzunehmen und daraus geeignete Berechnungshilfen für die schalltechnische Prognose abzuleiten. Hinweis: Vortrag nach Möglichkeit bitte in die gleiche Gruppe und zeitlich unmittelbar vorher einordnen vor Vortrag CFADAGA2004/26 - Ederer, Hans-Jörg !

Tu. 8:30 Oberlin Soundscapes and community noise

The Multidimensional Evaluating of Soundscapes. An Overview

Brigitte Schulte-Fortkamp
Institut für Technische Akustik , Technische Universität Berlin

Among the many potentials research ideas on soundscape some clearly have higher priorities. The question about the criteria (beyond sound level) of a good soundscape or what is a sensitive soundscape or what are the soundscape requirements of a resort area or a quiet area, which should be protected, are central to the origin of the soundscape idea. In order to reduce noise-annoyance and improve soundscapes a planned echeloning of the eco-tax would be helpful. Other classical acoustics questions

such as the role of background noise, audibility, intrusiveness under critical conditions, and under condition of mixed sources and time pattern should be asked differently than hitherto put to deepen insight and understanding. Both central questions should be pursued only in the context of psychscape and enviroscape preferably studied in different areas with a sufficiently large sample of typical urban and rural layouts, lifestyles, and patterns of land use

Tu. 8:50 Oberlin Soundscapes and community noise

How to validate the urban soundscape?

Catherine Semidor
EAPBx -GRECO

The urban planners and others town designers need information to improve the acoustic comfort of the cities. Among them are the components of the urban sound environment. Its analysis from the standard data (measurements of the Equivalent Sound Level with an omnidirectional microphone on one spot during a determined period from a few seconds to a week or more) doesn't allow to describe correctly the urban soundscape. It's why we propose a method based on the recordings with a 'dummy' head and a DAT recorder of soundwalks through varied urban forms. In a previous paper [Semidor C., PLEA 2003] we had shown how it allows to distinguish the soundscape of a 'car free' Sunday from the soundscape of a Sunday with cars. We have applied this method to evaluate the soundscapes of different towns in Europe and we present here the results of these surveys.

Tu. 9:10 Oberlin Soundscapes and community noise

How Different Sources Fill the Soudscape : a Perceptive and Acoustical Approach

Boris Defreville, Catherine Lavandier, Marc Laniray
LASA et Université de Cergy-Pontoise

In order to assess urban soundscape, new indicators are developed. These indicators should characterize the perception of sound sources in urban environment : vehicles, human voices and bird's sings. Within the framework of this article, only indicators built on identification of the vehicles are presented. 5 minutes of an uninterrupted sound stimulus, recorded in urban environment, is presented to 20 listeners. A the end of the listening, the subject is invited to evaluate 3 aspects of source perception on a scale from 1 to 10. First, the "pregnancy" of a sound source is assessed as the importance which it takes in its environment. Secondly, the "presence" and at last, the "proximity" of the source. A second auditive test is also proposed. 20 listeners hear the same 5 minutes sequence, cut into a serie of

20 stimuli of fifteen seconds each. After each 15 seconds sequence, the listener is invited to note the 3 same appreciations pre-cited. At the same time, the search for data measuring the likeness and the level of the sound sources is developed. The likeness measure, built from the spectral and temporal characteristics of a standard vehicle in a urban displacement, is stored in real time. A gauge adapted to each type of source is used as a filter to store also in real time a temporal evolution of each source. Based on those curves, new relevant indicators are studied to optimize their correlations with the perceptive "pregnancy", "presence" and "proximity" evaluation of each type of source.

Tu. 9:30 Oberlin Soundscapes and community noise

Cognitive approach of soundscape

Danièle Dubois
c/o Laboratoire d'Acoustique Musicale

We will present some results from a new method of exploration of the cognitive properties of soundscapes elaborated in our laboratory. From free categorization tasks associated to linguistic discourse analysis of real life experience of urban soundscapes, the results suggest that acoustic stimuli can be processed either as part of a meaningful event (i.e as NOISE) or, in a more analytic manner, along physical parameters (as SOUND), when the identification of the source fails. Language can be considered as allowing an access to the diversity of cognitive conceptualizations for acoustic phenomena : sounds and noises, both present in soundscape, depending on the orientation of the cognitive processes and the activities we are involved in (a s pedestrian vs driver, as worker or tourist..), on the knowledge and interest we have about these phenomena (mucisians, acousticians, ^{3}novices^{2}), but also on the constraints from the recording and restitution devices. Finally, we would like to point out that this diversity of cognitive representations entails methodological consequences on sound restitution in experimental settings, and suggests the challenge of a ^{3}reverse^{2} paradigm for studying soundscapes, shifting from psychophysics to semiophysics.

Tu. 9:50 Oberlin Soundscapes and community noise

The Importance of Grounded Theory with Respect to Soundscape Evaluation

Andre Fiebig, Brigitte Schulte-Fortkamp
Institut für Technische Akustik , Technische Universität Berlin

The perception of sound for human beings is a really complex phenomenon. For example acoustical, psychoacoustical, visual parameters influence the sound perception in a confusing way. Especially in urban environments almost every sound is

unwanted and would be interpreted as annoyance. This study aims at clarifying and improving the comprehension between assessment, response and attitude of inhabitants in urban environments regarding their urban soundscapes. Narrative and issue-centered interviews were carried out to identify common perceptive patterns in the process of judging urban soundscapes. At the same time acoustic measurements were conducted. This work employs the methodology of qualitative-interpretative research since perception is constantly embedded in social contexts. Therefore the analytical basis of the interpretation should be the ?Grounded Theory? approach, a general methodology of qualitative social analysis (developed by Anselm Strauss and Barney Glaser). It is expected to descry fresh relations between grounded categories which improve previous perception models and add further aspects to theories of multidimensional perception.

Tu. 10:10 Oberlin Soundscapes and community noise

Physical and perceptual point of view on soundscapes: comparing physics, perception, and analysis

Vincent Gibiat, Abril Padilla
Laboratoire d'Acoustique Métrologie et Instrumentation, Université Paul Sabatier

Propagating sound waves implicates different analysis levels: the perceptual governs our sensations, the physical explains the acoustic source emission, and linked the geometrical and surface acoustical characteristics describe and bound the propagating medium. These three points have then to be represented through sophisticated signal and perceptual analysis methods. The association of a composer using natural recorded sounds as a musical material and a physicist working with sound waves in their whole complexity, amplitude and phase included, has been our starting point. Eliminating the physical aspect of the source, we concentrated our work on the two other points. We recorded soundscapes, produced in parisian underground (Metro) and Express Regional Network (RER). The recordings have then be described with the words of perceptual musical language when unusual phase spectrograms have been performed in conjunction with amplitude spectrograms or sound level representations. These have been realised through classical Discrete Fourier Transform or Differential Spectral Analysis. We will present the comparison of our diverging and converging analysis and give hints to explain why they diverge or converge. More important we will show that perceptual effects as acoustical emergence of low amplitude signals cannot be detected on signal analysis without the phase of the spectrograms.

Tu. 14:50 Oberlin Soundscapes and community noise

Improving soundscapes through the Eco-Tax

Cay Hehner
Institut für Technische Akustik , Technische Universität Berlin

In order to tackle unbearable or even barely bearable noise annoyance and work for an improvement of the quality of urban life through noise reduction and 'indigenous' soundscape improvement it has to be borne in mind that the ecological system of taxation according to Henry George does not amount to 'yet another tax' on top of the uncountable taxes already in place in most countries to interfere with the worldwide badly needed upswing of the business cycle. The Georgist tax of natural resources and kindred factors of production is not an accretion of taxes, but over a reasonable period of years or decades the replacement of other major taxes. If the producer and the laborer are taxed all the more so in relation to their working more and being more productive a tax system that does not punish the economic subject for more work and a higher production output with ever higher taxes, but rewards them with tax breaks, is apt to boost the economy overall. And as all natural resources including air and any kind of sound space are by definition preliminaries of any economic activity and as they are hence by definition communal from the full financial responsibility of the community should derive. This presentation will discuss various economic aspects of Georgist fiscal policy condusive to the furthering of an improved environmental balance and a sound protection from excessive noise annoyance. These will come under the headers of: cost-benefit, price-earnings, illness-health, noise outsourcing-social acceptance.

Tu. 15:10 Oberlin Soundscapes and community noise

Sound topologies as a spatial description of the soundscape: The qualitative sound map of Rossio square in Lisbon

Mohammed Boubezari, José Luis Bento Coelho
CAPS-IST

In the qualitative approaches of the acoustical environment, the psychoacoustics criteria of quality focus on the signal, and the subjective criteria, usually describe the way in which a community perceives a noise. It misses an intermediate criterion that allows us to describe the sounds in a soundscape before even to apply a socio-cultural or aesthetic judgement on it. The qualitative cartography should thus distinctly report the sounds that make a (urban) sound environment intelligible with the same ratio that they are perceived in situ. With this intention, the hypothesis of sound topologies obtained by a semantic filtering of a local

sound environment was tested. Sound topology is the spatial distribution of a sound distinguished from its background. Semantic filtering was obtained by using a 'subject' in the protocol of the acoustic analysis of a locally recorded data, and by using the cocktail effect and the masking effect. The method was applied to a part of the Rossio square in Lisbon, a major square in this city. A qualitative sound map was obtained that distinguishes the sound sources of the soundscape of the place. The reading of the soundscape is easier and faster. We believe that this type of map can target with more precision the intervention on the urban sound environment, which is to regulate a problem of annoyance, or management and recombining of the soundscape or control of its evolution in the long term. The paper describes the method and the first results.

Tu. 15:30 Oberlin Soundscapes and community noise

Perception of Sound Quality of City Streets: Comparison of German and Swedish Samples

Gert Notbohm, Claudia Gärtner, Daniel Vjästfäll, Sieglinde Schwarze

Institut für Arbeitsmedizin und Sozialmedizin, Universitätsklinikum Düsseldorf

The SVEN project (Sound Quality of Vehicle Exterior Noise) funded by the EC aimed at describing the sound quality of vehicle exterior noise. In three laboratory experiments in Germany and Sweden, factors influencing the subjects' responses to traffic noise were studied. The same set of sound recordings from city streets in Paris was used for assessing the subjective evaluations of the subjects. The sounds were presented pair-wise with the sounds of a pair resembling each other except one specific feature such as type of building or traffic control. The 3 experiments were different with regard to cultural background (Swedish vs. German samples), but also in the variation of the sound pressure level of the stimuli. One tool for the assessment of the subjective evaluation of the sounds was an adjective list consisting of 27 items which had been developed as a questionnaire suited generally to assess the perception of soundscapes. The data of the 3 samples were analyzed by Principal Component Analysis (PCA) separately and also as a joint data pool of 106 subjects. With minor differences, the PCAs show that 4 factors are most important in the evaluation of urban traffic situations which can be understood as "annoyance and danger", "time variation", "impact of non-traffic or single sounds", and "spatiality". Index variables were created by averaging over all items belonging to a factor.

The means for each component show interesting differences between the 3 samples in the the perception of the traffic noises which ask for interpretation.

Tu. 15:50 Oberlin Soundscapes and community noise

The Importance of Sound Pressure Level in the Assessment of Sound Quality

Claudia Gärtner, Gert Notbohm, Sieglinde Schwarze
Institut für Arbeitsmedizin und Sozialmedizin, Universitätsklinikum Düsseldorf

The joint research project SVEN (Sound quality of Vehicle Exterior Noise) funded by the European Union aims at investigating the possibilities of applying the methodological approach of assessing and optimising sound quality to vehicle exterior noise. In this context a laboratory experiment was carried out in which subjects were exposed to vehicle pass-by noises of two different middle-class cars (petrol or diesel engine) under the driving conditions 70 km/h, 3rd gear, constant speed. Different sound pressure levels were applied: Subjects listened to sounds with the original sound level of about 73 dBA and to the same sounds adjusted to a Leq of 83 dBA. In order to assess the individual's psycho-physiological reaction to the different pass-by noises, physiological measurements were taken continuously during noise exposure. Additionally subjects had to evaluate the sounds subjectively by means of questionnaires. Results indicate that under both sound pressure levels the sound of the car with the petrol engine was evaluated more positively than the diesel car. With regard to sound level, both cars were judged more favourably when presented in the original sound level than compared to the higher adjusted one. For both cars, physiological reactions proved to be much stronger with the adjusted than with the original sound level. However, there was a clear stronger reaction to the sound of the diesel car in both cases. Thus, the validity of the measures used is reinforced, but a sufficiently high sound pressure level is necessary to elicit meaningful differences in physiological responses.

Tu. 16:10 Oberlin Soundscapes and community noise

Airport Noise Assessment-Simplicity and truth will help

Paul Schomer
Schomer and Associates

Currently, in the USA, we use DNL in decibels to assess noise producers such as airports and the EU is going in a similar direction. We talk about SEL in decibels, maximum levels in decibels and DNL in decibels?all physically different but all called decibels. Further, we talk about the Day-night Average Sound Level when

in is NOT an average. And then, as if this unintelligible technical jargon is not enough, we sometimes outright lie in our assumptions or statements. Then we wonder why the public is confused, upset and agitated. This paper offers a means to reduce the confusion generated by current assessment procedures as well as several up-to-date examples of the lies to the public that have no place in noise assessments.

Tu. 16:50 Oberlin Soundscapes and community noise

The Temporal Structure of the Urban Soundscape

Dick Botteldooren, Bert De Coensel, Tom De Muer
Acoustics Group, Department of Information Technology, Ghent University

Noise annoyance and sleep disturbance are often used to assess the quality of the urban sound environment. Recently a more holistic approach including positive and negative aspects as well as other than the residential function of the urban environment has gained renewed interest. The label 'urban soundscape' is often used to refer to this approach. Research towards quantification of the acoustical descriptors of the urban soundscape is however still in an early stage. Loudness and sound quality measures have been suggested. The longer time scale has attracted much less attention. This paper draws on the analogy to music to propose an indicator for studying the temporal structure of the urban soundscape. Sound level dynamic as measured by the difference between event levels and background noise give a first indication. The sequence and grouping of acoustic events will be shown to add substantial information to the assessment. It is proposed to investigate this temporal structure by analyzing the spectrum of loudness fluctuations over a several minute period. It is known that this spectrum shows a typical 1/f structure for most musical genres. This gives us a hint for interpretation. The main focus is on the temporal structure generated by road traffic and road traffic flow management. The link to underlying self-organized criticality, a quite common feature is natural systems that generates 1/f-like noise, is drawn.

Tu. 17:10 Oberlin Soundscapes and community noise

Hearing-adequate Description of a Soundscape Based on Standardized Measurement Procedures

Klaus Genuit
HEAD acoustics GmbH

Regarding the soundscape the following approach is needed: the overall effects of noises need to be observed in the context of the sensitivities of the human beings living in that said soundscape. An important task herein consists in the description of the

sound events situated within the soundscape according to the requirements of its measurement technology. As it is well known the diminishing of the quality of life through the acoustical ambience may not be registered alone by way of the A-weighted sound pressure level. With regards to the complex signal processing within human hearing at least equally complex procedures of analysis are required such as psychoacoustics parameter like loudness, sharpness, roughness etc. At this point it becomes an issue that, except for the loudness of stationary noise no generally accepted calculation procedures have been specified by standard. Until now no other measurement quantities in order to describe noise annoyance in addition to the existing A-weighted sound pressure level can be requested by government regulations. On the other hand it is possible to deduce parameters based on known, standardized procedures of measurement , which approach the given psychoacoustic quantities more readily and thus allows a greater quality of assertion with regards to noise annoyance than the mere regarding of the A-weighted sound pressure level or of the energy-equivalent sound pressure level respectively. The use of third-octave filters as well as the use of sound pressure level meters that feature variable integration times with constants far below 125 ms enable the user to approximate several psychoacoustic parameters.

Tu. 17:30 Oberlin Soundscapes and community noise

Audio-Visual Coupling in Human Perception

Michael Haverkamp
Ford Werke AG Köln

Recent research shows that inter-modal properties of the human perceptional system have to be included into an integral description of soundscapes. During the last 15 years, several approaches try to involve various aspects of inter-modal coupling into investigations of sound perception. Most approaches, however, focus on specific phenomena and interpret them from a particular point of view. While different disciplines are involved, each with peculiar methodologies, there is lack of a total description, including all. This presentation introduces a model of various levels of audio-visual interaction suitable to classify all kinds of coupling. The main strategies of the perceptional system are described and principle rules of inter-modal coupling are discussed. This model provides an important approach for setting up experimental conditions as well as description of field conditions, principles of visualisation of sound measurement results and proposals for a multi-modal product design.

Tu. 17:50 Oberlin Soundscapes and community noise

Annoyance due to industrial noise: perceptual assessment of legislation standard

Stéphanie Viollon, Catherine Marquis-Favre, Clément Baumann
EDF R&D

In France, the legislation standard for characterizing annoyance due to industrial noise is the "sound emergence", measured as the difference between the A-weighted equivalent sound pressure level of the ambient noise (installation on) and the A-weighted equivalent sound pressure level of the residual background noise (installation off). Besides in some conditions of noise exposure, this criterion seems to be inadequate to assess noise annoyance as it is actually perceived by the surrounding population and is worth examining in a more-in-depth way. Indeed, EDF, concerned with developing a global policy of sustainable development, is interested in a perceptual assessment of noise annoyance due to its installations. The aim of our research work is to examine the legislation standard "sound emergence", through a perceptive test. Subjects have to evaluate the perceived annoyance when listening to industrial sources, mixed with background noises according to an environmental approach. Our experiment involved: 3 background noises (natural sound environment, quiet environment and road traffic noise), mixed with 4 industrial sources noises (cooling tower, power plant turbine, transformer with fans and wind turbine), controlling the sound emergence (+3dB and +5dB). Results are presented and the experimental parameters are discussed.

Tu. 18:10 Oberlin Soundscapes and community noise

Noise abatement in Switzerland: present projects and perspectives

Hans Boegli, Irène Schlachter, Marc Schaffner, Jean-Daniel Liengme, Fredy Fischer
Bundesamt für Umwelt, Wald und Landschaft (BUWAL)

Noise abatement has a long history in Switzerland. The recognition of noise as a public health problem led to a parliamentary report in the sixties and finally to a noise policy which was laid down in the Environmental Protection Law (1983) and in the Noise abatement ordinance (1986). The policy contains plans to study dose-effect relationships, to introduce limiting values and to apply measures, focusing on reducing noise mainly at the source. Costs are handled according to the polluter-pays principle and prevention measures to avoid future noise problems as well as improvement measures for existing noisy installation

have been stipulated. A critical review of 15 years of noise abatement published in 2002 proposed further actions to improve the strategy. In particular, the report recommended a better monitoring of noise abatement, concerning noise exposure and improvement projects. It also suggested a closer collaboration with international noise policies, especially with view to ongoing EU-activities. The report concluded that supplementary measures were needed in order to effectively protect the population from hazardous or undesirable effects of noise. Some of the proposed measures are presently being implemented. It concerns the introduction of a national monitoring system of noise exposure, a stricter control over the slowly-progressing improvement projects as well as tighter regulations to monitor noisy installation. Further projects deal with the quantification of noise effects on health by means of the DALY-principle (disability adjusted life years) and its monetisation in order to cover the external costs of noise.

Tu. 18:30 Oberlin Soundscapes and community noise

Soundfield reproduction: the limits of the physical approach

Jean-Dominique Polack, Michèle Castellengo, Valérie Maffiolo, Corsin Vogel, Catherine Guastavino
c/o Laboratoire d'Acoustique Musicale

Soundfield reproduction is usually based on the physical reproduction of the sound heard at the ears of the listener, preferably by means of HRTF. However, most listeners have experienced that this reproduction has little common with real life. We propose a methodological shift in soundfield reproduction, based on Gibson?s concept of ecological validity. Instead of accurately reproducing the physical signals impinging on the ears of the listeners, we propose to focus on the meaning of the signals heard by the listeners. Three examples of the interaction of meaning with signals are given to illustrate the limits of the physical approach: the effect of temporal organisation on loudness; the influence of perception threshold on the meaning of warning signals; and background noise perception thresholds at low frequencies. The poster focuses on the different recording and reproduction techniques adapted to these different situations. This poster is an illustration of Danièle Dubois?s contribution to the session ?Soundscape and communitynoise?.

Tu. 18:50 Oberlin Soundscapes and community noise

Approaches to classification of urban areas in relation to transport noise impact

Barbara Lebiedowska, Michel Maurin
Technical University of Lodz, Department of Building Physics and Building Materials

Transport noise and its distribution are conditioned not only by road- and street-loads but also by the spatial organisation of a region, and, in urban areas, also significantly by the spatial (geometric) form of the city. Our aim is to determine the relationship between energy distribution and urban morphology, despite the multiplicity of factors influencing noise propagation in built-up areas that render this issue difficult. These factors may be classified in three groups: physical factors (source - propagation of the acoustic wave), geometric factors (geometry of an area together with its buildings), and human factors (vulnerability to excessive noise, differentiated perception). Due to the time needed for in situ measurements, and, consequently, required financial resources, and because of a somewhat limited body of data provided by them, direct study methods are necessarily substituted with increasingly more common computer simulations. While measurements are first of all a reflection of the actual situation, and their comparison is possible exclusively in the case of actual, existing urban structures, simulations make it possible to assess the influence of individual elements defining the geometry of a city. Attempts at comparative analysis based on simulations and in situ studies have been made by a number of research centres. In this presentation, primary attention is given to the studies conducted at INRETS, using both in situ measurements and the results of simulation techniques. A certain limited classification of urban areas in relation to transport noise impact is proposed on their basis.

Tu. 19:10 Oberlin Soundscapes and community noise

Unconventional method of the evaluation of acoustic comfort of pedestrians in urban space

Barbara Lebiedowska, Jacques Beaumont, Marek Jablonski
Technical University of Lodz, Department of Building Physics and Building Materials

A number of indicators are used in room acoustics to define the quality of the reception of an acoustic signal and, consequently, to evaluate the acoustic quality of an enclosed space from the point of view of the audience. It may thus be accepted that acoustic indicators applied in room acoustics, such as Reverberation Time (RT) or Early Decay Time (EDT), could also be employed for the

purposes of the acoustic evaluation of urban interiors, including open spaces. It would contribute to an improved assessment of acoustic comfort of occupants of such a space, as, for instance, pedestrians travelling through city streets. A direct analysis of the acoustic climate of urbanised spaces, based on in situ measurements, both requires a great deal of effort and is highly expensive. The measurement procedure may, however, be eliminated in many cases, and the interpretative process, useful in several preliminary analyses, simplified. A simple analogy between an enclosed space, limited by strict geometric dimensions, and an open space whose boundaries are arbitrary, was the underlying assumption in the analysis. Computer simulations of such spaces were examined. The simulations relied on numerical calculations performed in keeping with the European standards based on the Mithra program (software used in out-door acoustic) and the Odeon program (software used in room acoustic). The analysis of the results shows that the methodological approach adopted should be developed and future studies on the issue are called for.

Tu. 8:30 Arp 1 Measuring methods in building acoustics II

Sound Absorption of Microperforated Duct Systems

Steffen Hettler, Philip Leistner
Fraunhofer Institut Bauphysik

In recent years, the concept of microperforated sound absorbers has been successfully implemented in various applications, such as transparent panel absorbers, microperforated foils or suspended ceilings. For the first time, interior design and room acoustics were merged by using various benefits of microperforated absorbers. In order to introduce the principle of microperforation to further engineering areas, micro perforated ducts have been investigated as a visible element of the room. In this case, air flows through the microperforation. Hence, not only the ventilation aspects have to be designed but also the sound absorption effects need to be taken into account. For this purpose, the theory of a microperforated absorber was extended by the effects caused by airflow through the microperforation. Experimental evidence is provided. The investigations show a high sound absorption characteristic, which results in an attractive and flexible room acoustic element that can be easily integrated into duct systems.

Tu. 8:50 Arp 1 Measuring methods in building acoustics II

The Virtual Reality Acoustics Laboratory - SonicLab

Stefanie Litjens, Schew-Ram Mehra

Lehrstuhl für Bauphysik der Universität Stuttgart und Fraunhofer-Institut für Bauphysik

Acoustic measuring technology and methods of measurement form substantial parts of student training in the fields of building acoustics, room acoustics, noise and noise control. Due to lack of test rooms, time and money, mostly transparencies and slides are used to explain acoustic metrology. The virtual reality acoustics laboratory 'SonicLab' was developed with the aim of providing a close-to-practice training option for students: using 'SonicLab", interactive measurement processes are made available in the network. Up to now, it is possible to perform measurements in the following virtual-lab test chambers: wall and window test facility, floor and ceiling test facility, reverberation room. In performing virtual measurements, students can get familiar with test chambers, measuring instruments and measurement procedures. Graphical views, animated images and instructional films allow to convey a close-to-reality impression of test facilities and measurement processes. In the lecture it will be demonstrated how to select different test objects in the virtual test rooms and how to compare the experimental results to analyses of further measurements.

Tu. 9:10 Arp 1 Measuring methods in building acoustics II

Building and Room Acoustics Measurements with Sine-Sweep Technique

Ole-Herman Bjor, Igor Nikolic

Norsonic AS

New measurement methods based on digital signal processing bring a number of advantages compared to well-established classical methods for the measurements in building and room acoustics, such as extended signal-to-noise ratio (SNR) and high distortion immunity. Importance of these techniques is confirmed by the fact that the International Organization for Standardization (ISO) is working on a standard for applications in building acoustics. The paper presents a real-time implementation of this measurement method, based on excitation with a logarithmic sinusoidal sweep and focuses on its practical use and benefits. Comparisons with methods based on maximum-length sequence techniques are also given.

Tu. 9:30 Arp 1 Rating methods in building acoustics

Assessment of the Impact Sound Insulation by Light weight Floors and Floor Coverings

Judith Lang
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A method to assess the reduction of impact sound level by floor coverings on massive floors by a single number, based on standardised measurements is laid down since many years in ISO 717-2. A similar procedure for floor coverings on light weight floors however has not been defined until now. Only during the last years ISO 140-11 has been drafted describing the method of measuring the reduction of impact sound level by floor coverings on light weight floors (type of typical bare floor and excitation). With that the question about a single number definition based on the results of these measurements arose. To gather information on the impact sound level of light weight (wooden) floors with and without floor coverings and useful types of reference curves for the lightweight floors a series of measurements has been carried out on the reference floor Nr.1 (typical for European wooden floors) with excitation of the floor by the standard tapping machine, the modified tapping machine and the "heavy soft impact source" (rubber ball), which are described in ISO/DIS 140-11. Additionally measurements with walking persons with different types of shoes were carried out on some floor coverings. The results were compared with respect to the single numbers for the impact sound level of the floors. The single numbers for the reduction of impact sound level for all tested floor coverings were calculated with proposed reference curves for 2 types of wooden floors and the suitability for their application was tested.

Tu. 9:50 Arp 1 Rating methods in building acoustics

Psychoacoustic studies on the evaluation of impact sound of lightweight stairs

Andreas Drechsler, Heinz-Martin Fischer
Fachhochschule Stuttgart - Hochschule für Technik

Impact sound measurements of lightweight stairs often show a lack of correspondence between the evaluation according to the standards and the hearing impressions of the inhabitants. As a consequence actual measuring and rating procedures seem to be not suitable to avoid annoyance. To improve this situation and derive evaluation methods closer to the subjective impressions, some first psychoacoustical studies were made, in addition to physical investigations already presented at earlier DAGA conferences. Different walking noises on lightweight stairs were investigated to characterise them from a psychoacoustical point of

view. Also a listening test with 21 persons was conducted. Furthermore psychoacoustic quantities of different artificial impact sound sources and of human walking and jumping were measured and compared. The intention was to find the most appropriate impact sound source to represent impact sound by real walkers.

Tu. 10:10 Arp 1 Rating methods in building acoustics

A First Step towards Auralisation of Impact Noise

Rainer Thaden
Institute of Technical Acoustics

For a subjective evaluation of the annoyance of impact sound, listening tests have to be performed. It is very time consuming to collect material for the tests as the noise has to be recorded in real buildings. Therefore an auralisation of the receiving room signal based on the typically available data of a construction would be desirable. As a first step, an auralisation of the impact sound insulation based on the normalised impact sound level is done. The force time signal of the source (walker, ball etc.) is measured and the dynamic interaction between source and structure is neglected. Accordingly, only floors with a high impedance (heavy-weight constructions) can be considered. A simple algorithm for synthesizing the force-time signal e.g. of a walking person by single footsteps is used to generate the input signal for the model. The receiving room is modelled in the same way as in a model for airborne sound insulation which was developed some years ago. In the presentation, the model and first results will be shown and ilustrated in audio examples.

Tu. 14:50 Arp 1 Rating methods in building acoustics

Walking Noise: Physics and Perception

Ennes Sarradj
Gesellschaft fuer Akustikforschung Dresden m.b.H.

Hard floors such as laminate became increasingly popular in the last years. As a consequence, the annoyance by the noise from walking over such floors became a problem. This problem was addressed by various efforts to manufacture less annoying floorings. In order to assess the quality of each solution, a number of different rating procedures were developed. These procedures occur to lead not to consistent results. One main reason for that is a lack of knowledge regarding the physical mechanism of walking noise production. Another reason is that there is not much known about the perception of walking noise. The presentation addresses several open questions both from a physical and perceptional view and explains some necessary prerequisites for a rating method. Preliminary results of calculations for the sound

generation by the impact on the flooring are shown and important influence factors will be listed.

Tu. 15:10 Arp 1 Rating methods in building acoustics

Evaluation of walking noise on floors

Hartmut Schröder, Bettina Richter
Fraunhofer Institut Bauphysik

Apart from impact noise in adjacent rooms, walking noise in the source room - also referred to as drum noise - is of increasing interest. Drum noise is not a subject of authority regulations in Germany. This situation offers space for newer measurement techniques und evaluation procedures away from the well-established single number values. Psychoacoustic findings could be considered more appropriate and the sound of drum noise itself could be investigated. A measuring method for in-room impact noise by floor coverings was developed in France (NF S 31-074), which is based on laboratory measurements using the standard tapping machine. Several institutes in Scandinavia and Germany created their own measurement procedures using also different types of excitation and more sophisticated measurement techniques. About one year ago a European standardisation group (CEN/TC126/WG1/AHG7) was established under active participation of the European Producers of Laminate Flooring (EPLF). The aim of this group is to agree upon a unique test method to characterize walking noise of floor coverings. One of the parameters in focus is the loudness according to Zwicker. The current state of the discussion will be reported. Further more, some measurements from persons walking on different floors will be presented. The hearing impression is then compared to the determined rating parameters.

Tu. 15:30 Arp 1 Building acoustics I

A review of partition's transparency analytical calculation methods

Antoine Pellicier, Nicolas Trompette
INRS

There are several methods used for the calculation of partition's transparency. This work deals with direct analytical methods as opposed to deterministic modal methods, more accurate but also less rapid. Various ways of modelling partitions are tested here: at first, well-known classical methods are used to model transmission of sound through an unbounded single or double leaf partition in pure bending. For double leaf partitions, absorption in-between panels is added using Delaney & Bazley 's theory (i.e. limited to fibrous absorbent material). Then, to take into account the shear, Munjal's model based on the calculation of transfer

matrices for each component of the partition and their assembly, has been implemented. It also allows the introduction of porous material inside panels by means of the Biot & Allard's theory. At last, a spatial windowing on the infinite panel transmitted wave, stemming from Villot & Guigou's work, has been added. It allows the extension of all models to finite panels. At each step, a comparison with measured data found in literature is done.

Tu. 15:50 Arp 1 Building acoustics I

Sound Reduction Index and Mode Shapes of Cavity Walls

Jochen Seidel
Xella T&M Bautechnik

At the last conference DAGA'03 laboratory measurement results of cavity walls were presented by the author. Differences of more than 10 dB in Sound Reduction Index were observed with walls even though they had the same mass per area and the same width of the cavity. It was found that differences in the modal frequencies between the two leafs of the wall lead to higher Sound Reduction Indices. This year further results will be presented. We have made more measurements not only in the transmission suite but also at construction sites. Again, we found that different modal frequencies of the opposite wall leaves gave a higher sound reduction. Moreover, we had a closer look at the mode shapes themselves. Movies of the mode shapes in motion will be shown. The value of modal testing methods as a tool in the acoustics of cavity walls will be discussed.

Tu. 16:10 Arp 1 Building acoustics I

Zweischalige Haustrennwände mit vollständiger und unvollständiger Trennung

Jürgen Maack, Elmar Sälzer
ITA Ingenieurgesellschaft für Technische Akustik mbH

Bei Reihenhäusern mit 'Weißer Wanne' im UG oder bei kellerlosen Reihenhäusern mit durchgehender Bodenplatte liegt eine unvollständige Trennung vor. Für derartige Konstruktionen wurden die Schnellepegeldifferenzen an den Stoßstellen sowie die Schalldämmung zwischen den Räumen an ausgeführten Bauten messtechnisch untersucht. Auf Grundlage der ermittelten Schnellepegeldifferenzen wird es möglich, die Schalldämmung in Anlehnung an DIN EN 12354 zu berechnen.

Tu. 16:50 Arp 1 Building acoustics I

Investigation of the Sound Transmission through Double-leaf Separating Walls with respect to Incomplete Separation

Jochen Scheck, Heinz-Martin Fischer, Martin Schneider
Fachhochschule Stuttgart - Hochschule für Technik

The separating walls between attached row and twin houses usually are of heavyweight cavity construction. For stability reasons the two leaves of the wall in most cases are structurally linked, particularly through the ground plate. This bridging increases the sound transmission of the cavity wall and also the flanking transmission. However, the international standard ISO 12354-1 offers no prediction methods for such cases. In order to investigate the direct and flanking transmission of heavyweight cavity walls, field measurements have been carried out at various building situations. The presentation contains the latest results of the survey.

Tu. 17:10 Arp 1 Building acoustics I

Influence of Flanking Transmission on Impact Sound Insulation in solid Multi-Dwellings

Martin Schneider, Katrin Kohler, Heinz-Martin Fischer
Fachhochschule Stuttgart - Hochschule für Technik

In solid multi-dwellings the airborne sound insulation between adjacent dwellings is often reduced by transmission of lightweight solid flanking walls. The transmission of these walls is not clearly taken into consideration, predicting the impact sound insulation according to the German standard DIN 4109, Beiblatt 1 (1989). Author: However, the calculation procedure according to the European standard DIN EN 12354-2 Simplified Model considers the flanking transmission globally using the averaged mass per unit area of the flanking walls in the receiving room. The Detailed Model of DIN EN 12354-2 considers the flanking transmission calculating the sum of the transmitted energy via the separating and the flanking elements. Within a research project at the Fachhochschule Stuttgart- Hochschule für Technik the predictions of the impact sound insulation using Simplified and Detailed Model of EN 12354-2 will be compared. The calculated weighted normalized impact sound pressure level will be compared with measured in-situ data. Further investigations will be predicting the influence of the flanking transmission on impact sound insulation. Therefore structure borne sound measurements were carried out to determine the individual flanking transmission on each path. Using calculated and measured data the influence of lightweight solid flanking walls on impact sound insulation will be discussed.

Tu. 17:30 Arp 1 Building acoustics I

Radiation Factor Correction when calculating Flanking Transmission

Heinrich Metzen
DataKustik GmbH

The calculation scheme in EN 12354-1 and -2 calculates the flanking transmission index Rij from the sound reduction indeces Ri and Rj of the elements in each transmission path. These sound reduction indeces result mostly from tests performed in transmission suites according to ISO 140. This procedure leads to an overestimation of the flanking transmission caused by the difference in the radiation factor for forced and free bending waves. When predicting sound insulation it is would be useful to apply a correction to account for the different radiation efficiency below the critical frequency. Approaches to consider this effect are discussed and compared with measured data. Data from fields measurements are presented to judge whether the proposed correction increases the accuray of the predictions in different building situations.

Tu. 17:50 Arp 1 Building acoustics I

Flanking sound reduction of suspended ceilings

Bettina Richter, Hartmut Schröder, Philip Leistner
Fraunhofer Institut Bauphysik

In 2003 a series of measurements on suspended ceilings made from closed gypsum boards was carried out at the Fraunhofer-Institute of Building Physics (IBP). The reason for these investigations was, that construction examples given in the German standard DIN 4109 are based on very old measurements. Since that time, building materials have been modified and some acoustically important features as the mass per unit area and the thickness of currently available products have changed. Furthermore, the corresponding test code DIN EN 20140-9 has gone through substantial changes. The focus of the measurements was put on the construction examples given in table 26 of supplement 1 to DIN 4109. The measurement program is presented in detail and different parameters, which influence the flanking sound reduction are explained when looking at the results. The single number values are compared to the existing table 26 and some historic measurements. As DIN 4109 is currently revised, some proposals are made for new design values of the flanking sound reduction of suspended ceilings.

Tu. 18:10 Arp 1 Building acoustics I

Modern Masonry Walls - Plaster versus Open Joints
Ralph Haberkern
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Open vertical joints inside plastered masonry walls are a well-established way to reduce the expenditure of human labour in construction work. Due to the same reason, modern bricks and classical bricks fundamentally differ in their proportions: the wall thickness diminishes and the in-plane dimensions increase. In particular, the increase in height has to be mentioned. Due to cost effectiveness, both techniques are often combined. As long as the open vertical joints are small compared to the length of the brick, the vertical stiffness of a wall - the vertical Young's modulus - is hardly affected by thin open joints. Hence, the static load capacity is about the same. However, this does not hold for other effective elastic properties of the wall, e.g. the in-plane shear modulus. By means of a suitable homogenisation software, the dependence of the effective elastic properties of a plastered wall of simple bricks on the in-wall proportions, the wall thickness, gap size and plaster layers has been investigated for sand-lime stone. The method has been compared to experimental data. It is found that for thin walls the plaster plays an important role in sustaining the shear stiffness of walls. Sufficiently thick and armored, the plaster transfers most of the shear loads across the open gaps, especially for thin walls. Hence, the plaster and its connection to the wall plays a important - but rarely perceived - role in concurrent masonry.

Tu. 18:30 Arp 1 Building acoustics I

In situ Characterisation of materials using parametric sonar
Manell Zakharia, Manell Hibral
Ecole navale, IRENAV

Parametric sonar techniques have been intensively used in underwater acoustics since the early sixties for bottom observation: both qualitative (geometrical structure of the sub-bottom) and quantitative (impedance estimation) measurements. Nevertheless, the application to airborne acoustics was envisaged more recently (in the eighties). The principle consists in transmitting two primary high frequency signals at high power in order to generate a low frequency directive source. An airborne sonar system has been developed in order to characterise acoustics material in situ. As characterizing insulation panels in a factory (in the presence of noise and multipaths) is similar to the characterisation of sea sediment in situ, similar sonar approaches have been used. In particular, the parametric array principle has been

used to generate low frequency chirps and gain in signal to noise by pulse compression. Several results will be presented using an airborne parametric sonar for the characterisation of acoustic foam (insulation panels) in both transmission and reflection modes. The data obtained with this equipment will be compared to the results obtained with conventional methods (in a reverberation room) for a wide band of frequency in a noisy room of a few square metres. The final objective is the in situ characterization of installed materials in order to validate the installation, to detect defective panels and/or to study the aging effect. This work was supported by the European Commission in the framework of the ISCAP project (G6RD-CT-2000-00040).

Tu. 18:50 Arp 1 Building acoustics I

Acoustics Learning Programmes - Precision Versus Intention

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Lehrstuhl für Bauphysik der Universität Stuttgart und Fraunhofer-Institut für Bauphysik

In the field of building physics, teaching acoustics presents a major constituent in the training of civil engineers and architects at German technical colleges and universities. Relating acoustic phenomena using conventional teaching and learning methods often requires rather complex efforts when performed in presence teaching. By applying computer-assisted learning programmes, illustrations and auralisations, these phenomena may be introduced to the students in quite an impressive way. In developing such learning units, the question as to the units' precision and accuracy turns up constantly: Is it really necessary to consider each and every detail when calculating acoustic phenomena with a learning programme (running the risk of pushing some phenomena into the background) - or should the programme be rather kept simple, in order to make the student familiar with the fundamental phenomena? Within the framework of the project 'Multimedia Learning-Network Building Physics', which was funded by the German Federal Ministry for Education and Research and included the participation of another five German colleges and universities, numerous building-physics learning programmes were developed, also for the field of acoustics. In this context, the above-mentioned question concerning the precision and the intention of such programmes was posed repeatedly. This issue will be discussed in the lecture using examples from the acoustic practice. The lecture will also include the presentation and discussion of learning programmes and illustrations and auralisations that have emerged from the project work.

Tu. 8:30 Arp 2 Temporal envelope processing in hearing

Neural coding of carrier- and envelope periodicity in the auditory brainstem

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Complex periodic sounds evoke a pitch sensation when their envelope- or carrier period is in the range between about 0.7 and 30 ms (fundamental frequency, f0, about 33 to 1400 Hz). Electrophysiological recordings in the auditory nerve of mammals have shown that an autocorrelation of the temporal discharge patterns of auditory-nerve fibres provides a good physiological correlate of the pitch perceived by humans. But how is a computation akin to autocorrelation performed in the central auditory system? Here I show that neurons with intrinsic oscillations (chopper neurons) in the cochlear nucleus provide a selectivity for the f0 of periodic sounds. A chopper neuron with an intrinsic oscillation equal to f0 synchronises to f0 if it is stimulated by f0 or an integer multiple (a harmonic) of f0. These neurons behave like a template-matching device, only this template is neurally implemented in the time domain, not in the frequency domain. Thus, this physiological model of pitch shows characteristics of both temporal and spectral functional models of pitch extraction. Chopper neurons, together with the neurons they project to in the inferior colliculus, provide a neural place code for pitch as it has been described in the auditory cortex.

Tu. 8:50 Arp 2 Temporal envelope processing in hearing

Analysis of reproducibility in auditory evoked responses

Boris Gourévitch, Régine Le Bouquin Jeannès, Gérard Faucon
LTSI - Université de Rennes 1

The reproducibility of cortical responses to acoustic stimuli is crucial in order to draw conclusions from stereo-electroencephalographic (SEEG) studies. The present research focuses on the repeated responses to amplitude-modulated noises. A database composed of responses recorded from 20 epileptic patients is used. Preliminary analyses show that neural responses display oscillating features for different auditory cortical areas, and that these oscillations occur at the stimulus' modulation frequency. Estimating parameters in these signals (amplitude, phase, frequency...) depends on both mathematical estimator variance and biological recording variance. More detailed analyses show that the variance observed when measuring amplitude, phase or frequency of the oscillation for the repeated recordings depends only on the level of depth SEEG activity. The recording procedure was such that two different stimuli were

recorded in turn randomly. Additional analyses show that the oscillation amplitude remains constant in the course of the recordings: for 16 patients out of 20, more than 50% of leads show a constant amplitude (for 11 patients, the percentage reaches 80%). For the remaining patients, some decreasing linear trends are observed for 20% to 80% of leads. These results suggest that the auditory system generates reproducible oscillation amplitude, and that envelopeprocessing time (from the external ear to the cortical areas) is identical for all recordings. This justifies the usual averaging of auditory responses to obtain AEPs.

Tu. 9:10 Arp 2 Temporal envelope processing in hearing

The processing of complex envelopes in the normal-hearing and the hearing-impaired auditory system

Jesko Verhey, Stephan Ewert, Torsten Dau
Carl von Ossietzky Universität Oldenburg

Many natural sounds including speech exhibit a complex temporal envelope. Psychoacoustical and physiological studies showed that the auditory system is sensitive to the envelope pattern. Recent modulation-detection experiments using complex envelopes indicate that the auditory envelope processing is nonlinear. However, the nature of the nonlinearity is still unclear. In the present study, psychoacoustical modulation masking data for normal-hearing and hearing-impaired subjects are presented, together with model predictions testing different types of nonlinear processing. The model predictions and the similarity in the experimental patterns obtained for normal-hearing and hearing-impaired subjects demonstrate that cochlear compression does not play a major role in the processing of amplitude modulation, in contrast to findings previously published by Moore et al. [Moore et al., 1999, J. Acoust. Soc. Am., 106, 908-918]. A model for the processing of complex envelopes in normal-hearing and hearing-impaired subjects is proposed.

Tu. 9:30 Arp 2 Temporal envelope processing in hearing

Perception of the envelope beat rate of inharmonic, complex temporal envelopes

Christian Füllgrabe, Christian Lorenzi
Laboratoire de Psychologie Expérimentale - UMR CNRS 8581, Université René Descartes Paris 5

Listeners can detect slow, sinusoidal variations in the depth of sinusoidally amplitude-modulated (SAM) stimuli. Here, the SAM stimulus of rate fm acts as a carrier (or '1st-order') SAM, and the slow variation in depth of rate fm' - referred to as '2nd-order' SAM - corresponds to a beat in the temporal envelope (Lorenzi et al.,

2001). Recent studies have suggested that 2nd-order SAM detection is mediated by the detection of a modulation distortion product at fm'. This suggestion was tested by transposing to the temporal-envelope domain the paradigm used by Schouten et al. (1962) to study the perceived pitch of inharmonic SAM tones. In the present study, listeners were asked to estimate the 2nd-order rate evoked by a 2nd-order SAM white noise using an adjustment procedure. The 2nd-order rate fm' was fixed at 5 Hz. The 1st-order rate fm corresponded to 15, 20, 35, or 60 Hz (i.e. the 3rd, 4th, 7th, or 12th harmonic of fm'), or was shifted in frequency by df (ranging from -/+ 25-100 % of fm') relative to these frequencies, making the complex envelope inharmonic. The data indicate that the perceived 2nd-order rate is mainly shifted at the lowest 1st-order rates, contradicting the notion that listeners use only a distortion product when perceiving 2nd-order SAM rate. However, the observed shifts were smaller than what would be predicted if the perceived 2nd-order rate were entirely based on the 1st-order envelope periodicity. The results are discussed in light of the model developed by Ewert et al. (2002).

Tu. 9:50 Arp 2 Temporal envelope processing in hearing

Are fine structure cues an important feature for temporal streaming ?

Nicolas Grimault
UMR CNRS 5020 'Neurosciences et Systèmes Sensoriels'

Alternating sequence of two A and B bursts of sound tends to be perceptually organized in different auditory streams when introducing either a spectral or a temporal difference between A and B. The spectral difference between A and B sounds can be simply a frequency shift for pure tones or a spectral-pitch shift for complex sounds. In general, the channeling theory of streaming predicts that any salient difference between the excitation patterns evoked by A and B sounds would lead to a segregated percept. Some previous studies have however evidenced that a sequence of sounds with similar spectral properties but with different temporal properties can be heard as segregated. In particular, temporal envelope cues are probably responsible for the segregated percept when hearing a sequence of bursts of white noises that are amplitude-modulated at widely different rates. All previous streaming experiments involved stimuli that had frequency components bellow 5000 Hz. As a consequence, the individual contribution of temporal fine structure cues and envelope cues could not be dissociated and remains largely undetermined. The current experiment is dedicated to test further the relative importance of both envelope and fine structure cues to segregate sequences of unresolved harmonic complex tones

with different fundamental frequencies. Two high- frequency regions above and bellow 5000 Hz and several phase relationships leading to several temporal peak factors have been used in a subjective streaming task.

Tu. 10:10 Arp 2 Temporal envelope processing in hearing

Cross-Frequency Temporal Envelope Correlation for the Processing of Degraded Speech: Preliminary Investigations

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It is well known that long-term temporal envelope information is crucial to the identification of speech in quiet. The present investigation aims at considering its influence for the processing of auditory mixtures. The cross-frequency correlation of temporal envelope modulation was computed on a subset of the 'TI-Digits' database within various amplitude-modulation channels (0-4Hz, 4-8Hz, 8-16Hz, 16-32Hz, 32-64Hz) after passing them through an 8-channel FIR filterbank. It is shown that, whichever amplitude-modulation channel is considered, the envelope of speech signals is highly correlated between spectral channels, especially when they are close to one another. In order to investigate the likely influence of temporal modulation in the processing of degraded speech, a behavioral experiment is presented in which participants had to identify digit sequences that were previously passed through a signal processing algorithm. This algorithm is aimed at removing various levels of the temporal information available in the speech signals while keeping their fine spectral structure intact. Mixtures of these processed speech signals with either steady-state or amplituded-modulated noise signals were presented for identification. Interestingly enough, while the processing of speech signals was easier in modulated than in steady-state noise when long-term temporal information was available, the reverse occurred when temporal modulations were highly filtered. Processing speech with few temporal envelope information led to better performance in steady-state than in amplitude-modulated noise. The implications of this observation for the understanding of speech perception processes in adverse environments are discussed.

Tu. 14:50 Arp 2 Temporal envelope processing in hearing

Temporal-envelope related processing in advanced digital hearing aids

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Siemens Audiological Engineering Group

Noise reduction, compression and classification algorithms have become standard features in advanced digital hearing aids. In this paper it will be illustrated that analysis and appropriate processing of the signal envelope play an important part in designing these algorithms. In the field of compression algorithms the appropriate speed of gain adaptation is still the subject of discussion. From a physiological point of view, compression algorithms should act as fast as possible to restore the loss of compression due to the damage of outer hair cells. Fast compression strongly affects the signal envelope. However, in listenings tests hearing impaired subjects often prefer slow compression systems, which do not affect the signal envelope. This indicates that the appropriate "transmission" of the signal envelope is a crucial point in compression algorithms. In respect of noise reduction algorithms, it will be shown that an early group of approaches exploits the specific envelope properties of speech and noise to slowly adapt the frequency response of the hearing aid to the noisy condition. Moreover, it will be demonstrated that the processing of state-of-the-art procedures like spectral subtraction or Wiener filtering can be interpreted as the frequency-specific restauration of the temporal envelope of the (undisturbed) speech in each frequency band. Some hearing aids already offer classification systems which automatically enable the optimal hearing aid setting. It will be demonstrated that robust classification systems capable of distinguishing between "Speech", "Speech in Noise" and "Noise" situations can be developed mainly based on the analysis of the signal envelope.

Tu. 15:10 Arp 2 Temporal envelope processing in hearing

Temporal envelope coding in the inferior colliculus. Evaluation of two computational models of octopus cells

Alexandre Guérin, Gérard Faucon, Régine Le Bouquin Jeannès
LTSI - Université de Rennes 1

Amplitude modulation (AM) is a common feature of sounds like speech, and plays an important role in intelligibility. This paper presents two computational models of octopus cells of the inferior colliculus (IC), known to be involved in the temporal coding of AM. These cells, characterized by onset responses, are respectively based on i) the McGregor point neuron equations,

ii) ion concentration gradient and Nernst equation. The evaluation is conducted using a global auditory model of AM encoding, simulating processes taking place from the external ear to the IC. The model includes a gammatone filterbank (cochlear stage), followed by a model of inner hair cells (transduction stage) and a discharge generator (auditory nerve stage: AN). The resulting AN discharges correspond to the inputs of a simplified cochlear nucleus, modeled as a bank of stellate cells (SC) with similar same Best Modulation Frequencies (BMFs). Each SC neuron is implemented using modified Hodgkin-Huxley equations, with parameters tuned to produce chopper responses with BMFs ranging from 60 to 200 Hz. The neuron axons project to the IC model where octopus cell models enhance the synchronization to the stimulus AM by detecting the coincident activity in the SC inputs. Simulations show that different types of temporal modulation transfer function (t-MTF) can be obtained with a limited set of parameters and identical inputs. Measures of synchronization index show that the model based on Nernst equation is able to synchronize over a wide range of modulation frequencies, exhibiting a lowpass t-MTF as observed in the auditory cortex.

Tu. 15:30 Arp 2 Temporal envelope processing in hearing

A Neuronal Correlate of Octave Similarity and Discrimination in the Auditory Midbrain of Gerbils

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Complex signals, that are important in human and animal communication, are mostly harmonic and periodic signals. In addition to the frequency analysis of the cochlea the periodicity is processed by a time analysis in the central auditory system. In our experiments we used awake gerbils. We investigated Neurons in the central nucleus of the inferior colliculus (IC) of Gerbils for their selectivity to periodic amplitude modulations. We discovered that most neurons in the IC with a good tuning to a best modulation frequency (BMF) show also responses to multiples of their BMF shortly after the onset of the stimulus. Coincidence detection between delayed signal representations is appropriate to explain such comb-filter like modulation transfer functions (MTF). After stimulus onset these harmonic responses are suppressed resulting in a band pass shaped MTF and a major peak at BMF. By iontophoretic application of inhibitory receptor antagonists and examination of slow neuronal reactions, we were able to show an inhibitory input to these coincidence detector neurons, suppressing activity for half of the BMF period between the coincidences. This inhibition, which is phase coupled to the envelope of the

signal, leads to a low pass shaped MTF, by suppressing the reaction if the modulation frequency of the acoustic signal is twice ore more of the neurons BMF. The combination of both mechanisms, coincidence detection (high pass) and phase coupled inhibition (low pass) can explain the commonly observed tuning of IC-neurons to one BMF. Supported by the Volkswagen Foundation

Tu. 15:50 Arp 2 Temporal envelope processing in hearing

Effect of Aspirin on the Temporal Effect in Simultaneous Masking with On- and Off-Frequency Maskers

Sophie Savel, Sid Bacon

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The threshold for a brief signal can be 10-20 dB higher when it is at the onset than at the temporal center of a longer masker. This temporal effect with broadband maskers is thought to depend on the input-output function of the basilar membrane, which is linear at low and possibly high levels, but compressive at moderate levels. The elevated threshold near masker onset (which occurs at moderate levels) is thought to reflect compression of the signal whereas the decrease in threshold over time is thought to reflect a decrease in that compression. Consistent with this are findings that temporary or permanent cochlear hearing loss reduces the temporal effect by reducing threshold at onset. A temporal effect with off-frequency maskers also exists, although the role of compression there is less clear. The purpose of this study was to examine the role of compression on the temporal effect with on- and off-frequency maskers by studying the effects of aspirin ingestion. The signal frequency was 1730 or 4000 Hz and the masker was 10 ERBs wide and centered at the signal frequency or 500 Hz wide and positioned above the signal. Despite some variability, aspirin tended to reduce thresholds at masker onset when the level of the signal was moderate, but not when it was high. Aspirin had no effect on thresholds when the signal was at the temporal center of the masker. These effects were observed for both maskers, suggesting that compression plays a role in the temporal effect for both.

Tu. 16:10 Arp 2 Temporal envelope processing in hearing

Effects of concurrent and sequential streaming in comodulation masking release

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Comodulation masking release (CMR) refers to the reduction in the masked threshold of a signal due to the presence of flanking noise bands, which share the same pattern of amplitude fluctuations as the on-frequency noise masker. An unresolved issue is the extent to which CMR reflects within- and/or across-channel processes. This study addresses the question by assessing the influence of auditory grouping cues on CMR. Perceptual segregation of the on-frequency masker and the flanking bands was manipulated by (i) introducing an onset/offset asynchrony between the masker and the flanking bands, or (ii) introducing precursor or following flanking bands. This was done for spectral configurations where the flanking bands were presented relatively close to the on-frequency band or were widely separated in frequency. In conditions where the flanking bands were close to the on-frequency band, manipulating perceptual segregation had little effect on thresholds. In contrast, when the flanking bands were widely separated, CMR was abolished in conditions promoting perceptual segregation. As perceptual segregation should not affect within-channel processes, the differential effect of segregation cues may provide a functional definition of within- and across-channel CMR. Also, as "true" CMR is generally associated with across-channel processing, the strong influence of perceptual grouping cues places strong constraints of physiological models of CMR.

Tu. 16:50 Arp 2 Temporal envelope processing in hearing

Discriminating temporal loudness patterns in the absence of overall level cues

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To investigate the capability of the auditory system to discriminate the temporal 'shape' of short non-stationary sounds, in a One-Interval-Forced-Choice procedure, samples of white noise randomly fluctuating in level were presented in two patterns in random order: one containing a distinct level increment at the beginning of the stimulus (on the 2nd of ten stimulus components), the other containing that increment at the end of the stimulus (on the 9th of ten stimulus components). The subjects' task was to

discriminate between these two kinds of 'loudness profiles', presented in a 'short condition' (temporal segments of 10 ms duration) and a 'long condition' (temporal segments of 20 ms duration). The data of three subjects, who all completed 6400 such trials, show that the auditory system is able to identify the shape of these loudness profiles, even in the case of very short stimulus components of only 10 ms. Applying COSS-analysis [B.G. Berg, J. Acoust. Soc. Am.,86,1743-1746 (1989)] to the data, weights were assigned to each stimulus component, yielding a measure for the strength of the influence that each segment has on the listener's decision. The stimulus patterns turn out to be reflected in the shapes of the weighting functions, assigning high positive weights to the incremented component and low or negative weights to the non-signal components. The results confirm the assumption that the auditory system is capable of analyzing individual stimulus components selectively with high temporal resolution, when it is required by the task given.

Tu. 17:10 Arp 2 Change detection and repetition . . .

Is the auditory continuity illusion based on a change-detection mechanism? A MEG study

Daniel Pressnitzer, Richard Ragot, Antoine Ducorps, Denis Schwartz, Sylvain Baillet
IRCAM

This study investigates neural correlates of the auditory continuity illusion, using the magnetoencephalography brain-imaging technique (MEG). Four types of sounds were presented to listeners: 1) a continously amplitude-modulated noise; 2) the same modulated noise interrupted by a brief silent gap; 3) the modulated noise interrupted by a louder, unmodulated noise burst; 4) the unmodulated noise burst alone. In condition 3), listeners report hearing a continous modulation even though it is physically interrupted by the unmodulated noise burst: a case of illusory auditory continuity. A whole-head MEG system with axial gradiometers (CTF Omega 151) recorded brain activity when listeners attended passively to the stimuli. Here we report analysis on individual channels, averaged across 15 listeners. The amplitude-modulated noise produced a correspondingly modulated magnetic activity, the well-known auditory steady-state response. However, the illusory modulation did not produce such a steady-state response. A possible neural correlate of the illusion was found in transient evoked responses. When a physical change in the stimulus was linked to a perceptual onset, oscillatory activity in the gamma-band range as well as slow evoked potentials were observed. In the case of the illusion, where a

physical change in the stimulus was not accompanied by a perceptual onset, these neural responses were largely reduced or absent. An interpretation of our findings is that the continuity illusion is based on the suppression of a putative onset/change processing mechanism, involved in the perceptual organisation of auditory scenes.

Tu. 17:30 Arp 2 Change detection and repetition . . .

Pre-attentive change detection as indexed by the mismatch negativity event-related potential component

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The mismatch negativity (MMN) is a component of the event-related brain potential elicited by an irregular sound occurring in a series of sounds setting up a regularity. It peaks between 100 and 250 ms after onset of the irregularity. EEG, MEG, and fMRI data indicate that it is mainly generated in temporal and partly in frontal cortex. It is explained by a memory comparison mechanism in which the sensory representation of a current sound is mismatched to a neural model of the regularity established by the preceding stimulation. In other words, from the elicitation of MMN it can be inferred that a regularity has been established in the brain and that a deviancy from this regularity has been detected. Importantly, MMN is even elicited when the sounds are not attended. This pre-attentive scanning of the auditory environment for deviations from some regularity enables the involuntary switching of attention towards potentially meaningful events. Interestingly, MMN is not only elicited by "simple" deviations where an isochronous sequence of identical sounds is interrupted but also by the violation of abstract rules, and it even has some extrapolatory power. Thus the pre-attentive change-detection system underlying MMN reveals a considerable degree of adaptivity and may be regarded as an intelligent system operating at sensory level.

Tu. 17:50 Arp 2 Change detection and repetition . . .

Informational masking and pitch memory: Perceiving a change in a non-perceived tone

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Listeners were presented with 300-ms 'chords' of five synchronous pure tones, followed after a silence (0.5 - 8 s) by a single pure tone. The frequencies of each chord's components were selected randomly, but were constrained to be spaced by

intervals of at least 6 and at most 10 semitones. In one experimental condition ('up/down'), the single tone following a chord was 1 semitone higher or lower than one of the chord's three intermediate components; on each trial, the corresponding component was selected randomly and the task was to indicate the direction in which its pitch was changed. In another condition ('present/absent'), the single tone following a chord was either identical to one of the three intermediate components or halfway in frequency between two components; the task was to indicate if the single tone was present in the chord or not. Performance was much better in the 'up/down' condition than in the 'present/absent' condition. Yet, an opposite trend would be expected if it was possible to hear out the individual components of the chords. The listeners typically reported that, in the 'up/down' condition, they could perceive pitch changes without perceiving the pitches which had changed. The 'up-down' task was not markedly more difficult when the chord and the following tone were presented to opposite ears than when both stimuli were presented to the same ear. These results provide strong evidence for the existence of pitch (or spectral) change detectors at a central level of the auditory system.

Tu. 18:10 Arp 2 Change detection and repetition . . .

Auditory Sensory Memory for Random Waveforms

Christian Kaernbach
Institut für Allgemeine Psychologie der Universität Leipzig

The memory of auditory random waveforms (i.e. noise) is a special case of the auditory memory for sensory information. The experiments reported here evaluate the dynamics of this storage system as well as the interactions with new input. Periodic waveforms can be discriminated from uncorrelated noise by naive listeners up to a cycle length of 20 seconds, with the major decline in performance between 5 and 10 seconds. Even single repetitions of a piece of the waveform can be detected up to a stimulus onset asynchrony of 6 seconds. The capacity of this storage system is limited to a few items of in total a few hundred milliseconds length. Within this capacity, however, items do not interfere strongly. These results are compatible with the view that auditory sensory memory is a modality-specific module of short-term memory.

Tu. 18:30 Arp 2 Change detection and repetition . . .

Short-term memory for temporal envelopes

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Short-term memory for the modulation frequency and intensity of sinusoidally amplitude-modulated (SAM) white noises was investigated in forced-choice discrimination experiments conducted with 4 listeners. The two stimuli presented on each trial lasted about 1.25 s and were separated by a variable delay D. Modulation frequency discrimination was assessed for an average frequency value of 8 Hz, with a fixed modulation depth of either 12 % or 100 %. Intensity discrimination was assessed for an average level of 75 dB SPL, using a modulation frequency of 8 Hz and a 100-% depth. In each case, a roving procedure was employed in order to minimize the influence of context coding. Initially, frequency and intensity discrimination thresholds [P(C)=0.75] were measured while D was fixed at 0.25 s. The corresponding physical differences (in % or dB) were then constantly presented at 6 values of D: 0.25, 0.5, 1, 2, 4, or 8 s. For both intensity and frequency discrimination, the decline of sensitivity (d') as a function of D was quite slow. For frequency discrimination, decreasing depth from 100 to 12 % did not have a marked effect on the decline of d' as a function of D, although this degraded the initial discrimination threshold by a factor of about 2. Taken together, these results suggest that there is little information loss in the short-term memory representation of simple temporal envelopes. Moreover, the data concerning frequency discrimination appear to be inconsistent with the model of perceptual memory proposed by Kinchla & Smyzer (1967).

Tu. 8:30 Arp 3 Silicon and other microphones

Silicon Microphone Development at Infineon Technologies AG

Stefan Barzen, Michael Brauer, Marc Fueldner, Alfons Dehé
Infineon Technologies AG

Within the framework of the nationally funded project "Silicon Microphones for Array Applications"(BMBF 16SV1273), which started in Feb. 2001, Infineon Technologies AG has developed Silicon micromachined condenser microphones for applications in automotive and hearing aids. The advantages of Silicon Microphones compared to electrets are their ability to sustain temperature in excess of 300°C, their long term stability and their good reproducibility in terms of sensitivity and noise. These are important facts for precise matching of microphones in array solutions.

This paper will show how Silicon microphones are processed in a standard six inch CMOS fab. Innovative surface and bulk micromachining processes have been developed to realise the microphone functionality. Basically, the microphone consists of a thin poly-Silicon membrane electrode which has precise distance of about 2μm to a highly perforated counter electrode. Monolithically integrated microphones as well as two chip solutions have been developed. Especially the hybrid integration opens up a wide spectrum of applications in terms of signal conditioning. Microphones have been realized with sensitivities of up to 30mV/Pa at 2.5V bias and without amplification. These microphones show superior noise equivalent sound pressures of only 25dB(A). With the aid of the developed simulation tools Infineon is nowadays capable of designing microphones to a given specification. Especially the surface mount device packages allow automatic manufacturing and reflow soldering of the devices.

Tu. 8:50 Arp 3 Silicon and other microphones

Simulation of acoustical and electrical Performance of Silicon Microphones

Michael Brauer, Alfons Dehé, Marc Füldner, Rainer Laur
Infineon Technologies AG

This paper presents a microphone model, which allows simulating acoustical and electrical behaviour. Furthermore the simulation results compare very well with measurements. The model is based on a SPICE network comprehending the possibility to use it with different simulation tools like PSpice or Spectre. So the benefit is a surrounding area which is compatible with most circuit design areas and the acoustical behaviour can smoothly be integrated into the simulation. For example a complex circuit with integrated filters and amplifiers to analyse the microphone output signal can be simultaneously simulated with the acoustics to match a given specification. The model includes the entire silicon microphone system with all subsystems like the acoustics, the mechanics, the mechanical-electrical transducer, the circuit including the parasitic capacitances and the housing of the microphone. The acoustical-mechanical simulation depends on the electromechanical analogy between mechanical, acoustical and electrical systems. Therefore it is possible to describe the sensitivity, the noise and particularly the signal-to-noise ratio considering the acoustical and electrical parts of the microphone. The verification of the model with different bias voltages and various load resistors for the microphone capacity on the one hand and the modification of the sound inlet port on the other hand show an excellent agreement between simulation and measurement.

Thus a variation of electrical or mechanical parameters is accurately considered in the model.

Tu. 9:10 Arp 3 Silicon and other microphones

Development of Directional Silicon Microphones

Marc Füldner, Alfons Dehé
Infineon Technologies AG

In hand-free applications and hearing aids, microphones with directional characteristic are used for improved signal-to-noise-ratio. Basically there are two different approaches to separate a localized speech source from a noisy environment. Microphone arrays employ two or more omni directional microphones with electronic processing of the directivity-dependent time delay between the signals. For smaller devices, an acoustical phase-shifting element between two sound ports of a single microphone provides a directivity-dependent differential sound pressure. This paper presents microphone packaging concepts in Surface Mount Technology, electro-acoustical modelling and measurement results of directional silicon microphones using a single-microphone approach. Microphones on a PCB (printed circuit board) with premolded cap as well as microphones in a premolded package with metallic cap have been tested and optimized. The front sound port is a drilled hole in the bottom of the package below the microphone chip. The acoustical impedance of the rear sound port which specifies the needed phase-shift is adjusted by different damping materials and very small holes realized by chemical etching and laser cutting, respectively. According to the formal analogy between mechanical, acoustical and electrical systems, an equivalent circuit representation of the directional microphone was composed. In this technique, mass, stiffness and damping are represented by electrical inductors, capacitors and resistors. The time delay between the signals entering the front and rear port was included by a transmission line element. Based on the directional microphone model, the design of the rear port was optimized regarding its acoustical impedance, resulting in measured signal attenuations up to 19 dB at 1 kHz.

Tu. 9:30 Arp 3 Silicon and other microphones

MEMS Packaging - Technological Solutions for a Si-Microphone

Karl-Friedrich Becker, Mathias Koch, Tanja Braun, Volker Bader, Rolf Aschenbrenner, Herbert Reichl
Fraunhofer IZM Berlin

Micro Systems and Micro Devices play an important role in today's high tech products. They are used as acceleration sensors for airbag control, as piezo actuators for high resolution

print heads, as micro pumps for high precision chemical/medical dispensers or as silicon microphones for smallest hearing aid applica-tions. In order to facilitate the use of such fragile devices, packaging of these structures is on major issue. Due to the cost and yield issues associated with this process step, significant evolution on top of the mi-croelectronic packaging techniques is required. MEMS packaging fulfils a crucial role within the function of the MEMS device. Besides the electrical interconnection, the package provides mechanical protection, media separation or coupling (e.g. pressure), signal conditioning, etc., it must enable the resulting package to be manufactured and assembled at low cost. Also, high reliability requirements even under harsh conditions (e.g. oil sink with extreme tempera-ture differences and aggressive ambient) must be fulfilled in order to be accepted in the market for high tech solutions. Within the project InFON a packaging technology for stress sensitive MEMS devices has been developed, that allows the cost effective packaging of a silicon microphone. The development of the packaging tech-nology is described in detail from concept development and material selection to manufacturing process development and reliability characterization.

Tu. 9:50 Arp 3 Silicon and other microphones

Design Support and Development of Miniaturised Si-Microphone Packages

Johann-Peter Sommer
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Numerical sensitivity analysis by means of finite elements (FE) is useful to reduce cost and time to market by minimising real tests and expensive redesign. Within the research project 'InFON', funded by the German government (BMBF), the FE methodology was improved and applied to miniaturised Si-microphones, to be starting already at an early stage of the design process. Several material combinations for board, adhesives, and case were investigated in order to evaluate the pre-stress stability of the chip membrane, which is influenced by the sequence of manufacturing steps and their temperatures due to the unavoidable thermal mismatch between different materials. Besides them, the membrane deflection under electrostatic loading had to be characterised regarding the pre-stress state in the membrane and the real topology of the backplate electrode. Reliable numerical results can only be expected based on reliable material data for all components. Therefore, the visco-elastic behaviour of several important adhesives has been characterised, taking into account thermal as well as time dependencies of the parameters. Subsequently, the contribution gives an impression about the advances

which can be expected to be made with the help of FE techniques in early design steps of innovative and advanced microelectronic systems, and pinpoints the numerically recommended solution for Si-micophone packaging.

Tu. 10:10 Arp 3 Silicon and other microphones

Measurements of Silicon Microphone Arrays in Hearing Aids

Christian Weistenhöfer, Torsten Niederdränk
Siemens Audiologische Technik GmbH

Miniature electret microphones are the state-of-the-art hearing aid transducers. In modern hearing aids several single microphones are combined to directional microphones in order to get a higher speech intellegibility in noisy environments. For this purpose it is essential to have a high directivity which can only be achieved if the microphones are matched accurately. Silicon microphones a priori have low interindividual tolerances since they are manufactured using silicon micromechanic processes. In principle they are very well suited for directional microphones. If the microphones are placed in one housing, the hearing aid manufacturing process can be simplified (e.g. reduction of liz wires). In the talk prototypes of silicon microphone arrays applied in hearing aids will be presented. These prototypes have been developed within the joint research project InFON granted by the BMBF (Federal Ministry of Education and Research). Results of basic measurements (e.g. sensitivity and equivalent input noise) will be dicussed as well as results of directional microphone related investigations.

Tu. 14:50 Arp 3 Silicon and other microphones

Unidirectional Silicon Microphones: Testing And Basic Modelling

Helmut Krüger
Peiker acustic Gmbh&Co.KG

Unidirectional Silicon Microphones: Testing And Basic Modelling Any microphone intended for automotive communication purposes must fulfill a long list of acoustical and electrical specifications, i.e. directivity,immunity and a purpose-built output configuration. Silicon microphonesoffer many advantages in respect of vibrational, electrical and thermal immunity, but for direct replacement of existing parts, the desired directivity pattern has to be designed inside a micromechanical environment. This paper is intended to show the early iteration process of measurement and modelling with first production samples.

Tu. 15:10 Arp 3 Silicon and other microphones

Directional Microphones in Automotive Applications (Adaptive Beamforming)

Patrick Vicinus
Peiker acustic Gmbh&Co.KG

Handsfree communication in car environement becomes more and more common for the general public. The acceptance depends directly from the achieved audio-quality during phoning and error rate in speech recognition. Signal processing can enhance these factors. To take advantage out of a multi channel processing, this paper will present a dual silicon microphone array and its algorithm, which combines adaptive beamforming and dual channel noise cancellation. It analyses measurements of the microphones and the array in various scenarious of car environment and discusses the benefits of directional silicon microphones in automotive array applications.

Tu. 15:30 Arp 3 Silicon and other microphones

Analytical simulation of silicon condenser microphones

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University of Bremen, Institut für Mikrosensoren, -aktuatoren und -systeme (IMSAS)

G.M. Sessler [1] introduces an electromechanical equivalent circuit diagram for a capacitive transducer with a perforated backplate. This paper describes an extended analytical model for silicon condenser microphones to calculate e.g. receiving and transmitting sensitivity, membrane deflection and input impedance. Electrical and mechanical elements of the transducer can be integrated into the same equivalent circuit employing a transformer.

The membrane is modeled as a spring-mass system using a lumped element approach. In addition, dynamic effects as the mechanical reaction force of the air-gap and flow losses in the air-gap as well as the acoustic holes in the backplate are considered [2].

All essential design parameters of the device are taken into account in the model with a detailed examination of the influence of the parameters on sensitivity and input impedance. Figure 1 shows the equivalent mechanical parts of the device. Finally, an optimized backplate perforation is proposed to minimize flow losses of the air flowing through air-gap and perforation holes [3].

1. G.M. Sessler, Acoustic 1, Lecture, University of Darmstadt, 1998

2. L. Tebje, S. Junge, A. Buhrdorf and W. Benecke, An Analytical

Model for Low Frequency Capacitive Ultrasonic Transducers and Condenser Microphones
3rd Workshop on Micromachined Ultrasonic Transducers (MUT 2003), Lausanne, 2003
3. A. Buhrdorf et. al., Capacitive Micromachined Ultrasonic Transducer (cMUT) Array for The Frequency Range Below 500 kHz, Proceedings of the IEEE International Ultrasonic Symposium, 2000, San Juan, Puerto Rico, p.915

Tu. 15:50 Arp 3 Silicon and other microphones

Design and Application of a Low-Cost Microphone Array for Nearfield Acoustical Holography

Joachim Bös, Lothar Kurtze
Fraunhofer Institute for Structural Durability LBF

An 8x8 microphone array consisting of 64 low-cost microphones was developed at the Department of Mechatronics and Machine Acoustics, Darmstadt University of Technology, and applied to nearfield acoustical holography (NAH) measurements at the Fraunhofer Institute for Structural Durability LBF. Since microphone arrays usually require a large number of microphones for NAH to cover a reasonable frequency range, it is particularly attractive to reduce the cost per microphone. A silicon microphone was chosen because it is very cheap (approx. 18 Euros including preamplifier vs. 350 to 500 Euros for ”professional” array microphones - a factor of about 25!), temperature and shock resistant, and insensitive to structure borne noise. It has a flat frequency response, which was confirmed by comparisons with a Brüel&Kjaer microphone. The dimensions of the array (1.4 m x 1.4 m) result in a lower frequency limit of approx. 250 Hz, the microphone spacing (currently 200 mm, adjustable to smaller values) leads to an upper frequency limit of approx. 850 Hz. The microphone array is used to perform NAH measurements on various test objects using a Scadas III front-end and Cada-X software, both from LMS. The results of the NAH predictions are verified by sound pressure measurements (sound pressure distribution), laser vibrometer measurements (velocities at the source), and sound intensity measurements using a 2D intensity probe.

Tu. 16:10 Arp 3 Silicon and other microphones

Free-Field Calibration of Microphones and Sound Level Meters in an Anechoic Chamber

Holger Nicklich, Heinz Weißing
SPEKTRA Schwingungstechnik und Akustik GmbH Dresden

More often than not, the results of acoustic measurements have far-reaching consequences for technical, financial and legal decisions - that is why high precision is required. Careful calibration of the employed measuring instrumentation is one of the basic prerequisites to achieve this goal. The paper starts with an overview of the methods available for sound pressure calibration, assessing their relevance to practical application. In a second part the free-field acoustic calibration system is introduced that SPEKTRA, Germany developed for the calibration of measuring microphones and sound level meters by the method of comparison in an anechoic chamber. The method presented is of fundamental importance, as it is the only one that applies the type of sound field on which the standardized requirements for sound level meters are based.

Tu. 16:50 Arp 3 Speech in vehicles

Realtime Performance of Acoustic Echo Canceler and Postfilter in the Car Environment

Gerald Enzner, Dirk Mauler, Peter Vary
RWTH Aachen

A very simple and elegant signal processing solution to the acoustic echo control problem has been presented recently [1]. This approach is based on the purely statistical adaptation of an acoustic echo canceler and a postfilter for residual echo suppression. A double talk detection is not required for the stability of this algorithm. We have now used the algorithm to reduce the acoustic echo of hands-free telephones in the car environment. In this paper we present the results of the performance evaluation on the basis of our realtime implementation. It turns out that the main strength of the algorithm is the duplex ability, i.e. the fast and robust adaptation in the double talk situation. [1] Gerald Enzner and Peter Vary, 'Robust and Elegant, Purely Statistical Adaptation of Acoustic Echo Canceler and Postfilter', Proc. IWAENC 2003.

Tu. 17:10 Arp 3 Speech in vehicles

Evaluating Speech Recognition Performance in the Car - A Pragmatic Approach

Markus Lieb
Volkswagen AG

During the development of voice-controlled applications the continuous monitoring of the speech recognition performance from the lab into the final product is of crucial importance. There is a gap between large-scale off-line automatic speech recognition (ASR) tests being run in the lab on pre-recorded speech material, and tests with real speech uttered by test persons in the

target cars under realistic, e.g. driving, conditions. Both tests are necessary and conclusive, yet not sufficient for objective performance comparisons e.g. of different ASR installations. To evaluate ASR performance in a transferrable and repeatable manner for different cars at different point of time without the need to assemble test persons for every new test, a different approach is proposed with this paper. Starting from pre-recorded speech material covering all sorts of variations like gender, accents, age, and background noise conditions, we aim for a reproducable calibrated playback mechanism in the car. Such controlled playback comprises the ASR performance evaluation in an objective manner and especially allows for the comparison of different systems, e.g. in different cars, based on the same speech material. We present the experimental set-up for such performance investigations, describe the test procedure and give insight into results from the field.

Tu. 17:30 Arp 3 Speech in vehicles

Robust adaptive beamformer for automotive applications

Markus Buck, Tim Haulick
Temic SDS GmbH

The application of microphone arrays for speech acquisition in cars promise significant signal improvement compared to systems operating with a single microphone. By applying beamforming algorithms a spatial selectivity can be achieved which permits the suppression of noise signals coming from directions other than the speaker direction. Adaptive beamformers offer a potentially superior performance to fixed beamformers particularly in the case of time varying sound field characteristics or in the case of coherent noise (such as interfering speakers, loudspeaker signals, etc.). However, for real-world applications adaptive beamformers hold the risk of severe signal degradation. Disturbances such as an imprecise steering direction, mismatched microphones or reverberation due to multipath propagation may cause the adaptive beamformer to cancel out the desired signal. This behaviour is known as "Signal Cancellation" effect. This contribution describes a subband adaptive beamformer in GSC structure which is optimized for car environments. In order to prevent signal cancellation the system comprises a combination of several robustness methods which have proven to be effective for practical application.

Tu. 17:50 Arp 3 Speech in vehicles

Convolutive Blind Source Separation for Noisy Mixtures
Robert Aichner, Herbert Buchner, Walter Kellermann
University of Erlangen-Nuremberg

Recently, we presented a blind source separation (BSS) framework for convolutive mixtures. The resulting algorithms are suitable for separating speech signals in real-world environments with room impulse responses modeled by long FIR filters of several thousand taps. In this paper we extend the BSS model to the case when noise is present. In the case of arbitrary noise sources, suitable noise estimation methods have to be utilized to obtain noise-robust BSS algorithms. Here, we combine a frequency-domain BSS algorithm based on second-order statistics with a bias removal technique utilizing minimum statistics. This leads to improved separation performance for noisy environments. Experiments conducted in a car environment show the effectiveness of our method.

Tu. 18:10 Arp 3 Speech in vehicles

Speech Recognition for Mass-Production Vehicles
Eike Gegenmantel
ScanSoft

In many areas speech is a considerable choice for user interfaces to devices and services. In a vehicle, speech control has specific value: It is a true additional channel to the many already existing buttons and displays. Speech control does not need the hands, they can stay at the steering wheel, and with an acoustic feed back, the eyes are not forced to a display and remain on the road. A new way of control is available for navigation systems, telephone, car audio, on-board computer and many more. There are high demands on speech control in vehicles: The noise level is comparably high, the underlying electrical devices have to fulfil high physical requirements, and the cost pressure is very tough when targeting the mass market. This presentation will describe how modern speech recognition technology fulfils these requirements already today. It will give an overview how the combination of microphone position and direction, and electronic and algorithmic filters copes with the acoustical conditions. The presentation will also show that mature digital signal processors fulfil the physical requirements at low cost, however, at another price: Sophisticated software engineering is needed to prepare complex speech recognition and filter algorithms in a way that - despite limitations of memory space, computing power and precision - the required quality of speech control is still ensured.

Tu. 18:30 Arp 3 Speech in vehicles

Challenges in Mobile Hands-free System Optimization
Frank Kettler, Hans Wilhelm Gierlich, Frank Rosenberger
HEAD acoustics GmbH

Built-in car hands-free telephones may consist of different components consequently leading to a heterogeneous system design. Each component like the microphone (or microphone array respectively), the hands-free unit itself and sometimes the mobile integrated additionally introduce various kinds of signal processing. This may even lead to cascaded algorithms providing the same kind of, or at least comparable signal processing in order to improve speech quality. A typical example is the noise reduction which can be found in the microphone array (beam forming, algorithmic noise reduction), additionally in the hands-free unit and in the integrated mobile. In order to guarantee a good speech quality for the complete system it is absolutely necessary to choose the parameter settings of these algorithms according to the characteristics of the cascaded systems. Typically these cascaded systems have been optimized independently of each other and the combination of the systems do not necessarily lead to a sufficient speech quality of the whole system. This presentation shows some practical examples how single parameters - and as a final result - the complete system can be optimized.

We. 8:30 Schweitzer Car acoustics IV

Evaluation of vibration perception in passenger cabin
Michael Bellmann, Hermann Remmers
itap GmbH - Institut für technische und angewandte Physik

The human body is exposed to various whole-body vibrations from different sources, e.g., at working place in industry or in daily life traffic. The comfort or discomfort caused by interior sound and vibration in a passenger cabin is an important property which became more and more important for the acceptability of transport facilities over the last years, especially in automotive industry. In this study, vibro-acoustic multi-channel recordings are measured in different types of passenger cabins in vehicles and aircrafts. It would be very advantageous knowing the properties of the noise and vibration signals that are fundamental for quality assessments. This study focuses on vibration perception. However, the vibration signals are measured at the man-machine interfaces between the vibrating part of the machine (e.g., the seat) and the human body. On the basis of representative spectra typical vibration characteristics of different types of exposure in cabins are discussed, like relevant frequency and magnitude selectivity aspects. Furthermore, new and reliable possibilities to

evaluate and to describe vibration perception in passenger cabins are pointed out. The discussion refers to experiences and results from basic experiments which take into account sinusoidal (deterministic) excitation as well as stochastic broadband stimuli. The benefit is to improve the objective description of subjective (dis-) comfort caused by vibrations. However, the advantage of more and better information and knowledge about the perception of vibrations allows to improve human response to vibration models (HRVM) so that 'comfort' would increase and the annoyance experienced from vibrations would be reduced.

We. 8:50 Schweitzer Car acoustics IV

A sound Perception Approach inside a mechanical Shovel Cabin

Nacer Hamzaoui, Etienne Parizet, Pierre Loisy
Lab. Vibrations Acoustique, INSA Lyon - Bât. 303

Acoustic studies usually consist in carrying out either an experimental diagnostic or vibro-acoustic computations allowing to understand the physical functioning of the noise source, and then in making modifications respecting a specification developed by specialists. The perceptive analysis part including the users of the product still remains a rather low one in these studies. Perceptive approaches can complete physical studies in a very useful way, allowing to reach a target expected by customers more quickly. The subjective result can be linked to physics trying to correlate it with one or several indicators representing the processed signals. This correlation then allows to identify the physical parameters characterizing the studied noise annoyance, and thus to identify annoying frequencies and annoying sources, and increase the efficiency of the resolution of the formulated problem. In this communication, the application of a global process of sound perception on an industrial object is presented with the will to reach the targeted physical objectives. This work is stemmed from a study carried out in the frame of a collaboration with the Volvo Compact Excavators company, a manufacturer of mechanical shovels. The objectives determined within this collaboration have been : 1. On a complete machine, the manufacturer wanted to have a predictive model of sound annoyance at his disposal and identify the elements of the machine contributing to annoyance so as to establish a hierarchical approach of noise reduction inside the cabin. 2. Definition of frequency bands said to be useful, intervening in sound perception and thus allowing to choose a physical modeling method adapted to the problem.

We. 9:10 Schweitzer Car acoustics IV

Interior Vehicle Sound Composition: Wind Noise Perception
Markus Bodden, Gerd Booz, Ralf Heinrichs
Ingenieurbüro Dr. Bodden

Interior vehicle sound is composed of three major components: engine, road&tires, and Wind noise. The role of the balance of these three components was investigated first. The main focus was then set on wind noise perception. A typical characteristics of wind noise are temporal variations caused by the outdoor and driving condition, which are perceived as signal fluctuations. Customer perception of these fluctuations was investigated by means of listening studies and a customer forum.

We. 9:30 Schweitzer Car acoustics IV

Audibility of resolved tonal components of gear noise in passenger car cabins by trained listeners
Axel Mors, Werner Deutsch, Holger Waubke
ZF Friedrichshafen AG

Professional acoustic engineers as drivers especially of middle-, upper- and premium class cars are extremely sensitive to any acoustical signal detectable in the passenger cabin for quality control. They have to be categorized as highly trained listeners due to their long term experience in driving different models of cars. Even quite low level tonal components of gear noise can be separated by the ear from engine noise because of their higher order and their different modulation characteristics. Although the gear tone components are temporally masked by amplitude modulated engine noise, they are perceived as continuous emissions. They build a continuous auditory stream because of psychoacoustic phenomena such as stream segregation and the picket fence effect. A numerical model combining simultaneous masking and modulation effects is under development in order to evaluate and predict subjective reactions. Acoustic engineers with high listening experience have been tested extensively in pre-tests, classifying different sound segments depending on speed and gear. The results confirm the importance of the interaction between masking effects and the modulation characteristic of both, the highly modulated engine noise and the slowly varying tonal components of the gear. The over all detectibility has to be assumed at the levels of human auditory sensitivity under close to laboratory conditions for highly trained listeners.

We. 9:50 Schweitzer Car acoustics IV

Wavelet Transformation and gear noise

Daniel Bader, Peter Holstein, Heiko Marx
Technische Universität Ilmenau

The investigation of gear noise emitted by automotive tooth gears has gained increasingly in importance. The activities are focused on the reduction of acoustic emissions and the detection of gear failures. For these purposes, standard procedures of joint-time-frequency-analysis are applied, based on the short time fourier transformation. With this method important information resulting from non-stationary events are often detectable only with difficulty. Many problems also result from the large amount of data Produced by sampling in audio-quality when post-processing algorithms are applied for further data treatment. In many cases, the amount of data prevents real-time analyses with conventional tools, which are therefore only of limited use for quality inspection. For this reason, a wavelet analysis treatment for streaming data has been implemented on DSP boards in real time mode. The method is tested on several types of tooth failures and compared with wavelet analysis in post-processing mode and conventional joint time frequency analysis. The objects under investigation were spur gears of balancer systems. These units are responsible for compensation of second-order inertia forces and run at a speed of up to 12000 rpm. It is demonstrated that non-stationary methods such as the proposed wavelet techniques are suited to recognize and in particular to classify tooth failures to a better extent than the conventional JTFA analysis techniques. The system is designed to use FFT- and wavelet-based DSP techniques in a complementary manner at the real-time level. The DSP modes are part of a general modular software system extending over several levels.

We. 10:10 Schweitzer Car acoustics IV

Combustion Noise and Piston Slap Noise: Identification of Two Sources Responsible for Diesel Engine's Sound Signature

Cyril Renard
LAUM

Sound quality of engines has become an important criteria in customer's choice. For this purpose, car manufacturers tend to work in two ways : - noise reduction, which consist in lowering global noise level by decreasing " bad " noise components, like aerodynamic noise or combustion noise and, - sound design which is more about making " good " noise components appear. For example, an engine will inspire a " sporty " image to the audience by the rise of harmonic 3 and 6 because it will sound like a

6 cylinders. This work registers in the noise reduction part, because it deals with the combustion noise and piston slap noise that are two undesirable components of Diesel engine's sound signature. These two sound sources appear with a very short time delay. Hence it is extremely difficult to identify their respective contributions to global sound. In order to discriminate these two contributions, we have planned an experiment which consists in increasing or decreasing independently the two sources. Thus, four test set-ups have been defined, namely : - low clearance piston + combustion turned off, - high clearance piston + combustion turned off, - high clearance piston + standard combustion, - high clearance piston + severe combustion. Vibrations of the engine are then measured using accelerometers placed at different areas. Then a time-frequency analysis allows us to see the impacts in terms of frequency, amplitude and location.

We. 10:30 Schweitzer Car acoustics IV

Fahrzeugakustik im Diesel Kaltstart

Norbert Alt, Stefan Heuer, Rainer Thiele
FEV Motorentechnik GmbH

Das hervorragende Drehmoment- und Leistungsangebot moderner Dieselmotoren, kombiniert mit niedrigen Kraftstoffverbräuchen und Abgasemissionen, lassen diese zunehmend Marktanteile gewinnen. Auch das Geräusch ist bei vielen Fahrzeugen auf einem akzeptablen Niveau. Beim Kaltstart nageln jedoch bis heute die meisten Motoren unangenehm laut. Durch eine gezielte akustische Optimierung der Kaltstartkorrekturen im Steuergerät ist eine signifikante Verbesserung möglich. Es sind, abhängig von der Basiskalibrierung, Pegelreduktionen im Innen- und Außengeräusch von 0.5 - 5 dB bei -10°C Umgebungstemperatur erreichbar, ohne dass Einbußen bezüglich Startbarkeit, sichtbarem Schwarz- oder Weißrauch oder im MVEG-Zyklus auftreten.

We. 13:50 Schweitzer Car acoustics IV

Kompensationsmöglichkeiten des Wegfalls von Fahrzeugbaustufen im Fahrzeugentwicklungsprozess durch den gezielten Einsatz von Mess- und Simulationswerkzeugen am Beispiel der BTPA (Binaurale Transferpfad Analyse)

Bernd Winter, Bernhard Lange
Adam Opel AG

Um schneller auf die Anforderungen des Marktes reagieren zu können, ist eine Verkürzung der Fahrzeugentwicklungszeiten erforderlich. Mit der Verkürzung der Entwicklungszeiten verringert sich auch der zeitliche Abstand zwischen der Verfügbarkeit der ersten Prototypen und dem Beginn der Produktion. Im Zuge

der Einführung neuer Entwicklungsprozesse bei der Adam Opel AG kann es dazu kommen, dass bestimmte Fahrzeugentwicklungsstufen wegfallen.
Durch den gezielten Einsatz von Mess- und Simulationswerkzeugen muss diesem neuen Entwicklungsprozess Rechnung getragen werden. Dies geschieht durch übertragung von Erkenntnissen aus dem Entwicklungsprozess des Vorgängermodells bzw. aus Erkenntnissen von parallel laufenden Entwicklungsprozessen verwandter Modellreihen.
Anhand der BTPA (**B**inaurale **T**ransfer**p**fad **A**nalyse) zweier verwandter Modelle, des Opel Vectra und des Opel Signum, soll beispielhaft gezeigt werden, welche Datensätze bzw. Erfahrungswerte man zukünftig prozessübergreifend verwenden kann. Worst-Case-Abschätzungen durch die Verwendung von Targetkurven sind dabei ein Werkzeug, um im Entwicklungsprozess nicht vorhandene Datensätze fundiert ersetzen zu können.

We. 14:10 Schweitzer Car acoustics IV

SEA as Tool in Vehicle Development
Andreas Müller
AUDI AG

Statistical Energy Analysis (SEA) is a method for calculating higher frequency interior cavity acoustics. Application of the method relies on high modal density subsystems, into which the whole dynamic system must be broken. This induces a lower frequency bound, which is in contrast to finite element or boundary element methods, which are most useful, when vibrations of structures or fluids are dominated by individual modes. After an introduction into the SEA theory the applicability of the method in vehicle development will be assessed on the basis of some examples.

We. 14:30 Schweitzer Car acoustics IV

A combined modelling approach for improved SEA-predictions in automotive applications
Thorsten Bartosch, Christoph Fankhauser, Michael Vorraber, Alexander Glettler
Magna Steyr Engineering

For automotive engineers the predictive SEA with tools like AutoSEA and the measuring method of the experimental SEA with e.g. LMS ESEA are often two worlds. SEA prediction is used to check well-known parameters like the sound insulation of a material/layer combination and to detect some of the main sound transmission paths to the driver's ear. The experimental SEA is fundamentally based on transfer functions and allows under

certain well-known SEA assumptions the calibration of internal and coupling loss factors between subsystems. A new aspect, which seems very promising, is the combination of the analytical modelling and the experimental modelling in order to gain a better simulation accuracy. This goal can easily be achieved if the experimental and the analytical modelling processes result in an identical subsystem partitioning. On the other hand Magna Steyr's practise shows that this strict modelling instruction cannot be fulfilled in daily work. Therefore special techniques for merging the two worlds are outlined in the following. Besides experimental SEA it is further shown how a new hybrid FEM-SEA approach can be used in order to improve analytical SEA models. This contribution will give a brief overview over applied SEA modelling techniques and then point out the power of combined simulation. A strongly reduced AutoSEA model for airborne as well as structural noise is proposed and the results are discussed. From the authors' point of view the combined analytical and experimental approach is very likely to become the SEA modelling technique of the future.

We. 14:50 Schweitzer Car acoustics IV

Interaktion Motor-Getriebe Geräusch

Norbert Alt, Christoph Steffens
FEV Motorentechnik GmbH

Die getrennte akustische Optimierung an den Einzelaggregaten Motor und Getriebe wirkt sich im Allgemeinen auch positiv auf das Gesamtgeräuschverhalten eines Komplettaggregates aus. Zunehmend werden die Konstrukteure bei steigenden Forderungen an die Geräuschminimierung jedoch mit dem Phänomen konfrontiert, dass die als Einzelkomponenten getrennt entwickelten, optimierten und erprobten Baugruppen im Zusammenspiel unerwünschte bzw. unvorhergesehene Geräusche verursachen. Die Ursache ist darin zu suchen, dass alle Elemente der maschinenakustischen übertragungskette nicht unabhängige Größen der Einzelaggregate, sondern abhängig von deren Zusammenwirken im Gesamtsystem sind. Gegenstand des vorliegenden Artikels ist die Analyse der Wechselwirkungen zwischen Verbrennungsmotor und Getriebe in Bezug auf Anregungsmechanismen und Körperschallflüsse an einem PKW 4-Zylinder-Ottomotor mit Fünfgang-Schaltgetriebe. Zur Untersuchung wird die gesamte Schallentstehungskette von der Anregung bis zur Schallabstrahlung betrachtet. Aufbauend auf experimentellen Untersuchungen wurde dazu ein Berechnungswerkzeug entwickelt, das es erlaubt, die akustischen Eigenschaften des Motor-Getriebe-Verbunds abzubilden. Mit Hilfe dieses Tools können Gesamtaggregate akustisch analysiert, beurteilt und optimiert

werden. Darüber hinaus kann der Einfluss von Design- und Parameteränderungen auf das akustische Verhalten von Motor und Getriebe quantifiziert werden. Besondere Beachtung findet hier die Biegedynamik von Kurbelwelle und Getriebewellen sowie die Ausführung des Schwungrad-/Kupplungssystems.

We. 15:10 Schweitzer Car acoustics IV

Antriebsstrang NVH Optimierung mit MKS/FE

Norbert Alt, Klaus Wolff, Eugen Braun
FEV Motorentechnik GmbH

Obwohl die Aufgabe des Antriebstrangs lediglich darin besteht, das Drehmoment auf die Straße zu übertragen, ist die Auslegung durch eine Reihe von Vorgaben wie z. B. Haltbarkeit, Packaging, Akustik, Fahrverhalten sehr anspruchsvoll. Die Vorgaben führen oft zu widersprüchlichen Anforderungen, bei denen man angemessene Kompromisse in Kauf nehmen muss. Die vorliegende Arbeit untersucht zwei Beispiele, bei denen Abstriche unvermeidlich sind, und zeigt auf, wie man den bestmöglichen Kompromiss finden kann. Ein Beispiel behandelt das Problem des Getrieberasselns bei Handschaltgetrieben unter Berücksichtigung von Aspekten sowohl der Akustik als auch der Fahrbarkeit. Ein zweites Beispiel behandelt das ‚Clunk-Geräusch/Vibrationen" bei Fahrzeugen mit Automatikgetriebe. Bei einem Gangwechsel im Stand von ‚D zu R" oder von ‚P zu R" können störende ‚Clunk-Geräusche" und Vibrationen auftreten. Mit Hilfe von Tools wie z. B. Mehr-Körper-Simulation (MKS) und and Computer Aided Testing (CAT) werden Optimierung durchgeführt. Für die MKS Methode wird ein komplettes Fahrzeugmodell benötigt, bestehend aus Aggregat, Antriebsstrang und Chassis. Die Gummilager aller elastisch aufgehängten Komponenten - Powertrain, Differential, Fahrschemel - werden ebenfalls berücksichtigt. Durch eine Sensitivitätsanalyse kann der Einfluss der wichtigsten Parameter untersucht und somit der beste Kompromiss gefunden werden. Zur Reduktion des Getrieberasselns werden u.a. die Einflussmöglichkeiten über die Kupplung und Antriebswellen analysiert. Zum ‚Clunk"-Phänomen werden die Ursachen und ebenfalls mögliche Lösungen, z. B. Gelenkspiel, im Detail erörtert.

We. 15:30 Schweitzer Car acoustics IV

Analysis of NVH issues in Automotive Industry

Jean-Marc Guerinot
Centre d'Essais Vibro-Acoustique pour l'Automobile

Reducing noise and vibration is a major preoccupation for car manufacturers. Consequently, the system suppliers have been led to integrate this function very early in the design phase of

their products and have adapted to customer requirements. The author will present some examples regarding N.V.H. & durability topics based on automotive development projects : · Modal & operational modal analysis, · Running modes studies, · Acoustics (airborne transparency,oe), · Transfer Path Analysis, · Fatigue/Durability regarding vibration constraints. It will be shown that the NVH requirements have to be taken into account as early as possible in the development projects and that suppliers in this domain have to be increasingly involved in the global car manufacturers NVH process.

We. 15:50 Schweitzer Car acoustics IV

About High-Speed-Cameras in Acoustics

Holger Pastillé

IVM Automotive Ingolstadt GmbH

High-Speed-Cameras are normally used for car safety (airbag, head impact etc.). They are also very usefull to detect noise problems of elctrical drives (seat, mirror, roof). HSC are optimal to view the motion of parts and components, especially rotary motion. The application is a reasonable completition to the laser-doppler-vibrometrie with a series of advantages, e.g. the use under climate conditions. In the lecture will be shown the possibilities and limitations of this method.

We. 16:30 Schweitzer Benchmarking tests in . . .

Parameters Influencing the Benchmarking of Vehicle Interior Noise

Klaus Genuit

HEAD acoustics GmbH

The sound quality of vehicle interior noise has become a very important task for the acoustic engineer. As vehicles become more and more quiet, the customer's sensitivity to the acoustical comfort increases. On the one hand no disturbing noises should be heard, on the other the perceived sound quality should fulfill the expectations of the listener with respect to the sound design. For current and future needs the vehicle sound must act as a distinguishing criterion that supports the positive image of a car. In this context the following characteristics of sound are useful: - sound is informative, it includes information of quality, functionality - sound implies a certain image, such as luxury, sportive or cheap - sound may be identified, it may be used for corporate or product sound purposes In consequence, sound quality is an essential part of vehicle quality. But besides the sound the contribution of vibration is not negligible. The passenger of a vehicle has to be seen as part of a vibro-acoustical system. Consequently,

the subjective judgement of pleasantness or sound comfort is influenced by both sound and vibration. For a task-oriented proceeding in sound design it is absolutely necessary to consider these aspects. The performance of benchmarking tests of vehicles firstly requires an analysis for which market - that means for which relevant customer - and in which competition this vehicle stands. The performance of a simulated modification in real time for the adaptation of the acoustical features to the new target sounds is very important.

We. 16:50 Schweitzer Benchmarking tests in . . .

Door Operating Sound Improvement Based On Jury Testing And System Analysis

Philipp Sellerbeck, Christian Nettelbeck
HEAD acoustics GmbH

Door opening and closure sounds are an important factor influencing the quality impression received from a vehicle and are therefore often subject to sound design. Jury listening tests using recorded door operating sounds can provide helpful information not only for benchmarking but also for deriving target sounds. A sound judged best in a benchmark can either be used as a direct target or provide attributes for designing a synthetic target sound. A listeners rating of a sound depends on many additional factors such as personal attitude and visual feedback. Therefore, when conducting jury listening tests it is important to correctly define the appropriate soundscape and to take the listening environment into account. A procedure for benchmarking door operating sounds is presented along with results and target sound attributes are derived. Psychoacoustic signal analyses that correspond to the results of the jury tests are introduced. In order to improve an existing door opening or closure sound, transfer path analysis can be applied. A new simulation method based on a time-variant transfer model is presented. The procedure allows individual auralization of door sound components originating from the latch mechanism, striker impact, seals interaction and cavity boom, revealing the origins of unwanted noise patterns. Furthermore, the influence of component modifications can be predicted, and changes can be applied that improve the overall sound with respect to the target.

We. 17:10 Schweitzer Benchmarking tests in . . .

Interactive Contexts and their Contribution to Benchmarking

Brigitte Schulte-Fortkamp

Institut für Technische Akustik , Technische Universität Berlin

In the interior of a vehicle sound quality is a brand name. Binaural measurement and analysis technology is more or less standard, but general standards and parameters for sound quality still there are none. Evaluation of noises are highly sensitive to context, but testing procedures that can include this realization are exceedingly rare. Specific constellations of a general noise volume in clearly defined ambiences can characterize those ambiences and combine the daily recurrent patterns of sound multi-factorial in the process of analysis. The evaluation of noise situations generally gets interactively modified by their significance for the ambient space. It is contingent upon the respective ponderation of acoustic and non-acoustic modifiers which in turn constitute the environment to be experienced. In this frame of reference an innovative, sensitive evaluation procedure is introduced and discussed with regards to its importance for a customer-oriented benchmarking.

We. 8:30 Schuman Physical acoustics II

Near-Field Levitation Generated by Ultrasonic Vibrations : Theoretical Analysis and Experiments

Anne-Christine Hladky, Christian Granger, Gérard Haw, Bertrand Dubus

Institut d'Electronique de Microélectronique et de Nanotechologie, UMR 8520 CNRS, département ISEN

With a view to obtaining particular displacement conditions, such as friction cancellation, higher speed or non contact transportation, film air bearings using piezoelectric bending elements have many advantages in comparison with conventional air bearing systems, because they are autonomous and they take a reduced place. In this paper, the film air bearing is provided by the flexural vibration of a piezoelectric bimorph, made of a passive disk stuck on a piezoelectric disk. The system is excited at the frequency of its first bending mode. For a sufficiently high vibration amplitude, an air bearing appears between the bimorph and the ground. The gas remains stationary and is undergoing periodic cycles of compression and decompression. The acting principle relies upon the acoustic radiation pressure appearing in the air layer. Due to the thermal boundary layer thickness, neither adiabatic nor isotherm conditions have to be used in the air layer and an intermediate condition (equivalent compressibility) is used. With the help of the theoretical model, the thickness of the fluid layer is estimated

as a function of the lifted mass, the frequency and the drive level. Several prototypes are then designed using the ATILA finite element code and are built. First experiments show that, if the excitation level is greater than a given level, there are strictly no contact between the bimorph and the ground. The air bearing thickness and its relative variations are measured with the help of the laser vibrometer. Experimental and numerical results are compared and discussed.

We. 8:50 Schuman Physical acoustics II

The Time Reversal Kaleidoscope: a New Concept of Smart Transducers for 3D Imaging

Delphine Palacio, Gabriel Montaldo, Mickael Tanter, Mathias Fink
ESPCI - LOA

In real time 3D echographic imaging, the acquisition of volumic data set requires the recordingof an echo from all the 3D region of interest. Traditionally, two dimensional arrays composed of several thousand of transducers are used to obtain the beam focusing and steering in the volume. However, the design, the connections and the multiplexing required by these 2D arrays are technically complex to realize. Here we present a completely new approach to achieve 3D images with a very small number of transducers using the coupling concepts of time reversal mirrors and chaotic reverberating cavities. The small number of transducers (typically 32) are glued on one surface of the solid cavity, an other face is in contact with the imaged fluid medium (like the body). Thanks to hundred of reverberations inside the cavity, the ultrasonic waves emitted by the transducers are able to focus in any point of the volumic fluid by using time reversal techniques. At each reflection, 'virtual' transducers, images of the real ones by the reflection on the surface of the cavity, are created. As a result, a kaleidoscopic transducer array is obtained from a small number of transducer used in a time reversal mode, and allows equivalent performances than conventional 2D matrices made of thousands of transducers. The coupling of chaotic reverberating cavities with times reversal techniques leads to the concept of a 'smart' transducer. First experimental 3d images obtained with a pioneer prototype will be presented.

We. 9:10 Schuman Physical acoustics II

Characterization Of The Electrochemical Deposit Of A Conducting Polymer Film By The Means Of Acoustic Sensor (QCM)

Bachar Kanj, Franck Teston, B. Pirot, M. C. Pham, Marc Lethiecq
GIP Ultrasons/ LUSSI

Quartz crystal microbalances (QCMs) are largely used in several sectors of activities. More particularly, they are used to characterize the gravimetric effect during the deposit of polymeric film. The impedancemetry method is used to determine the resonance frequency and quality factor of the quartz oscillator. This double determination makes it possible to improve the sensitivity and especially to detect potential viscoelastic disturbances in polymeric film process. In the first step, a device which operating at a fundamental frequency of 9 MHz is used. Results show that these devices allow to follow and characterize the polymerization process of a conducting polymer film (PEDT). In the second step, devices can be used to, in particular, follow oligonucleotide (ODN) grafting. Gravimetric and viscoelastic effects of the film were investigated and discussed during the ODN integration onto the polymer surface. Finally, these studies allow us to identify, investigate and to better understand the gravimetric and viscoelastic processes caused by ODN on the film and also will offer the potential advantage of real time solution monitoring of nucleic acids hybridization by QCM.

We. 9:30 Schuman Physical acoustics II

Two-Channel Resonant Formalism Applied to the Scattering of a Fluid Cylinder in an Elastic Medium

Pascal Rembert, Hervé Franklin, Jean-Marc Conoir
Laboratoire d'Acoustique Ultrasonore et d'Electronique (LAUE), UMR CNRS 6068

The problem of acoustic waves interacting with a fluid cylinder included in an elastic medium at normal incidence is investigated. At first, the two-channel L(ongitudinal)-T(ransversal) scattering S-matrix is built up, for a given mode n, from the separate problems of the scattering of an incident cylindrical longitudinal wave on the one hand, and the scattering of an incident transversal wave on the other hand. In order to isolate the fluid cylinder resonances, an exact factorization of two-channel « soft » background scattering S_0 matrix is performed such that

$$S = S_0 S^{(*)} \tag{1}$$

where $S^{(*)}$ is the resonant scattering matrix that only contain the fluid column resonances. The eigenvalues of the resonant scattering eigenmatrix are found to be equal to 1 and $exp(-j2\delta_n^{(*)})$ respectively, where $\delta_n^{(*)}$ is the classical resonant eigenphase related to the fluid cylinder resonances in the n^{th} mode. It clearly demonstrates that the resonant energy is contained in a single eigenchannel. The mixing angles α and γ (involved in the rotation matrix that allows to diagonalize $S^{(*)}$) define the polarization states of the fluid resonances in the global S-matrix ; they can be expressed only as functions of the scattered scalar and vector potential coefficients involved in the tangential stress equation. The asymptotic behaviour of the fluid resonance parameters (frequency and width) and the mixing angles are analyzed . The relation between the global S-matrix eigenvalues and the resonant scattering matrix eigenvalues is also provided.

We. 9:50 Schuman Physical acoustics II

Acoustic properties of a corona discharge sensor

Vincent Joly, Philippe Béquin, Philippe Herzog
LAUM

The creation and the detection of acoustic waves with help of ionised gas is called ionic transduction. This work deals with the sensor aspect in which the ionised gas is obtained with a negative point-to-plane corona system in air at atmospheric conditions. This work starts from the phenomena involved in negative corona discharges, to understand how a plane wave interacts with the charged particles of the ionised gas to give rise to an electric perturbation of the discharge. An experimental set-up has been designed in order to evaluate the acoustic properties of this ionic sensor. This lets us know what the sensor is sensitive for: pressure or velocity and, according to the case, to measure its frequency response and its sensibility. In this way, an investigation is made of the electric perturbations produced in the discharges placed in a tube closed at one end and at the other by a loudspeaker oscillating at near resonant frequencies. Experimental results will be compared with predictions from models adapted to each configuration (pressure or velocity).

We. 10:10 Schuman Physical acoustics II

Field flucuations inside a reverberant cavity with moving scatterers

Julien De Rosny, Claire Debever
ESPCI - LOA

In this talk, we report a study of transient ultrasonic waves inside a strong reverberant cavity filled with moving scatterers. In such a system, the scatterers motion induces field fluctuations. In a recent paper, based on a diffusive model, de Rosny et al. (PRL 2003) show that the elastic mean free path and the dynamics of the scatterers govern the field fluctuations. In this talk we go further by also taking into account the inelastic (absorbing) part of the scattering process. Hence ultrasonic reverberant cavity provides a new and simple tool in order to estimate the inelastic and elastic total cross sections of one or several scatterers. We have successfully applied this technique to spherical (Ø0mm diameter) scatterers made of different materials (steel, gelatine, Ureol, oe). These experiments are performed inside a 1.5 litre reverberant water tank at 900kHz central working frequency.

We. 10:30 Schuman Physical acoustics II

Acoustic radiation efficiency of a structure covered by a porous layer

Cédric Devaux, Nicolas Dauchez
LAUM

Porous materials such as polymer foams are well known as sound absorbers [1]. In many applications, they are attached to a structure subjected to vibrations. Considering the structure, they act as an intermediate layer modifying the coupling conditions with the acoustic domain. The aim of this study is to investigate how a porous layer bonded to a vibrating structure may affect its acoustic radiation. A 1D model has been developed to calculate the acoustic radiation efficiency of a covered piston in a duct [2]. The porous layer is described by an equivalent fluid model or by Biot theory [1]. It is shown that the radiation efficiency is not affected in the low frequency range. In a mid-frequency range, the Biot model shows an increase related to skeleton resonance. This increase is not be predicted by the equivalent fluid model. At higher frequencies, the radiation efficiency decreases, the equivalent fluid model predicting a slower decrease. The tendencies given by the Biot model have been confirmed in the case of two experimental configurations: a piston radiating in a duct, and a clamped plate radiating in an anechoic chamber, both covered by two different porous layers.

[1] Allard J.F., Propagation of sound in porous media - modelling sound absorbing materials, Chapman & Hall, London, 1993
[2] Wallace C.E., The Radiation Resistance of a Rectangular Panel, J. Ac. Soc. Am. (51), p.946-952, 1972

We. 13:50 Schuman Physical acoustics II

Characterization of a dipole radiation by Laser Doppler Velocimetry

Grégory Souchon, Bruno Gazengel, Olivier Richoux
LAUM

This work concerns the use of a Laser Doppler Velocimetry (LDV) technique for measuring the acoustic particle velocity in free field condition. The aim of the study is to characterise the radiation of an acoustic dipole. First, pressure measurements are performed in a anechoic room in order to estimate the dipole moment used in a radiation model. Pressure measurements are also performed in the LDV experimental room (semi-anechoic room) using the same experimental protocol. In this case, results highlight the great influence of the environment (room and experimental system acoustic properties), especially at low frequency. In a second time, acoustic velocity measurements are performed in the semi-anechoic room using the LDV system and a sound intensity probe. The study points out two major results : - As shown by the pressure measurements performed in the preliminary study, velocities deduced from the sound intensity probe and from the radiation model does not agree for low frequency, the room being not anechoïc. - The acoustic velocity estimated by means of the LDV bench and by the sound intensity probe agree for medium frequency (1 kHz). For low frequency, the acoustic velocity can not be estimated by means of the LDV system because of the natural convection that exists in the room. The presented results show that it is possible to estimate the acoustic particle velocity in free field condition with a flow velocity in order of 20 mm/s and acoustic velocity in order of 4 mm/s with a frequency of 1000 Hz.

We. 14:10 Schuman Physical acoustics II

Measure of the group velocity of an acoustic wave in an one-dimensional lattice

Stéphane Griffiths, Olivier Richoux, Vincent Pagneux
LAUM

The aim of this work is the study and the measure of the group velocity of an acoustic wave propagating in a complex medium. This medium is an one- dimensionnal lattice formed by Helmholtz resonators periodicaly connected on a cylindrical tube. This kind of system allows an important scattering illustrated by the appearance of forbidden and allowed bands in the spectral domain.

Experimental and theorical results are presented on perfectly waveguide lattice showing the presence of band gaps frequency in which the transmission of sound is forbidden. This property is used to show that the group velocity of an acoustical wave can be more important than sound velocity. A gaussian sound pulse whose frequeny content lies completely with the forbidden transmission region is used to measure the group velocity. Two sorts of procedures to determine the group velocity are used and compared: the time difference of the maximum of the pulse and the time difference for its barycentre before and after the lattice. We show that experimental group velocity can be considerably larger than the speed of sound: with a lattice composed by thirty resonators, the group velocity in the first Bragg stopband is measured between 2000 and 3000 m/s.

Attempt to improve the pressure reciprocity calibration of microphones

Cécile Guianvarc'H, Jean-Noël Durocher, Michel Bruneau, Anne-Marie Bruneau
Laboratoire National d'Essais

While pressure reciprocity calibration of microphones has been investigated for a long time, especially for a standardisation purpose [1] [2], works has been done during the past decades [3] [4], which provide tools to improve the modelisation and then to improve the accuracy of measurements. However, existing models does not fully include viscous and thermal boundary layer effects and involve methods (based on empirical models) to characterise microphones parameters which cannot fulfil current requirements, preventing us from calibrating accurately the microphones in the law and the upon part of the frequency bandwidth (up to 30 kHz). Thus the focus here is to investigate more deeply, analytically (even experimentally) the reciprocity calibration method and technique, using first revisited description of each element of the reciprocity calibration devices which conveys significant improvements, and then introducing new tools in the experimental procedure. Finally, requirements would be addressed to decrease the uncertainties in the results of calibrations, thereby supporting the aim of the work. [1] H. Gerber, Acoustic properties of fluid-filled chambers at infrasonic frequencies in the absence of convection. Journal of the Acoustical Society of America, 36, pp 1427 - 1434, 1964. [2] IEC 61094-2, 1992 : Measurement microphones - Part 2 : Primary method for pressure calibration of laboratory standard microphones by

the reciprocity technique. [3] K. Rasmussen, The static pressure and temperature coefficients of laboratory standard microphones. Metrologia, 36, pp 265 - 273, 1999. [4] K. Rasmussen, Radial wave-motion in cylindrical plane-wave couplers. Acta Acustica, 1 : pp 145 - 151, 1993.

We. 14:50 Schuman Physical acoustics II

Mapping of fluid pressure fluctuations using a scanning Laser-Doppler interferometer

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Robert Bosch GmbH, Corporate Research and Development, FV/FLP Acoustics

Mapping sound fields can extend the understanding of sound creation and radiation. For an experimental recording of sound fields, pressure, velocity or intensity values have to be gathered at many measurement positions with great effort. However, the presence of the microphones or anemometers may significantly influence the sound field. When investigating aero-acoustic noise sources the sensors may also disturb the flow and additional noise might be produced. These disturbances can be avoided by using Laser-Doppler interferometers. The method is based on the dependency of the refraction index on the local fluid pressure. The optical path length along the laser beam varying with time according to the pressure variations can be detected by Laser-Doppler interferometry. As a reference signal for the phase of the local pressure fluctuations a microphone outside the measurement field or the driving voltage of the sound source can be used. The method described here has been introduced e.g. by Zipser (DAGA '01). As an example, the method will be demonstrated for an industrial application, the ultrasonic field of a car parking aid. The radiation and propagation of the ultrasound and its scattering at a car bumper will be presented.

We. 15:10 Schuman Physical acoustics II

Time Response of a Plate excited by a short duration Point Force

Dominique Habault, Paul Filippi
LMA CNRS

The paper presents a comparison between experimental and numerical results obtained in the case of a baffled clamped plate excited by a short duration point force. The plate is a homogeneous steel plate, placed between two anechoic rooms. The excitation force is provided by a hammer. The hammer can be equipped with three types of heads made of rubber, plastic or metal. The following measurements were taken: excitation force at the head of the hammer, acceleration at one corner of the plate, sound

pressure at two microphones situated at 0.5 and 1.5m from the plate. The theoretical results were computed by a method which consists in expressing the plate displacement as a series of the resonance modes of the coupled fluid/plate system. In particular, this method provides a straightforward way to describe the decreasing behaviour of the sound pressure versus time, due to the fluid/plate coupling. For the excitation force, an analytical model was chosen in order to describe as closely as possible the measured force; the same model was used for the three heads, with different values of the parameters. The smoothest curves were obtained for the rubber and the plastic heads. Comparisons have been made for the first 60 ms of the acceleration and pressure signals. The best agreement between computed and measured sound pressure has been obtained for the rubber head. Further comments will be also made on the comparison between these numerical and experimental results, based on perceptive criteria.

Localization of scars in the stadium billiard using reassigned Husimi distribution

Benoît Teyssandier, Vincent Pagneux, Laurent Simon
LAUM

In this paper, classical ray trajectories and high frequency eigenfunctions of a billiard with the shape of a stadium are discussed with the aid of quantum Poincaré plots. This quantum Poincaré section or phase space distribution is given in terms of the Birkhoff variables (s,cosø), introduced in quantum mechanics. This technical point of view have been studied intensively using Wigner and Husimi distribution functions. In this regard, the current study presents an effective alternative procedure by combining a novel digital signal processing technique, the reassigned method, with the so-called Husimi distribution specialized to the case of mixed irregular dynamic motion. More than a better localization of scars in phase space, the results are then used to develop a quantitative understanding of eigenmodes scars produced by resonance on periodic orbits. While each distribution has given strenghs and weaknesses, the reassigned Husimi distribution appears to be the best choice to characterize scars in billiards.

We. 15:50 Schuman Physical acoustics II

Multiple scattering of acoustic waves in porous absorbing materials

Aroune Duclos, Vincent Tournat, Vincent Pagneux, Denis Lafarge, Luc Jaouen
LAUM

Multiple scattering of acoustic waves in porous absorbing media is studied theoretically and experimentally. Porous media like air-saturated polymer foams with open cells, have a non-trivial frequency-dependent absorption that arises due to viscous and thermal effects at the scale of the rigid frame microstructure. In order to produce multiple scattering at ultrasonic frequencies, mesoscale scatterers are introduced in the porous medium host. The effective wavenumber of such a multi-scale medium should take into account the peculiar absorption at the micro-scale and the multiple scattering at the meso-scale to describe precisely the propagation of a coherent acoustic wave. For this purpose, an equivalent fluid model, derived from an homogenization method, is used to model the acoustic propagation in the host porous medium itself. Then, at the meso-scale, the scattering by the inclusions is described with a multiple scattering approximation (independent scattering approximation), allowing to obtain the total effective wavenumber of the porous medium. After some validating results on the multiple scattering by an array of rigid cylinders in air, experiments on the multiple scattering by rigid cylinders embedded in a porous medium are presented and compared to the developed multi-scale approach. For the host medium itself, the same multiscale approach provides a convenient mean to account for scattering effects not described by the equivalent fluid model.

We. 16:30 Schuman Physical acoustics II

Numerical Description of the Generation of Modal Waves by a Bounded Acoustic Beam

Nacera Bedrici, Philippe Gatignol
Laboratoire Roberval, CNRS, Université de Technologie de Compiègne

The generation of the (generalized) Rayleigh wave by a bounded acoustic beam has been first shown experimentally by Neubauer. The first numerical approach of the phenomenon goes back to Ngoc and Mayer who gave the pressure values of the reflected field on the fluid/solid interface. Using a numerical simulation method for the description of the acoustice beam, we show the generation in plane layered structures of so-called 'modal waves' such as the Rayleigh wave, the Scholte-Stoneley or the Stoneley

wave at the fluid/solid or solid/solid interface, guided waves in a fluid layer and finally Lamb waves. In the two-dimensional case, cartographies for the pressure or the stress fields are given in each medium of the structure, allowing to visualize the generation phenomenon. The generation of the interface waves is observed when the beam crosses a first fluid ot solid layer, with a specific incidence angle, before it reaches the relevant interface. The setting up of each guided wave, as the incidence angle varies, is also well understood.

We. 16:50 Schuman Physical acoustics II

The Origin of the Audio Signal in a Beam of Modulated Ultrasound in Air

Volker Mellert, Bernhard Schwarz-Röhr
Carl von Ossietzky Universität Oldenburg

The parametric generation of low-frequent sound by means of modulated or interfering ultrasound is well-known in underwater acoustics. The non-linearity of the equation of state produces a low-frequent sound beam of the high directivity of the ultrasound projector. In recent years similar devices are used to generate audible sound in air. The so-called ultrasound loudspeakers radiate with surprisingly high directivity ("audio spotlight"). Experiments indicate that the audio signal in air results not only from the non-linear equation of state but fluid boundaries play an important role as well.

We. 8:30 Tivoli 1 Outdoor sound propagation I

On the Influence of Source Height on the Sound Propagation over Flat Terrain

Edmund Buchta
Institut für Lärmschutz Düsseldorf

The influence of the source height must be known to determine the predicted noise load. The influence of the source height is well-known in room-acoustics however, without reflecting surfaces, but the ground effect is not observed in outdoor-acoustics. In order to investigate this effect, a measuring campaign was conducted. An impulsive source was triggered at different heights at 0m, 1m, 2m, 3m and 4m above ground. At distances of 50m, 100m, 200m and 400m from the source two microphones at each distance measured the impulsive sound at two heights (0m and 5m). The measuring results gave no evidence that the receiver levels at any position depend on the height of the source with one exception, that is the source at the ground yields two dB less receiver levels.

We. 8:50 Tivoli 1 Outdoor sound propagation I

On the Height of Burst Gain For Small Arms

Karl-Wilhelm Hirsch
Institut für Lärmschutz Düsseldorf

For large explosions in air, the so-called "Height of Burst" gain (HOB) is introduced in respective guidelines to consider the influence of the source height above ground on the acoustical receiver levels in the far field. The technical paper ISO 13474, describing the prediction of receiver levels for muzzle blasts from large weapons, inherited the idea of the HOB correction from the ANSI standard S2.20-1983. The HOB formula of the ISO 13474 predicts significant corrections up to 7 dB, depending on charge weight and height of burst. If the prediction schemes for muzzle blasts need to consider the HOB gain for all weapons including civil and military small arms, this correction would have a great influence on the noise assessment of shooting noise: The number of relevant emission situations would strongly increase. And it would force range control to record the aiming position of a shooter for every shot to provide reliable input data for noise predictions. In order to decide whether this effect must be taken into account for the prediction of sound levels in the vicinity of a small arms range, a dedicated test was conducted using a charge weight of 100 g TNT as an adequate sample source. Receiver levels were recorded at several distances and two directions. As a conclusion, the analysis of the measuring results falsifies the HOB gain for such small explosions. The paper presents the test layout and discusses the way of analysis. It concludes that the HOB correction does not apply to small arms.

We. 9:10 Tivoli 1 Outdoor sound propagation I

Simple and multi-reflections using the PE method with a complementary Kirchhoff approximation

François Aballea, Jérôme Defrance
CSTB

Sound impact of road and railway infrastructures are more and more severely regulated by European laws: acceptable thresholds in emission and reception are decreasing. This implies to develop propagation models able to take many phenomena into account at the same time (meteorology, uneven ground, impedances discontinuities...). The parabolic equation (PE) is one of the numerical methods used for sound propagation simulation in complex outdoor situations. It neglects backscattering. Even if this assumption is effective in many configurations, it does not allow to use PE for studies of acoustic wave propagation between a source and a receiver when an obstacle (rigid

barrier, building) is located just before the source, or just behind the receiver. In those cases, energy reflected by obstacle is not negligible and results obtained with PE may be incorrect. This paper aims at presenting a new method able to integrate backscattering in GFPE (Green's Function Parabolic Equation method). In this approach a complementary Kirchhoff approximation is used by setting to zero the sound pressure above the vertical obstacle. Thus, new configuration as the multi-reflections can be studied with this new method. In order to point out the role played by backscattering, we first study a barrier located just behind a source. Then, comparison with BEM (Boundary Element Method) calculations is presented in the case of a simple reflection in homogeneous and inhomogeneous atmosphere. A more complex road traffic noise configuration made with two parallel barriers and meteorological effects is also studied. Results show that the complementary Kirchhoff approach seems to be promising.

Outdoor sound propagation modelling in complex environments: A new PE code coupled with a micrometeorological code

Bertrand Lihoreau, Benoît Gauvreau, Isabelle Calmet, Michel Bérengier, Philippe Blanc-Benon
Laboratoire Central des Ponts et Chaussées

In complex environments the modelling of outdoor sound propagation implies to take into account the mixed influence of ground characteristics (topography, obstacles, impedance, etc.) and atmospheric conditions (refraction and turbulence). We have developed a new PE code coupled with a micrometeorological code in order to calculate the sound propagation above a non flat ground in such realistic outdoor situations. Numerical resolution have been developed using the paraxial approximation of the wave equation in bidimensionnal configurations with a split-step Padé marching scheme. In our approach the effects of the topography are modelled using rotated systems of coordinates in order to treat the ground as a succession of flat domains. Our code can deal with different boundary conditions like the introduction of impedance jumps or thin screens which lead to diffraction of the acoustic energy. It also includes scattering effects due to atmospheric turbulence through the discrete random Fourier modes technique. The atmospheric turbulence is considered as isotropic, homogeneous, and essentially due to temperature scalar fluctuations. Predicting long-range sound propagation over a non-urban site with complex propagation media requires the knowledge of micrometeorological fields in the lower part of

the atmospheric boundary layer. Thus our modelling is coupled with a dedicated micrometeorological code (SUBMESO) which simulates wind and temperature fields over moderately complex terrain with high resolution. Its output data are used as input data for our PE code through a suited routine.

We. 9:50 Tivoli 1 Outdoor sound propagation I

Ray-Tracing in a 3-D Wind Field for Prediction Purposes of Shooting Noise: Part I

Karl-Wilhelm Hirsch, Jürgen Zangers
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For correlation purposes of annoyance due to shooting noise, specific prediction models are available that in particular consider the long-range propagation necessary to cover the whole range where such blasts are audible. They follow traditional concepts of noise prediction relying on long-term average levels, distinguishing only between downwind and up wind conditions. The wide distribution of measured receiver levels for shooting sounds at medium and large distances, however, indicates that the short-time variation in the atmosphere has a dominating influence on the propagation of sound. It is clear, that these models do not apply to short-time predictions. Two major applications need short-time predictions: Firstly, the daily noise management for shooting ranges and training facilities requires a prediction of receiver levels for specific, predicted weather conditions. Secondly, any optimisation of a design for a "low noise" range needs in advance information on the benefit of an improved layout with respect to the local geometry and to a variety of expected weather conditions. The paper reports on a trial to set up a model that considers the acoustical phenomena needed for both tasks. The model relies on 3-D ray propagation in a 3-D wind vector field. Therefore, it allows to study the effect of local changes in the wind field, for instance of a vertical air flow or of vortices generated over a corn field or by a wind turbine. Part I of the paper discusses the background, part II explains the basic physical and numerical ideas of the approach.

We. 10:10 Tivoli 1 Outdoor sound propagation I

Ray-Tracing in a 3-D Wind Field for Prediction Purposes of Shooting Noise: Part II

Jürgen Zangers, Karl-Wilhelm Hirsch
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Part I discusses the need of a short-time, long-range sound propagation model for the prediction of shooting noise. In order to develop a 3-D prediction model to describe the long-range propagation of shooting sounds, the implementation of a 3-D wind

vector field is a pre-condition, because in a realistic lower atmosphere, vertical air flows and vortices on a medium scale are not an exception that proves the rule of a stratified atmosphere, it is often a typical state. Therefore, the approach relies on Pierce's concept of wave front ray tracing. As a basic idea, the model propagates hexahedrons as finite elements (looking like tents) to describe the transfer and the reception of acoustical energy from a directional spherical source to the receiver. The numerical implementation requires sophisticated procedures. (1) Due to the ill-conditioned non-linear differential equations, it is necessary to generate a mesh on the sphere that is fine enough to solve the equations on the propagating wave front accurately. (2) The step size increments used for integration are critical for accuracy and computation time. (3) In order to maintain spatial resolution for long-range propagation, a splitting process is required to divide rays into a collection of sub-rays. (4) The reflection at the ground needs complex numerical concepts to describe the geometry of the elements close to the ground. 3-D wind vector and temperature fields are natural features of this model. The paper discusses the physical and numerical challenge of this approach and highlights the steps to follow.

Study of the relative influence of some outdoor propagation phenomena

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CSTB

Regulations concerning traffic noise are becoming more and more demanding: acceptable noise levels imposed are lower and lower. Today, meteorological effects can no more be neglected, they have to be taken into account in models which predict sound propagation at long ranges. In order to predict accurately the sound field in outdoor acoustics, the Boundary Element Method (BEM) is a powerful tool, but it can be used, in its classical formulation, only for quiescent media. A work is currently undertaken, aiming at including meteorological effects (temperature and wind speed gradients) in the BEM approach. In outdoor sound propagation, many phenomena such as absorption, refraction, diffraction can occur and interact in a complex manner in the same time. In this view, it is of particular interest to investigate if some propagation phenomena can be separated or have to be considered simultaneously. A study has been carried out on a configuration with a noise barrier in order to assess a maximum distance under which refraction effects can be neglected compared to diffraction. In this paper, computational results are given and

the evolution of this maximum distance is represented versus different parameters (frequency, barrier height, receiver and source positions, meteorological parameter). Comparison of noise levels maps show that the results are encouraging: it seems that areas where meteorological effects can be neglected compared to diffraction effects could be enhanced.

We. 13:50 Tivoli 1 Cavitation and sonoluminescence

Particle modeling of strongly collapsing microbubbles

Thomas Kurz, Daniel Schanz, Burkhard Metten, Werner Lauterborn
Drittes Physikalisches Institut Göttingen

Microbubbles having a rest radius below a few micrometers can be regarded as mesoscopic systems amenable to direct particle simulation on a molecular scale. In the final stages of strong collapse of such bubbles under ultrasonic or shock wave excitation a highly-excited, rapidly changing inhomogeneous state of the bubble medium emerges. Modeling of its dynamics is an involved task due to the interplay of several physical processes, e.g. heat and mass diffusion, phase transition, ionization, light emission, and chemical reactions. A review is given of our recent attempts to simulate the physical and chemical scenario within collapsing bubbles by means of molecular dynamics simulations with up to several million particles. Different driving conditions, bubble compositions, and thermodynamic and physicochemical mechanisms were implemented and selectively turned on. In this way the relative importance of the included effects can be assessed, as regards the maximum temperature and pressure achieved in the bubble, the formation of compression or shock waves, the generation of cavitation luminescence light, and the concentration and outflow of chemical products.

We. 14:10 Tivoli 1 Cavitation and sonoluminescence

Boosting Single Bubble SonoLuminescence with an acoustic pulse

Jean-Louis Thomas
Centre National de la Recherche Scientifique

Single bubble sonoluminescence is characterized by a great concentration of energy conducting to the generation of UV photon with ultrasound of centimetric wavelength. The estimate of the gas temperature at the end of the bubble collapse has fluctuated of four orders of magnitude according to the assumptions controlling the gas dynamics. These fluctuations mainly come from the hypothetical existence of an acoustic shock wave inside the bubble, which would lead to very high temperature at the bubble core. This work addressees the feasibility of modifying the SBSL

domain of stability to reach this shock wave dynamic in the bubble interior. The idea is to add a high frequency pressure pulse to the monochromatic low frequency field used in the now classical set-up. This pressure pulse is generated with eight high frequency transducers adaptively focused on the bubble and synchronised with its low frequency cycle. A transient boosting of sonoluminescence can be achieved by applying a negative acoustic pulse during the expansion stage. This last case results in an increase of the maximum radius of the bubble. More interesting, a positive pressure pulse impinging on the bubble during its collapse induces a brutal acceleration and launches strong pressure waves inside the bubble. This leads to a flash of much higher intensity and this gain is correlated with the gas pressure heterogeneity. This transient process is not limited by the classical domain of stability and acoustic pulses of higher amplitude should lead to the very high temperatures associated with shock wave dynamic.

We. 14:30 Tivoli 1 Cavitation and sonoluminescence

Determination of the upper boundary in the energy distribution involved in the collapse of sonoluminescing bubbles

Thierry Lepoint, F. Mullie, Stéphane Labouret, C. Pétrier, D. Kefting, Reinhard Geisler, Robert Mettin, Thomas Kurz, Werner Lauterborn

Laboratoire de Sonochimie et d'Etude de la Cavitation, Institut Meurice

Multibubble sonoluminescence (MBSL) spectra of $95 - 98\% H_2SO_4$ solutions containing noble gas consist of a continuum which extends from ~250 to ~1000 nm. For $\lambda < 250$ nm, there is no observable emission. With Kr or Xe as the dissolved gas, small-intensity lines are observed in the 700 - 950 nm wavelength range. By comparison with appropriate lamps, we attributed them to $Kr[4s^2 4p^5 5p^1 - 4s^2 4p^5 5s^1]$ and $Xe[5s^2 5p^5 6p^1 - 5s^2 5p^5 6s^1]$ electronic transitions. This means that energy levels of 11.3-12.1 eV are populated in the case of Kr and ~9.9 eV in the case of Xe. When Ar is the dissolved gas, no Ar lines (which would involve a populating in $3s^2 3p^5 4p^1$ levels characterized by energies of 12.9-13.3 eV) are observed. Given the absence of emission below 250 nm, these observations show that the upper boundary in the distribution of energu released to the intracavity medium upon the collapse of sonoluminescing bubbles is ~12 eV. These observations enable to understand the reason of the absence of the hydrogen 'Balmer' series in water MBSL. Indeed, transitions leading to $H_\alpha\,(656.28\,nm)$, $H_\beta\,(436.13\,nm)$, $H_\gamma\,(434.05\,nm)$ and $H_\delta\,(410.37\,nm)$ lines requires $H \rightarrow H^*$ electronic excitations over a range of 12.10-13.11 eV. Moreover, the absence (or

negligible) emission below 250 nm discards thermal or plasma origins for MBSL. The ~12 eV upper boundary in the energy distribution associated with the collapse of sonoluminescing bubbles indicates that MBSL spectra are mainly molecular.

We. 14:50 Tivoli 1 Cavitation and sonoluminescence

Sonochemical yields of cavitation collapse by molecular dynamics simulation

Daniel Schanz, Thomas Kurz, Werner Lauterborn, Burkhard Metten
Drittes Physikalisches Institut Göttingen

The collapse of a single acoustically excited bubble is simulated using a hard-sphere molecular dynamics model. Initial bubble size, acoustic driving pressure and bubble composition are varied to study the influence of these parameters on the physical conditions attained during the collpase. Also, modifications of the MD model, e.g. by implementation of the variable-soft sphere (VSS) potential, are introduced to assess the model fidelity. In the simulation, different particle species (e.g. noble gas atoms, water vapor molecules) and their chemical reactions are taken into account. At the end of the collapse, high temperatures and particle speeds occur because of energy-focusing in the spherical bubble. At driving conditions typically encountered with single-bubble sonoluminescence, temperatures and pressures are sufficiently high to lead to molecular dissociation and sonochemical reactions, in particular the formation of OH radicals. We investigate the sonochemical yield in a number of representative cases and point out that the effect of mixture segregation appears to be important to correctly predict the rate at which reaction products enter the liquid phase.

We. 15:10 Tivoli 1 Cavitation and sonoluminescence

Optical Cavitation in an Ultrasonic Sound Field

Dennis Kröninger, Thomas Kurz, Reinhard Geisler, Werner Lauterborn
Drittes Physikalisches Institut Göttingen

The dynamics and luminescence of transient bubbles produced by optical breakdown in a standing ultrasonic field are investigated experimentally. For this purpose, single laser pulses of 130 fs duration and of adjustable energy are focused at the center of a water-filled cuvette insonicated at about 45 kHz. The sound generator and laser electronics are synchronized to be able to generate bubbles at well-defined, adjustable phases of the acoustic cycle. The first few oscillations of the bubbles are photographically

recorded to give their radial dynamics and collapse behaviour. Alternatively, they are observed by a photo multiplier to detect possible cavitation luminesence. It is found that by the action of the acoustic field, the collapse time and maximum radius can vary significantly as a function of the initial phase. These parameters also depend on the acoustic pressure and the laser pulse energy. Luminescence has been detected almost exclusively after the first collapse, its intensity also being dependent on the initial phase. The characteristics of cavitation luminescence suggest a strong influence of the sphericity of the generated bubbles. The experimentally observed dynamics are compared with numerical calculations of a spherically symmetric Gilmore model.

We. 15:30 Tivoli 1 Cavitation and sonoluminescence

Role of the Emergence Delay of the Inertial Cavitation Field in the Iodine Release by Ultrasonic Cavitation in Chopped Irradiation Mode

Stéphane Labouret, Laurence Deraes, Jacques Frohly, Thierry Lepoint
Service de Physique-Electricité, Institut Meurice

The ultrasonic cavitation is known to give larger effects when produced by pulsed ultrasound mode rather than produced with a continuous emission. This phenomenon is due to a reconstitution of the population of the chemically active cavitation nuclei by the partial dissolution of free bubbles between two pulses. Several of these results have been obtained for irradiation duration in the minute range and for an ultrasound frequency close to 1 MHz [1,2]. We observe in similar conditions that the inertial cavitation field occurs with a delay that depends on the chopping frequency. We have also controlled that the presence of the inertial cavitation field is necessary to obtain a significant iodine (I2) production from KI solution (Weissler reaction). At last, the variation of the cavitation effect intensities in function of the chopping frequency, which is meet in literature, displays some similarities with the behaviour of the emergence delay of the inertial cavitation field. We will present measurements of iodine production in function of the chopping frequency, of the irradiation duration and of the acoustic power, taking care to note always the emergence delay of the inertial cavitation field. We will discuss of the possible links between this emergence delay and the effect increase in chopped irradiation mode. Ref : [1] Ciarravino V., Flynn H.G., Miller M.W.: Ultrasound Med. Bio., 7, pp 159-166 (1981). [2] Clarke P.R., Hill C.R.: J. Acoust. Soc. Am., 50, pp 649-653 (1970).

We. 16:30 Tivoli 1 Cavitation and sonoluminescence

On the Classification of Cavitation Bubble Structures

Robert Mettin, Dagmar Krefting, Topi Tervo, Philipp Koch, Werner Lauterborn
Drittes Physikalisches Institut

It has recently been recognized that the appearance of acoustic cavitation can be classified into several prototypes of bubble structures. We report on new results and characterization of such structures. Experimental methods comprise high-speed cinematography and recording of acoustic emissions. Properties of different bubble patterns are discussed, in particular with respect to ultrasonic cleaning and surface erosion. Furthermore, the controllability of bubble structures by external means is investigated.

We. 16:50 Tivoli 1 Cavitation and sonoluminescence

Simulation of Cavitation Bubbles in Travelling Acoustic Waves

Philipp Koch, Robert Mettin, Werner Lauterborn
Drittes Physikalisches Institut

A particle model is employed to simulate bubble tracks in a travelling acoustic wave. The primary Bjerknes force is rewritten for the general case of spatially varying phase of the pressure, leading to a force term related to the phase gradient. Other features of the particle model include rectified diffusion, bubble merging and splitting. We compare experimental observations of bubble structures below a sonotrode of large diameter to simulation results. In this experiment, a high contribution of travelling waves is found at elevated sound intensity, leading to a large acoustic pressure onto the bubbles away from the emitter surface. The observations are reproduced fairly by the model, if certain assumptions on the bubble sources are made.

We. 17:10 Tivoli 1 Cavitation and sonoluminescence

Experimental Studies concerning Ultrasonic Cleaning

Marcus Kristen, Annekathrin Kern, Reinhard Lerch
Department FV/PLO, Robert Bosch GmbH Stuttgart

High-intensity ultrasound is nowadays widely used in industrial applications, including cleaning of precision manufactured mechanical parts. Increasing demands on the cleanliness of such parts ask for an improvement in the design and optimization process of ultrasonic cleaning systems. To get a deeper physical understanding of the interrelations inside the cleaning bath, it is necessary to utilize precise simulation and measurement tools to determine the relevant parameters such as the pressure field distribution. Due to the high acoustic intensity, cavitation is mostly present. Results from fundamental studies in standing wave fields within tube reactors using different measurement techniques (hydrophone and laser vibrometer) are presented. In order to determine the values of the sound intensity in a standing wave field, we have built up a new type of intensity probe. The results of all these measurements are compared with those from finite element (FE) simulations as well as with analytical solutions. When the acoustic intensity is raised above a certain level nonlinear wave propagation and cavitation effects have to be considered. Hydrophone measurements and sonoluminescence images are taken to visualize the structure of the cavitation field. These results are compared with FE simulations in which the influence of cavitation is taken into account. Finally, a new method to soil parts in a consistent way is presented. These soiled parts are exposed to the ultrasound field and the effect of cleaning is determined. A correlation between the results of the cleaning tests and the parameters of the ultrasonic field is deduced.

We. 17:30 Tivoli 1 Cavitation and sonoluminescence

Ultrasonic cavitation in thin liquid layer

Bertrand Dubus, Alexei Moussatov, Christian Granger
Institut d'Electronique de Microélectronique et de Nanotechologie, UMR 8520 CNRS, département ISEN

The generation of ultrasonic cavitation in a thin liquid layer comprised between a sonotrode and a hard surface and bounded laterally by a gas-liquid interface is investigated. Theoretical analysis predicts that a large amplification of the pressure is obtained with this configuration. Experiments conducted by driving the layer with axisymmetrical resonant transducers (20 kHz) show that ultrasonic cavitation is obtained at very low input intensity and in a broad frequency range. Two types of cavitation are found depending upon the sonotrode vibrational velocity: at low

velocity, stable bubble structure takes place along the symmetry axis; at high velocity, transient bubble structures constituted by so-called 'smokers', are observed. Erosion tests on metallic foils demonstrate the existence of an intense mechanical activity which can be localized by controlling the input intensity. Cavitation in thin liquid layers appears to be an attractive approach to scale-up sonoreactors for industrial applications.

We. 17:50 Tivoli 1 Cavitation and sonoluminescence

Interaction of Bubble Clouds and Solid Objects

Topi Tervo, Robert Mettin, Dagmar Krefting, Werner Lauterborn
Drittes Physikalisches Institut

We present high-speed observations of acoustic cavitation bubbles near and on solid objects submerged in the liquid. The dynamics of various bubble structures are revealed in the presence of the boundaries, and the effect on surface cleaning is investigated. Bubble sizes and density statistics are obtained from the recordings. It is known that cleaning and erosion effects are mainly caused by bubbles in direct neighborhood of or in contact with the object. The number of such active bubbles is estimated.

We. 8:30 Tivoli 2 Auralisation

Evaluation of microphone positions for music and speech recording by auralisation

Marcel Babazadeh, Ingolf Bork
Physikalisch Technische Bundesanstalt, FB 1.6 Schall

For the quality of a music recording the room properties and the positions of the microphones are crucial. Systematic investigations have been carried out comparing measured and simulated binaural sounds at well defined positions relative to the sound source, a loudspeaker with omnidirectional or normal directivity resp.. Pink noise, sounds of musical instruments and male voice were used as test signals in two rooms: a concert hall and a recording studio. The well audible differences of the different positions could be related to the calculated room acoustical parameters according to ISO 3382 as well as to particular recording conditions (wall reflections). It could also be shown that the calculated sounds match the real recordings to a high degree which enables future experiments based on simulations only.

We. 8:50 Tivoli 2 Auralisation

Virtual Binaural Auralisation of Vehicle Interior Sounds

Roland Sottek, Daniel Riemann, Philipp Sellerbeck
HEAD acoustics GmbH

In order to optimize the quality of vehicle interior sounds already at an early stage of development, two methods called "BTPA" and "BTPS" (Binaural Transfer Path Analysis and Binaural Transfer Path Synthesis) have been developed. Since these methods involve the auralisation of the contribution of each individual sound path, all corresponding transfer functions must be measured separately. The methods distinguish between airborne and structure-borne sound paths. The transmission of airborne and structure-borne sound to the driver's ears is measured reciprocally using a recently developed binaural volume velocity transducer on the driver seat as well as microphones or accelerometers at the noise source positions. The advantages for taking reciprocal measurements of acoustic transfer functions are evident: First, little space is required for sensors. Therefore the measurement positions can be chosen almost without restriction leading to a higher accuracy. Second, significant time is saved, since all paths can be measured simultaneously. The first applications in vehicles are very promising. Further research projects deal with replacing intricate measurements by simulations using computer models. The goal of these efforts is to divide each transfer path into partial structures, i.e. if only one component is modified, the simulation only needs to be performed for the modified substructure rather than for the entire transfer path. Simplified models describing the structure-borne sound transmission in vehicles from engine to chassis can be found with the help of the four-pole-theory. Four-poles are approximated by electromechanical circuits, in order to analyse the influence of the subsystem on the complete vehicle model.

We. 9:10 Tivoli 2 Auralisation

Objective and Subjective Evaluation of the Large Signal Loudspeaker Behavior

Wolfgang Klippel
klippel GmbH

The results of nonlinear and thermal loudspeaker modeling are the basis for simulating the transfer behaviour of loudspeakers in real time by using any electrical input signal (test stimulus, music). The model implemented in a DSP provides important state information (displacement, current, temperature) and allows a decomposition of the sound pressure output into the linear and nonlinear distortion components. This technique combines objective loudspeaker analysis with subjective auralisation

used as a new tool in loudspeaker design and basic research on the perception of loudspeaker distortion. Preliminary results of an interactive listening test currently performed on the website www.klippel.de/aura are presented and the factors influencing the audibility of loudspeaker distortion are discussed.

We. 9:30 Tivoli 2 Auralisation

Auralisation of room acoustics - A tool for planning broadcast production rooms?

Sebastian Goossens, Roman Stumpner
Institut für Rundfunktechnik

Broadcast sound engineers are very critical users of their production rooms. For an assessment of the acoustical characteristics of rooms being planned you have to make the acoustical characteristics audible by simulation. Therefore you need a high-quality-auralization of the sound field at a time when the rooms are still being planned and actually do not exist yet. The consistency with the physical conditions is particularly important. The sound reflections of the walls must be calculated in magnitude and phase for rooms with a low reverberation time. The sound absorbers - necessary for adjusting the room acoustics - have to be calculated according to the theory of sound absorbers and that is dependent on the angle of the sound incidence. For low frequencies the spreading of spherical waves must be taken into account. Special calculation methods for simulation and auralization have been developed and will be introduced in the lecture.

We. 9:50 Tivoli 2 Auralisation

Auralizing Auditoria in North Portugal: Two case studies

Maria Ribeiro, Ingolf Bork
Faculdade de Engenharia da Universidade do Porto (FEUP/CEDEC)

This paper deals mainly with auralization performed in two auditoria: one highly absorbent mainly for cinema presentations but also used for music concerts (CMM), the other much more reflective, mainly used for musical theatre performances (TECA). Our main objectives were to evaluate their sound quality and how that sound is related to architectural and acoustical properties of the two auditoria. First we will present and compare acoustical objective parameters values obtained by in situ measurements and by room acoustic prediction software. Secondly we will compare the results from analysis of the impulse responses obtained by performing binaural auralization: a) over measured impulse responses in the real rooms using a real-head technique; b) over computer simulated impulse responses using room acoustic prediction and auralization software. Finally we will compare the

subjective experience of listening directly to the measured and to the generated IR and after their convolution with anechoic recordings obtained from audio libraries. Further, a real sound recording with loudspeakers, as sound sources, will also be used. As a conclusion, we will comment the difficulties experienced and, based on our own and very recent incursion in this area, the real possibilities to use auralization for detecting some acoustical and undesirable phenomena, like flutter echoes and virtual source displacement and make them audible for architects.

We. 10:10 Tivoli 2 Auralisation

Auralisation of machine structure-borne sound due to rolling bearings

João Henrique Diniz Guimarães
Institute of Technical Acoustics

This work presents the results of the auralisation of machine structure-borne sound coming from a rolling bearing. Firstly, a physical model of the contact was created to calculate the load distribution during the contact of rough surfaces. This model was adapted to correspond to the case of rolling bearings and its dynamic was considered to simulate the actual excitation signal in dependence to parameters such as rotational velocity, radial load in bearing and roughness profile of the surfaces. Then, with the use of previously measured transfer functions from the excitation point to a vibration sensor mounted on the machine surface, the result of these excitations can be auralised for different surface conditions of ball and cylindrical rolling bearings. The resulting signals are then compared with measurements taken with accelerometers on the running experimental machine.

We. 10:30 Tivoli 2 Auralisation

Towards an Optimal Sound Insulation by Auralisation and Computational Prediction Methods

Klaus Nasshan
Fraunhofer Institut Bauphysik

The audible difference of the sound transmission of different building parts under a certain excitation noise, e. g. road traffic, does not necessarily correlate to the weighted sound reduction index. But how can the decision making be supported during the developing process of building parts? Auralisation is the tool of choice for giving an impression of both the state and the aim of the development. Several software products, which run real-time, allow presentations of arbitrary length and instantaneous switching to another building element or to another sound source. As

a second tool for optimisation of the sound insulation of building elements computer programmes for the prediction of the frequency dependent sound insulation are available, in particular the programme LAYERS written for layered structures. The unsatisfactory trial-and-error procedure, which is still used in the development of building elements, can be avoided by these prediction and auralisation capabilities. Some audible examples of sound transmission and walking noise will be presented.

We. 13:50 Tivoli 2 Auralisation

Using Auralisation as a Tool for Subjective Evaluation

Eva Arato-Borsi, Andor T. Furjes
AFT ACOUSTICS Ltd

The set of room acoustical parameters used for qualification still needs to be investigated from the subjective points of view. Arranging comparative experiments is hard and time-consuming, both for the subjects and the researchers. Auralisation can be a tool for supporting these experiments, since room acoustical models can be varied and calculated easily. In practice it is hard to find a set of rooms that represent a given architectural or acoustical tendency (e.g. same shape with different sizes). The paper gives a short overview of the background of the experiments, the auralisation system and some results.

We. 14:10 Tivoli 2 Auralisation

Comparisons between a new Binaural Microphone and a traditional Head and Torso Simulator

Poul Ladegaard, Henrik Haslev, Tommy Schack
Brüel & Kjær

In some cases, Binaural Recording using a conventional Head & Torso Simulator (HATS) is not practical or desirable. Then the use of a Binaural Microphone featuring two miniature microphones positioned at the entrance to the ear canal is an obvious choice. The first experiment lists the range of measured objective differences in a few Head Related Transfer Functions with the Binaural Microphone mounted on a small number of test persons. Measurements were done both in Free field and Diffuse field. The results were very satisfying. In another test set-up, recording of sounds with a traditional HATS and the Binaural Microphone mounted on a number of test persons were made. After this followed Paired Comparison preference evaluation of all recorded sounds. Included, as jury members were the test persons participating in the sound recordings as well as other jurors for later comparison. A preliminary analysis of the results indicates that the bias errors, when comparing recordings from a HATS and the Binaural Microphone, mounted on different persons are small

and generally acceptable. However, some deviations in the results seem to relate to the size of the head - distance between the ears of the person wearing the Binaural Microphone. Further investigations regarding this as well as the use of more test persons and other test conditions have been used to validate the first findings.

We. 14:30 Tivoli 2 Auralisation

Experiments with Spatially Distributed Sound Sources in Real and Virtual Environments

Pedro Novo
Institut für Kommunikationsakustik (Web: www.rub.de/ika)

Strictly speaking every sound source has a finite dimension which may be approximated as a point source in circumstances where the source-listener distance or the actual dimensions of the sound source allow. Point sources constitute an useful abstraction which is commonly employed in, for example, Auditory Virtual Environments. However, in circumstances where a point source approximation is not valid various point sound sources may be employed. Yet, a set of sound sources, do not necessarily evoke a continuous auditory event as was observed for crowd sounds simulated in a virtual environment and in the reproduction of binaural recordings of applause. In fact the auditory events were located predominantly to the right and to the left although the sound sources surrounded the listener. These findings have prompted further experiments, this time in real environments, in order to investigate if the observed phenomena were due to the non-individual HRFTs employed in the dummy head and the virtual environment cases. These experiments were performed in a reverberant and in an anechoic chamber employing impulsive tests signals. The results obtained confirmed the previous findings but only for signals within a particular range of temporal density of impulses. These results as well as possible explanations will be presented and discussed.

We. 14:50 Tivoli 2 Railway Noise II

T.G.V. disk brake squeal : a dynamic instability ?

Xavier Lorang, Quoc Son Nguyen, Florence Foy, Pierre-Etienne Gautier
SNCF - Direction de la Recherche et de la Technologie

Disc brakes squeal noise of railway rolling stocks is a source of discomfort for both passengers on trains and customers in stations. New research studies are necessary to understand this phenomenon. Various investigations show that squeal is a self excited vibration of the brake and that the emitted noise ranges from frequencies of 5000 to 20000 Hz. It has also been

shown that no thermal coupling needs to be considered and that the phenomenon is highly increased when the train comes to a stop. In this paper, recent results based on a numerical model of the T.G.V. brake are presented and compared with running tests data. The numerical study takes into account the Coulomb Friction Law with a constant friction coefficient which is sufficient to describe the vibrations of the brake. The chosen method based on a modal approach allows to highlight flutter instability of the steady sliding solution of pads on the disc. It is shown that unstable modes are responsible for the evolution of the dynamic solution: from a sliding solution to a more complex solution. Indeed, non-linear vibrations which propagate as waves and are characterised by a stick-slip-separation cycle on the contact zone, seem to be responsible for the emitted noise.

Soundscape design in train stations, I: Soundscape function and identity

Julien Tardieu, Patrick Susini, Franck Poisson
SNCF - Direction de la Recherche et de la Technologie

The goal of sound design is to improve the relation between an object and its user by way of the sounds the object produces. In order to achieve this goal, we propose to consider three problems : auditory comfort, function, sound identity. A soundscape includes sound sources, sound signals, and the environment in which all of the sounds exist. In the case of train stations, various areas are of interest that can have one or more functions. Auditory comfort is well-known and many efficient technical solutions have been proposed. With regard to the second problem, the question is to know whether it is possible to improve the function of a space by modifying its soundscape. Finally, sound identity concerns the capacity of listeners to recognize a given sound in all the soundscapes corresponding to the different areas of a train station or across all SNCF train stations. We decided to evaluate the last two problems (function, sound identity) within existing train stations. Thus, two categorization experiments were performed with the same sound samples and two different groups of subjects. For each experiment, the instructions given to the subjects were different in order to study respectively the perceptive and the functional representation. Then, a third experiment determined whether people can recognize recordings taken from train stations among recordings of different public areas. The present paper will give a definition of soundscape design in train stations, explain the methodology, and, finally, present the results of the experiments on function and sound identity.

We. 15:30 Tivoli 2 Railway Noise II

Curve Squeal: Noise Monitoring of applied solutions

Bernhard Müller

Rail Environmental Center, Swiss Federal Railways

The Combating Curve Squeal Project is executed by the International Union of Railways in order to develop tools to reduce the disturbing noise of trains passing curves. In the last years an overview of the extent of the noise-problem for railways, a tool box with methods and solutions to combat squeal noise and a theoretical model was developed. The workpackage lead by SBB in 2003/2004 is concentrating on noise monitoring of existing solutions against squeal noise. The aim is to get applicable practical solutions for the railways to reduce squeal noisel. Measurements on test-rigs accompany this monitoring. This paper focuses on the development of the test procedure and first results of the monitoring program are presented.

We. 15:50 Tivoli 2 Railway Noise II

Noise Emission Measurement campaign for high speed interoperability in Europe : the NOEMIE Project

Pascal Fodiman

Association Européenne pour l'Interopérabilité Ferroviaire (AEIF)

Environmental noise has known many recent evolutions concerning both the needs required by European environmental policy, and the technical capabilities induced by research and standardisation work. The main generation mechanism involved has been proved to be due to rolling noise excitation, through the combination of wheel and rail roughness. From a noise emission policy approach, the conditions imposed by interoperability for rolling-stock acceptance tests are described within the railway Technical Specification for Interoperability (TSI), which are in favour of the definition of a type testing reference track. In that scope the NOEMIE project aims : - To provide a common database of comparable and reproducible noise emission values of high-speed trains in Europe, - To contribute to the definition of an adapted operated reference track, which performances are adapted to the noise emission type testing requirements, - To propose and validate a common measurement methodology. After a review of the needs, scientific constraints, and technical input of such a project, the measurement campaign results, and their impact on the railway noise acceptance methodology testing are presented.

We. 16:30 Tivoli 2 Railway Noise II

Reduction of noise of railway steel bridges with tuned absorbers on rail

Franck Poisson, Olivier Coste
SNCF - Direction de la Recherche et de la Technologie

Even if all railway steel bridges are different, most of them produce more noise than a ballasted track. Located in populated area, steel bridges may generate annoyance for the population. Specific noise reduction solutions must be developed. A research program has been started by the French railway company SNCF for Réseau Ferré de France to deal with this problem. To understand phenomena responsible of noise, the vibroacoustic study is carried out on the whole frequency range from 5Hz to 5000KHz. The sound pressure level rises up around 40 Hz and 500 Hz. In this frequency band, the statistical energy analysis (SEA) approach is used to evaluate the efficiency of each noise reduction solution. Tuned absorbers seem to provide the same noise reduction as a sound barrier. Experiment on a test steel bridge are carried out to confirm this result. The SEA model will be presented in the paper and especially the diagnostic which leads to conclude that the rail is the more important noise source in high frequency bands. The principle of the tuned absorbers will be depicted too. The efficiency of this noise reduction solution will be discussed.

We. 16:50 Tivoli 2 Railway Noise II

Noise Source characterization on a TGV-Duplex running at up to 350kph by means of a 2D acoustic array

Fédéric Alibert, Fabien Letourneaux, Olivier Coste, Franck Poisson
SNCF - Agence d'Essai Ferroviaire

Within the frame of an acoustic field test campaign organised by the SNCF on a TGV-Duplex running at up to 350 kph on a high speed line in France, some specific measurements were carried out to localise and characterize the main sources on the train which radiate noise in the environment : the implemented technique was an acoustic 2D array apparatus combined with a beamforming processing including dedopplerisation effect. Another objective was also to improve the measurement method itself, the SNCF 2D "star shaped" array, as most of the others conventional array devices, requiring several configuration of captors and therefore several train pass-bys to be able to analyse the whole frequency range of interest (200- 4000Hz). An alternative device was then tested at the same time to overcome this drawback : a 3 by 3 m array support, equipped with a set of 30 captors

irregularly distributed. This paper proposes at first to describe and analyse the acoustic sources localised on the TGV-Duplex, and to give their relative strength as a function of the frequency and of the train speed. In a second part, the performances of the measurement method are investigated : thus, a comparison of results provided by the 2 array techniques tested is addressed ; some repeatability test and the influence of the post-processing parameters are also examined. Finally, the results confirm the capability of the acoustic array measurement method to localise and classify the noise sources on a train at high speed and furthermore that improvements of the measurement technique are possible.

We. 17:10 Tivoli 2 Railway Noise II

Silent Railway Bridges - A prediction method to optimise the sound emission

Dorothée Stiebel, ?? Degen
Deutsche Bahn, DB Systemtechnik

The acoustic problems associated with railway bridges have been well known for a long time. When a train runs over a bridge, a noise can be heard to the side of and under the bridge. This noise is called 'bridge-hum'. This effect arises from the vibrations caused during the passage of the train being transmitted into the bridge structure via the rails and the track. Vibrations are incited in the components of the bridge and consequently noise is emitted. This so-called 'secondary air-borne noise' is particularly distinct in the area of low frequencies. Up till now, the noise problems associated with railway bridges have been dealt with primarily empirically and experimentally. In spite of the expenditure that has been invested in investigations in the last few years, the familiar noise-reducing measures have not been sufficient in many cases and there are hardly any specifications for the construction of low-noise bridge structures. Particularly in view of the large variety of bridge designs, the approach adopted by Deutsche Bahn of an effective and cost-efficient combination of experimental investigations with simulations to produce the low-noise bridge is presented in the paper.

We. 17:30 Tivoli 2 Railway Noise II

Railway noise abatement: the implementation in Switzerland

Rudolf Sperlich
Swiss Federal Office of Transport

In October 2000 the Swiss federal law on railway noise abatement was enacted. These noise abatement measures are financed by a federal fund which was accepted by the Swiss electorate in 1998 within a package of railway infrastructure projects.

The general objective is defined by protecting at least 2/3 of the actually annoyed population. The reduction of the noise impact will be achieved with retrofitting the entire Swiss rolling stock by replacing cast iron blocks with composite blocks until 2009. Noise barriers with a required length of 300 kms will be essential above all along the freight transit lines to protect highly annoyed inhabitants during the night period. Buildings with residual values above the general noise reception limit are entitled to financial contributions for insulation measures. Further elements within the program or as supporting measures are the implementation of an emission ceiling, a low noise bonus on track access charges, noise emission limits for new and improved vehicles and a monitoring programme to observe the noise development by continuous noise emission measurements until June 2015.

Track specification for noise type test - specification of components versus functional approach

Manfred Kalivoda, Monika Bukovnik, Martin Jaksch
psiA-Consult GmbH

Pass-by noise type testing of rolling stock requires tight specifications for the test track. There are two main reasons for that. On one hand track noise generation has to be reasonably lower than vehicle emission. On the other hand track specifictions have to guarantee a high reproducability especially for type testes at different sites. Both, the prEN ISO 3095 and the Technical Specifications for Interoperability of High Speed Trains (HS-TSI) therefore include a number of requirements for the test track. They describe the components to be used such as mono-bloc concrete sleepers, stiff rail pads and UIC 60 rail profile. This sort of approach is questioned and an alternative approach (called ATSI) has been proposed in the final phase of the HS-TSI adoption. ATSI uses a functional track specification by limiting the spatial vibration decay of the track. The spatial decay rate is a criterion to describe the vibration damping of the track along its longitudinal direction expressed in decrease of rail vibration in dB by meter of track. There is a lot of concern that the ATSI approach cannot guarantee a low noise track. The compilation of a big number of pass-by noise, decay rate and track vibration measurements on different test tracks will be presented here. This data made us able to show that the TSI and the ATSI specifications are not equivalent. The decay rate limit as it is proposed at the moment is not able to preclude tracks with high noise radiation.

We. 18:10 Tivoli 2 Railway Noise II

Automated monitoring station for railway noise

Matthias Brechbühl
Norsonic Brechbühl AG

A railway is a high-capacity and environmentally friendly mode of transport. However, for people living nearby it is an onerous source of noise. Swiss transport policy is based on the principle of sustainability and is therefore committed to the transfer of goods from road to rail transport. This will lead to an increase in rail traffic and hence to increased noise alongside the railway lines that could become a growing problem; the Confederation is therefore actively addressing the problem. The Federal Council has passed a new Law on noise control measures on Swiss railways along with a Federal Decree on financing of the necessary noise reduction measures. A consequence of these noise control programmes is the monitoring and analysis of railway noise. Six permanently installed noise-monitoring stations undertake this task. These measurement stations are self contained and fully automatic. Sensors in the track will detect the passage of a train and provide information on its speed, transit time, the number of axles as well as the axle spacing. Two microphones connected to each station provide noise data to a sound level analyser that will compute the relevant acoustic parameters with high time resolution. The measurement station computer will correlate the acoustic data with the axle-count information to complete a database of rail movements with their resulting environmental noise burden; this data is transferred regularly to a central station. Each measurement station has a comprehensive alarm and failure location system in order to ensure that downtime is controlled to a minimum.

We. 8:30 Gutenberg Railway noise

Railway Noise Monitoring in Switzerland

Robert Attinger
Bundesamt für Umwelt, Wald und Landschaft (BUWAL)

The monitoring of railway noise is part of the Swiss railway noise abatement programme. At six measuring sites on the railway network the noise emissions of every train passing by are recorded. For each train, important parameters such as noise emission, speed, length, type of train and number of axles are recorded. The results of the first year of measurement, amounting to more than half a million trains, are available now. The large sample allows us to perform reliable statistical evaluations. The measurements will continue until 2015. The collected data will allow for an evaluation of the emission plan 2015 The emission plan

2015 is a prediction of the noise emissions of railways in the year 2015 including the running renovation of the rolling stock. It is the basis for the planning of abatement measures like noise barriers and sound insulated windows along existing railway lines. The data gives information about the whole noise emitted by the system vehicle-track. In addition the evaluation of the transit exposure level (TEL) provides information about the improvement of new and renovated rolling stock in operationg conditions.

We. 8:50 Gutenberg Railway noise

Lower railway noise and railway noise valuation by information system - The German Railway noise exposure cadastre

Rolf Gessner

Deutsche Bahn AG, Bahn - Umwelt - Zentrum

Dr.-Ing. Rolf Geßner DB AG, Bahn-Umwelt-Zentrum Schall- und Erschütterungsschutz Schicklerstrasse 5 - 7 D - 10179 Berlin Germany Abstract Lower railway noise, and Railway noise valuation by noise information system - - The German Railway noise - exposure - cadastre Railway noise is created between the rolling wheel and the rail. Freight trains with influence on the environmental noise are most important at nighttime (22.00 - 06.00) The German Railway will reduce the railway noise where it is created. Source related measures could be a smooth rail surface (acoustic grinding) and a smooth wheel surface. The change of the brake system is one possible solution to reduce the passby noise level of freight trains. The noise reduction is in a range of 8 to 10 dB(A). The rail surface is very importend for the noise reduction. One measure is rail grinding - in Germany we know the "Besonders überwachtes Gleis" this is rail grinding and surface control with the sound measurment coach. In the current noise abatement program on existing railway lines, the measures for noise reduction are noise barriers, insulating windows and rail grinding. The German Railway Environment Centre has created a noise-exposure-cadastre. It is based on a geographical information system and includes the whole network of the German Railway (37.000 km). It is very important for strategic statements and the benefit of noise reduction measures. The system gives the German Railway the basic tool to fulfil the EU - directive regarding the assessment and management of environment noise. Strategic noise maps and action plans require only slight modifications.

We. 9:10 Gutenberg Railway noise

Mitigation of the ventilation noises at the electric locomotive BR-182

Karlheinz Bay, Peter Brandstätt, Norbert Rambausek
Fraunhofer Institut Bauphysik

Electric locomotives depend on a multiplicity of ventilation systems. The noise of ventilation systems is dominant at standstill in the station. The possibilities of sound power reduction at the inlet and outlet of a cooling tower for the water/oil circuits are presented in the paper. The modelling of the coupled system of thermodynamics, fluid dynamics and acoustics is briefly inspected. Modifications of the components with respect to the technical requirements are shown together with measurements of the original and modified cooling tower, as well as the effect of silencers. In collaboration with different manufacturers, suppliers and research establishments, these investigations are part of the Joint Research Project "Silent Trains and Tracks" supported by the Federal Ministry of Education and Research (BMBF), Germany.

We. 9:30 Gutenberg Railway noise

Sound radiation from railway tunnel openings

Kurt Heutschi, Rene Bayer, Claude Feiss
EMPA, Swiss Federal Laboratories for Material Testing and Research

More and more often railway tunnel openings can be found in the vicinity of inhabited areas. Whereas for road traffic tunnels it is standard to make the segment close to the opening from absorbing material railway tunnels are usually built without any absorber. For lack of knowledge on the significance of the sound radiation from railway tunnel openings this part is usually ignored. For that reason the Swiss Agency for the Environment, Forests and Landscape (BUWAL) initiated a research project to quantify the tunnel effect for railway lines. As the ratios of cross sectional areas for railway tunnels differ strongly from road tunnels the experiences from roads can not be transferred easily to railways. The problem was tackled by three different methods: theoretical investigations and calculations, real-life measurements at existing railway tunnel openings and 1:16 scale-model experiments. Results (tunnel amplification and radiation directivity) are presented for different tunnel sections, different train types and different conditions of absorbing material close to the tunnel opening.

We. 9:50 Gutenberg Railway noise

Developing Noise Control Strategies for Entire Railway Networks

Jakob Oertli
Rail Environmental Center, Swiss Federal Railways

The EU Environmental Noise Directive requires member states to deliver noise maps to the commission by 2007 and action plans by 2008 for agglomerations as well as for major roads, railways and airports. Noise mitigation projects resulting from action plans are usually very expensive and therefore may threaten the economic viability of the railways in the current harsh competitive transport market, thus hindering sustainable transport policies. This is particularly important if projects are strongly infrastructure and not rolling stock based. It is therefore of vital interest that the action plans and the resulting projects are designed in the most cost-effective way possible. The EU and UIC sponsored STAIRRS (Strategies and Tools to Assess and Implement noise Reducing measures for Railway Systems) project recognised this need and developed a tool, with which such optimal solutions can be obtained for entire railway networks. In testing the tool along 10'000 km of railway lines in seven European countries, it was found that usually a combination of noise abatement measures lead to sufficient protection in a cost-effective manner. Since data collection is the most expensive part of the analysis, noise mapping data is ideally collected in such a way that it can be used for the calculation of the different scenarios, from which the most cost-effective action plans are chosen. The paper shows how the STAIRRS tool is used for this purpose and how cost-effectiveness considerations have led to optimal railway noise mitigation strategies in Switzerland and have supported noise related decision making in Luxembourg.

We. 10:10 Gutenberg Railway noise

The 'Specially Monitored Track'

Johannes Onnich, Bernhard Koch
"DB AG; DB Systemtechnik, Abteilung Akustik"

In efforts to lower the amount of rail traffic noise, it is important to reduce the sound at the source of its origination. To realize this, DB Systemtechnik at Deutsche Bahn has developed a procedure by the name of "Specially Monitored Track" (SMT). This procedure is based on the realisation that the condition of the running surface of rails plays a significant role in the creation of rolling noise. By grinding the running surfaces of the rails, any areas of unevenness (known as "rail corrugations") are eliminated. The Federal Railway Office (EBA) officially confirmed "Specially

Monitored Track" in 1998 as a noise reduction system with effectively -3 dB(A). Two grinding procedures are currently approved for "Specially Monitored Track" and may be adopted when implementing the process. One is a system of rotating grinding discs operating with a belt grinder and the other is a milling machine operating with oscillating and static motion rubbing stones. The SMT concept is based on the periodic acoustic monitoring of the relevant track sections by means of a sound measuring car developed especially for this purpose.

We. 10:30 Gutenberg Railway noise

Determination of the source height of a moving rectilinear distribution of point sources with 2 microphones - Application to tramways

Guillaume Dutilleux, Aurélien Salvucci, David Ecotiere
Laboratoire Régional des Ponts et Chaussées

Equivalent source height is an important parameter for accurate predictions of the impact of new transportation infrastructures. It has been shown recently that it is possible to obtain in situ the source height of passenger cars by a method based on the interferences between two microphones. Passenger cars are a represented by a single point source. The present papers shows first that the measurement principle can be generalized to a rectilinear distribution of point sources. The distribution is supposed to be parallel to a flat homogenegous ground. A supplementary hypothesis is that the relation between the amplitudes of the different sources involved is known. A measurement system based on this principle is outlined. The underlying uncertainty and the parameter sensitivity of the method is investigated. The method is applied to experimental data from tramways. For this kind of vehicules, the obtained equivalent source height appears to be located very close to the ground, which is coherent with expectations.

We. 13:50 Gutenberg Railway noise

Acceptance of Noise Control Measures Along Railway Lines

Judith Hauenstein, Valentin Delb, Matthias Burkhardt, Fredy Fischer, Tommaso Meloni
Ernst Basler + Partner AG

The principal purpose of noise control measures is the reduction of harmful or annoying effects of sound. We assume the noise barriers being accepted if the noise reduction undershoots the value that can be expected based on the well-known dose-effect relationship. A telephone research done in 1999 focused primarily on noise along Swiss roads. It showed that the acceptance towards noise control measures was mainly determined by their

acoustic effectiveness and the remaining noise exposure. The goal of a second study was to compare those results with the situation along railway lines. 169 residents have been interviewed in May 2003. As a case example Rheinfelden (20 km east of Basel) was chosen where noise barriers of two to three meters height were realised. Furthermore, Eiken, which is situated at the same railway line, was chosen as a control group with similar noise emissions but with no barriers. It could be confirmed that the acceptance of noise control measures is mainly determined by the remaining noise exposure. However, the acoustic effectiveness of a noise barrier has no significant impact on the acceptance. This is probably because of the relatively poor average noise reduction of 5 dB for the buildings adjacent to the railway line. In addition, following the study of 1999 and a German investigation of road noise control measures, we examined whether the fact that there is a noise barrier reduces the subjective annoyance. This so-called "barrier bonus" could not be confirmed in Rheinfelden. However, a certain tendency is recognisable.

We. 14:10 Gutenberg Sound reinforcement & imm. control

Prognose der Schallemissionskenngrößen von Freiluft-Beschallungsanlagen

Axel Roy
Akustik Bureau Dresden

Im Rahmen der Untersuchungen zu einer Sächsischen Freizeitlärmstudie wurden aus einer Vielzahl von Messergebnissen Prognoseverfahren für emissionsrelevante Kenngrößen von Freiluftbühnen entwickelt. Als Ausgangsdaten dienen dabei u.a. die Zuschaueranzahl bzw. die Größe der zu beschallenden Fläche oder die maximale Beschallungsentfernung sowie die Art der Darbietung (z.B. Pop oder Klassik). Daraus lässt sich mit vertretbarer Genauigkeit die zu erwartende mittlere Schallleistung einer Bühne voraussagen, ohne dass die genaue Konfiguration der Beschallungsanlage bekannt ist. Mit Hilfe des ebenfalls hergeleiteten mittleren Richtwirkungsmaßes kann dann der zu erwartende Beurteilungspegel an einem bestimmten Immissionsort vorausberechnet werden. Damit erhalten Genehmigungsbehörden und Planer im Bereich Immissionsschutz die Möglichkeit, langfristig z.B mögliche Standorte für Freiluftkonzerte zu untersuchen sowie kritische Situationen zu erkennen und z.B. Maßnahmen zur Pegelbegrenzung vorzuschreiben. Das Verfahren wird an Hand konkreter Beispiele von Freiluftkonzerten erläutert und die Prognosewerte werden mit Messergebnissen verglichen.

We. 14:30 Gutenberg Sound reinforcement & imm. control

Interaction and dependencies of total sound power level, sound quality and noise pollution potential in typical multi purpose arenas

Volker Loewer
IFB consulting

Multi Purpose Arenas have become common during the last years. These facilities actually serve as multi purpose event locations for huge crowds from a several thousand to 50.000 and more spectators. The range of events ranks from soccer to indoor motocross, ice hockey, rock music, musicals and even opera events. Multi purpose arenas have been built as open stadiums, semi-open or closed spaces some of them using retractable roofs. The range of events require enormous flexibility of installed sound reinforcement systems and high quality, as well as high power output systems.
Sound system design goals are analysed and discussed using samples of existing multi purpose arenas.
Examples of typical sound pressure levels and sound quality parameters are presented. It is shown that the total sound power level may not only be a fundamental parameter for noise pollution potential, but may as well be used being one of the basic criteria for evaluating and comparing sound system design quality for in- and outdoor applications.

We. 14:50 Gutenberg Sound reinforcement & imm. control

Sound System Design in Public environments–Sony Center Forum Berlin

Jakob Kraft
Rahe-Kraft GbR

Public spaces nowadays require optical attractions like videoscreens but also an acoustic 'environment' for large areas. Typical issues in public spaces can be legal immission restrictions, difficult room acoustics, high background noise as well as specific expectations from clients and architects. The Sony Center Forum Berlin includes appartments only 26m from the main speaker with immissions restricted to 60 dB(A), 14.000 m2 of glass surface, approx. 6 sec. reverb, a constant background noise of 60-62dB(A) and a client expecting not to see any speakers, but still getting excellent audio performance everyplace. Clearly, an integrated approach combining loudspeaker choice and placement with time-controlled signal processing was clearly required due to immission restrictions. The project showed also that simulation and auralization (CATT-Acoustic) is a necessity to find the best technical solution but also as a psychological measure to

show the client what is possible. The final technical solution using beam-steered Duran Intellivox columns, securing level limitating with password-protected DSP-Mainframe programming, signal distribution over Cobranet, loudspeaker measurements as well as architectural solutions making the system 'invisible' are furthermore discussed.

We. 15:10 Gutenberg Sound reinforcement & imm. control

Optical Linear Position Measurements of the Speaker Membrane Displacement - a New, Cheap and Easy Way to Characterize the Speaker Behavior with High Accuracy

Wolfgang Geiger
Universität

Manufacturers of speakers characterize the properties of chassis with the Thiele-Small parameters, which are calculated from the electrical impedance. The influence of the mechanical parameters is largest at the mechanical fundamental resonance of the membrane displacement. In additional there are natural resonances of the membrane that influence the quality of the speaker at higher frequencies. All mechanical resonances of the speaker membrane oscillations are detected as electrical impedance peaks, but at higher frequencies the mechanical natural vibrations of the speaker membrane are concealed by eddy current effects and the speaker voice coil impedance. Therefore, it is difficult to calculate the mechanical displacement from the electrical impedance at higher frequencies, which is fundamental for the sound pressure propagations. Until today most developers measure only the mechanical resonance of the speaker to characterize all speaker properties. When a Position Sensitive Detector is used, it is possible to measure the real displacement with high linearity, a large dynamic range and a signal to noise ratio up to 90 dB even at high frequencies are obtained. The electrical impedance can be calculated from the voice coil displacement transfer function with the lumped element model. The comparison of the calculated data with the measured electrical impedance shows an excellent correspondence. The sound pressure can be predicted from the mechanical displacement of the speaker membrane with a simplified lumped rigid piston model. The linearity of the measurement system makes it possible to control the speaker membrane displacement in a real time closed loop system

We. 15:30 Gutenberg Sound reinforcement & imm. control

Calculation of sound pressure distribution and relevant values for immission control with computer simulation at the example of a large sports stadium

Anselm Goertz
Audio & Acoustics Consulting

In locations and rooms for public events today's standards for sound reinforcement and PA systems are very sophisticated. Not only a certain speech intelligibility is demanded, there are also strict limits for immission control. By taking a large sports stadium as an example, different design concepts of the PA system will be explained. This covers the calculation of sound distribution including audience areas and surfaces relevant for immission.

We. 15:50 Gutenberg Sound reinforcement & imm. control

Immission Protection in Spite of High Useful Levels

Wolfgang Ahnert, Benjamin Jäger
ADA Acoustic Design Ahnert

This contribution explains how acoustical quality criteria for a stationary stadium sound reinforcement system were elaborated with particular regard to minimizing immission to neighboring areas, and how forthcoming concepts from bidding firms were evaluated. Thanks to the inclusion of the results obtained by sound-reinforcement computer simulation (EASE) in the calculated immission prediction it was possible to assess various sound-reinforcement concepts with regard to the sound quality to be expected within the stadium, but also in respect of immission avoidance.

The object of these investigations was the Berlin Olympiastadion, which is presently undergoing complete refurbishing, and partial redevelopment. During future utilization of the stadium, even with the partial roofing closed, clearly audible noise immissions will have to be reckoned with for the adjacent living quarters consisting of detached and multifamily houses. The aim consisted in minimizing these immissions at least as far as can be achived by technical means.

We. 16:30 Gutenberg Sound reinforcement & imm. control

Controlled illumination by DDS-driven (cardioid) loudspeaker arrays

Evert Start
Duran Audio BV

During the last decade, digitally controlled loudspeaker arrays (based on the AXYS® DDC concept) have proven to be an essential tool for the improvement of the sound (re)production in large, acoustically difficult spaces, like (semi open) stadiums, churches and passenger terminals.
The next step in the ongoing development of digitally controlled loudspeaker arrays is the introduction of Digital Directivity Synthesis (DDS). Now, the radiation pattern of (scalable) digital loudspeaker arrays can be fully customised and controlled by software and can be predicted accurately in the far field as well as in the near field.
In contrast to the conventional approach of clustering loudspeaker systems with a given directivity to achieve a "hopefully" desired result, the DDS software calculates optimum driving filter for each channel in an array starting from the desired 'illumination' of the audience area. In addition, not only can DDS define the area(s) specified to be covered, but it can actually define the area(s) requiring no coverage.
Recently, a DDS-controlled cardioid bass array has been evaluated. This array combines a strong vertical directional behaviour with a high front-to-back ratio, yielding many acoustic benefits both indoors and outdoors.
After a short overview of the theoretic principles, this paper will address the practical design and optimisation aspects of these (cardioid) loudspeaker arrays. The flexibility of the DDS-technology will be illustrated by several examples.

We. 16:50 Gutenberg Sound reinforcement & imm. control

Environmental Noise Guidelines and Sound Management for UK Concerts

Jim Griffiths
Director of Acoustics

The UK has seen a steady increase in the demand for staging concerts both inside purpose built arenas to major rock concerts held outside on green field sites. This has focussed the attention to the potential environmental noise impact which is a critical issue in respect of obtaining a public entertainment licence before the event can proceed.
This paper discusses the research leading to the current noise guidelines adopted for the majority of concerts in the UK and

highlights the sound management control procedures that have been successfully adopted at many musical events for over 15 years. Engineering measures are also discussed in relation to the design of new or refurbished venues.

We. 17:10 Gutenberg Sound reinforcement & imm. control

A Test Procedure for Sound Level Limiters in Toys

Thomas Fedtke
Physikalisch Technische Bundesanstalt, FB 1.6 Schall

According to the standard DIN-EN 71:1998 on safety of toys the sound pressure level of toys which were 'obviously designed for generating sound' has to be limited in order to protect the hearing of the users - the children. This standard specifies level limits for free-field measurements of the sound immission for toys which are designed to be used as a unit close to the ear as well as level limits for the sound immission at the eardrum for toys which are equipped with earphones. If the acoustic output signal of the toy is generated by means of built-in program material, the maximum output level can be measured with test signals while the toy is working with full-on gain. If, however, the output signal depends on an acoustic input, eg a microphone, the performance of the level limitation has to be tested by suitable acoustic input signals and input levels. A test procedure for toys with an acoustic input will be described in this paper.

We. 17:30 Gutenberg Sound reinforcement & imm. control

Broadband compact absorbers for anechoic linings

Helmut Fuchs, Xueqin Zha, Gerhard Babuke
Fraunhofer Institut Bauphysik

Freefield rooms are normally equipped with voluminous porous or fibrous wedges the depth of which corresponds to a quarter of a wave length of the lowest frequency to be measured. When such passive absorbers are intelli-gently combined with reactive/resonant panel absorbers, anechoic linings be-come possible, which may save valuable space and provide a smooth and re-sistive surface. When measurements are to be performed in third-octave bands, down to 50 Hz, a lining thickness of 250 mm is required. For narrow-band analyses down to 100 Hz the surface facing the source must be corrugated in a specific manner increasing the total thickness to 620 mm. For aeroacoustic wind tunnels and a large number of test beds at six automobile manufacturers and several component suppliers have been equipped with the new anechoic linings with excellent results.

We. 17:50 Gutenberg Sound reinforcement & imm. control

Acoustical transparency of perforated panels with fabric linings

Michael Leistner, Horst Drotleff
Fraunhofer Institut Bauphysik

In interior works perforated panels are occasionally used to cover up sound ab-sorbers mounted behind them. In order to create a visually smooth surface, now and then a thin layer of cloth or fleece is applied to the side facing the room. There are also cases, in which paint is additionally sprayed on top of that layer. The influence of these steps on the sound transmission at normal sound incidence was investigated with some unexpected results.

We. 8:30 Kleber Numerical methods in acoustics II

Temporal Formulation in the Wave Number Domain of Forward Propagation of Time Evolving Acoustic Pressure Fields

Vincent Grulier, Jean-Hugh Thomas, Jean-Claude Pascal, Jean-Christophe Le Roux
LAUM

The wavenumber method using the FFT algorithm has proven to be a more efficient tool than the Rayleigh integral method for calculating harmonic acoustic fields from planar radiators (Williams, Maynard). However, this method is not adapted when considering non-harmonic acoustic fields. Therefore the aim of this work is to provide a relevant reconstruction of non-stationary acoustic fields using a time domain impulse response formulation of the problem in the wavenumber domain. This formulation, to our knowledge first given by Forbes and Stepanishen, allows a real-time prediction of the acoustic wave propagation in the near-field of vibrating structure or in waveguide for applications in active control. First the acoustic propagation in the wave number domain described by the temporal wave equation in plane geometry is considered. A two-dimensional Fourier transform is applied to this equation that leads to a differential equation written in a Laplace formalism. The resolution of this equation gives the expression of an impulse response that, convolved with each component of the time-dependant wavenumber spectrum in a mesurement plane, yields the wavenumber spectrum in a forward plane. Then the two-dimensional inverse Fourier transform in space domain provides the instantaneous spatial pressure in the forward plane. Some explanations to reach the formulation are given in the paper. Numerical simulations are also reported to confirm the validity of this formulation. These simulations deal with sources composed of monopoles and more complex planar radiators whose sound emission fluctuates in time.

We. 8:50 Kleber Numerical methods in acoustics II

A journey of Sound Radiation, from the Baffled Plate to the Infinitely Long Cylinder Segment

Berndt Zeitler, Michael Möser
Institut für Technische Akustik , Technische Universität Berlin

The characteristics of sound radiation of the baffled plate bearing modal velocity distribution will be introduced shortly. Following, the analytically derived radiation characteristics of an infinitely long cylinder possessing the same modal velocity will be presented. It was chosen as a stepping-stone between the baffled plate, and the infinitely long cylinder segment; with infinite radius it possess the same radiation characteristics as the baffled plate. By shortening the radius the influence of curvature and diffraction arises, which also occurs for the case of the infinitely long cylinder segment, which was solved with semi-analytical methods. Finally, the radiation characteristics of all cases will be compared, whereby some of the results are presented by particle animations.

We. 9:10 Kleber Numerical methods in acoustics II

Synthèse Modale pour les problèmes poroélastiques

Olivier Dazel, Franck Sgard, Claude-Henri Lamarque
ENTPE-DGCB-LASH

Porous material involves interesting properties of dissipation of mechanical energy. That is the reason why they are commoly used in many fields of engineering. Nevertheless, the modelling of such components at the macroscopic scale involves constitutive and inertial coefficients which are complex and with a frequency dependency. This particularity prevents the application of classical modal techniques to predict the dynamical behaviour of multilayered structures involving porous materials. Recently, the authors have developped a technique based on the notion of complex modes. By extending the original Duncan transformation, it has been possible to obtain generalized complex modes enable that account for internal coupling and dissipation. This technique has been shown efficient in the case of monodimensionnal and tridimensional single porous structures. In this presentation , the case of multilayered structures is considered and the aim is to introduice component mode synthesis techniques for generalized complex modes. We mainly focus on the application of free face interface techniques as Craig and Chang CMS method. The definition of inertia relief generalized complex mode and residual generalized complex modes is undertaken. It is then possible to procced to an optimal correction of the boundary condtions. A global basis of the whole structure is then built by

considering the modal families of each substructure taken separately. Numerical applications are then shown and various cases are considered. First of all, the coupling of an elastic plate and a porous media, then, the coupling of a porous media and an acoustic cavity and finally the case of coupling of two porous media.

We. 9:30 Kleber Numerical methods in acoustics II

Simulation and measurement of pulsed ultrasonic wave propagation in viscous fluid exhibiting frequency power law attenuation

Ludwig Bahr, Manfred Kaltenbacher, Barbara Kaltenbacher, Reinhard Lerch
Department of Sensor Technology, Friedrich Alexander University Erlangen-Nuremberg

Measurements of acoustic attenuation in tissue reveal, that attenuation increases with increasing frequency according to $\alpha = \alpha_0|\omega|^y$, where α_0 is a scalar constant and y is a non integer exponent ranging from 1 to 2. Classical lossy time domain wave equations exist only for the restricted cases of y = 0 and y = 2. We will present a time domain model, which is capable of numerically simulating pulsed pressure waves propagating through media, whose attenuation obeys a frequency power law. To ensure system causality, phase dispersion has to be included according to Kramers-Kronig relations. Because of the interdependence of attenuation and phase shift, the two terms describing each phenomenon can be combined to a single factor. The attenuation and dispersion term is approximated by a fractional derivative in the time domain. Simulation results are verified by measuring attenuation and phase spectra of excitation pulse signals after passing through a tissue phantom. The phantom is immersed in a water tank of a ultrasonic screening system. We compare the collected data with the predictions of the underlying theoretical damping model.

We. 9:50 Kleber Numerical methods in acoustics II

Quadratic Time-Frequency Representations For Signals Passing Through Dispersive Systems

Jerome Bernard, Silvio Montresor, Jean-Hugh Thomas, Claude Depollier
LAUM

The aim of this work is to study the propagation of an acoustic wave in porous media using quadratic time-frequency representations (QTFR), for example the Bertrand distribution. Because of the dispersive characteristic of such a system, the wave velocity in the porous structure is a complex function of the frequency,

i. e., the energy of the signal carried by each frequency has is own velocity. So, a sample of porous medium is excited by an ultrasonic pulse, and the QTFR of the output signal is observed to evaluate the group delay law, function of the frequency, and then the parameters of the material. The relevance of such signal processing tools is their capacity to concentrate the energy of a signal in a two-dimensions plane (time-frequency, time-scale,...) along his group delay law. In the case of propagation in porous media, the group delay law is compared to a power law in the time-frequency plane. Finally, the properties of the Power Class of QTFR are used. This class of representations allows to generate a large number of QTFR and each of them matches with one adapted power law in terms of lisibility and the concentration of energy in the time-frequency plane. Hence, to choose the most relevant representation, concentration measurement tools as Renyi entropy are used. Here, the situation where a signal passes through a dispersive system which includes a power law group delay to the signals is considered. So, a QTFR which localizes efficiently this kind of signals is needed as well as the Wigner-Ville QTFR localizes the linear chirp signal.

We. 10:10 Kleber Numerical methods in acoustics II

Uncertainties and Errors caused by the Use of Noise Prediction Software

Wolfgang Probst

Accon GmbG

Noise levels in the vicinity of planned sound radiating facilities are generally calculated with software programs. With such a program it is possible to evaluate the uncertainty of the resulting sound pressure level caused by uncertainties of the assumed emission levels of sources. This method has been presented at DAGA 2002 and is in the meantime widely used by consultants and environmental agencies. It supports the GUM-approach in standardization and helps to receive results with a given confidence interval. Uncertainties caused by the use of algorithms deviating from standardized procedures can be minimized by using quality ensured software. With the new draft of DIN 45687 test problems and self declaration of software producers help the potential user to evaluate the correctness of software programs and to rank them with respect to his requirements. But there are also errors that may be caused because the software architecture and philosophy is not completely understood. Methods are presented allowing to detect and to avoid these errors.

We. 10:30 Kleber Numerical methods in acoustics II

Adaptive time-frequency representation for sound analysis and processing

Florent Jaillet, Bruno Torrésani
Genesis

Readability and interpretability of time-frequency representations may highly depend upon prior choices, such as the type of representation, an analysis window, or a smoothing procedure. In the context of sound processing and particularly for component extraction or elimination, it is possible to optimise such choices to achieve the best results. We propose a framework for automatic adaptation of the analysis parameters to the signal. This adaptation relies on the optimisation of the sparsity of the representation and will be described in the case of the short-time Fourier transform. Two different settings are proposed : Supervised adaptation The user selects a time-frequency region of interest and the chosen representation is that one which optimises a given sparsity criterion for the components in the selected region. Different criteria may be used, which are studied theoretically as well as numerically. Unsupervised adaptation The time-frequency plane is divided into several regions and in each region, the sparsest representation in a given set of possible representation is chosen. In particular using only two short-time Fourier transforms computed with two different sizes of window, a 'wide' one and a 'narrow' one, we show that the algorithm provide a good tool to separate and represent the transient part of the sound, which is best represented using the 'narrow' window, and the tonal part, which is best represented using 'wide' window. Examples on real sounds will be presented to show the interest of the proposed method.

We. 13:50 Kleber Audiology

Evidence for positive training effects of the acoustical environment on the auditory threshold

Gerald Fleischer, Reinhard Mueller
Auditory Research, University of Giessen

For nearly a decade, our team collected data on the auditory performance and the acoustical environment of roughly ten thousand persons. Using special analytical procedures this data base is being analyzed in different ways. One approach is to examine - and compare - the hearing capability of entire groups, as determined by pure-tone audiometry up to 16 kHz. Males and females are studied separately, and every group is seprarated by program in two sub-groups: persons with good hearing and persons with auditory damage. Both of these sub-groups are then

examined further. Among the groups examined are college students, fans of discos, orchestra musicians, office personnel, university students, audio engineers, airline pilots, military helicopter pilots, military recruits, dentists, construction workers, avoiders of discos, Tibetian monks, Tibetian nomads, Chinese from remote mountain valleys, Chinese from metropolitan areas, and others. Comparing the auditory performance of these groups made it possible to work out a ranking. The best-hearing groups are all working in loud environments, while people not exposed to noise - e.g. nomads - do not hear well at all. While excessive noise damages the ear, an extended low level of exposure to sound is apparently not good either. It is being concluded that the auditory system needs training to fully develop its capacity. Evidence will be presented to show the training effects and to indicate what appears to have positive effects on the auditory theshold. These trained ears are ageing more slowly than normal.

Evidence for different susceptibility to auditory damage between men and women

Gerald Fleischer, Reinhard Mueller
Auditory Research, University of Giessen

For ten years now, our group works on the relation between exposure to sound and auditory performance. Primarily we use puretone audiometry up to 16 kHz to determine the sense of hearing. In order to get an overview, we are examining and comparing entire groups of persons, such as office workers, music teachers, military jet pilots, Chinese city dwellers, etc. Using a special analytical procedure the auditory performance is determined and the results are compared among the various groups. Examining the data of a group by program, the first step is to separate persons with good hearing from those with auditory damage. Further analysis involves the entire group, but also - separately - the sub-groups of the good-hearing persons, and those with auditory damage. Men and women are, of course, examined separately. Looking at the results of the various groups showed a surprising effect. Comparing men with auditory damage to women with auditory damage - of the same groups - showes that women have more low-frequency damage than men, but less high-frequency damage. In groups with larger numbers of such persons, the effect is statistically significant, over the entire frequency range analysed. It is apparent among very different groups - from Chinese nomads, and Chinese city dwellers to European orchestra musicians and German college students, university students,

amateur musicians, and others. This widespread occurrence indicates that differences in susceptibility may be responsible, at least in part.

We. 14:30 Kleber Audiology

Improved venting systems for hearing aid applications

Torsten Niederdränk, Harald Klemenz
Siemens Audiologische Technik GmbH

Hearing systems can be positioned in or behind the ear. In the latter case the acoustic signal propagates through an acoustic tubing and the ear mould into the ear canal. In both cases the ear canal is closed to keep the sound signals inside the limited rest volume. This way the acoustic stability of feedback is improved. In real applications the ear canal cannot completely be closed. Reasons are that a closed volume with a certain degree of humidity might provide skin irritations due to fungus or bacterial growth. Additionally the occlusion effect appears, which of course does not support the comfort of hearing. To take care of these issues venting systems are applied connecting the rest volume of the ear canal with the outer environment. The positive effects of these vents to improve the venting of the ear canal has a negative side effect: the acoustic leakage allows a certain amount of sound energy to escape the ear volume and to propagate back to the microphone. Thus a feedback loop is closed. This contribution reports on venting systems which provide a considerably reduced sound radiation to the outer space. While keeping the venting effects constant the acoustic radiation of the venting canal is reduced. By using acoustic filters the propagation through the ventholes can be influenced in order to achieve a considerable reduction of the feedback sensitivity in the critical mid and high frequency range.

We. 14:50 Kleber Audiology

Bone Conduction effecting the Peripheral Hearing Organ

Henning Taschke, Herbert Hudde
Institut für Kommunikationsakustik (Web: www.rub.de/ika)

In order to analyse the components of bone conduction a finite element model of the human head was developed. The model presented here is a revised version of a previous model (Taschke, Daga '02) whereby it now confirms to in vivo measurements of real heads. Furthermore the model has been extended by a model of the whole peripheral hearing organ. Due to the large number of degrees of freedom, the model had to be sub-divided into three parts: the head, the temporal bone, and a cuboid section including the inner ear and its bony shell. The calculations of the three parts had to be made in succession for each different

type of excitation. In this dividing process, care was taken so as to maintain the correct pattern of vibration at the interface areas. The model allows us to investigate the mechanisms of bone conduction with regard to their characteristic patterns of vibration: Firstly, the vibrations of the tissue enclosing the hearing organ were examined in order to assess whether the tissue is being deformed or driven as a whole. Secondly, the changes in air pressure within the outer and the middle ear, the inertial movement of the ossicular chain, and the vibrations of the basilar membrane in response to the excitation of the surrounding tissue were studied. The significant findings with regard to the assessed components and their underlying mechanisms will be presented.

We. 15:10 Kleber Audiology

Modelling the Dynamic Behaviour of the Human Middle Ear Using the Finite-Element Method

Yvonne Curdes, Herbert Hudde, Henning Taschke
Institut für Kommunikationsakustik (Web: www.rub.de/ika)

In the talk a finite-element model of the human middle ear will be presented. This model is based on the results and properties of a three-dimensional circuit-model of the middle ear from Weistenhöfer which is a further development of the one-dimensional model from Hudde and Engel. In contrast to such mathematical methods, the application of the finite-element method enables the representation of the anatomy of the middle ear. Furthermore it offers a wider field of application like, e.g. static analyses. A geometric model of the middle ear was constructed in a computer-aided design environment, using tomograms of temporal bones and silhouettes from ossicles. The model is embedded in an existing model of the outer and inner ear developed by Taschke. It consists of the tympanic membrane, the ossicular chain including joints, ligaments (anterior malleal ligament, posterior incudal ligament, and annular ligament), tendons (tensor tympani tendon and stapedial tendon), and the tympanic cavity. The unknown mechanical parameters of the components of the middle ear were mainly determined from the geometry dependant properties of the three-dimensional circuit model. For this purpose special, self-programmable elements were used for the joints and the anterior malleal and posterior incudal ligament. To confirm the validity of the model, the motion of the ossicles obtained with this model was compared and adjusted to the results of the circuit models and measurement data. The development of the model and the simulation results of the dynamic behaviour of the middle ear will be presented and discussed.

We. 15:30 Kleber Audiology

How do Head-Related Transfer Functions of Children depend on Growth?

Janina Fels
Institute of Technical Acoustics

In many standards for development and measurement of hearing aids (for example DIN EN 60 118) an artificial head is used. This artificial head (KEMAR), however, is based on anthropometrical data of adult heads. Head-related transfer functions (HRTF) of children differ from adult ones. Consequently, there are still uncertainties in the development of dummy heads and proper hearing aids for children. On the DAGA'03 a system has been introduced which makes possible to obtain the HRTF even for very young children with the use of a photogrammetrical system and the calculation of the HRTF with BEM out of CAD-Models. Very first results showed that there is a big difference between HRTFs of infants and of adults. Even a scaled adult head yields big differences in the HRTF in comparison to an infant or child. The geometrical data needed for the CAD-Models have been optimised for children producing a database that allows statistical analysis of different groups of ages. Hence, corresponding heads can be created and computed. The results will be presented and discussed.

We. 16:30 Kleber Medical acoustics I

Ultrasonic wave propagation in human cancellous bone: Application of Biot theory

Zine El Abiddine Fellah, Sylvain Berger, Walter Lauriks, Claude Depollier, Jean Yves Chapelon
National Institute of Health and Medical Research, INSERM Unit 556

Ultrasonic wave propagation in human cancellous bone is considered. Reflection and transmission coefficients are derived for a slab of porous material having an elastic frame using Biot's theory modified by the Johnson et al model for viscous and inertial exchanges between fluid and structure. The sensitivity of the Biot-Johnson parameters is studied showing their effects on phase velocity and attenuation of the fast and slow waves. Experimental results for waves transmitted and reflected by human cancellous bone samples are given and compared with theoretical predictions.

We. 16:50 Kleber Medical acoustics I

Fragmentation Mechanisms of Kidney Stones in Shock Wave Lithotripsy can be Detected with MicroCT X-ray Imaging

Robin Cleveland, Javier Van Cauwelaert
Dept. of Aerospace and Mechanical Engineering, Boston University

Micro computed tomography (CT) imaging was used to follow the progressive development of cracks in artificial and human kidney stones. The artificial stones were made from U30 cement with a cylindrical shape (6.5 mm diameter and 8.5 mm long). The stones were held within a polypropylene vial in one of three orientations: vertical, horizontal and angled at 45 degrees. The stones were treated with either an electromagnetic or an electrohydraulic lithotripter and the initiation and growth of cracks was observed using microCT. The images showed that the dominant mechanism of failure was very sensitive to orientation of the stones with spall, cavitation and splitting mechanisms observed. Similar experiments were carried out on human stones of various types. Stones with homogeneous interiors broke with classic spall and squeezing like cracks. Natural stones with a complex layered structure appeared to initially lose their outer layers by a cavitation mediated process before the core fractured by spall. Our experiments indicate that most of the proposed mechanisms for stone fragmentation are present in shock wave lithotripsy. Variations in stone size, geometry and orientation appear to play a dramatic role in determining which mechanism dominates the fragmentation process. We conclude that there is no one dominant fragmentation mechanism in lithotripsy but rather multiple mechanisms combine to produce stone comminution. [Work supported by the Whitaker Foundation].

We. 17:10 Kleber Medical acoustics I

Focal Pressure Variations in Shock Wave Therapies Caused by Cavitation Bubbles

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For medical applications of pressure pulses in extracorporeal shock wave therapies different generator types (electrohydraulic, electromagnetic, piezoelectric) are used. Unlike electrohydraulic sources, electromagnetic and piezoelectric transducers are characterised by a high reproducibility of the pressure pulse waveform. But even for these sources pressure measurements with

a fiber optic probe hydrofone show significant variations in pressure waveforms after the first tensile phase of the wave. It is supposed that these quasi statistical changes are caused by cavitation effects. Numerical and experimental investigations are presented which support this hypothesis. The numerical model used is based on a two-phase continuum approach for bubbly liquids and combines nonlinear ultrasound propagation with cavitation bubble activity. The Gilmore equation is applied to calculate the bubble dynamics. Simulation results with different bubble densities demonstrate that the first positive pressure part of the shock wave is not affected by the bubbles. Increasing the gas content the tensile part gets shorter and is followed by augmented pressure oscillations. Measurements on two focusing piezoelectric transducers using different gas contents confirm the simulations. Calculations as well as experiments demonstrate that the activity of cavitation bubbles induced by the shock wave itself causes significant changes in the decaying part of the pressure signal.

Frequency effect on the cell detachment by ultrasound

Ludovic Peyre, Dorothée Callens, Annie Lefebvre, Edouard Radziszewski, Hartmut Hildebrand, Jean-Jacques Fabre
IEMN - DOAE Université de Valenciennes

Like any physiological phenomena, the integration of biomaterials is controlled by different biological processes. One of the most important is adhesion quality between tissues and implant. The mechanical properties of the interface cells/substrate are directly related to the quality of adhesion. Only some techniques are able to give quantitative information on this adhesion, and none to our knowledge uses ultrasounds however known to be an efficient tool in mechanical properties investigations. Our objective is to observe the behaviour of adherent MC3T3-E1 subjected to a quantified insonification. The cells were cultivated on a glass substrate during 3 days. We used continuous longitudinal waves to apply variable and quantified ultrasonic stress on cell culture. Two parameters of the insonification were investigated: frequency and power. Initially the cells detached during experimentation are counted in order to obtain curves of detachment according to the desired parameter. Secondly, we observed using a laser interferometer the amplitude of the oscillations undergone by the cells during the insonification. We succeeded in establishing the link between observations made with the interferometer and the curves of cellular detachment. This link made it possible to obtain a value of the cells adhesion force for the considered substrate and time of culture.

We. 17:50 Kleber Medical acoustics I

Safety of Diagnostic Ultrasound: Relevance of TI, MI, Safety Class, ETI or RTI, EAS or RAS

Joachim Herbertz
Universität Duisburg-Essen

Safety of the patient in the ultrasonic field is subject of controversies. Key to fundamental controversies is the question, whether safety is of minimal concern, if an ultrasonic field is neither a thermal hazard nor a cavitational hazard. As in that case the hazard would be of minimal concern, exposure of a patient would not constitute a risk of concern. In the commercial approach, application of the ALARA principle by the operator on the basis of indicated indices TI (Thermal) and MI (Mechanical) is said to establish safety of the patient. These indices and the presumption, that any exposure constitutes a risk, are propagated via the International Standard IEC 60601-2-37. The Harmonised European version of that Standard has not come into effect in Germany. Based on the consensus of the international experts in the 'Ultrasonics' Committee 87 of the IEC in April 1999, the Safety Standard GEFAU N 01 has been published in May 2001. This Safety Classification uses the physical parameters relevant to thermal and cavitational hazard and their biological threshold values. If any limit of Safety Class A is exceeded, the extent of the excess is indicated to the operator, for instance by the parameters ETI or RTI and EAS or RAS, and by indication of Safety Class B. Ongoing research on bio-effects does no longer justify further delay of implementation of the Safety Classification, as existing equipment may pose a risk to the patient while the relevant scientific basis has not changed since more than a decade.

We. 18:10 Kleber Medical acoustics I

Multichannel Recording and Classifying of Respiratory Sounds

Franz Graf, Karl Putz, Gert Wurzinger, Ulrike Kleb, Hans Köhler
Joanneum Research

The auscultation of the lung by means of a stethoscope is an important and straightforward diagnostic method. It is the simplest and least intrusive technique to determine direct information regarding the structure of the required lung tissue. The variations in the sound of the lungs are in direct relation to the pathological variations of the lung. Based on the variety of the heard lung sounds, it is often difficult to make a precise diagnosis. Therefore a system for multichannel recording and classifying of respiratory sounds was developed. First several kinds of sensors were constructed in order to obtain high-quality respiratory sounds. The data collection was realized with two off-the-shelf data acquisition

cards, the upstreamed the voltage supply of the sensors and an aeroplethysmograph. The devices are controlled by a software which has the further purpose to collect additional data for statistical analysis. In a clinical trial more than 60 persons with different kinds of diseases were examined. The analysis and classification was done by using different methods of digital signal processing, statistics and stochastics. The results of the study will be presented.

We. 8:30 Oberlin Ultrasonic non-destructive testing

NDE OF Materials Properties by Ultrasounds

Ali Badidi Bouda, Rafik Halimi, Mourad Benzohra, Amar Benchaala
Centre de Soudage et Controle CSC

The ultrasonic waves, with the matter interaction study, is an increasingly effective tool for qualitative and/or quantitative characterization of industrial materials. In this article we describe experimental studies, which were the work object at the Welding and Control Center (CSC), based on the measurement of some simple ultrasonic parameters such as propagation velocities and attenuation coefficients of the longitudinal and transverse waves through various samples. These measurements were taken on samples of suitable nature , shape and dimensions and eventually heat treated in order to obtain the required properties. The analysis of the obtained results showed that one can determine, by simply measuring the parameters above cited, quantitatively with an appreciate precision: éæ the second elastic constants of several materials éæ the width of the heat affected zone (HAZ) of a welding operation which is a representative parameter of the weld quality . éæ the third elastic constants of some materials if a tensile testing machine is available. This experimental work, also, shows the possibility to assess the qualitative hardness and grain size [1, 2] of a steel only from its longitudinal velocity wave. The experimental results obtained are compared with those obtained by classical methods or quoted from the literature, discussed and analyzed in order to develop non destructive techniques for materials characterization by ultrasounds. [1] A. Badidi Bouda & al Ultrasonic characterization of materials hardness, Ultrasonic, vol.38, 2000, pp224-227 [2] A. Badidi Bouda & al, Grain Size Influence On Ultrasonic Velocities and Attenuation, NDT&E International, in press.

We. 8:50 Oberlin Ultrasonic non-destructive testing

A Parametric Model of Acoustical Signature including Attenuation and Electrical Responses of Transducer and Measuring Chain

Jérôme Mathieu, Christian Fasolo, Gilles Despaux
LAIN, Univ. Montpellier II

Transducers used in ultrasound microscopy are usually constituted with a delay line in which a small lens is hollowed out. The delay line is designed in a way that the field produced by the piezoelectric element is relatively plane at the level of this lens. The classical models of acoustic signature V(z) include the ultrasound field effects onto V(z) into a function called the pupil function. Now these models make systematically some hypotheses : the lens is supposed to be smooth, axially centered and thin, the field is supposed to be zero outside the lens, and so on. Furthermore, the classical models don't include either the electrical responses of transducer and measuring chain, or the attenuation inside the delay line and the coupling media. It results for V(z) big differences between theory and experiments. In this article, a parametric model of V(z) is proposed. The aim is to obtain the amplitude of V(z) more accurately than with the classical models. It is based on the same propagations' theories than the last ones, but introducing some parameters and adding the attenuation and the electrical responses mentioned above. These changes with regard to the classical models were introduced one by one, which enables to determine for each change its relative extent in the differences observed between theory and experiments in V(z). For each parameter or additional effect taken into account, an experimental procedure is described to determine it. Some experiments support our comments.

We. 9:10 Oberlin Ultrasonic non-destructive testing

Defect Detection by Split Spectrum Processing and Discrete Wavelet Transform in Coarse Grains Materials

Redouane Drai, Abdesselem Benammar, Mohamed Khelil, Amar Benchaala
Centre de Soudage et Controle CSC

In some metallic materials with coarse grains, signal energy is lost due to scattering so the detection of defects by ultrasounds is often difficult. This noise can mask the defect signal and creates a constraint in its detection. It is thus necessary to increase the visibility of the defect by techniques based on the analysis of defect echo spectrum. The ultrasonic echo nature is non-stationary, this is due to the nonuniform propagation medium and which contains discontinuities, which causes the variation

of the frequency of the wave received compared to the emitted wave. This situation can be still complicated if the material has a coarse grains. In this work, we propose to develop on the first hand, algorithms based on Split Spectrum Processing (SSP) with Q constant method associated to 'Group delay moving entropy' (GDME), on the second hand, we develop a method based on Discrete Wavelet Transform (DWT). These algorithms allow detecting and locating imperfections echoes drowned in the structural noise of materials. The investigation is performed with known defects echoes with different characteristics (position, amplitude, center frequency and bandwidth). The defect echoes frequency is varied around the frequency of the input signal in order to evaluate, by SNR calculation, the robustness of the detection method. The grain noise signal is generated first, by a simple clutter model which consider the noise, in the time domain, as the superimposed of signal coming from backscatterers in the medium and second, experimentally by a material with a coarse grains.

Early defect recognition using Nonlinear Ultrasonic Resonance Spectroscopy (NURS)

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Conventional ultrasonic equipment for non-destructive evaluation (NDE) widely used in industry and technology for material characterisation and quality assessment makes use of so-called linear elastic response of materials that results in the amplitude and time variations of the input signal due to its scattering, reflection and transmission. The nonlinear approach to NDE discussed in this paper is concerned with non-linear material response, which is related to intrinsic frequency changes of the input signal due to acoustic wave interaction with material flaws. As a result, in addition to the eigen-frequencies the NURS acquires new nonlinear frequency components (higher harmonics, subharmonics, frequency side-lobes, etc.) that carry information on local material imperfection. By monitoring the local nonlinear spectral response (nonlinear spectroscopy), the nonlinear NDE modes appeal directly to the vulnerable (faulty) areas within a material or a product. Such a nonlinear NDE-methodology is extremely sensitive to a wide-range of imperfections and can deliver unique information about deterioration of material properties, early stage of defects development in components, integrity, quality and lifetime of the manufactured products. The paper includes the study and applications of the unstable modes of the nonlinear spectroscopy

caused by acoustic wave-defect interaction: nonlinear shift of resonance frequency, fractional subharmonic and self-modulation instabilities, bistability and transition to dynamic chaos.

We. 9:50 Oberlin Ultrasonic non-destructive testing

Imagerie du bois par ultrasons

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Centre de Recherhes Forestieres de Nancy, INRA

The purpose of this report was firstly to obtain an ultrasonic image with a thin (2 mm thickness) solid wood specimen, without a special preparation of the surface, specimens which are used currently for X-rays microdensitometric technique, and secondly, to obyain an ultrasonic image of a very thin microscopic section (12μm), fixed between two glass lamellae. This specimen is the classiccc specimen used for optical microscopic studies of wood anatomic structure. The images were obtained with the scanning acoustic microscope SONOSCAN C SAM D 9000, in a frequency range between 100 MHz and 230 MHz, for two species : spruce and oak. THe image resolution was between 10 μm and 25 μm . It was possible to establish a relationship between the amplitude of the ultrasonic signal and the corresponding microdensitoùmetric values of different anatomical elements

We. 10:10 Oberlin Ultrasonic non-destructive testing

Characterisation of small cylindrical scatterers by Decomposition of the Time Reversal Operator : Theory and Experiment

Jean-Gabriel Minonzio, Claire Prada, Mathias Fink
ESPCI - LOA

We propose to use the D.O.R.T. method to improve characterization of sub-wavelength scatterers with conventional transmit receive arrays like those used for medical imaging. The D.O.R.T. method consists in the measurement of the array response matrix K, and the diagonalization of the corresponding time reversal operator KK*. In most former studies, a one to one correspondence between the eigenvectors of the time reversal operator and the scatterers in the medium was shown. This correspondence, valid in most experiment, is only true for isotropic scatterers, that is for point like inhomogeneities of compressibility. The question we now try to answer is : can we observe several eigenvalues for sub-wavelength object? From the associated eigenvectors, can we get information on the physical parameters of the object as the size, the compressibility, or the density? Simulations taking into account the contribution of the different vibrations modes of the object have improved the understanding of the eigenvectors of the time reversal operator for the small object. For an elastic

very thin cylinder, monopole and dipole scattering terms are the two significant ones, it is then possible to calculate analytically the eigenvectors of the TRO for a linear array. We will present experimental results obtained with the 128 channels electronic device, using a 1.5 MHz 128 elements array and 0.2 to 0.4 mm cylindrical nylon or steel wires. A good agreement between results and simulations is shown. (1) french acronym for Décompostion de l'Opérateur de Retournement Temporel

We. 10:30 Oberlin Ultrasonic non-destructive testing

Nonlinear Elastic Wave Spectroscopy in Quenched Metallic Samples With Contact Calibrated Ultrasonic Measurements

Serge Dos Santos, François Vander Meulen, Lionel Haumesser, Michel Vila, Jérôme Fortineau, Olivier Bou Matar
GIP Ultrasons/ LUSSI

The nonlinear acoustic parameter (beta) is of great interest for material characterization for non-destructive testing in industrial applications such as aircraft company. Furthermore, Nonlinear Elastic Wave Spectroscopy (NEWS) comprise a new class of innovative ultrasonic techniques that provide extreme sensitivity in detecting damage in the form of microcracks or delaminations. The sensitivity of nonlinear methods to damage hide a great difficulty for : i) obtaining calibrated absolute measurement of nonlinear effects: ii) performing accurate models including nonlinear and hysteretic state relation of microcracks. In this paper, we propose an experimental characterization of the nonlinear acoustic parameter of steel samples previously bounded by water and oil quenching using an ultrasonic contact calibrated measurement set-up. A high frequency signal is inserted in the sample by a contact-transducer. A low frequency pulse is applied to the other side such that the nonlinear interaction takes place during the back propagation. This interaction creates a phase modulation of the HF wave which is proportional to beta and to the particle velocity of the LF pulse, determined by self reciprocity calibration of the transducer. This method, previously validated in solid plates has been applied in metallic parts (XC48 steel) with different crystallographic structure induced by austenite-martensite transition. The stress-strain relation resulting from microstructure in the austenite-martensite transformation induce a phase modulation coefficient proportional to the nonlinear parameter. Experimental results showing the dependency between the steel quenching process and the nonlinear parameter measurement will be presented.

We. 13:50 Oberlin Ultrasonic non-destructive testing

Angular spectrum modelling of longitudinal guided wave propagation in a embedded cylinder - Application to the non-destructive evaluation of grouted tendons

Anne Grimault, Laurent Laguerre, Marc Deschamps
LCPC

Steel members of civil engineering structures undergo degradations due to corrosion and mechanical fatigue mainly, which can lead to its ruin in a long term. Hence, non-destructive inspection techniques are needed to monitor these structures. In this study, we are more particularly interested in non-destructive evaluation of bridge post-tensioned tendons using longitudinal mechanical guided waves. As by construction, the tendons have a single access to their ends (tendons are embedded over their whole lengths), the use of the guided propagation can have some advantages to inspect a given length from this single point (reflectometry technique). Nevertheless, the conditions of propagation in a waveguide (the tendon) are strongly influenced by its geometry and the embedding material. In order to propose an adapted non-destructive evaluation methodology, a model of propagation is studied. This work is focused on the determination of the exact solution of a cylindrical waves beam propagation, limited in time and space, inside a solid concentric cylinder embedded in a vacuum, liquid or solid (the steel tendon will be considered as a cylinder of same diameter). The model is based on the angular spectrum method and a Fourier-Bessel analysis to predict the spatio-temporal elastodynamic fields. Two types of approaches are then possible. A local analysis which describes the solutions as a partial waves series (Debye's series expansion) for the reflection/refraction of cylindrical waves at the steel/grout interface and thus allows an immediate physical interpretation. A global resolution which presents a condensed mathematical form of the above-mentioned local analysis.

We. 14:10 Oberlin Ultrasonic non-destructive testing

Nonlinear interaction of ultrasonic waves studied with Frequency Response Function (FRF) analysis

Alexei Moussatov, Bernard Castagnède
LAUM

There is a growing interest for ultrasonic nonlinear techniques to assess and characterize damages in materials and structures. The presence of cracks drastically increases the nonlinearity of a material. Consequently, to analyse the interaction between independent ultrasonic waves there is a very sensitive and efficient method, i.e. the interaction of a powerful ultrasonic pump

wave with a probe wave at a smaller amplitude. For instance, if the pump wave is amplitude modulated, the interaction due to the presence of cracks takes place in the form of a modulation transfer from the pump wave to the probe wave depending on the amount and sizes of the damaged features inside the material. Glass plates (230x190x15mm) with limited damaged zones (around 1cm) have been tested over the 30-110kHz bandwidth. In order to obtain precise and robust results, Frequency Response Functions (FRF) of the plates have been recorded with and without non-modulated pump. Correlations between the FRF variations (with and without pump) and the observed corresponding side lobes on the related amplitude spectra of the probe wave (when pump is amplitude-modulated) have been observed, explained and documented. Analysis of FRF deviation caused by an external powerful ultrasonic excitation of a damaged object constitutes a new NDE method. This method did demonstrate a strong potential to detect slight defects. A. Moussatov, B. Castagnede, V. Gusev, 'Frequency up-conversion and frequency down-conversion of acoustic waves in damaged materials', Phys. Lett. A, 301, pp.281-290 (2002). A. Moussatov, V. Gusev, B. Castagnède 'Self-induced hysteresis for nonlinear acoustic wave in cracked material' Physical Review Letters - V.90, No.12, pp.124301/1-124301/4 (2003).

New Approaches to Ultrasonic Characterization and NDT of Wood

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Ultrasonic characterization and NDT of flaws in wood is usually complicated due to high acoustic damping and sensitivity of the material to coupling media. However, wood also has some peculiar properties beneficial for development of new ultrasonic NDT methodologies. The approaches reported in the present paper make use of its high elastic anisotropy, nonlinearity and low acoustic impedance. An orthotropic symmetry of wood results in the acoustic birefringence for shear waves. A simple technique suggested to determine the fibre orientation is based on measurements of the delay and amplitude of shear waves as functions of the azimuth angle of transmitter polarization. The low acoustic impedance facilitates air-coupled ultrasound transmission in wood. The focused slanted transmission mode of the air-coupled ultrasound was adopted for non-contact measurements of local elastic anisotropy of wood plates and veneer specimens.

Higher harmonic and subharmonic modes of nonlinear vibrometry were used for nonlinear imaging and NDT of flaws (delaminations, cracks, knots, poorly bonded areas, etc.) in wood-based materials and products.

We. 14:50 Oberlin Ultrasonic non-destructive testing

Etude de la diffraction d'une onde plane dans une inclusion élastique par une méthode numérique couplée

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Dans beaucoup d'applications en contrôle non destructif par ultrasons ou en géophysique, on est amené à étudier l'interaction d'une onde élastique avec une hétérogénéité localisée. Le résultat de cette interaction peut donner des informations sur l'hétérogénéité (géométrie, matériau, emplacement, effet de concentration de contrainte dynamique, ect..). Pour une géométrie simple, il est possible de traiter ce problème d'une manière analytique ou quasi- analytique (méthodes basées sur la décomposition en ondes planes, méthodes modales), dans les autres cas les méthodes numériques sont les plus adaptées. Plusieurs techniques ont été utilisées : méthode des éléments finis, méthode des différences et méthode des éléments finis de frontières basées sur les représentations intégrales. Chacune de ces méthodes est mieux adaptée à une configuration donnée de ce problème. Nous présentons dans ce travail une méthode couplée éléments finis / éléments finis de frontières pour étudier la diffraction d'une onde élastique incidente émise dans un milieu élastique homogène et isotrope par une hétérogénéité localisée. L'utilisation d'une méthode d'éléments finis de frontière, déterminée à partir d'une formulation intégrale indirecte, permet de bien prendre en compte la condition de rayonnement à l'infini lorsque le domaine élastique homogène est non borné. Pour palier à sa limitation aux milieux homogènes, on lui associe une méthode d'éléments finis qui est plus appropriée pour modéliser les hétérogénéités et les anisotropies localisées. Nous appliquons cette formulation à des problèmes plans. On présente quelques applications qui mettent en évidence l'effet de la géométrie, de la rigidité relative et des dimensions pour différents types d'inclusion sur le champ diffracté.

We. 15:10 Oberlin Ultrasonic non-destructive testing

Global Approach for the ultrasonic Structural Health monitoring of concrete

Maher Shaira, Hossam Elaqra, Rachid Elguerjouma, Phillipe Guy
Insa de Lyon- Gemppm

A global approach for the continuous damage monitoring in concrete is performed. This approach uses ultrasonic wave propagation and acoustic emission simultaneously on instrumented concrete samples. During a tensile test, ultrasonic velocity and attenuation dispersion are measured, simultaneously acoustic emission is collected. The occuring damage is characterised by this global approach till the rupture of the sample. Good correlations are found between ultrasonic velocity decrease, attenuation increase and acoustic emission events. Furthermore, the evolution of the velocity and the attenuation dispersion associated to the acoustic emission analysis during the tensile test allow to discriminate between different damage phenomena. This global approach on an instrumented samples appear to be very efficient for the structural health monotoring of materials and structures

We. 15:30 Oberlin Ultrasonic non-destructive testing

Creep Damage and failure of Polymer Based Composites : Non-Destructive Evaluation with Ultrasonic Waves and Acoustic Emissions and Modelling

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The creep behaviour and the damage mechanisms of cross-ply glass fibre reinforced polymer composites are investigated using ultrasonic wave propagation and Acoustic Emission (AE). The mechanisms of the damage events and their space-time localizations are identified from AE. Simultaneously, the longitudinal ultrasonic velocity is measured in situ by transmission through the composites. The AE is very well correlated with the loss of stiffness determined from ultrasonic velocity measurements. For the strain (respectively AE), an Andrade (respectively Omori) law describes the first (primary-creep) regime of the creep test. The latest (tertiary-creep) regime is characterized by a finite-time power law singularity culminating with the global failure of the sample. The correlation between AE primary creep and the AE tertiary creep leeding to the failure of the material is investigated. These results are rationalized by a simple mechanical model, formulated in terms of a democratic Kelvin-Maxwell fibre bundle model with non-linear viscosity. Analytical expressions of the strain and

the AE are derived as function of time and are checked by numerical integration of the equations. A good agreement is found between experiments and the model prediction, particularly for strain and acoustic emission power-laws scaling in the primary-creep regime and in the tertiary-creep neighbourhood of rupture, which is consistent with power-law seismic activation observed prior to some earthquakes.

We. 15:50 Oberlin Ultrasonic non-destructive testing

Design of Low Frequency Ultrasonic Sensors for Cheese Draining Investigation

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IEMN - DOAE Université de Valenciennes

The quality evaluation of food products is of great interest to the food industry for two main reasons. Firstly production should be fairly repeatable in order to gain trust in the market. Secondly food processing should be up to the hygienic norms to preserve consumer health. To reach these goals, we propose a new ultrasonic system working by through-transmission in the frequency range of 100-200 KHz. The system is made of ultrasonic point sources and is used in order to follow the mechanical properties of cheese during the early phases of the process. We will present the specialized sensor system designed for this purpose as well as a comparison between the system's model and experimental results and its application to the evolution of the medium while draining. Results show a good prediction via ultrasonic velocity measurement of the mechanical properties throughout the change of the physical state of the medium. This method will be later used to study the effect of parameters interfering in the consolidation of cheese grains during draining on the final quality of cheese.

We. 16:30 Oberlin Ultrasonic non-destructive testing

Non Destructive Testing to detect the action of the sulfito-reducing anaerobic bacteria by ultrasonic method in tinned food

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The sterilisation in the tinned foods aims at the wholesomeness and the bacteriological stability of foods. The clostidium botulinum which is an sulfito-reducing anaerobic bacterium is choice in this work as a reference bacterium because of its strong

heatproof. The analyse by a microbiologic method entails sterilised material and very strict work conditions. Moreover these analyses are slow and expensive. Negative results obtained on samples subjected to an examination do not indicate that they are not entirely wholesome. In this work, we utilise an ultrasonic testing to detect the effects of the sulfito-reducing anaerobic bacteria on foods. The samples take place in a parallelepipedic tank. They are insonified by a short ultrasonic pulse. The reflected signal is detected and amplified, it is digitised by a numerical oscilloscope and transmitted to a computer by a IEEE 488 interface. These signals are treated by the computer to determine the viscoelastic parameters of the samples (phase velocity and attenuation). The evolution of these parameters as function of time allows us to know the different phases of the development of clostridium botulinum bacteria. The results show also the effect of the bacterial charge on the evolution of different phases.

We. 8:30 Arp 1 Building acoustics II

Sound Insulation of Solid Wood Constructions

Joachim Hessinger, Hans-Peter Buschbacher, Andreas Rabold, Fritz Holtz

LSW - Labor für Schall- und Wärmemesstechnik GmbH

Solid wood constructions in form of laminated timber boards or case-type-building elements have become the basis of many different building elements, like timber floors, walls and roofs. Yet the knowledge on the sound insulation of these elements is rather small. For that reason a research project on the sound insulation of solid wood constructions was initiated by German society for wood research (Deutsche Gesellschaft für Holzforschung DGfH e.V.). Acoustic measurements were performed at the LSW - Labor für Schall- und Wärmemesstechnik GmbH and the results of a preliminary report will be discussed in this paper. The airborne- and impact-sound insulation of walls and floors built of solid wood constructions has been measured in a test facility according to ISO 140. The test elements displayed the variety of solid wood constructions currently available from timber industry: laminated-timber-boards, case-type-building elements. Although the airborne sound insulation of the different basic timber construction displayed a great scatter within the results. However as soon as a lining (floating screed, thermal insulation of the wall) is applied to the wall / floor the different elements behave very similar within the frequency dependent R and the Rw. The different floor elements under investigation showed an impact sound insulation that behaved quite similar within the frequency dependent Ln and the Ln,w. For practical reason it is therefore sufficient to

classify the different construction types of solid wood constructions within one class of elements.

We. 8:50 Arp 1 Building acoustics II

Airborne Sound Insulation in Studio Rooms

Frank Schnelle, Roland Kurz
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The requirements for the airborne sound insulation between studio rooms depend on the necessary sound level difference. It is determined by the highest sound levels in the source room and the permissible background noise level in the receiving room. Studio rooms are built as "Room-in-Room-System". Usually, partitions between rooms are lightweight multi-layered constructions. Various measurement results from new and refurbished studio buildings built with system elements will be presented. The system components are manufactured as lightweight metal board partitions, suspended ceilings and floating floors. Predictions of sound insulation from partitions without and with windows/doors will be compared with measurement results. Further, it will be focused on the sound insulation at low frequencies, which is a typical problem for this kind of construction.

We. 9:10 Arp 1 Building acoustics II

Messergebnisse des Schallschutzes im Wohnungsbau - statistische Auswertungen

Christian Burkhart, Agnes Schwartzenberger
Akustikbüro Schwartzenberger und Burkhart

Statistische Auswertungen von Messergebnissen der Luft- und Trittschalldämmung werden häufig zur Begründung von Anforderungen und zur Beurteilung des Schallschutzes herangezogen. Häufig wird auch eine mittlere Art und Güte als Mittelwert aus statistischen Auswertungen abgeleitet. über Sinn und Unsinn derartiger Betrachtungen und den Grenzen der Anwendbarkeit wird berichtet und auf häufig anzutreffende Fehlinterpretationen hingewiesen. Eigene Messdaten der letzten 10 Jahre wurden statistisch ausgewertet, die Ergebnisse werden vorgestellt.

We. 9:30 Arp 1 Building acoustics II

Bauakustische Anforderungen - Vergangenheit und Zukunft

Agnes Schwartzenberger, Christian Burkhart
Akustikbüro Schwartzenberger und Burkhart

Bauakustische Anforderungen - Vergangenheit und Zukunft Die Neufassung der DIN 4109 ist in Bearbeitung und über die zukünftigen Anforderungen von 2- oder 3-stufigen Anforderungsniveaus wird heftig diskutiert. Die Gegner eines 3-stufigen Anforderungsniveaus befürchten die Einführung des mittleren Niveaus als allgemein anerkannte Regel der Technik und damit eine Anhebung der Anforderungen. Als beratender Ingenieur und Sachverständiger ist man mit allen Baubeteiligten in engem Kontakt und erlebt die typischen Bauweisen, deren Probleme, regionale Unterschiede und Bedürfnisse (nicht zu verwechseln mit den Erwartungen) der Bewohner an erster Stelle. Ein Blick über den deutschen Tellerrand hinaus führt zu interessanten Lösungsmöglichkeiten, die vorgestellt und diskutiert werden sollen.

We. 9:50 Arp 1 Flow noise

Optimisation of correlation function models for statistical aeroacoustic noise prediction

Rosa Wells, Peter Jordan, Yves Gervais
Laboratoire d'Etudes Aérodynamiques

The use of statistical approaches for the prediction of acoustic radiation from aeroacoustic systems generally involves modelling the spatiotemporal correlation of some system parameter (velocity in the case of unbounded flows, pressure in the case of systems containing solid boundaires). An intrinsic limitation of all statistical approaches, resulting from the low acoustic efficiency of aeroacoustic systems, resides in the error incurred in modelling such quantities, as an error which can be larger (by as much as an order of magnitude) than the actual acoustic energy radiated. If such approaches are to have any chance in the quantititive modelling of aeroacoustic noise, they need to be extremely accurate. In this work different analytical models are examined with a view to accurately reproducing the true character of the temporal correlation of the turbulence velocity components implicated in the generation of subsonic jet mixing noise. These models are validated using Laser Dopler Velocimetry measurements performed in the mixing layer of such a jet. Subsequently, using Lighthill's formalism, the models are used to derive expressions for the farfield sound intensity spectra, and these are compared with acoustic measurements performed on the same jet. This work was supported by the EU research program JEAN (contract no. G4RD-CT-2000-00313).

We. 10:10 Arp 1 Flow noise

Stability of an Axisymetric jet with Variable Velocity Peripherical Flow

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The acoustic emission of supersonic sheared flows is known to be mainly due to instability waves as shown by Tam & Burton (1984). However, this noise mechanism is still debated for subsonic flows, see e.g. Crighton & Huerre (1990). With this aim in view, the linear stability of a round incompressible jet is investigated. A tangent hyperbolic velocity profil controlled by the parameter Ru = (Uj-Uinf)/(Uj+Uinf) is chosen with Uj and Uinf the speeds of the jet and the peripherical flow respectively. The long time behavior of small amplitude perturbations of the axially slowly divergent free jet, i.e. for Ru = 1, has been recently predicted by Cooper & Crighton (2000) thanks to the global linear stability theory. In the present work, both cocurrent ($Ru<1$) and countercurrent ($Ru>1$) configurations are investigated. First, a local stability analysis along the jet axis is performed. The instability is searched as a normal mode of complex pulsation, complex streamwise wave number and azimutal number n. We focus on absolute instability modes. Critical Ru parameters delimiting absolute stable and unstable behavior are calculated. Thus the axisymetric mode n = 0 is found unstable on a bounded axial range for $Ru > Ruc0 = 1.191$. In the case n = 1, we exhibit a threshold Ruc1 = 1.388. Global linear stability criteria are then applied and the critical global parameter Rucg is calculated at leading order in function of the ratio between the initial momentum thickness and the jet diameter. Our results are compared to Strykowsky & Niccum's (1991) experimental data.

We. 10:30 Arp 1 Flow noise

Jets Instabilities Producing the Slot-Tone

Alexis Billon, Vincent Valeau, Anas Sakout
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The nature of the instability governing the self-sustained tones produced by a low Mach number free plane jet impinging on a slotted plate, known as slot-tone, is identified experimentally. The experimental apparatus permits to control the Reynolds number and the distance from the jet outlet to the plate. For a Reynolds number, the shear-layer natural frequency and the jet column mode frequency of the free jet without the obstacle are estimated and compared to the minimal and maximal frequencies of the tones (for any position of the plate). The frequency of both instabilities defines the frequency domain of the self sustained tones.

The lowest frequency of the tones, obtained when the plate is placed downstream the end of the potential core, are the result of the amplification of the column mode frequency. On the other hand, the maximal frequency of the tones, obtained when the plate is situated near the jet outlet, is close to the natural shear-layer frequency. Moreover, when the tones frequency is higher than the natural shear-layer frequency, the sound pressure level produced is very inferior to the maximal sound pressure level measured at the same Reynolds number. This confirms the prominent role of the shear-layer instability in the self-sustained tones process for the highest frequencies. Tones with a frequency lower than the jet column mode frequency are rarely observed.

We. 13:50 Arp 1 Flow noise

Numerical Simulation of Aeroacoustic Problems Using Lattice Boltzmann Method

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Renault - Research Department, Acoustic Group - TRC RUC 4 05

The lattice Boltzmann method (LBM) is an innovative numerical method based on kinetic theory to simulate various hydrodynamic systems. The lattice Boltzmann method simulates the time-dependent motion of a perfect gas at low Mach number that is governed by the compressible Navier-Stokes equations. The theory of this new numerical scheme is reviewed and a two-dimensional solver based on the well-known nine-velocity model is developed for aeroacoustics simulations. The usual issues of CAA codes are treated such as the non-reflective boundary conditions and the damping of short numerical waves. Test case simulations show that the LBM is a low-dissipative scheme : it is therefore possible to calculate simultaneously the aerodynamic and acoustic fluctuations of the flow. A direct simulation of the noise radiated by the flow over a rectangular cavity is presented.

In the framework of automotive simulations, a commercial code based on LBM is used. Two main applications are presented. First, the prediction of pressure fluctuations on the external surfaces of a vehicle is studied. For high Reynolds number flows, a sub-grid turbulence model is used. The cutoff frequency of this Very Large Eddy Simulation (VLES) approach is evaluated as a function of the mesh resolution.

The second automotive application is the simulation of sunroof buffeting. The LBM predicts the acoustic coupling between the

vortex shedding and the Helmholtz resonance of the passenger compartment. The frequency lock-on around the cavity resonance frequency and the maximum amplitude of oscillation at the critical flow speed are obtained. Then, LBM simulation can be performed for the design of wind deflectors.

We. 14:10 Arp 1 Flow noise

Diffraction and refraction effects in airfoil trailing-edge noise free-jet experiments

Michel Roger, Stéphane Moreau

Centre Acoustique - Ecole Centrale de Lyon

Trailing-edge noise is the noise radiated by an airfoil as boundary layer disturbances are convected past the trailing edge. Reliable measurements of that noise are needed to assess analytical models developed elsewhere and used to provide simple fan broadband noise prediction methods. Dedicated experiments are generally performed in open-jet wind-tunnels. The airfoil is held between side-plates at the nozzle of the wind tunnel and far-field measurements are made in the mid-span plane, outside the flow. The paper is devoted to the installation effects associated with one such experiment in the ECL facility with a thin cambered CD airfoil developed by Valeo, different flow regimes being obtained by varying the angle of attack. The first effect is the jet deflection observed at non-zero airfoil loading; it is accounted for by using the mean pressure coefficient as an indicator of the flow conditions. The second one is the scattering of the noise emitted by the airfoil at the nozzle lips, more severe in the upstream direction because trailing-edge noise is known to radiate preferentially upstream as frequency increases ; a diffraction correction is computed using the SYSNOISE software and applied to analytical calculations, providing a very good agreement with the measurements. The third effect is the sound refraction at the jet shear layers ; the relevance of a refraction correction usually made is re-addressed in view of the intended comparison with analytical modeling, including the effect of additional refraction across the airfoil boundary layers.

We. 14:30 Arp 1 Flow noise

Numerical Modelling of Wake-Jet Interaction with Application to Active Noise Control in Turbomachniery

Graham Ashcroft, Jan Schulz
Institute of Propulsion Technology

Recent experimental investigations have demonstrated the possibility of using aerodynamic noise sources to generate the secondary (anti-phase) sound fields for active noise control applications in turbomachinery. One particular method proposed, developed in cooperation between DLR and TU Berlin, for creating such secondary aerodynamic noise sources is to employ high-speed air jets in the tip region in order to disturb the flow field around the rotor blade. In this study we investigate the mechanisms of noise generation of such a configuration, and then consider the application of this control strategy to a low-speed high-pressure axial-fan with a blade count ratio of unity. Numerical simulations are performed for a single jet, per blade passage, located aft of the rotor trailing edge. The analysis focuses on the temporal interaction of the rotor wake with the transverse high-speed jet. Time-accurate numerical simulations are performed using a Reynolds-Averaged Navier-Stokes flow solver, with the effects of turbulence modelled using a one-equation turbulence model. To mitigate spurious reflections at external computational boundaries, non-reflecting boundary conditions based on the Giles formulation are employed. To reduce computational overheads, a high-order accurate spatial discretization scheme is used. Results of the numerical simulations are compared with available experimental data.

We. 14:50 Arp 1 Flow noise

Active control of tip clearance noise and aerodynamic performance of axial turbomachines

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Axial turbomachines have a radial gap between the casing and the rotor blades. The pressure difference between the suction and the pressure side of the impeller blades drives a secondary flow over the tip of the rotor blades. This tip clearance flow is detrimental to the aerodynamic and acoustic performances of the machine, i.e., pressure rise and efficiency drop, the radiated noise increases, and the usable range of the performance characteristic is diminished.

Previous work on the axial fan test bench at DLR-Berlin, investigating the noise and performance effects of varying tip clearances showed the existence of a broad-band noise source for large tip-casing clearances.
To control the flow conditions, air is injected into the gap through slit nozzles mounted flush with the inner casing wall and distributed uniformly over the casing circumference. As a result, the aerodynamic performance is improved and the tip clearance noise is reduced. To optimize this effect, the axial location of the injected air flow relative to the impeller position and its direction relative to the main flow are varied.

We. 15:10 Arp 1 Flow noise

Active Flow-Control for Reduction of Lift-Generated Airframe Noise

Lars Koop

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Airframe noise is a significant contribution to the total sound radiated during landing approach. One dominant source of airframe noise is situated at the side-edge of the extended wing-flap. Oscillation of the side-edge vortex leads to pressure fluctuations at the rigid surface and thus to sound radiation into the far field. The objective of the present study is to reduce this noise by blowing a jet of air into the vortical structure. The basic idea behind this concept is to displace or weaken the vortex, reducing the surface pressure fluctuations and thus the amplitude of the radiated sound. Measurements were performed with a A340 half-model in a wind tunnel. The angles of incidence and the flap- and slat-angles of the model can be varied. The extended flap was equipped with a blowing facility. The noise emission was measured with a phased microphone-array. In addition the flow field at the side-edge was investigated by means of particle image velocimetry and unsteady pressure fluctuations were measured. The array measurements show that the flap side-edge noise is dominant between 2500 and 6500 Hz and strongly dependents on the angle of attack of the model. The flap side-edge noise can be significantly reduced by means of active blowing through the side-edge of the flap. The flow field in the vicinity of the side edge shows two mechanisms that may be responsible for the noise reduction: decrease of the peak-vorticity in the vortex core and pushing the vortical structure away from the side-edge surface.

We. 15:30 Arp 1 Flow noise

Wind Noise - A dominant Source for In-Cabin Noise in Comparison to other Noise Sources of a Vehicle

Matthias Riegel
FKFS

Previous examinations of the vehicle interior noise look mostly only at single sound source such as engine noise or rolling noise, but don't take into account their contribution to the overall noise. By measurements in the aeroacoustic wind tunnel and in the vehicle acoustics test stand the in-cabin contribution of wind, rolling and drive train noise are determined separately. Therefore measurements are carried out at different car speeds in different gears on two different street pavements to determine the overall noise and the appropriate engine speeds and loads. Already at medium speeds wind noise is the most important sound source for interior noise in the higher frequency range above 2 kHz, independent of road surface and engine speed. Even in the low frequency range wind noise can be louder than engine and drive train noise. At low vehicle speed and high engine speed the engine noise is rather high, if the engine speed goes down the rolling noise gets dominant. On concrete pavement the rolling noise is even at high driving speed as loud as the wind noise.

We. 15:50 Arp 1 Flow noise

Analytical solution for multi-modal acoustic propagation in circular ducts with laminar shear flow

Romuald Boucheron, Hélène Bailliet, Jean-Christophe Valiere
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An analytical solution for the propagation of sound in circular ducts in the presence of laminar mean flow is derived. This solution, using Kummer's formalism, generalizes previous results found by Gogate and Munjal in the particular case of axisymmetric modes [J.S.V. 1993 160(3), 465–484]. Connections between the solution and already known solutions of more particular cases will be shown. The dispersion equation is established which allows the calculation of propagation constant. The knowledge of propagation constant allows in turn to calculate acoustic pressure profiles. The evolution of propagation constant and acoustic pressure profile with Mach number and working frequency will be presented and discussed. These results are satisfactorily compared with previous numerical simulations. Dispersion curves will also be presented non only for non-radial modes (as previously done by Bihhadi and Gervais [Acta Acustica 1994 2, 343–357] but also for radial modes. It appears that the effect of shear flow is strongly linked to the radial order of the propagating mode.

We. 16:30 Arp 1 Flow noise

Attenuation of acoustical waves in duct with flow

Yves Auregan, Vincent Pagneux
LAUM

Two main issues will be addressed in this communication. First, the attenuation in a rigid duct with shear flow is presented. The flow is considered as quasi-laminar and asymptotic expansions of the visco-thermal propagation equations are given. By comparison with experiments it can be seen that this model cannot be used for all the frequencies. Thus a model taking into account the effect of turbulence is presented. This model is compared to experimental results and to numerical simulations (LES). The second issue is the influence of visco-thermal effects on the effective impedance of a liner located at the wall of the duct. Experimental results call the classical acoustical displacement continuity at the wall into question. Thus a new model based on Match Asymptotic Expansion is presented.

We. 16:50 Arp 1 Flow noise

Acoustical attenuation in a rectangular channel with turbulent flow

Maud Leroux, Yves Auregan
LAUM

The attenuation of an acoustical wave in a tube in presence of a turbulent flow is not a well known problem. Ronneberger and Ahrens, and Peters et al. have measured the acoustical attenuation in a cylindrical tube with flow. They distinguish 3 zones as a function of the ratio of the acoustical boundary layer thickness and the viscous sublayer of the turbulent mean flow boundary layer. If the ratio is small, the damping of acoustical waves is not influenced by the turbulent stresses. If the ratio is large, a quasi-stationary theory can be applied. In the middle range, a strange behaviour is observed: the acoustical stresses at the wall are smaller with flow than without flow. This strange behaviour is still not understood. Direct Numerical Simulations of the turbulent flow are needed to understand this effect. In order to compare these simulations in a plane channel to experimental results, we measure the attenuation in a rectangular tube (1.5 cm $\times$10 cm). The 3 zones described previously for the cylindrical geometry are also observed in this case. A new model based on asymptotic expansion of the propagation in a 2D duct with turbulent flow is presented.

We. 17:10 Arp 1 Flow noise

Predicting the Aerodynamically Generated in 2D-Mufflers Noise and its Far-Field Propagation Using a Combined LES/LEE Approach

Wim De Roeck, Wim Desmet, Paul Sas
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Mufflers are often installed in ducted flow systems to attenuate the noise generated by engines, fans, oe Under certain circumstances, however, they may become flow-excited noise generators rather than silencers. Up till now only limited research is related to the numerical computation of flow-induced noise in automotive muffler applications. In the present paper, a combined Large Eddy Simulation-Linearized Euler equations (LES/LEE) approach is used to predict the aero-acoustic source field and its far-field propagation. This approach is applied to predict the flow-induced noise in a 2D-muffler and to gain some insight in the noise generating mechanisms such as tailpipe and chamber resonances. An evaluation of different kind of source terms in the LEE and their effects on the generated sound field is presented. The acoustic near-field results are compared with LES-results to validate the different kinds of acoustic source terms and to evaluate the use of a combined LES/LEE approach to compute the generated sound field in a 2D-muffler. The acoustic far-field will be compared with acoustic analogy calculations based on the Ffowcs-Williams/Hawkings (FWH) analogy. The effect of the flow field on the propagation of acoustic waves will be investigated by comparing LEE-results that incorporate the flow field, with the FWH-results that assume a medium at rest.

We. 17:30 Arp 1 Flow noise

Application of Laser-Scanning Interferometry on Aeroacoustic Problems

Martin Fischer, Marco Zucchini
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Prediction of flow-induced noise is an object of intensive ongoing research. Statistical properties of pressure fluctuations of the unsteady fluid flow or of sound waves can be mapped by means of laser-scanning interferometry. External microphones or flow probes can serve as reference sensors. Animation of interesting turbulent flow events and of the generated and propagating sound waves leads to a deeper understanding of aeroacoustic sound generation. Besides this qualitative analysis the fluctuating pressures can be evaluated quantitatively in the case of symmetrical flow configurations. The experimental data sets obtained

by means of laser-scanning interferometry are useful for comparison with numerically modelled sound fields based on CFD-data. In this way, CAE tools for the prediction of flow-induced sound can be calibrated. The application of this new method is shown for different elementary and technically relevant sound sources.

We. 17:50 Arp 1 Flow noise

Microphone Array Measurements for Aeroacoustic Investigations Using a Frequency Band Filtering Method

Andreas Zeibig, Christian Schulze, Joern Huebelt
Institut für Akustik und Sprachkommunikation

Within the scope of the research project SWING+ (Simulation of WingFlow Noise Generation) it is necessary to develop a microphone array to localize sound sources on a generic wing profile. As a first approach a line array was constructed. Using this line array a lot of basic investigations with various array geometries and signal processing methods were carried out. As a result of these basic investigations the optimal configuration for a line array was found consisting of eight equal spaced microphones. This geometry can be used over a broad frequency range, if a spectral band filtering technique is applied. This way a narrow main lobe as well as a reasonable side lobe suppression can be reached. Reference measurements were carried out to prove the feasibility of this method. During the reference measurements acoustic model sources like monopole and dipole were localized and separated. Afterwards the use of this microphone array for the localization and separation of aeroacoustic sound sources on a generic wing profile and a cylinder in an air flow will be described. From these measurements useful experiences and knowledge for the design of a two-dimensional microphone array could be obtained.

We. 18:10 Arp 1 Flow noise

Estimation of installation errors in acoustic flowrate measurements by CFD-modeling

Segey Ruchkin, Michael Rychagov
Moscow Institute of Electronic Technology (Technical University)

The results of investigation concerned with the development of new computer-based models for ultrasonic multipath time-of-flight measurements of perturbed flows as well as the data of corresponding numerical modeling are presented. Up-to-date algorithms for numerical modeling of the problems of diametral and chord acoustical measurements enable to obtain with high precision (1,5 - 2 %) an axisymmetric flow velocity profile v(r) at steady-state flow conditions in an arbitrary cross-section on the

basis of indirect data. Thereby, a set of high-precision estimations of the averaged flow velocities v(i), i= 1 ... I in I measuring planes is provided with and high-quality determination on it's basis the total flowrate. It is shown that effective CFD-modeling of fluid and gaseous media is an additional powerful tool allowing to obtain analogous, above-mentioned estimations even in the case when ultrasonic measurements are produced at unstable or perturbed flow conditions, i.e., v=v(x,y) where (x, y) are Cartesian coordinates in a normal cross-section. The estimation of the flow velocity profiles nearby hydraulic resistances of different kinds is carried out on the first step by using set of Salami basis functions. Numerical modeling include, in particular, three interrelated stages: a) flow profile assignment; b) making up set of projections of time-of-flight data for an arbitrary rotation angle of the measuring system; c) obtaining direct and quadrature volumetric/mass flowrate estimations. Applied software for effective modeling multipath measurements of asymmetric flows supplied with an interactive GUI is demonstrated. In addition, strict mathematical estimations for the unperturbed flow profile reconstruction errors are also given.

We. 8:30 Arp 2 Application of psychoacoustics I

Is the Railway Bonus influenced by the Directions of the Sound Sources?

Hugo Fastl, Markus Fruhmann, Simon Ache
AG Technische Akustik, MMK, TU München

At same energy equivalent A-weighted level LAeq, rail noise usually is judged less annoying than road noise. This effect is called railway bonus. On the other hand, at same LAeq aircraft noise frequently is judged more annoying than road noise, an effect termed aircraft malus. As one reason for the aircraft malus it is often assumed that sounds which come from above might be particularly frightening. When accepting this argument it should be possible to reduce the railway bonus by presenting the road noise in front of the subjects, but the rail noise above them. Results of related experiments with original as well as 'neutralized' sounds are presented and discussed.

We. 8:50 Arp 2 Application of psychoacoustics I

Sound-generating Parameters of Starting Electric Railbound Vehicles and their Influence on Sound Quality

Martin Klemenz
Institute of Technical Acoustics

In recent years, research activities and sound-abatement measures in the field of electric railbound vehicles (e.g. trams, subways and light-rail vehicles) have been mostly concentrated on

rolling noise. On the other hand, some additional noise components often play an important role especially during the starting procedure of modern vehicles. Among them, one can point out the motor in connection with the traction converter apart from other sources such as the gear. The acoustic optimisation potential of this kind of noise, called 'traction noise', is rather unknown. Therefore, a study is actually carried out concerning sound sources, relevant psychoacoustic quantities and optimisation measures of traction noise. In this contribution, a short overview of the sound-generating parameters is presented. This includes a classification of motor types, power-electronic devices, and switching sequences. Since traction noise can sound quite differently, each classified noise type is also analysed with regard to its influence on psychoacoustic quantities. More detailed discussion about perception of traction noise will be presented in another paper of this conference.

Sound Quality of Starting Electric Railbound Vehicles - Dimensions of Hearing and Relevant Psychoacoustic Quantities

Martin Klemenz
Institute of Technical Acoustics

In order to investigate the psychoacoustic optimisation potential of starting electric railbound vehicles, sound-generating parameters have been analysed in the preceding contribution. Before finally varying some of these parameters (e.g. switching-frequency randomisation), quantities for psychoacoustic evaluation must be chosen first. However, apart from general psychoacoustic descriptors like loudness or sharpness, it cannot be excluded that some other, product-specific quantities also have to be considered. In this contribution, it is described how these quantities are determined with the help of listening tests. A semantic-differential approach with subsequent factorial analysis yields four main dimensions of hearing. The most important factor which can be called 'unpleasantness' is analysed itself in a second experiment by multiple regression. It is assumed that among the predictors are not only 'classical' quantities. For example, traction noise is often composed of characteristic musical intervals, so that a detailed analysis is carried out if consonance plays a relevant role and if roughness is an appropriate predictor. Finally, the use of these quantities for optimisation studies will be outlined.

We. 9:30 Arp 2 Application of psychoacoustics I

Sound quality of impulsive noises in interior noises of cars

Peter Daniel
CORTEX INSTRUMENTS GmbH

Weak impulsive components may deteriorate significantly the sound quality of interior noises of cars. Especially near the threshold of hearing, as for example in modern diesel engines sounds, the correct measurement poses high demands on the used instrumentation. Clearly audible impulses, as for example in closure sounds like door slam noises, are in addition essential for the perception of the quality of the closing mechanism. It is known for example that low frequency contents of impulsive noises are associated with high quality and multiple impacts contribute to annoyance and higher sharpness is associated with cheaper quality. All these impulsive components have in common that a correct assessment is not possible without taking into account the time and frequency resolution as well as masking properties of the human ear. The results of listening experiments will be compared with psychoacoustical and conventional measures and an intuitive method will be presented to design target sounds.

We. 9:50 Arp 2 Application of psychoacoustics I

Annoyance and loudness of pure tones in noise: application to active control of fan noise

Sabine Meunier, Guy Rabau, Emmanuel Friot
LMA CNRS

The aim of the work reported here is to study the perception of hissing or booming in noise. These kinds of noises are known to be very annoying. They are composed of a background noise, to which a pure-tone signal is added. If the frequency of the pure tone is high, a hissing is heard , if it is low, a booming is heard. Many studies have been done on the perception of pure tones in noise, especially by R. Hellman and by H. Fastl and his team for applications. In this paper we will focus on a particular application which is active noise control of aircraft fan noise. In the study, the fan noise was composed of a pure tone at around 1.8 kHz with a high level, in a broad band noise, with weaker pure-tone components at other frequencies. By active control, the peak at 1.8 kHz can be eliminated. First, we made experiments to quantify annoyance in different cases : 1- different sounds were synthesized that were composed of pure tones of different frequencies added to a white noise. 2- a sound was synthesized that was composed of a pure tone at 1.8 kHz added to a low-pass noise. 3- noises were recorded on a fan engine in a groundtest facility

with and without control. Secondly, the perceptual benefit of the control has been evaluated. In the end, the perceptual mechanisms involved when listening to hissing or booming sounds are studied in terms of masking and masked loudness.

We. 10:10 Arp 2 Application of psychoacoustics I

Evaluation of sound quality affected by tonal components in Japan and Germany

Hans Hansen, Reinhard Weber, Takanori Matsui, Sonoko Kuwano, Seiichiro Namba
Carl von Ossietzky Universität Oldenburg

Experiments were conducted in Japan and Germany concerning the effect of tonal components on sounds quality. The Japanese results were the following: (1) Three factors were extracted by factor analysis: "pleasant", "metallic" and "powerful". (2) The "pleasant" factor decreases with increasing SPL of tonal components larger than 21 dB, while the "metallic" impression increases at about 18 dB and the "powerful" factor at about 18 dB. (3) The simple adding of a second sinusoid with a similar frequency and the same SPL has no significant effect on the timbre of the sounds. The effect of the frequency on the "metallic" factor was measured, when the frequency was doubled. No significant effect was found on the "powerful" factor. (4) A two cluster solution is obtained by cluster analysis. The sounds are clustered according to the presence of a large tonal component or not. The greater the difference in frequency becomes, the earlier can the sound be found in the "tonal" cluster. These Japanese findings will be compared to the evaluation of German subjects.

We. 10:30 Arp 2 Application of psychoacoustics I

On the pitch strength of harmonic complex tones and comb-filter noises

Markus Fruhmann
AG Technische Akustik, MMK, TU München

Combfilter-Noises, produced e.g. by filtering white noise by of a series of FIR-filters, evoke harmonic spectra. Characteristic features for these sounds are the delay time and damping factor used for the delay branch and also the number of filtersteps used to generate the signal. The perceived pitch is comparable to the pitch of a harmonic complex tone with components at multiples of the inverted delay time of the FIR-filter. The pitch strength of these sounds is very much depending on the number of filtersteps (iterations) used in the generation process. Comb-filter noise produced by only one filterstep evokes a very weak peak and thus a very low pitch strength. Using one and the same

filter several times, a so called iterated rippled noise (IRN) is produced, and its pitch strength grows with an increasing number of iterations. In listening experiments, the pitch strength of iterated rippled noises and harmonic complex tones was compared using the method of magnitute estimation with an anchorsound. The experimental results show an expected dependency on the number of iterations. Additionally a strong dependency of the results on the used delay time (2, 4 and 8 msec corresponding to 500, 250 and 125 Hz) was found. In the talk, the experimental results are presented. Additionally, the reasons for the dependencies of the present data are discussed in the context of pitch strength data from the literature.

We. 13:50 Arp 2 Application of psychoacoustics I

Comparison of listening test methods : a case study

Etienne Parizet, Nacer Hamzaoui, Guillaume Sabatié
Lab. Vibrations Acoustique, INSA Lyon - Bât. 303

The goal of this study was to compare various listening test methods in the particular case of nine in-car ventilation noises. Six listening tests were conducted : - absolute evaluation of noise pleasantness; - evaluation of pleasantness, during which the subject could hear all noises as often as necessary; - pair comparisons (forced choice procedure); - pair comparisons (five levels scale); - pair comparisons (continuous scale); - similarity ratings, analysed with a multidimensional scaling method (Indscal). These six tests were realised by 64 subjects. Different items were examined for each test : its perceived and real duration, its estimated difficulty, the accuracy of merit scores attributed to noises, the perceptual spaces which could be built and the accuracy of a pleasantness indicator which computed from the results. It appeared that : - the second procedure can propose a good compromise between the accuracy of the results and the time needed for subjects to realise the test. Thus, it can be recommended for many industrial purposes; - perceptual spaces built from the pair comparison tests and the similarity rating one were similar, indicating a great stability of sound features used by listeners, whatever their task; - the MDS analysis of the similarity ratings lead to the more accurate pleasantness indicator.

We. 14:10 Arp 2 Application of psychoacoustics I

On the Use of Psychoacoustical and Psychophysical Methods to Predict Consumer Preference for Interior Car Sounds

Daniel Västfjäll, Anders Sköld, Mendel Kleiner
Department of Applied Acoustics, Chalmers Univ of Tech

When designing for product sound quality, it is important to predict consumer preference since making consumer investigations

time consuming. One way of assessing this is by correlating metrics for sound character with preference data from consumers. The sound character can be assessed in a number of ways. In the present research expert listeners were used to retrieve psychological dimensions. This was done by a listening test of the where the subjects were to rate the sounds on number of unipolar adjective scales. The results were analysed ANOVAs and PCA, and resulted in five reliable dimensions, explaining 79% of the variance. Consumer preference was mapped by a paired comparison test design where listeners were to decide which of the sounds in each pair they prefer. This data was here analysed with the Bradley-Terry Luce model (BTL), which resulted in merit-scores for the sounds included. To get a good overview of the perceptual space present for the sounds in the test, expert listeners were asked to rate the difference between the sounds, which was done in a half matrix design. The data was analysed with an MDS-procedure that resulted in three dimensions explaining 97% of the variance present. When the correlation is calculated between the position of the sounds in the perceptual space and the rating in the psychological dimensions, one gets vector representation for the psychological dimensions. If the same thing is done for the preference merit scores, one gets a very clear picture of what dimensions and psychological properties of the stimuli are important for the consumer preference.

A method to assess the ecological validity of laboratory-recorded car horn sounds

Guillaume Lemaitre, Patrick Susini, Suzanne Winsberg, Stephen Mcadams
IRCAM

A method is presented which explores the ecological validity of a corpus of car horn sounds, based on the perceided dissimilarities between these sounds. A car horn is a self-oscillating electroacoustical device, the sound of which is strongly influenced by its fixation to the body of the car. The usual procedure to record a horn is to fix it on a heavy metal bar. But the sound emitted by this horn-bar device may be fairly different from the sound perceived on the road. Hence the question arises, 'can the conclusions drawn from experimental studies using these recorded sounds be generalized to real-life situations?". To answer this question, a method is designed, which combines qualitive representation of the data with quantitative statistical tests. Car horn sounds were recorded in two ways: three horns were either fixed to the bodies of two different cars, or were fixed to a standard metal bar and recorded in three positions. Dissimilarity ratings were obtained

from listeners. Multidimensional scaling was used to assess the influence of the fixation on the structure of the dissimilarities perceived between the different horns. This representation leads us to conclude that the dissimilarities perceived among a set of horns for a given fixation are independent of the fixation and of the position of recording. This assumption is verified by means of a contrasted analysis of variance. The results of this study allow conclusions drawn from dissimilarity ratings between laboratory recorded sounds to be generalized to the real-life cases.

We. 14:50 Arp 2 Application of psychoacoustics I

Impact of Office Noise, Irrelevant Speech and Music on Short-Term Memory Performance

Sabine Schlittmeier, Jürgen Hellbrück
Catholic University of Eichstaett - Ingolstadt

Verbal short-term memory performance is impaired by irrelevant background sound so far as the irrelevant speech and non-speech sounds are characterized by distinct temporal-spectral variations (e.g. narration, instrumental music with prominent staccato passages). This empirical robust effect is well-known as Irrelevant Sound Effect (ISE). It has practical implications for workplaces such as open-plan offices, call-centers and classrooms. At such places people have to conduct mental work in ambient speech noise or office noise (telephone ringing, printer noise and so) which often shows temporal and spectral variations. In our contribution we present results of several experiments which investigate impacts of such noise on a memory span task. In the first series of experiments we were able to show, that memory span of visually presented digits is significantly disrupted by background speech as well as by instrumental staccato music, but not by legato music and pink noise. In additional experiments we found the same results for the memory span of auditorily presented items, although these items were presented in a signal-to-noise ratio which allowed perfect intelligibility. In a third series of experiments, we investigated the effect of office noise including speech, telephone ringing and other typical open-plan office sounds on memory span for visually and auditorily presented items as well. Our results demonstrate that the detrimental effects of untreated office noise on short-term memory performance can be reduced by superimposing the office noise with pink noise or instrumental legato music.

We. 15:10 Arp 2 Application of psychoacoustics I

Psychoacoustic investigations on the efficiency of a vehicles' encapsulation in the underbody area

Christine Patsouras, Klaus Pfaffelhuber, Dimitrios Patsouras, Herbert Finsterhölzl, Michael Birnkammer, Rene Schönfelder
AKsys GmbH

As described in former investigations (Patsouras D. et al. Daga 2003) with new concepts of passive measures in a vehicles' underbody area good improvements can be obtained for the outdoor idling noise of Diesel powered cars. These concepts were realized by means of an upper middle class car. The differences in level reached by those measures served in the following as filter functions to simulate the measures for further outdoor idling noises. In particular for the power-enhanced version of this vehicle the possibilities of sound quality enhancements by passive measures should be studied in this way by means of psychoacoustic experiments. It appeared that in case of a consequent realization of the concept the sound quality of the power-enhanced version can actually get ahead of the sound quality of the standard one.

We. 15:30 Arp 2 Application of psychoacoustics I

Application of a psychoacoustic model for the determination of the psychoacoustic roughness of interior car sounds

Carsten Zerbs, Otto Martner
Müller-BBM GmbH

Besides the design and the optical appearance of a car also the interior sound is important for its perceived character. In order to quantify and to characterize the different factors contributing to the sound perception of a car and to explore the differences in the perceived image between listeners originating from a different origin, a hearing test was designed and carried out in Central Europe and North America. Test sounds from three driving modes had to be compared according to 12 different attributes within a paired tournament test. Altogether, 71 test subjects took part in the test. Test results were checked for concordance and interindividual reliability. A factor analysis (PCA) was performed on the average scale values within one driving condition. A comparison of subjective judgements and objective psychoacoustic parameters showed that the correlation between subjective roughness and the objective roughness was quite poor. A recently presented model (DAGA 2001), which considers the order structure of car sound, was employed to improve the correlation between subjective and objective psychoacoustic roughness.

We. 15:50 Arp 2 Application of psychoacoustics I

Perception of sound emitted by vacuum Cleaners

Jérémie Brocard, Etienne Parizet
Lab. Vibrations Acoustique, INSA Lyon - Bât. 303

The noise emitted by an object is a source of objective and subjective information. For instance, it is a way to know whether the system can correctly work or not (objective information) and to estimate its quality (subjective information). In the particular case of the vacuum cleaner, it is important to keep the subjective information related to the impression of power, and to minimize the annoyance linked to different criteria (sound pressure level, sharpnessoe) The purpose of these perceptive tests is to determine how listeners assess the impression of both the efficiency and annoyance of sounds in vacuum cleaners. A preliminary session of listening tests has shown that each of the 8 models of vacuum cleaners has its own tone. The position of the dummy head does not seem to influence the tone very much during the recording. Consequently, the recording position does not generate any confusion between different models, one position is freely chosen for all recordings. The task of each of the 61 subjects (aged 25 to 65) is to supply an estimation of both the annoyance and efficiency impression during the session of perceptive tests that follows. It is to be done on an absolute scale. The whole group can be divided into two sub-groups having their own estimation strategies on the impression of efficiency.

We. 16:30 Arp 2 Application of psychoacoustics I

Application of psychoacoustical models for speech intelligibility prediction

Birger Kollmeier, Thomas Brand, Kirsten Wagener, Rainer Beutelmann
Medizinische Physik

Hearing-Impaired listeners have tremendous communication problems in a cocktail party situation.This talk will review current models that predict cocktail party performance in normal listeners and also describe the degradation of performance in sensorineurally hearing-impaired listeners. The models can be validated by comparing human performance with numerical model predictions of auditory perception for normal and hearing-impaired listeners and with computer speech recognition.A good approximation of human auditory performance in cocktail parties seems to be an adaptive two- microphone array with a lossy dynamic compression followed by an optimum detector. A straight-forward implementation of this idea is the model by v. Hövel (1984) which

has recently been updated and applied to more complex acoustic situations in our lab. It employs a filterbank with independent Equalization- and Cancellation mechanisms in each frequency band that are numerically adjusted to optimize the signal-to-noise ratio at the output. Another important issue is the prediction of speech intelligibility in fluctuating noise as a function of the individual'sspeech reception threshold in quiet and in stationary noise (Wagener, 2003): The best prediction of human performance is obtained with a two-stage model of sentence recognition, where in a first stage the individual subunits of each word is perceived with a certain error probability. In a second stage, the recognized items are combined in a more or less faulty way to form the complete recognized words and sentences.

An Auditory Model for Coding Speech into Nerve-Action Potentials

Marcus Holmberg, Werner Hemmert
Infineon Technologies AG

Information coded within the spike-trains of auditory nerve fibres provides the basis for spectral, temporal, and spatial information processing at higher levels in the auditory pathway. Here we present an auditory model that codes audio signals into action potentials. A wave-digital filter models the inner ear and provides spectral decomposition. A phenomenological model of the active amplification of the outer hair cells compresses the dynamic range up to 80 dB, while matching the level-dependent shape of the active inner ear filters. Fluid forces, derived from basilar membrane displacement, deflect the inner hair cell (IHC) stereociliary bundle. The deflection opens ion channels and the resulting current triggers an IHC receptor potential, which in turn activates voltage-dependent calcium channels. The intracellular calcium concentration controls the fusion probability of vesicles close to the synapses. Fusing vesicles release neurotransmitter, which elicits action potentials in the auditory nerve fibre (ANF). Adaptation is caused by depletion of a pool of vesicles in the vicinity of the synapses (ready releasable pool) and ANF refractoriness. Tests with voiced speech show that formants, but not individual frequency components, are resolved in the ANF spike-trains. The representation conserves periodicity in the form of amplitude modulation with the fundamental frequency. Thus speech sounds are coded into a spatio-temporal pattern rather than a pure frequency-place code. The additional temporal information is thought to be important for speech intelligibility in noisy and reverberant environments.

We. 17:10 Arp 2 Application of psychoacoustics I

Psychoacoustics in Audiology: applications for diagnosis and treatment of hearing disorders

Uwe Baumann
LMU München/Klinikum Großhadern/HNO/Audiologie

One of the most important domains of applied psychoacoustic is the area of audiology. A wide variety of applications of psychoacoustical methods are employed to assess auditory dysfunctions as well as to achieve a satisfying fit of hearing aids or cochlear implants. The presentation will give an overview over basic audiological tools in use for differential diagnosis of hearing disorders and also address advanced methods such as loudness scaling or adaptive procedures to measure speech perception in quiet and in noise. Another important application of psychoacoustics can be found in the area of audiological research. As an example, some of our recently obtained results concerning pitch discrimination and sound quality estimations with cochlear implants will be presented.

We. 17:30 Arp 2 Application of psychoacoustics I

Finite Difference Time Domain Simulation of the Outer Ear

Sebastian Schmidt, Herbert Hudde
Institut für Kommunikationsakustik (Web: www.rub.de/ika)

The examination of sound field problems by using finite or boundary element calculations is well established. Usually a harmonic analysis is performed; for each frequency of interest a complete solution of the equation system is done. If systems having short acoustic impulse responses are to be investigated, time-domain calculations can be expected to be more efficient because complete frequency responses are obtained from a single impulse response calculation by taking the inverse Fourier Transform. In this project a finite difference time domain (FDTD) approach with centered grids is applied to wave propagation problems concerning the outer ear. This general class of FDTD formulations leads to fast algorithms. The model yields time functions of acoustic variables by straightforward discretisation of the wave equation. For each time step the evolution of the values is calculated at every node in the centered grids. In further processing stages transfer functions, radiation impedances, or chain matrix parameters are derived from the calculated results. The fundamental formulation of the model is based on orthogonal grids. It turned out that the accuracy can be impaired when irregular boundaries occur or if boundaries are inclined referred to the grid. To improve the accuracy voronoi cells are used near the boundaries.

This technique avoids the wave retardation observed for staircase boundaries. The current set of geometrical models includes various ear canals and natural and artificial (dummy head) pinnae. Results of ear canal calculations are shown, and the accurateness of the results is examined for different grid configurations.

We. 17:50 Arp 2 Application of psychoacoustics I

Hörgeräte mit verschiedenen Regel-Zeiten bei Verständlichkeitsuntersuchungen

Edward Hojan, Dorota Hojan-Jezierska, Hugo Fastl
Institut für Akustik Adam Mickiewicz Universität

Bemerkenswert ist, das die getragene Hörgeräte, bei Schwerhörigen noch vorhandene - normale Gehöreigenschaften, verschlechtern können; es ist zu vermuten das es sich hier von allen um Zeitauflösungsvermögen handelt. Es wird zu überprüfen sein, in wie weit diese Verschlechterung des Zeitauflösungsfaktors einhergeht und welche Sprachverständlichkeit von Schwerhörigen Personen, insbesondere bei Verwendung von Hörgeräten mit einstellbaren Stell - und Regelschaltungen, erzielt werden kann.

We. 18:10 Arp 2 Application of psychoacoustics I

Significance of Meaning in Sound Quality Evaluation

Alfred Zeitler, Wolfgang Ellermeier, Hugo Fastl
Sound Quality Research Unit, Dept. of Acoustics

There is wide agreement that perceptually-adequate sound evaluation has to encompass not only the sensory domain but also cognitive and emotional aspects of the auditory event. In particular, the meaning of a sound has been identified as an important factor in sound quality evaluation. The current investigation inquires into the significance of this factor for sound-quality judgements of various environmental and product sounds using a new signal-processing method which reduces the identifiability of sound sources substantially while preserving the loudness-time function [H. Fastl, ICA, Rome, 2001]. In contrast to a previous investigation [A. Zeitler, J. Hellbrueck & H. Fastl, DAGA 2003] that focussed on the effect of this type of signal processing on perceived loudness, the present study investigated the issue for perceived annoyance as well. In the first part of the experiment, four independent groups of subjects (N=25 each) responded on category-subdivision scales of loudness or annoyance to either the original or processed version of the signals. In the second part, subjects provided ratings of the stimuli on a concept-specific Semantic Differential. Results include analyses of the impact of source identifiability on loudness and annoyance judgements as

well as an investigation of these effects in terms of differences in the semantic profiles elicited by the sounds.

We. 8:30 Arp 3 Environmental noise and machinery noise II

Acoustic-signature-based determination of railway vehicule speed - application to tramways

Guillaume Dutilleux
Laboratoire Régional des Ponts et Chaussées

When characterizing the acoustic emission of transport vehicules, acoustic parameters must be linked with kinematics and speed in particular. Speed is usually obtained from a radar device. Unfortunately, the standard devices tend to be unreliable below 30 km/h. It is shown in the present paper that, in the case of railway vehicule, speed information can be recovered from a pass-by acoustic recording taken close to the axis the investigated vehicule moves along. This is made possible by the fact that events in the signature gives unambiguous spatial informations. The computation of speed is performed on short Leq time series. Different elaborate post-processings are considered. One is based on auto-correlation of the Leq signature that filters out parasitic signature irregularities. The other adopts a pattern matching approach. It involves a simple model of the acoustic signature. On experimental data, the first method gives good results but appears to be somewhat operator-dependent. The pattern matching approach proves to be more robust, although more time-consuming, due to the iterative matching process.

We. 8:50 Arp 3 Environmental noise and machinery noise II

Investigations into the Prediction of Construction Noise

Uwe Trautmann, Matthias Pötter
AIT Ingenieurbüro Dr. Trautmann GmbH

Residents are often exposed to a considerable noise impact from inner-city building sites. To shorten construction times, reduce construction costs and perform technologically indispensable works, there is always an interest in performing building work even during resting hours. Construction-noise prediction provides the basis for a special permit to be granted by the competent authority. New investigations are presented, which allow to improve the agreement between predicted and measured rating levels by considering in detail the different times of use of the individual machines.

We. 9:10 Arp 3 Environmental noise and machinery noise II

Distribution Relations of Sound Emission, Propagation and Immission and Effects on the Uncertainty of Sound Immission Calculation and Measurement

Alois Heiß
Bayerisches Staatsministerium für Umwelt, Gesundheit und Verbraucherschutz

By currently valid standards in the field of sound impact assessment there is an increasingly demand for quality management. In this context the sound level distributions are important elements as the uncertainty of descriptors taken for prognosis or measurement of sound immissions are determined significantly by the structure of their probability distributions. This is reason that the available discussion papers on this topic are supplemented by a quite systematic resume of the distibution interactions of emission and propagation. Based on the distributions as for the emission as for the attenuation on propagation path, the sound level distribution created at immission site is here described explicitely in a quite general manner and is illustrated by representative calculations. The distributions used are founded on physical reasons and on common measurement experience. This procedure allows to examine easily the quite frequently claimed normal distribution in sound pressure level space on its probably still tolerable deviations from reality. This is of interest because the acceptance of a strict normal distribution hypothesis seems to be inadequate: The superposition of two normal sound pressure level distributions runs in intensity space and for this reason the resulting distribution cannot exactly be a normal distribution. The aspects following from this for acceptable approximations in the assessment practice are outlined. In addition, for presentation of the uncertainty of energy equivalent mean levels based on small samples, especially from very assymmetric parametric intensity distributions, a computer based bootstrap procedure, without using the variance by common definition, will be discussed.

We. 9:30 Arp 3 Environmental noise and machinery noise II

Correlation of sound pressure squared and sound intensity signals investigated for different positions of a measurement surface in the field of sound sources

Gerhard Hübner, David Kandelaki
Universität Stuttgart

The sound power of technical sound sources such as machines or equipment can be determined by measurements of the time averaged sound pressure squared or respectively by the sound

intensity both taken over a surface enveloping the source usually taken at N discrete measurement positions. From these data the spatial mean values pressure squared respectively the spatial mean intensity are to be calculated where the "quality" of this mean value and simultaneously that of the yielded sound power depends from the number N of these positions for a given sound field situation. Describing this "quality" by a certain span of its uncertainty the question arise how many positions N are necessary to fulfill a certain given accuracy requirement. A relevant rule for this determination issued by relevant ISO-Standards is based on statistical rules assuming non-correlated signals of the measured quantities. The paper presents results both of experimental and theoretical correlation investigations, where the objects for the sound pressure measurements are sources radiating structure borne and airborne noise. The theoretical investigations are focused as well as on sound pressure squared and intensity sound fields generated by baffled plates in "usual" measurement distances. This investigation is a first step for establishing a rule for the determination of number of measurement positions N guaranteeing a sound power value within a certain limit of uncertainty for practical situations.

We. 9:50 Arp 3 Environmental noise and machinery noise II

German Calculation Procedure for Aircraft Noise Exposure

Heinz-Dieter Marohn, Thomas Myck
Umweltbundesamt Berlin

German Calculation Procedure for Aircraft Noise Exposure Heinz-Dieter Marohn, Thomas Myck Federal Environment Agency Berlin In 2002 the European Parliament and the Council adopted the Directive on Environmental Noise. According to this Directive common noise indices (Lden and Lnight) must be used for the production of strategic noise maps. The European Commission strives for common methods for determination of these indices. Due to the fact that common methods are not available at present the directive contains interim computation methods for different noise sources. For aircraft noise the European Commission recommends an interim computation method which is primarily based on ECAC.CEAC Document 29 and is completed in some points. Until the use of common assessment methods for the determination of Lden and Lnight is made obligatory, Member States may use their own noise computation methods. The results of the chosen national computation method have to be equivalent with those of the interim method. Germany intends to use modified national noise calculation procedures. In the field of air traffic it is planned to adapt the national instructions for the calculation of noise protection areas ("AzB") to the requirements

of the Directive. This comprises in particular the adoption of Lden and Lnight as well as the proof of the equivalence of the results. The modified AzB calculation procedure corresponds largely to the interim aircraft noise calculation method and goes partially beyond it. For these reasons no difficult problems in demonstrating the equivalence of the results are expected.

We. 10:10 Arp 3 Environmental noise and machinery noise II

Sound Power of Construction Machines: Declared Values vs. In-Situ Measurements

Uwe Trautmann, Meike Peters
AIT Ingenieurbüro Dr. Trautmann GmbH

In accordance with EU Directive 2000/14/EG, construction machines must be labelled with a noise declaration. Furthermore, this directive also specifies limiting values for the maximum permissible sound power level of various construction machines, which are sometimes difficult to comply with. For selected earthmoving machines, the declared sound power (determined in accordance with the standard) has been compared with that measured in situ in order to - estimate the contribution of the working process to the overall noise and - obtain realistic input data for ambient-noise predictions. An attempt is being made at quantifying various measurement and operating parameters so as to explain differences between standard and in-situ measurements.

We. 10:30 Arp 3 Environmental noise and machinery noise II

Auf der Suche nach dem höchsten Beurteilungspegel

Berthold Vogelsang
NLÖ

In der Auseinandersetzung zwischen Anlagenbetreibern und Anwohner im Rahmen des akustischen Immissionsschutzes wollen alle Beteiligten ihre 'Ruhe' haben. Die Wege dorthin unterscheiden sich je nach Interessenslage mitunter erheblich. Während Anlagenbetreiber für beschleunigte Genehmigungsverfahren oder wenigstens für die Streichung einer Spalte in der 4. BImSchV starke Sympathien zeigen, fordern Anwohner vehement eine 'worst-case' Betrachtung bei der Beurteilung der Störwirkung statt der heute festgelegten Mittelung. Dies gilt insbesondere bei der Genehmigung von Flugplätzen. Die Gerichte unterstützten durchweg die Anwohner in ihrem Anliegen des Schutzes vor einer erheblichen Belästigung: Die Ermittlung der Geräuschbelastung habe auf der 'sicheren Seite' zu liegen. So fordert z.B. die TA-Lärm für alle Anlagen in ihrem Anwendungsbereich, die bestimmungsgemäße Betriebsart zu ermitteln, die den höchsten Beurteilungspegel erzeugt. Sofern verschiedene

solcher Betriebsarten im Hinblick auf die Lärmbelastung ununterscheidbar sind, tritt kein Problem auf. Welche Betriebsart ist aber einer Genehmigung zugrunde zu legen, wenn die Anlage deutliche, wetterbedingte Schwankungen aufweist, auf die der Anlagenbetreiber keinen Einfluß hat? Bei Flugplätzen konkurrieren mehrer Antworten auf diese entscheidende Frage: beispielsweise die Berücksichtigung nur der 6 verkehrsreichsten Monate im Prognosejahr oder die Verwendung der 100%- Regelung oder die Zugrundelegung der Bahn- oder Umweltkapazität. Der Beitrag entwickelt auf Basis der besonderen Regelungen der TA-Lärm einen einheitlicher Lösungansatz. Dieser Lösungsansatz wird exemplarisch an Windenergieanlagen, Badeanstalten und Flugplätzen vorgestellt und diskutiert.

We. 13:50 Arp 3 Environmental noise and machinery noise II

Zur Wahl des maßgeblichen Immissionsortes unter Berücksichtigung der Phänomene der Bodenreflexion

Berthold Vogelsang, Karl-Wilhelm Hirsch
NLÖ

Die Wahl des Messortes für eine Schallimmissionsmessung aber auch die Wahl der Höhe der Immissionspunkte bei der Ermittlung von flächenhaften Gerduschbelastungen wird häufig durch praktische Erwägungen bestimmt. Die in älteren oder auch noch gültigen Normen niedergelegte Vorschrift, 0,5 m vor dem geöffneten Fenster und oder in 4 m Höhe zu messen, ist einerseits der Begründung nach (Vermeidung von Gebäudereflexionen) schwach, solange es sich um mittlere bzw. tiefe Frequenzen handelt, andererseits aber auch völlig unpraktisch, da heute mehr Langzeitmessungen gefordert werden, um den geforderten Aussagen zur Qualität der Ergebnisse hinreichend gerecht zu werden. Bei der Berechnung von Schallimmissionsplänen ist es häufig die Rechenzeit und der Dokumentationsaufwand oder die pauschale Forderung nach Vergleichbarkeit, die die Wahl des Immissionshöhe auf eine einzige Höhe beschränkt. Der Vortrag möchte im Hinblick auf die Einflüsse der Bodenreflexion aufzeigen, welchen Einfluss die Empfängerhöhe auf den Immissionspegel haben kann. Dies wird anhand von Messungen und Modellrechnungen exemplarisch an mehreren Beispielen wie Windenergieanlagen, Knallen und Vorbeifahrten bzw. überflügen dargestellt.

We. 14:10 Arp 3 Environmental noise and machinery noise II

On the Accuracy of Sound Power Determination for a Given Level Distribution

Gustav Sehrndt
Beratung zur Lärmminderung

Some investigations of the errors of the machinery sound power determination from either sound pressure or intensity measurements are based on the assumption of its independence and random distribution. It can be shown that the accuracy for a given level distribution depends on the density of microphone positions on the measurement surface related to the other errors.

We. 14:30 Arp 3 Environmental noise and machinery noise II

Die europäische Umweltlärmrichtlinie - Das deutsche Berechnungsverfahren für Lärmbelastung durch die Industrie

Matthias Hintzsche
Umweltbundesamt Berlin

Die Europäische Kommission ist bei der Umsetzung der europäischen Umweltlärmrichtlinie auf die Besonderheiten der einzelnen Staaten eingegangen. So ist es z. B. möglich die genaue Lage und die Dauer der Beurteilungszeiträume entsprechend den nationalen Gegebenheiten anzupassen. Liegen nationale Berechungsmethoden zur Ermittlung der Beurteilungspegel bereits vor, können diese nach Anpassung weiter verwendet werden. Im Rahmen dieses Beitrages soll der aktuelle Stand der Umsetzung der europäischen Umweltlärmrichtlinie und die nationalen Besonderheiten im Bereich des Industrielärms beschrieben werden.

We. 14:50 Arp 3 Environmental noise and machinery noise II

Optimising Ergonomic and Acoustic Design of Hand-held Sound Level Meters

Julian Simpson, Douglas Manvell, Lars Kroman, Helge Larsen, Erling Olsen
Brüel & Kjaer Sound and Vibration Measurement A/S

Hand-held instruments are, by their very nature, used in the hand by humans. Genetic mechanisms make sure that all humans and their hands are different; not an ideal situation for a hand-held instrument designer who would prefer clones with the same outlook in life. However, in recognition of the fact that individuality exists, a research group investigated the expectations of potential and current hand-held instrument users, and the findings were used to construct a new form of sound level meter (SLM). The paper describes how a series of 'Panel of Experts' workshops

were used to arrive at two central demands from users for hand-held instrument design - robustness (proof against dust, water, humidity etc.) and practicality in all work situations - and how these demands were used, via physical and mathematical modelling tools, as guides to optimise the often conflicting ergonomic design and IEC 61672 acoustic performance criteria. This paper also describes how, through the use of new shapes and materials, an SLM was created to fulfil the design goals to make it easier, quicker and safer for all user groups to conduct measurement assignments.

We. 15:10 Arp 3 Environmental noise and machinery noise II

Low-Noise Circular Saw Blades

Jürgen Maue, Ralf Hertwig
BIA - Berufsgenossenschaftliches Institut für Arbeitsschutz

The high noise emissions from circular saws frequently represent a major impact in different branches of industry. In many cases the noise exposure of employees can be reduced substantially by using low-noise circular saw blades. Until now the low-noise saw blades available on the market have generally been used rather seldom in industry which possibly can be explained by lack of information. Therefore the BG-Institute for Occupational Safety and Health has started a project to determine the scope for the use of low-noise circular saw blades and the potential noise reductions, and to develop a manual for noise control of circular saws suitable for practical application. Based on a market survey of low-noise circular saw blades numerous comparative noise measurements were performed under different working conditions, cutting wood, aluminium and plastics, both in-plant and in the laboratory. The first results of this project are presented.

We. 15:30 Arp 3 Environmental noise and machinery noise II

Exigence of Sound Insulation Measures in the Vicinity of Airports and Traffic Routes

Heinrich Metzen
DataKustik GmbH

In noise mapping projects, the assessment of the noise levels is intended to result in actions to reduce the noise impact for the inhabitants in the investigated area. This aim has already been part of national regulations on noise immission maps and is emphasised by the EC-directive on Environmental Noise. Possible actions comprise besides traffic and land-use planning, measures at the sources also the reduction of sound transmission by improving the sound insulation of facades of buildings. This objective can be handled by software techniques evaluating the facade levels and the sound reduction index of the facade elements. For

rough estimations the performance of windows is used to assess which buildings in the area need further treatment or even a complete reinstallation. When a more detailed study is required the building facade composed of different parts (e.g. facade, window, air intake) can be modelled in detail making use of the outdoor level as calculated with the noise mapping software. This procedure is quite useful when national building regulations specify a maximum or mean indoor level as performance parameter. This paper discusses strategies and techniques focussing on noise mapping projects in the vicinity of airports and traffic routes.

We. 15:50 Arp 3 Environmental noise and machinery noise II

Wind turbines: Statistical parameters characterising noise emission and noise impact

Dr. Sergio Martinez
TüV Rheinland

According to TA Lärm (Noise Protection Guidelines according the Immission protection law of Germany) it has to be shown, that the noise level of wind energy plants meets the standard limits (TA Lärm) in the neighbourhood e.g. after putting into operation of new wind turbines or increasing the number of plants of a wind park. Therefore noise measurements will be made close to the plants and the noise power level calculated (emission measurements). With the (in situ) measured noise power level the rated levels at the impact points will be calculated. Direct measurements of the noise impact levels mostly turn out to be difficult because of the high wind velocities near the ground required for the rated power. Additionally it cant be required to measure the sound impact. These measurements should be made simultaneously to the emission measurements. The difficult measurement conditions necessarily lead to higher measurement uncertainties. A sufficient time window has to be provided were the wind turbines are completely switched-off. The measurement task can be statistically attributed to an inversion of the (mathematical) convolution of connected distributions. The wind turbines-specific distribution of noise emission and impact can be approximately reconstructed and the characteristic quantities of noise emission and impact can be derived.

We. 16:30 Arp 3 Environmental noise and machinery noise II

Akustische Linsen, Einsatz als offene Lärmschutzwände? - Untersuchungen an Modell-Linsen -

Michael Chudalla
Bundesanstalt für Straßenwesen

In der Halle für akustische Modelltechnik der Bundesanstalt für Straßenwesen wurden Messungen an im Maßstab 1:8 linear

aufgebauten akustischen Linsen (Umweglinsen) durchgeführt. Umweglinsen bestehen aus schräg zur Ausbreitungsrichtung angeordneten Lamellen unterschiedlicher Länge. Untersucht wurde die Lage der Brennpunkte verschiedener Frequenzen und die Abstrahlcharakteristik bei zwei unterschiedlichen Abständen zwischen Schallquelle und Linse. An den untersuchten Linsen wurden die Lamellenwinkel und -abstände (Anzahl an Lamellen) variiert. Es wird über erste Erfahrungswerte berichtet, ob ein Einsatz solcher Linsenaufbauten als offene Lärmschutzwände oder Aufsätze auf Lärmschutzwände möglich sein könnte.

We. 16:50 Arp 3 Environmental noise and machinery noise II

Aircraft Noise Annoyance at 5 German Airports

Joachim Kastka
Universität Duesseldorf

Noise Annoyance Reactions to Aircraft Noise of 6746 Residents at 5 German Airports (Frankfurt, Düsseldorf, München, Köln, Hamburg) were sampled by standardized Telephon-Interview-Technique at 220 sample points beween 1985 und 2001. Aircraft-Noise-Immission-Data (Leq3_Day , Leq3_Night, NAT70_day, NAT70_night) of the sample points were computed by Noise-Immission-software CADNA and Data of Aircraft Movements definded by the DES (Datenerfassungssystem) of the Airport Authorities.The Data give the impression of a general Dose-Response-Relation forr most of the Airports. Time of Day, Indoor/Outdoor Position of Resident and Position of Windows (Open/closed) are importand determinants of the Global Annoyance Reaction Results lead to the conclusion, that global annoyance is a rather indifferent and in some case misleading concept. Data analysis revealed a number of problems using the 28% cut_off for the defintion of Highly-Annoyed-Criteria Schultz), which seems to suffer under a proper conceptual background.

We. 17:10 Arp 3 Wave field synthesis I

Spatial Perception in WFS Rendered Sound Fields

Günther Theile
Institut für Rundfunktechnik

Modern convolution technologies offer possibilities to overcome principle shortcomings of loudspeaker stereophony by exploiting the well-known Wave Field Synthesis (WFS) concept for rendering virtual spatial characteristics of sound events. Based on the Huygens principle loudspeaker arrays are reproducing a synthetic sound field around the listener, whereby the dry audio signal is combined with information about the room and the source's position to enable the accurate reproduction of the source within its acoustical environment. Recent developments have shown

that a number of applications could be possible in the near future. However, they have also shown that basic and practical constraints of WFS systems limit the rendering accurateness and the perceived spatial audio quality to a certain degree, dependent on characteristic features and technical parameters of the sound field synthesis, such as spatial aliasing, effect of reflections of the reproduction room, restriction to the horizontal plane, limitation of array dimensions (diffraction effect), occlusion effects, etc. Psychoacoustic studies are necessary to evaluate the resulting impacts on attributes of spatial perception not only with respect to the development of WFS systems but also in view of scientific knowledge. Particular attention should be turned to the perception of direction, distance, spatial depth, spatial perspective, spatial impression, reverberance, and envelopment. The following papers in this structured session will highlight some of these aspects and already provide preliminary conclusions on the possibilities and limits of WFS applications.

We. 17:30 Arp 3 Wave field synthesis I

On the Audibility of Spatial Reflection Changes in Relation to WFS

Marinus Boone, Hiske Helleman
Delft University of Technology, Laboratory of Acoustic Imaging and Sound Control

The WFS-principle is very well suited for sound rendering over a large listening area without the limitations by a sweet spot. Even with the simplification of using line arrays of loudspeakers, the resulting 2.5-D solution gives reliable results in many situations. Source directions are maintained correctly as a result of the accurate wave front and distance perception by the addition of spatially correct reflection and reverberation patterns. In relation to the latter an important question is how accurate the recording or synthesis of spatial reflections and reverberation must be for a perceptual transparent reproduction with WFS. A preliminary study has been carried out to find the threshold of audibility of spatial variations in the position of a single reflection. It was found that the minimum audible distance variation of a single reflection is 1 - 2 m, or 5 - 10 degrees, depending on the spatial configuration, and whichever is the largest. From that result preliminary conclusions can be drawn about the necessary resolution in recording and synthesis of reflection patterns for WFS rendering.

Th. 8:30 Schweitzer Silencers

Acoustic Properties of Aluminium Foams - Measurements and Modelling

Waldemar Maysenhölder, Andrea Berg, Philip Leistner
Fraunhofer Institut Bauphysik

The cylindrical aluminium-foam samples investigated are the result of a high-pressure die-casting process around a sintered polymer-granulate compact. These porous materials possess a porosity around 60% and specific flow resistance between 3 and 10 kPas/m^2. Sound absorption and transmission at normal incidence and the insertion loss of a silencer have been measured. Two theoretical models - a corrected and extended version of the model of Lu, Chen and He and the variants 'Simplified' and 'Extended' of Wilson's model - have been used for fitting and analysing the experimental data. The agreement with some absorption measurements is quite satisfactory with both models. However, Wilson's model, which has some advantages in general and also in particular with respect to porosity and flow resistance, is preferred. It helped to explain the orientation dependence of the absorption as an effect of a slight inhomogeneity of the samples. Its validity has been further checked against absorption measurements with an empty cavity behind the sample. Approximate empirical relationships between the fitted model parameters and the measured properties porosity and flow resistance may serve as a (preliminary) prediction tool. Finally, calculated transmission and insertion losses obtained with the previously fitted model parameters are discussed.

Th. 8:50 Schweitzer Silencers

Panel resonator and slot absorber silencers for low and mid frequencies

Robert Hanisch, Norbert Rambausek, Peter Brandstätt
Fraunhofer Institut Bauphysik

New resonance type silencers designed for the low and mid frequency range in industrial applications as splitters and duct linings are presented. The silencers are characterized by their slim body with low pressure loss and good protection against exhaust air impacts. Working principle, application examples and insertion loss measurements are presented verifying the enhanced performance in the frequency range of interest.

Th. 9:10 Schweitzer Silencers

Noise reduction at heating system exhaust pipes
Peter Brandstätt, Karlheinz Bay, Günther Fischer
Fraunhofer Institut Bauphysik

New burner technologies in house heating systems and power stations have increased the efficiency of gas and oil consumption but also led to an increase of the noise levels in the exhaust pipes, mainly in the low and mid frequency range. As new regulations for noise in the neighborhood are discussed, silencers gain increasing importance. The paper will present the working principle of various new silencer developments together with measurements and installation examples at existing systems.

Th. 9:30 Schweitzer Silencers

Rohrschalldämpfer mit ovalen und rechteckigen Querrschnitten
Ulrich Ackermann, David Bergand, Christian Müller
Fachhochschule Südwetfalen

Rohrschalldämpfer mit ovalen und rechteckigen Querschnitten lassen sich besser in flache Kanäle einbauen. Diese Schalldämpfer lassen sich aber nur dann preisgünstig herstellen, wenn sie aus runden Rohren gedrückt werden können. Aluminium als Werkstoff reißt aber beim Drücken leicht. Die Rohrschalldämpfer wurden deshalb nicht nur akustisch optimiert, sondern auch fertigungstechnisch.

Th. 9:50 Schweitzer Silencers

'Surface radiated noise from exhaust systems - Structural Transmission Loss test rig'
Jan Brand, Dirk Wiemeler
Tenneco Automotive, Heinrich Gillet GmbH, Acoustics Competence Center

The sound radiation from exhaust systems can be divided into three categories: The tailpipe noise, the noise transmitted through the hanger and the surface radiated noise. The radiation from the tailpipe influences the pass-by test as well as the radiation from other sources like the engine and the wheels. The surface radiated noise and the noise transferred through the hanger generally do not influence the pass-by test but they represent a subjective noise problem. Measurements of surface radiated noise from exhaust systems currently require two rooms: one to isolate the engine against the exhaust system, and another, an anechoic chamber, to measure the radiated noise. The results are the radiated sound pressure or the sound power. These results depend on the noise source as well as on the geometry of

the surroundings. This paper deals with an innovative measurement procedure for radiated sound power which is independent of the geometry of the surroundings and the source. The measurement still requires an anechoic chamber but no extra facilities to house an engine. A simple speaker serves as the noise source. The measurement result is a transfer function of the structure. Noise mapping is possible as well as the calculation of the modal damping. Using this test rig it is also possible to separate air resonances from structural resonances. This test rig is not meant to replace the acoustics engine test rig, but to complement it.

Th. 10:10 Schweitzer Silencers

A Single-Run Method to Evaluate Sets of Mode Solutions in Lined Ducts

Fridolin Mechel
F.P. Mechel

The sound field eva1uation in lined ducts by moda1 ana1ysis requires solutions of the characteristic equation for the mode propagation constants of a set of modes (mode solutions). They must be · precise (i.e. nulling the characteristic equation-down to a small magnitude), · complete (i.e. no solution missing in a finite set), · unambiguous (i.e. no solution appearing repeatedly). Existing methods need 'starters' (approximate solutions) for the numerica1 solution of transcendental, complex equations. The starters must be a set of a1ready rather precise, and complete approximations, otherwise the equation solver risks to jump to unwanted solutions. Existing methods eva1uate one mode solution in one run. The proposed method is based on the fact, that the transcendental functions in the characteristic equations for modes in lined ducts can be expanded as continued-fractions with the square z2 of the wanted wave number as argument. The continued-fraction representation converges in the whole complex plane of z , except in poles on the rea1 axis (which belong to modes in soft-wa1led ducts). Terminating the continued-fraction at a finite depth of expansion, and collecting in a fraction with a common numerator N(z2) and denominator D(z2) will transform the characteristic equation to a polynomia1 equation in z2 . The solution of polynomia1 equations, even of high degree (z2)n , is a standard task of numerica1 mathematics. The set of mode solutions can be identified by simple criteria in the larger set of polynomia1 solutions.

Th. 10:30 Schweitzer Silencers

Calculation of Silencer with Circular Cross Section and Centre Body

Ulrich Kurze
Müller-BBM GmbH

Based on broad experience many computer programmes are available for the design of silencers. The more precise determination of the effects of dimensions, materials and operating conditions requires the solution of the wave equations with boundary conditions for sound absorbing walls. The simple geometry of a circular silencer results in Bessel functions, which contain the propagation constant in implicit form. Methods for determining explicit solutions have been the subject of various investigations over the last decades. Special problems arise when the flow profile shall be considered and - as for tubular silencers with centre body - when the boundary conditions are non-symmetrical. Extending former investigations on rectangular ducts, potentials are described resulting from the solution of finite difference - rather than differential - equations for four points in the cross section of the flow duct. Results obtained from such calculations are compared with those from other calculation procedures and from measurements.

Th. 13:50 Schweitzer Audiovisual interaction

Detecting and Using Temporal Correlations between Random Sequences of Auditory and Visual Events

Armin Kohlrausch, Steven Van De Par
Philips Research Eindhoven

In a first series of experiments, we created stimuli with 2 to 20 short audio-visual (AV) events (moving white disk on a computer screen, short tonal signal with Gaussian envelope), randomly distributed over an interval of 2 s. The timing relation between audio and video for the individual events had a certain amount of random variation (jitter). Subjects had to discriminate AV sequences without any temporal jitter from those containing a certain amount of jitter. Subjects turned out to be highly sensitive to detect small amounts of jitter between the A and V (thresholds as low as 20 ms), and thresholds were lowest if the sequences consisted of 5 to 10 individual pulses. This sensitivity to jitter was not affected by an additional constant overall delay between the whole audio and video sequence of up to +/- 100 ms. In a second series of experiments, we presented 2 to 6 random visual sequences in parallel, each made up of 20 short events occuring within a time span of 6 s. Simultaneous with the video images, a sequence of audio events was presented which had the same timing as

one of the visual sequences. The task of the subject was to select, as quickly as possible, that visual sequence corresponding to the audio sequence. The necessary time for correct selection increased roughly linearly with the number of simultaneous visual sequences, being 1 s for two sequences and 2.6 s for six sequences. This result is in line with a serial search model.

Th. 14:10 Schweitzer Audiovisual interaction

Cross-modal Effects of Visual Information on Auditory Presence

Kenji Ozawa, Yoˆ Iti Suzuki

Interdisciplinary Graduate School of Medicine and Engineering, University of Yamanashi

Two experiments were conducted to investigate the effects of visual information on auditory presence. (Presence is defined as the subjective experience of being in a specific place or environment, even when one is physically situated in another.) Seventeen sounds, e.g. a sound of a train passing and a sound of the engine heard in a moving car, were binaurally recorded via a dummy-head, and the corresponding moving pictures were recorded using a digital video camera in live situations. The experiments were carried out using Scheffe's method of paired comparison with eight subjects. In Experiment 1, only sounds were presented to the subjects via headphones. Two sounds, randomly selected from the seventeen sounds, were presented sequentially. The subjects compared the two sounds in terms of their auditory presence, and gave rating judgment on a seven-point category scale. In Experiment 2, both sounds and moving pictures with 50-inch display were presented to the subjects. The experimental procedure was the same as that of Experiment1: The subjects were asked to evaluate the auditory presence irrespective of the quality of the moving pictures. A scaling procedure was applied separately to the data obtained in the two experiments. Comparison between the results of the two experiments revealed that auditory presence showed a marked change if the corresponding moving picture gave information on the original sound field correctly such as when the sound source appeared in the picture. Moreover, the auditory presence was clearly enhanced when visual objects in the picture moved.

Th. 14:30 Schweitzer Audiovisual interaction

Cross-modal Interaction Between Aural, Tactile, and Visual senses: Sound Quality Evaluation Using the Virtual Aircraft

Daniel Västfjäll

Department of Applied Acoustics, Chalmers Univ of Tech

The present researched examined cross-modal interaction in interior aircraft sound quality evaluation. Previous research has mainly studied uni-modal (auditory or tactile) or bi-modal (audio-tactile) perception. The present study examines the perceptual effects of sound, vibration, and visual input presented simultaneously (multi-modal perception). A virtual aircraft for reproduction of a visual environment, binaural sound, and lateral vibrations was constructed and used in an experiment. Sixteen participants judged their reactions to- and rated perceptual qualities of twelve different sound, vibration, and picture combinations included in the principal study design. The results showed strong cross-modal interactions. Inconsistent with some previous research, a subtractive interaction was obtained where annoyance decreased with increase in modalities involved. The findings are discussed in terms of a perceptual process explanation, the cognitive capacity hypothesis, that suggests that multiple stimulus input may limit peoples' cognitive resources, thereby resulting subjective estimates different from those obtained when judging stimuli in isolation.

Th. 14:50 Schweitzer Audiovisual interaction

Audio-Visual Experiments on a Life-Size Videoconferencing System Combining Spatialized Audio and 2D Video Projection

Werner De Bruijn, Marinus Boone

Philips Research Eindhoven

Spatialized reproduction of audio can in general greatly enhance the feeling of 'presence' for an audio-visual system such as a life-size videoconferencing system. A very realistic spatialized audio reproduction, including a realistic reproduction of acoustic source distance, can for instance be obtained with the technique of Wave Field Synthesis. When such a sound reproduction technique is combined with conventional 2D video projection, this has effects on the resulting audio-visual experience of observers, which are not very easy to predict because of the complicated mechanisms of audio-visual interactions that are involved. Also, not all these effects are necessarily positive. Specifically, a mismatch between perceived auditory and visual source directions may occur for observers that are not in the ideal viewpoint of

the 2D video projection. This paper presents a series of subjective experiments that have been carried out to investigate these effects in the context of a life-size video conferencing system. Issues that were investigated include the need for vertical source resolution, correspondence of auditory and visual source positions, audio-visual source identification and overall impression of 'realism' of the audio-visual reproduction. Results show that the non-identical perspectives of the audio and video reproductions indeed have a significant influence on subjects' evaluation of the total system and care has to be taken in the design of such audio-visual systems to avoid problems. A simple way to avoid severe problems is presented as well.

Th. 15:10 Schweitzer Audiovisual interaction

Eliciting adaptation to non-individual HRTF spectral cues with multi-modal training

Alan Blum, Brian Katz, Olivier Warusfel
OmniHead

This paper presents the results of a series of tests which examine the ability of subjects to adapt to non-individual Head Related Transfer Functions (HRTFs) in the context of auditory localization. Binaural presentations using the HRTF are currently limited in quality due to individual differences in the HRTF which are based on morphological variations between subjects. In contrast to studies involving adaptation methods for generating individualized HRTFs, this study concerns the ability of subjects to adapt to non-individual HRTFs through a short interactive training experience. Two groups were evaluated in the study, one using non-individual HRTF spectral cues with individual Inter-aural Time Difference (ITD) and a second control group using individual HRTFs. Subjects were blindfolded and the binaural rendering was performed using IRCAM's Spat software. Each subject passed two localizations tests separated by a 10 min training session. The training session was presented in the context of a search-game where subjects displaced a virtual sound source (linked to the position of the subject's hand via a tracking system) to locate various virtual sound targets, all rendered binaurally. Results show that localization performance improved for the group using non-individual HRTFs, leading to errors comparable to the control group, while little improvement was found for the control group. This indicates that the improvement is not linked to the training session in general, but to a perceptual adaptation to non-individual HRTFs. Rapid adaptation to non-individual spectral cues has been shown to be possible using multi-modal interactions, in this case proprioceptive and auditory associations.

Th. 8:30 Schuman Ultrasonic transducers I

Broadband Amplitude and Phase Calibration of Hydrophones and Impulse Deconvolution within Diagnostic Ultrasound Exposimetry

Volker Wilkens, Christian Koch
Physikalisch Technische Bundesanstalt, FB 1.6 Schall

Reliable measurement of ultrasonic pressure fields requires hydrophones calibrated in a broad frequency range. A secondary hydrophone calibration technique using an optical multilayer hydrophone as the reference is described. The optical hydrophone offers high lateral resolution and a constant frequency response in a remarkably broad frequency range (1 - 75 MHz). By measurement of broadband ultrasound pulses with the optical hydrophone, and in a second step with the hydrophone to be calibrated, the complex-valued frequency response is obtained in a very fast, simple, and efficient way in a broad frequency range with high frequency resolution. The technique is applied to calibrate both a piezoelectric membrane and a needle-type hydrophone. The calibration data obtained can be applied to significantly improve hydrophone measurement results. This is demonstrated by exposure measurements on a typical diagnostic ultrasound machine. The standard pulse parameters such as positive peak pressure p+ and rarefactional peak pressure p- obtained by the commonly applied evaluation method using the voltage to pressure transfer factor at the acoustic working frequency M(fawf) are compared with those obtained by pulse deconvolution using the complete broadband complex-valued transfer function M(f). The membrane hydrophone is shown to systematically overestimate p+, underestimate p-, and overestimate the pulse intensity integral PII if no broadband conversion is applied. Using a deficient needle-type hydrophone all pulse parameters were dramatically overestimated due to strong variations of the frequency response, but the results could be improved to a large extent using the broadband conversion method made possible by the pulse calibration data.

Th. 8:50 Schuman Ultrasonic transducers I

Properties of acoustic waves guided by internal interfaces in piezoelectric crystals

Alexander Darinskii, Manfred Weihnacht
Institute of Crystallography, Russian Academy of Sciences

The paper discusses the properties of the interface acoustic waves (IAW) guided by an interface inside piezoelectric media. The interfaces of two types have been considered. 1) Infinitesimally thin metallic layer inserted into homogeneous piezoelectric crystal of arbitrary symmetry. 2) Rigidly bonded crystals whose

piezoelectric moduli differ by sign while the other material constants are identical; in this case, our analysis applies to the crystals of the lowest crystallographic symmetry allowing the fabrication of the structure desired, specifically, groups 2 and m. A number of general theorems has been proved regarding the existence of IAW propagating slower than bulk waves. In particular, a sufficient condition for the existence of such "slow" IAW has been derived. The propagation of leaky IAW has been studied. A special attention has been paid to the analysis of the situation when the imaginary component of the leaky IAW velocity vanishes, resulting in the appearance of non-attenuating IAW travelling faster than the slow transverse bulk wave. The branches of these "fast" IAW have been found out in LiNbO3 and LiTaO3. A comprehensive study has been made of the bulk wave reflection from the above interfaces. Analytical expressions for the coefficients of mode conversion have been derived. An analysis has been carried out of specific singularities arising for the angles of incidence corresponding to the resonance excitation of leaky IAW. The conditions for the occurrence of the resonance total reflection have been established. The computations performed for LiNbO3 and LiTaO3 illustrate general conclusions.

Th. 9:10 Schuman Ultrasonic transducers I

Acoustic wave measurements on SNGS crystals and determination of material constants

Eduard Chilla, Reinhard Kunze, Manfred Weihnacht, Joachim Bohm, Robert Heimann, Margitta Hengst, Ulrich Straube
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Single crystals of compounds with Ca3Ge(Ga2Ge)Ge2O14 (CGG) structure, have been discussed as promising new materials for SAW devices. Since they belong to the same trigonal symmetry group 32 as quartz, similar acoustic properties can be expected. Indeed it has been confirmed that the langasite-type crystals LGS, LGN, and LGT may have potential SAW applications. In particular, temperature compensated crystal cuts were proved. Recently compounds of 4 component congruent melting compositions have caught big attention. Within this class of materials Sr3NbGa3Si2O14 (SNGS) is of particular interest since a high electromechanical coupling factor is expected. Here we report on results of the material properties of SNGS. A starting set of elastic constants was derived from bulk wave measurements. Additionally, the angular dispersion of surface guided acoustic modes was measured. The surface acoustic waves were excited by thermo-elastic laser absorption. The normal component of the surface wave was detected by a piezoelectric PVDF foil transducer. The angular dependence of the velocity was obtained by

mounting the sample on a computer controlled rotation stage. Additionally the temperature dependence was measured in the range between -10 °C and + 75°C. Furthermore we report on direct measurements of the SAW coupling coefficient.

Th. 9:30 Schuman Ultrasonic transducers I

Ultrasonic Transducers for Matching the Performance of Natural Sonar Systems

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Inspired by bat's well known proficiency in ultrasonic sensing, the CIRCE* (Chiroptera Inspired Robotic CEphaloid) project is building a robotic reproduction of a complete biosonar system. Among others, two special challenges addressed by an interdisciplinary consortium are the development of pinna shapes optimized for biosonar functions and suitable ultrasonic transducers. The transducers have to match bandwidth, sensitivity (receiver), transmit efficiency (transmitter) as well as the overall insertion loss of living bats. The first step in the development of the pinna shapes was to obtain a 3D ear model from Micro-CT scans of ears from various bat species. The reflection and diffraction behaviour of the model was then studied by means of finite element simulations. These results were verified by measurements on bronze ear models. In addition, an ultrasonic transmitter with a transducer area of 2.25 square centimetre was developed for emitting a chirp signals with a sound pressure level of more than 90 dB in a distance of 1m. A new type of piezoelectric polymer film (EMFi foil) was used as transducer material. It has a resonance frequency of about 300 kHz, allowing a transmitter with a bandwidth of 50 to 150 kHz. With the same material, an ultrasonic receiver was designed and integrated into the pinna model. This sensor matches the bandwidth of the transmitter. We will discuss the simulation results for various designs of transmitters and receivers as well as corresponding measurement results. *(Supported by the European Commission, LPS Initiative)

Th. 9:50 Schuman Ultrasonic transducers I

Feasibility study for a primary free-field microphone calibration technique in the low ultrasonic frequency range

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Today ultrasound is extensively used in industrial and medical applications. Evidence on the harmful health effects of exposure to ultrasound suggests that caution should be taken in its use, but

until now no internationally agreed limits exist. In order to establish appropriate limits and to test the output of ultrasound devices there is a need to develop reliable sound pressure measurements in air in the frequency range from 20 kHz to about 150 kHz. This paper gives a preliminary study of a primary free-field calibration technique for quarter-inch microphones by using the reciprocity method. This method is based on the measurement of the electrical transfer impedance of a pair of microphones coupled in the free field, of the effective distance between the microphones, and of the air properties. The first step in this work was the measurement of the output signal of a Brüel & Kjaer microphone type 4135 used as a sound source. In the measurement set-up two microphones 4135 were located face-to-face in an anechoic chamber. A comparison of the experimental difference between signals corresponding to two different distances (10 cm and 20 cm) and the difference predicted theoretically resulted in a good agreement. The measurements showed a good reproducibility and a sufficient signal to noise ratio. These results are encouraging to start the development of a suitable reciprocity calibration method.

Th. 10:10 Schuman Ultrasonic transducers I

Experimental determination of the acoustical radiation resistance of a transducer: application to the noise factor measurements and transducer calibration

Vincent Loyau, Guy Feuillard, Marc Lethiecq
GIP Ultrasons/ LUSSI

Functional characterisation of electro-acoustic transducer is generally carried by the measurements of the pulse echo response, 50 Ohm loop sensitivity, electrical input impedance and when necessary radiation pattern. Little attention was paid to experimental measurements of the acoustical radiation resistance. However this property appears very appropriate for the determination of the noise factor or the efficiency of a piezo-electric transducer. This concept is also suitable to easily make an absolute self-calibration of hydrophone or contact transducer in pulse echo mode. Thanks to energy consideration and to thermal noise analysis in piezoelectric transducer, theoretical formulas are calculated that show that the radiation resistance can be experimentally determined on the basis of pulse-echo and electrical input impedance measurements. Experimental measurements are reported in the case of immersion and contact transducer in the mega Herzt range. They allow to deduce the noise factor, the efficiency and the absolute sensitivity of transducers. These results of the experimental self calibration are compared to absolute displacements measured by a laser interferometer. Furthermore, several methods including direct current or impedance analyser

measurements are compared. The precision of each method is discussed. Finally, the approach based on the radiation resistance where few calculations are need, can be generalised to the other kind of acoustical transduction phenomenon such as capacitive transduction, because only universal physical variables are used in the calculations.

Th. 10:30 Schuman Ultrasonic transducers I

A Space Optimization Method for Time-Reversal Super-Focusing

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The appliance of time-reversal acoustics to classical transducer design, medical, technical or audible range applications brings forward new ideas whenever we need both, focusing acoustical energy in time and space. Unfortunately, the spatiotemporal focusing is limited through the amount of transducer elements as well as the ergodicity and randomness of the cavity. This paper will present a novel but simple method to increase the narrowness of the refocused spot by breaking up randomness for the benefit of ergodicity in a predetermined cavity. Based on the simulated annealing technique, a multi-objective optimization algorithm, the positions of circular reflectors inside the cavity are recombined in analogy to the molecules of a molten bath. The rearrangement follows a certain cost function according to the uniqueness of pulse responses from one transducer to different focal spots of interest and the temperature of the smelter. The molecules or reflectors solidify with decreasing temperature so that the result should be a well-regulated system in terms of the preset objectives. Simulations and the appropriate experiments have shown that there is an improvement in both temporal and spatial focusing. The temporal compression in the considered example is more than three times better in comparison to random media. This article will present the principle of the optimization method as well as the results of asserted time-reversal experiments. With this the door is open for further developments in the above-mentioned application areas.

Th. 13:50 Schuman Organ and room

The influence of different types of wind chests on the sound formation of flue organ pipes

Judit Angster, Stephan Pitsch, András Miklós
Fraunhofer Institut Bauphysik

The influence of different wind chests on the sound of flue organ pipes has been investigated by voicing different Diapason pipes

on the slider chest and by measuring them on the slider chest and on a cone chest in the anechoic room of the Fraunhofer-Institute of Building Physics. The attack transients of the pipes in both cases have been analysed. The results show that the speech of the same pipe on different types of wind chests are different. It is assumed that at the very beginning of the attack different partials of the pipe sound have been excited on the different wind chests by the edge tone. The most important characteristics of the attack transients are discussed.

Th. 14:10 Schuman Organ and room

The influence of new types of wind systems on the sound of organ pipes

Stephan Pitsch, Martin Schaupp, Judit Angster, András Miklós
Fraunhofer Institut Bauphysik

By building new organs large pressure oscillations may occur in the wind system. These oscillations have to be reduced so that the played melody won't be disturbed. On the other hand organists express often the wish that the wind should be 'living'. Organ builders are not able to set the wind pressure modulation ('the livingness of the wind') according to the wish of the customer. An innovative, computer controlled pressure regulation system with "user defined" pressure response has been developed in the Fraunhofer-Institute of Building Physics. With the help of a software the organist can choose the type of wind according to the style of music he is playing: living wind, normal wind and slow wind. The effect of different types of wind pressure oscillations on the pipe sound has been investigated. This research work was supported by the European Union in the context of a CRAFT project, in which 12 organ builder companies participated from nine countries.

Th. 14:30 Schuman Organ and room

Expression Devices in Pipe Organs

Jonas Braasch
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In principle, three different swell systems are known in organs: the wind swell, the door swell, and the crescendo wheel. With the wind swell, the wind pressure supplying the pipes is changed using a variable valve in order to enable the organ to be played dynamically. Using the door swell, a similar effect is produced by enclosing a number of organ stops in a wooden cabinet, which has doors that can be shut to soften the sound of the pipes inside. The crescendo wheel is a device that allows the organ player to activate or deactivate organ stops successively by a foot mechanism. In this investigation, several swell systems were measured

acoustically for their efficiency. The crescendo wheel was found to be most effective and for frequencies around 2 kHz the increase in sound pressure level could be up to 50 dB between the softest and the loudest adjustment. The maximum dynamic range for the wind and the door swells was approximately 10 dB in the same frequency range. While the dynamic range is lower for the wind swell and the door swell, their advantage is the continuous variability. For all three systems, the dynamic range was dependent on frequency, in a similar way as it is found for orchestral instruments. The effects of the wind and the door swells are quite similar, and the reason why wind swells went out of fashion is probably because they can be successfully applied only to free-reed stops, while the door swell can be applied to all kinds of stops simultaneously.

Th. 14:50 Schuman Organ and room

Raumakustische Phänomene in Kirchen - Wechselwirkungen zwischen Orgel und Raum

Eva Veres

Lehrstuhl für Bauphysik der Universität Stuttgart und Fraunhofer-Institut für Bauphysik

Im Zusammenhang mit der Aufstellung und Intonation von Orgeln in Kirchen wird von Orgelbauern, Musikern und Zuhörern eine Reihe von raumakustischen Phänomenen beobachtet, die noch nicht ausreichend bekannt und erklärbar sind. Ein Beispiel für derartige Erscheinungen ist, dass einzelne Pfeifen eines Registers nach der endgültigen Anordnung an ihrem Bestimmungsort lauter oder leiser erklingen, als es aufgrund der Vorintonation in der Werkstatt zu erwarten wäre. Im Rahmen des Vortrages wird die Frage gestellt, ob es möglich ist, solche Phänomene, die aufgrund der Geometrie und der akustischen Eigenschaften der Raumbegrenzungsflächen in jedem Raum unterschiedlich in Erscheinung treten, durch messtechnische Untersuchungen vorauszusehen. Hierzu werden mithilfe der Maximalfolgentechnik Raumimpulsantworten in sechs Kirchen aus verschiedenen Stilepochen gemessen und daraus die übertragungsfunktionen bestimmt. Aus den Unregelmäßigkeiten im Frequenzgang der Raumantwort in der Nähe von musikalischen Frequenzen können Hinweise auf die Rückwirkung des Raumes auf den Orgelklang gefunden werden.

Th. 15:10 Schuman Organ and room

Apparent Source Width and the Church Organ

Brian Katz, Christophe D'Alessandro
LIMSI-CNRS

The Concert Organ and the Cathedral are the two major extremes of their disciplines: Musical Acoustics and Architectural Acoustics. With that, they represent some of the most difficult problems in both domains, violating many of the assumptions typically used. The interest of the current work is an examination of the effectiveness and interpretation of the Apparent Source Width (ASW) in evaluating the acoustic of both the church and also of the instrument itself. The ASW is becoming more commonly used in concert Hall acoustics as one of the descriptions of spaciousness of the hall. The measure of ASW is based on the Inter-Aural Cross-Correlation (IACC) from a binaural recording. The paper presents an investigation of the ASW in the context of the church acoustic. In addition, the church organ presents itself as a large distributed source, already having a non-negligible width. How the ASW varies with distance from the organ, in contrast to a simple source, is investigated as a potential means of measuring the interaction between the organ and the church acoustic.

Th. 15:30 Schuman Organ and room

Mechanical Pipe Organ Actions and their Interface with the Player

Alan Woolley
University of Edinburgh

It is widely, although not universally, believed that mechanical pipe organ actions allow the player to exert some degree of control over the speed of opening of the pallet and thus make subtle changes to the initial speech of the pipe. This project investigates how players might actually be able to control the pallet, particularly with reference to some of the characteristics of mechanical actions such as pluck (the initial resistance felt at the key due to the pressure difference across the closed pallet) and flexibility in the action run (due to rollers twisting, cloth bushes compressing, levers bending etc). The work is being carried out using an experimental organ that can be configured to replicate any design of mechanical action operating at any normal wind pressure, and also by attaching measuring devices to to real organs in order to measure how real players playing real music actually depress the keys in different circumstances. Initial studies show that flexibility in the action causes the pallet to spring open when the key has been depressed sufficiently for the stored energy to overcome pluck, resulting in a degree of movement over which

the player apparently has little control. Pluck itself requires the player to reduce the force on the key very rapidly if the pallet is to be prevented from opening suddenly and out of control. The limits within which at least some players can exert some degree of control have been investigated. The project also analyses the tactile feedback that a mechanical action provides and how the player might interpret and use it.

Th. 15:50 Schuman Organ and room

Attack transient analysis of flue organ pipes with modern measuring methods

Tilo Wik, Judit Angster, András Miklós
Fraunhofer Institut Bauphysik

The flue organ pipe is a complicated physical system whose functionality is not completely understood until now. The sound quality of an organ pipe is mainly influenced by the attack transients. This onset is first dominated by the so called edge tone, while later the resonator of the pipe will play a more important role. To understand the working of a flue organ pipe it is necessary to analyze the transition phase of the edge tone and the stationary sound of the pipe. For the analysis a Short Time Fourier Transformation is used. Since the resolution of this analysis method is not good enough in the time and frequency domain to examine the short attack transients of flue organ pipes, several improvements of the STFT have been made. For the measurements several special pipes have been used: narrow pipes whose onset is very slow; a pipe of which the cut up is adjustable; a pipe of which the length is adjustable. The results of the analysis of these organ pipes will be shown and discussed.

Th. 8:30 Tivoli 1 Outdoor sound propagation II

Future Prediction Scheme for Sound Propagation from German Railways

Ulrich Kurze, Ulrich Moehler, Johannes Onnich
Müller-BBM GmbH

Developments in high speed rail traffic gave rise to start a revision of the present German ‚Schall 03". Most important new aspects result from the consideration of different source heights for aerodynamic sources, traction noise and equipment noise in addition to the rolling noise and to the consideration of octave band sound power levels rather than A-weighted overall sound pressure levels at a reference distance. While the concept is widely consistent with the European regulation based on the Dutch model, the prediction scheme for sound propagation is even stronger related to reliable engineering procedures by tailoring ISO 9613-2

to the needs of un-ambiguity and the availability of data describing average meteorological and ground conditions. Sound propagation from segments of line sources at different heights will be described in terms of geometrical divergence, standard conditions for atmospheric absorption, interaction with soft and rigid ground, effect of barriers, a limited number of specular reflections and a meteorological correction term. Other parameters, e.g. tree zones and general descriptions of built-up areas, will not be taken into account.

Th. 8:50 Tivoli 1 Outdoor sound propagation II

Validation of Engineering Methods for Calculating Acoustical Diffraction by Screens

Fabrice Junker, Fabien Crouzet
EDF R&D

EDF has been developing methodologies and tools for measuring and calculating the noise impact of its installations. The study of the noise impact of an industrial installation cannot be achieved by using complex propagation models. The use of engineering simplified models is unavoidable. According to the recent hardening of European noise policy, the simplified calculation models have to be more and more accurate. New simplified models are going to be proposed by European work groups. In this context, EDF wants to take an active part into the validation of these kinds of models. Industrial noise often deals with real 3D diffraction problems on quite hard ground with tonal sources which leads to strong interference patterns. Usual simplified methods (ISO, NMPB, oe) are often based on the calculation of the difference between the direct and the diffracted path lengths. The following paper presents the results of a comparison between such a simplified model and a 3D code based on Linearized Euler Equations used for calculating acoustical diffraction by a cubic screen.

Th. 9:10 Tivoli 1 Outdoor sound propagation II

Meteorological effects on long-range sound propagation: evaluation of the long term sound level using statistical analysis.

David Ecotiere, Benoît Gauvreau, Yves Brunet
Laboratoire Régional des Ponts et Chaussées

The temperature and wind gradients influence on long-range sound propagation is a well known subject. But at present, it is very difficult to estimate a reliable long term sound level from one measured on a short period. This paper presents some statistical distribution properties of theoretical sound levels created by a point source over 29 years. The method is based on the

coupling of a meteorological model with a model of sound propagation. A serie of standard micrometeorological data, either provided by local meteorological offices or measured on a long term monitoring experimental site (St Berthevin, France), is used to simulate hourly profiles of sound celerity vertical gradients over a very long period, and their set of hourly sound attenuations. The statistical distribution of equivalent sound levels is studied for different periods of reference over a long period (29 years): one day, one night, one hour. The analysis provides typical cumulative statistical distribution of sound levels which can be used to appreciate the 'long term quality' of experimental data (for measurement conditions close to the theoretical ones). A regression statistical model, based on a polynomial decomposition of the sound energy, is also obtained and supplies some help on estimating a long term equivalent sound level from the value of one of the reference period.

Th. 9:30 Tivoli 1 Outdoor sound propagation II

Including anisotropic turbulence into outdoor sound propagation

Bernhard Schwarz-Röhr
Carl von Ossietzky Universität Oldenburg

Common methods to describe sound propagation in turbulent media like the parabolic equation method (PEM) rely on the assumption of locally isotropic turbulence. Experiments show that this condition is not met in the atmospheric boundary layer. It is discussed, how the correlation tensor of the velocity fluctuations is obtained from anemometer data. By reviewing different derivations of the PEM methods to incorporate non-isotropic turbulence into the theory are discussed.

Th. 9:50 Tivoli 1 Outdoor sound propagation II

Consideration of the Local Climate in the Prediction of long-term sound levels

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Institut für Physik der Atmosphäre, Deutsches Zentrum für Luft- und Raumfahrt

The propagation of sound over distances of more than 200 m is largely influenced by meteorological factors. In long-term noise prediction (e.g. of Lden) the local climate provides the relative contributions of different meteorological situations being favourable or adverse with respect to the propagation of noise. The paper presents a quantitative estimation of the climate effects on long-term noise predictions, proposes meteorological classifications, and sketches solutions for implementing them in practicable prediction tools for surface and air traffic noise.

Th. 10:10 Tivoli 1 Outdoor sound propagation II

Street Canyons and Quiet Side: Comparing FDTD Simulation and Engineering Models

Tom De Muer, Timothy Van Renterghem, Bram De Greve, Dick Botteldooren
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Recently, the impact of having access to a quiet side of the building on the perceived quality of the living environment has been pointed out. Ongoing studies aim at quantifying the effect of such a quiet area. In the urban environment continuous rows of houses screen sound propagation efficiently thus creating these quiet places. At the same time sound sources get enclosed in so called street canyons having their own particular acoustic features. Finite difference time domain (FDTD) numerical models for sound propagation in background flow, sometimes also referred to as Linearized Euler models (LEE) are perfectly suited to account for the important determinants of the quiet-side sound field (diffraction, wind induced refraction, turbulent scattering, and diffuse reflection on façade roughness). However, their demand on computer power limits their use to rather simple geometry and makes them unsuitable for modeling cities or parts of cities. Engineering models such as ISO 9613 or the more recent Nord 2000 are far more appropriate for this purpose. The paper presents a number of street-canyon-and-backyard test cases for which engineering models are evaluated by comparing the attenuation they predict to the more detailed FDTD model. Guidelines for selecting parameters of the existing engineering models such as the required number of reflections taken into consideration are extracted. Suggestions for improving future engineering approaches are made.

Th. 10:30 Tivoli 1 Outdoor sound propagation II

Long term monitoring site at Saint-Berthevin (France-53) : a tool for traffic noise characterisation using space and time statistical variability of acoustical and meteorological events.

Olivier Baume, Benoît Gauvreau, Michel Bérengier, Fabrice Junker, Francis Lauzin
LCPC

The large influence of atmospheric conditions and ground irregularities on noise level calculation is well known from theoretical approaches or numerical developments. For instance, computing the propagation of traffic noise has held great efforts since then but those works were based on approximate environmental

conditions. This paper deals with further investigations for realistic situations using statistical analysis. We aim at introducing our long term monitoring site that was settled for new research developments. The double objective of this important equipment is to validate of our numerical models for acoustical (PE based model) and meteorological (SUBMESO) predictions, and to lead to a statistical approach. Thanks to facilities supported by the Ponts et Chaussées laboratories network and specifications of Saint-Berthevin valley - complex topography, sound source from road and railway traffic - a great tool for such analyses is available. A software which verifies output data from this long term monitoring site (10s sampling) is currently in progress. It leads to a wide validated database of road traffic, acoustical and meteorological measurements controlled from corrupting events in non-urban areas. Then we explore new statistical theories and tools for both space and time correlation of those experimental figures, including multi-dimensional analysis. The purpose is to estimate the variability of noise levels for several time scales, from short term (10s duration) to long term (10 years) analysis to appreciate the "long term quality" of experimental data.

Th. 13:50 Tivoli 1 Ultrasonic transducers II

Flowmeter and audio application of wideband ultrasonic transducers

Jürgen Peissig, Vladimir Gorelik, Rainer Wiggers
Sennheiser Electronic GmbH&Co.KG

The ultrasonic (US) transducer based on Sell's principle is well known to work invertible as microphone and speaker with a broad-band frequency response. US transducers are used for movement and distance sensors, flow-meters and in parametric transducers where it is important to have a high US sound level in air and also good directivity. Different versions of Sell transducers with different power and directivity properties have been developed and examples of applications are shown. We discuss topics concerning long term stability, electrical and acoustical properties, design of the transducers as well as the electrical driving units for microphone and speaker operation.

Th. 14:10 Tivoli 1 Ultrasonic transducers II

Real time beam steering using an ultrasonic one channel time-reversal mirror coupled to a solid cavity

Nicolas Quieffin, Stefan Catheline, Ros Kiri Ing, Mathias Fink
ESPCI - LOA

Beam steering and beam forming is achieved using a time-reversal process and a unique transducer coupled to a solid cavity. This low cost technique allows one to focus acoustic energy anywhere on a 3-D domain with a spatio-temporal resolution comparable to multiple transducers array. We first record the signal emitted by the transducer and detected by a hydrophone needle at a reference point. The signal received is then time-reversed and remitted using the same transducer. At the reference point one can observes a spatio-temporal recompression. More over, it is shown how the experimental Green's functions at the surface of the cavity can be used to control the emitting ultrasonic field. A careful study of this phenomena leads us to better understand the resolution of the focusing system: the side-lobe level as well as the focal width are no more dependent on the transducer aperture but on the dimensions of the solid cavity. The signal-to-noise ratio of such a system is explained by a modal theoy and leads to define four influencing parameters: the frequency bandwidth, the number of transducers, the geometry of the cavity and the time reversed signal duration. Frequency analyse allows to define a one channel Inverse filter: its efficiency is compared to the time reversal one and linked to the modal theory.

Th. 14:30 Tivoli 1 Ultrasonic transducers II

Study of the performances of an ultrasonic acoustic generator producing an audible directive beam

Alexandre Ritty, Etienne Auger, Pascal Hamery, Pierre Naz
I.S.L. : Institut franco-allemand de Recherche de Saint Louis

It's possible to generate an audio frequency signal, within a narrow beam, with an ultrasonic parametric antenna. This ultrasonic generator has many applications i.e., in a large meeting to communicate with given people without interfering with others. For these applications, it's necessary to assess the performance of the systems, as a function of the distance to the source. First, the theoretical principles of these directive ultrasonic generators are summarized. Next, experimental measurements, in anechoic chamber and in free field have been performed with two different devices. These measurements enabled to underline the differences between the two different antenna technologies : ceramics' array and PVDF film. The free field measurements allowed to compare conditions of the propagation of the acoustic signals with the theory.

Th. 14:50 Tivoli 1 Ultrasonic transducers II

Measuring Spatial Cross Sections of Ultrasonic Pressure Fields by Fast Optical Means

Martin Klann, Christian Koch
Physikalisch Technische Bundesanstalt, FB 1.6 Schall

The measurement of spatial cross sections of ultrasonic pressure distributions is an essential element of exposimetry of ultrasonic medical equipment. An optical technique is presented that allows the two-dimensional determination of ultrasonic pressure. A dielectric optical multilayer coating on a 25 mm diameter glass substrate forming a micro Fabry-Perot interferometer is used as ultrasound probe. The beam of a stabilized laser diode with suitable wavelength is focussed on the probe. By detecting the change in reflectivity of the coating induced by the incident ultrasound, the pressure waveform can be determined. For two-dimensional acquisition, the laser beam is scanned across the area of interest by a micro mechanical engineered scanning mirror that is capable of independently deflecting the laser beam in two perpendicular axes. This serial detection scheme allows the measurement of repeating ultrasonic waveforms such as pulses at several hundred spatial points on the probe with a good signal to noise ratio. In an alternative approach incorporating the parallel processing capabilities of a CCD chip, the probe is illuminated by a large-diameter collimated beam of a pulsed laser diode that emits pulses with a width of about 15 ns, much shorter than the ultrasound period. The pressure distribution at a particular moment is derived from the captured reflectivity distribution. By delaying the laser pulse with respect to the ultrasonic pulse, the complete pulse waveform can be acquired with high spatial resolution. Measurement results on ultrasound fields from plain and focussing transducers obtained by these two different approaches are presented and individual advantages and drawbacks are discussed.

Th. 8:30 Tivoli 2 Medical acoustics II

A Tube Headphone Without Metallic Parts To Be Used For Functional NMR

Gottfried Behler, Tobias Lentz
Institute of Technical Acoustics

For the investigation of neuronal activities modern magnet resonance tomography provides the best possibilities for both local and time dependant resolution. Investigation of particular interesting parts of the brain (e.g. auditive cortex) are performed by applying appropriate stimuli and scanning the time dependant activity using specially designed magnetic sequences in the tomographs transducer. A major problem with NMR is the noise that is

produced by these sequences, which on one hand interferes with the stimuli applied and on the other hand requires precautions for the protection of the subjects ears. Usually this is solved by using capsule ear protectors which in many cases are additionally equipped with tube phones for communication purpose. The poor quality and the weak audio level provided, however, makes the usage of these devices impossible for the presentation of the stimuli. To overcome with these shortcomings a hearing protective headphone with a wide frequency range and high level capability is required that has to be free from magnetic and current leading parts. Therefore a tube phone system was designed, that uses a common capsule ear protector and a flexible tube of 4 m length, thus providing the possibility to place the electro-dynamic transducer as far away as possible from the tomograph. Due to extremely high damping of the high frequencies in particular a special treatment was needed. The system was realized using wide band compression drivers and digital FIR filtering to maintain the aimed dynamic and frequency range.

Th. 8:50 Tivoli 2 Medical acoustics II

Searching for phonological processing in the human brain using functional MR imaging

Stefan Uppenkamp, R. Patterson, I. Johnsrude, D. Norris
Medizinische Physik

Functional magnetic resonance imaging (fMRI) allows the visualization of neuronal processes in the brain with a spatial resolution of several millimetres and a temporal resolution of a few seconds. The combination of anatomical and functional images from the same listeners is a unique tool to directly relate physiological processes to anatomical structures in the brain regions of interest. The main problem with fMRI in the auditory modality is the distinction between controlled acoustical stimuli and unwanted noise, that is produced by the MRI scanner during data acquisition. One way to solve this problem is ‚sparse temporal sampling", that is, acoustical stimuli and scanner noise are separated in time, as suggested by Hall et al. (Human Brain Mapping, vol. 7, pp. 213-223, 1999). During this study, functional MRI in a sparse imaging paradigm was used to search for phonological processing in the human brain. Using a set of synthetic English vowels and a set of spectrally matched contrast stimuli that sound nothing like speech (Uppenkamp et al., DAGA 2001, pp. 106-107), we identified a region in the auditory system, where speech sounds are first distinguished from nonlinguistic sounds. When contrasted with silence, all of the sound conditions show remarkably similar activation patterns, centred around Heschl's

gyrus bilaterally, with the most prominent peak towards the lateral end of HG. The first processing stage that distinguished the speech sounds from the non-speech sounds was in the superior temporal sulcus (STS) lateral and inferior to auditory cortex.

Th. 9:30 Tivoli 2 Speech and voice - analysis and synthesis

Buzzing lips and vocal folds: the effect of acoustical feedback

A. Van Hirtum, Ines Lopez, M.H. Schellekens, X. Pelorson, N. Driessen, A. Hirschberg
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Buzzing of lips or vocal folds is controlled by lip tension, initial opening, lung static pressure and acoustical response of the vocal tract. The static response of the lips to the lung pressure provides an indication for the lip stiffness. The dynamic response to acoustic forcing (with and without flow) provides information about the resonance modes of the lips: frequencies and quality factor. The order of magnitude of the effective mass in a lumped parameter model can furthermore be estimated from fluid dynamics considerations. Experiments show that the critical blowing pressure for the onset of buzzing is strongly dependent on the acoustical loading of the system. This critical blowing pressure shows a minimum when the lip tension is adjusted to close the glottis at zero lung pressure. The results of these experiments indicate that our lips do not perform as expected for vocal folds, which are much less sensitive to acoustical loading. The mechanical boundary conditions of the lips may play a crucial role in explaining this difference. The experimental results are compared with a single mass model analogous to the model of Cullen en the two-mass model of Lous et al. (1998). A linear stability analysis is used to predict the onset of oscillation, while a nonlinear model provides a prediction of the established buzzing behaviour.

Th. 9:50 Tivoli 2 Speech and voice - analysis and synthesis

On the acoustic sensitivity of a symmetrical two-mass model of the vocal folds to the variation of control parameters

Denisse Sciamarella, Christophe D'Alessandro
LIMSI-CNRS

The acoustic properties of a recently proposed two-mass model for vocal-fold oscillations are analysed in terms of a set of acoustic parameters borrowed from phenomenological glottal-flow signal models. The analysed model assumes a symmetrical glottal structure and includes a novel description of flow separation within the glottal channel at a point whose position may vary in

time when the channel adopts a divergent configuration. Measuring the sensitivity of acoustic parameters to the variation of the model control parameters is essential to describe the actions that the modelled glottis employs to produce voiced sounds of different characteristics. In order to classify these actions, we applied an algorithmic procedure in which the implementation of the vocal-fold model is followed by a numerical measurement of the acoustic parameters describing the generated glottal-flow signal. We use this algorithm to generate a large database with the variation of acoustic parameters in terms of the model control parameters. We present results concerning fundamental frequency, intensity and pulse shape control in terms of subglottal pressure, muscular tension, and the effective mass of the folds participating in vocal-fold vibration. Finally, we produce evidence for the identification of vocal-fold oscillation regimes with the first and second laryngeal mechanisms, and simulate electroglottographic signals with the vocal-fold model. A strong correspondence is found between the features of experimental and numerical electroglottograms during the transition between different laryngeal mechanisms.

Th. 10:10 Tivoli 2 Speech and voice - analysis and synthesis

A virtual real-time room simulation to determine the influence of the room acoustics on voice quality

Philipp Heck, Malte Kob, Tobias Lentz, Christiane Neuschaefer-Rube

Dep. of Phoniatrics, Pedaudiology, and Communication Disorders, University Hospital

Professional speakers often suffer from voice diseases that are partially caused by uncomfortable conditions in the performance room. Among these conditions, reverberation time and background noise are of importance. Whereas the interaction between room and voice has been extensively studied with focus upon perceptual questions such as room-listener interactions, the voice performance of professional speakers influenced by room conditions have not yet been well investigated. One reason might be that for the assessment of voice quality in the actual environment of a speaker, both subjective and objective methods would suffer from the ambient noise as well as from the alteration of the voice signal due to reflections within the room. For evaluation of the room acoustic influence on the voice quality a virtual acoustic environment has been realised. This set-up makes use of a low latency convolution algorithm which allows to simulate arbitrary rooms. By using a speaking and listening artificial head the binaural room impulse response can be measured, including the head related transfer function from the mouth. The total latency

achieved with the set-up has been proven to be sufficiently short for realistic simulations of voice performances in normal rooms. The correlation between voice quality of several speakers and the room acoustics of different rooms is described by the assessment of the change in voice quality perceived by a phoniatrician and analysis of objective voice parameters in different rooms. First results are presented.

Th. 10:30 Tivoli 2 Speech and voice - analysis and synthesis

Cued Speech production: giving a hand to speech acoustics
Virginie Attina, Denis Beautemps, Marie-Agnès Cathiard
Institut de la Communication Parlée - INPG

Hearing losses often lead deaf people to use visual cues for perceiving speech through lip-reading. However multiple misunderstandings occur due to the intrinsic similarity of the visual lip shapes corresponding to different speech units. Manual Cued Speech (CS) is an easy accessible method that allows people with hearing impairments to receive a complete message through the visual channel. Usually used by hearing people to deaf people, CS is a syllabic code involving the use of the hand in addition to lip gestures. The speaker enhances each syllable he pronounces with a manual cue. The present study aims at investigating how a proficient user of French CS coordinated his hand with the lips and the sound emitted. The analysis is based on the labelling and the comparison of the following different signals in time: hand trajectory, finger gestures, lip area time-course in relation with corresponding acoustic signal. Results showed an advance of the hand on the lips and on the sound relatively to the syllable.

Th. 13:50 Tivoli 2 Speech and voice - analysis and synthesis

Application of impedance measurements for articulatory dysfunction
Malte Kob, Julia Stoffers, Matthias Lievens, Roman Katzer, Christiane Neuschaefer-Rube
Dep. of Phoniatrics, Pedaudiology, and Communication Disorders, University Hospital

The application of acoustic impedance measurements for the non-invasive characterisation of the resonance structure in the vocal tract has been reported earlier (M. Kob: Miniaturaufbau zur direkten Impedanzbestimmung, DAGA '02). The first method suffered from the problem that the impedance measurement is distorted by the voice signal during measurements with phonation. On the other hand, during the measurement of the vocal tract resonances without phonation, the configuration of the vocal tract and the glottal area is not exactly known. Therefore, a

comparison of the impedance measurements with results from established methods, as e.g. LPC analysis, was difficult. An algorithm was developed that eliminates the voice signal from the measured acoustic impedance at the mouth. The impedance measurements were validated by simultaneous measurements of formants (LPC) and vocal tract transfer functions (VTTF) of an externally excited vocal tract model. The results give valuable hints for the interpretation of vocal tract impedance measurements in patients with articulatory dysfunctions.

Th. 14:10 Tivoli 2 Speech and voice - analysis and synthesis

Measuring Pitch with Historic Phonetic Devices

Rüdiger Hoffmann, Dieter Mehnert
Institut für Akustik und Sprachkommunikation

Recording the pitch and the intonation contour of words and sentences has been focused by phonetic and linguistic research since a long time. There was recognized very soon that a sufficient description is not possible by means of human hearing alone. Instead, experiments and measuring devices were developed for pitch analysis. However, the investigations offered a lot of problems and were very time-consuming. The Dresden University of Technology owns a collection of historic phonetic equipment at the Institute of Acoustics and Speech Communication. This collection is recently prepared for a web presentation. Apart from this activity, selected devices are reconstructed and prepared for demonstrations in suited lectures (e. g., in psychoacoustics, signal processing, or speech technology). Until now, we demonstrated the chain of sound emission (by a larynx model of Wethlo combined with a vocal tract model), sound recording (by a kymograph), and sound analysis (by a mechanical Fourier analyzer). A text has been developed as supporting material for the students also. This paper describes methods and equipment for the measurement of pitch from the early days of experimental phonetics. We furthermore discuss the measuring accuracy and the subsequent development. This description is illustrated using devices from the historical collection of our institute.

Th. 14:30 Tivoli 2 Speech and voice - analysis and synthesis

Wizard of Oz tests for a dialog system in smart homes

Jan Krebber, Sebastian Moeller, Rosa Pegam, Ute Jekosch, Martin Rajman, Miroslav Melichar
Institut für Kommunikationsakustik (Web: www.rub.de/ika)

Within the scope of the European IST-project INSPIRE (INfotainment management with SPeech Interaction via REmote microphones and telephone interfaces) a speech-dialog system for accessing different kinds of home appliances (TV, VCR, lamps,

blinds etc.) is currently developed. The purpose of the system is to provide an intelligent and uniform user interface. The interface is capable of supporting the user by controlling different complex devices and increasing the acceptance and quality of the services. The system is controlled via microphone arrays for home use or by telephone or internet access for remote use. The Wizard of Oz (WoZ) replaces the automatic speech recognition and allows to set different error rates. More over it allows to test different metaphors. The presentation will focus on the architecture of the WoZ tool and the way how it was used to test the quality of the dialog system and the overall quality.

Th. 14:50 Tivoli 2 Speech and voice - analysis and synthesis

Grapheme-to-Phoneme Conversion in Mandarin Chinese Text-to-Speech

Hongwei Ding, Oliver Jokisch
Institut für Akustik und Sprachkommunikation

We present a lexicon-based model for segmenting Chinese text into dictionary entries and provide pronunciations for these words. This approach adopts a matching algorithm combined with several heuristic rules to resolve the ambiguities. It can achieve an accuracy over 98%, which proves to be an effective solution to grapheme-to-phoneme conversion for Mandarin Chinese. The written Chinese texts are composed with strings of characters without blanks to delimit words. The first step in text analysis is to segment a sequence of characters into words. The lexical-based word segmentation approach is to match the input character strings with entries in a large lexicon. The most effective matching method [1] says that the most plausible segmentation is the three-word chunks with maximal length. This algorithm is adopted in our system, some modifications are made to deal with numerals and personal names. A few morphological rules are then applied to allow for morphologically complex words that are not in the dictionary. The same lexicon will also provide the words with right pronunciations after the words are correctly segmented. This method is reported as one of the most effective ones in word segmentation. In order to achieve a better performance, statistical methods can also be combined. Literature [1] Chen, K. and Liu, S., Word Identification for Mandarin Chinese Sentences., In Proceeding of COLING, pages 23-28, August 1992

Th. 8:30 Gutenberg Wave field synthesis II

Spatial perception in WFS rendered sound fields: Distance of real and virtual nearby sources

Helmut Wittek
Institut für Rundfunktechnik

In theory Wave Field Synthesis is capable of reproducing a sound field by means of loudspeaker arrays. It is the goal to make a copy of the original sound field i.e. to render a virtual sound field with equal temporal and spatial characteristics. However, it has been shown that the characteristics are similar but not congruent, due to principal as well as practical reasons. For example, the head shadowing effect in the WFS rendered sound field differs, resulting in impairments of the monaural and interaural cues. This leads to the question of where compliances and differences are with regard to auditory perception. Considerations are made to illuminate the case of distance perception of virtual sources, and, in particular, the role of the curvature of the wave front for distance perception. A companion paper describes corresponding experiments undertaken.

Th. 8:50 Gutenberg Wave field synthesis II

Experimental investigations into the distance perception of nearby sound sources: Real vs. WFS virtual nearby sources

Stefan Kerber, Helmut Wittek, Hugo Fastl, Günther Theile
AG Technische Akustik, MMK, TU München

Wave field synthesis (WFS) is a technique which in principle is able to reproduce the temporal and spatial properties of a wavefield. Therefore, it should be possible to create exact interaural differences at a listener's head. They represent cues to near field distance perception, and should therefore lead to natural distance perception. This paper examines this assumption as follows: listening tests are performed in a non-reflecting room with virtual sound sources created by WFS, as well as with real loudspeakers at various distances (25cm to 190cm) from a person. The results confirm the suggestion described in the preceding companion paper that the direct sound rendered with a typical WFS setup does not create sufficient binaural cues for distance perception.

Th. 9:10 Gutenberg Wave field synthesis II

Spatial perception of virtual 3D sound scene: how to assess the quality of 3D audio rendering by WFS?

Rozenn Nicol, Laetitia Gros
France Télécom R&D

In the context of the CARROUSO Project, listening tests are carried on, in order to assess the quality of the 3D-audio rendering provided by WFS. The experiment is focussed on WFS rendering, which will be compared with other sound spatialization rendering systems, such as Ambisonics, intensity panning, and 5.1. All these systems are based on 3D-audio rendering provided by loudspeaker array of more or less complexity and the various experiments use a common 3D audio demonstrator, which consists in a circular array of 48 loudspeakers. In order to assess the quality of the 3D-audio rendering, two different, but complementary aspects are considered: first, the localization accuracy provided by the system, second, the overall quality, through different criteria, such as intelligibility, realism or immersion. The localization test focuses on the comparison between WFS and Ambisonic. On the other hand, for the quality test, WFS is compared to several sound spatialization systems, through three experiments: first, a speech intelligibility test, second, a test based on the collection of multi criteria judgment, in terms of naturalness, space impression, envelopment, accuracy and agreement. The third experiment focuses on immersion and consists in evaluating how a subject feels involved into a virtual complex sound scene. By this way, it is also intended to derive innovative and comprehensive test methodologies in order to assess the perceptual aspects of 3D audio system rendering. The paper will detail and discuss the results of the various experiments.

Th. 9:30 Gutenberg Wave field synthesis II

Perceptual Spatial Exploration of WFS Soundscapes

Olivier Warusfel, Etienne Corteel, Terence Caulkins
IRCAM

Wave field synthesis (WFS) provides an accurate reproduction of a sound field over an extended listening area. Depending on the position of the virtual source, the wave front exhibits a given curvature and the listener can experience the continuous update of auditory localisation cues while wandering around the soundfield. Another possibility of WFS is to take into account the radiation properties of the simulated sound source in order to shape the sound field and its interactions with the reproduction room. These properties allow new listening conditions where the listener may navigate in the sound scene with consistent acoustical

cues variations. This calls for new methods for spatial perception investigation where auditory perception must be integrated into a multisensorial frame. Especially, the congruence of auditory cues variations with idiothetic cues elicits the perception of the auditory spatial perspective. The study is illustrated with tests dedicated to the monitoring and perceptual assessment of sound scenes created in a WFS installation. In a first experiment, we study the necessity for maintaining independently the monitoring of the distance of sound objects through the conventional direct to reverberant ratio and through the WFS specific wave curvature control. In a second part, we study the influence of the interaction between the sound field generated by the WFS system and the reproduction room. This interaction is analysed with regard to the consistency between the resulting room effect and the actual acoustical properties of the reproduction room.

Th. 9:50 Gutenberg Wave field synthesis II

Creating plausible auditory virtual environments for Wave Field Synthesis

Renato Pellegrini
sonicEmotion AG

Wave field synthesis is a strong technology that allows to recreate the wave fronts of any number of virtual sound sources in a given environment. In this paper we discuss the achieveable localization accuracy, and the usage of discrete reflections to improve distance & room-size perception for a given auditory scene. A rendering scheme is introduced with distributed localized rendering in a low-latency network.

Th. 10:10 Gutenberg Wave field synthesis II

Perceptive evaluation of road traffic noise inside buildings using a combined image and wave field synthesis system

Julien Maillard, Jacques Martin, Jacques Lambert
CSTB

The evaluation of transport infrastructures in terms of environmental pollution remains a difficult subject due to the complexity of the disturbance under study. To be effective, the evaluation should be done in an environment where the main parameters of the disturbance can be controlled precisely. On-site experiments are therefore not suitable. This motivates the use of Virtual Reality which gives complete control over the parameters of the scene under study. This paper presents a practical application of virtual reality techniques to provide a multi-criteria evaluation tool of road traffic noise as it is experienced inside buildings. The approach described here creates an auditory and visual display of road infrastructures as perceived from inside a room. The main

objective is to provide a near-to-real environment. The subjects are free to move within a real room featuring a window, the other side of which is equipped with the virtual display system. The approach combines high resolution video restitution and an audio system based on Wave-Field Synthesis. A description of the system is given, focusing on the sound field synthesis and restitution of the road traffic noise.

Th. 13:50 Gutenberg Assessment of noise . . .

The European Directive relating to assessment and management of environmental noise and the harmonisation of noise assessment methods

Volker Irmer
Umweltbundesamt Berlin

The European Directive 2002/49/EC relating to the assessment and management of environmental noise obliges the Member States to draw up strategic noise maps for major roads, railways, airports and agglomerations, using harmonised noise indicators Lden (day-evening-night equivalent level) and Lnight (night equivalent level). One of the goals of the Direcitve is to get comparable data on the noise exposure in the different Member States. Therefore the methods to assess the noise exposure should be harmonised. Such harmonised methods do not exist now, the Directive leaves it to the Member States either to use their existing national methods, that have to be aligned with the provisions of the Directive, or to use interim methods laid down in the Directive; these methods are not in line with the provisions of the Directive and changes have to be made to fulfil these provisios. Therefore the European Commission has adopted a Recommendation concerning the guidelines on revised interim computation methods. The objective, however, is to get and publish harmonised assessment methods, which should then be used all over Europe. To this end a European project "HARMONOISE" is currently carried out. Detailled information is given on this process.

Th. 14:10 Gutenberg Assessment of noise . . .

Die Interimsverfahren zur Berechnung der Lärmbelastung in der Umgebungslärmrichtlinie

Edgar Wetzel
Wölfel Meßsysteme · Software GmbH & Co

Im Rahmen der Umsetzung der Richtlinie 2002/49/EG hat die General-Direktion Umwelt der Europäischen Kommission Leitlinien zu den angepassten vorläufigen Rechenmethoden am 22.08.2003 als ‚EMPFEHLUNG DER KOMMISSION vom 6. August 2003 über Leitlinien für die geänderten vorläufigen Berechnungsmethoden für Industrie-, Flug-, Straßenverkehrs-

und Eisenbahnlärm und diesbezügliche Emissionsdaten" im Amtsblatt der Europäischen Union veröffentlicht. Sie kommt damit einer Verpflichtung aus Artikel 2.2 des Anhangs II der Richtlinie 2002/49/EG nach. Die Leitlinien der Kommission basieren auf den Ergebnissen der Studie ‚Adaptation and revision of interim computation methods for strategic noise mapping". Die vorläufigen Rechenmethoden werden zur rechnerischen Bestimmung der Lärmindikatoren Lden und Lnight in strategischen Lärmkarten jenen Mitgliedstaaten empfohlen, die nicht über eigene nationale Rechenmethoden verfügen. Die in der Richtlinie genannten Rechenmethoden sind ‚vorläufig", weil sie nur bis zur Einführung einer europäischen, harmonisierten Rechenmethode zum Einsatz kommen sollen. Bis dahin sind jene Mitgliedstaaten, die über eigene nationale Rechenmethoden verfügen ermächtigt diese anzuwenden sofern eine Anpassung an die Forderungen der Richtlinie 2002/49/EG erfolgt, und der Nachweis der Gleichwertigkeit der Ergebnisse erbracht wird. Unter dem Aspekt der Verwendung bis zur Einführung der harmonisierten Rechenmethode sind auch die nationalen Rechenmethoden als ‚vorläufige" Rechenmethoden für die Erstellung strategischer Lärmkarten zu sehen, ungeachtet ihrer unangetasteten Gültigkeit in nationalen Verfahren. Es wird der Frage nachgegangen, welche Anforderungen an nationale Methoden sich ergeben aus den Empfehlungen der Kommission und möglicherweise aus anderen im Rahmen der praktischen Umsetzung der Richtlinie 2002/49/EG durchgeführten europäischen oder nationalen Studien.

Geometric Post-Processing of GIS Data for Noise Mapping

Hardy Stapelfeldt, Douglas Manvell

Brüel & Kjaer Sound and Vibration Measurement A/S

GIS data can help generate acoustic models. But this data has typically been collected without any consideration of the demands placed by acoustic calculations. Therefore, in many cases, efficient post-processing of geometry and attribute information turn out to be essential. Various aspects of this process will be addressed using actual case studies: * Bringing data into the proper shape (generating building polygons from single vertices, etc.) * Terrain models: Contour lines vs. ridge models, reconstructing a given topography to defined planned situations (for example, fitting a new highway in a landscape,) * Methods of converting 2-d models into 3-d models (interpretation of height attribute information, Laser scan data, use of textual height information, etc.) * Checking geometric integrity (duplicate objects, source polygons with forward-backward digitising resulting

in double emission, etc.) * Merging geometry of differing quality, and the inheriting of attributes * Simplification of geometry When aiming at the exclusive use of commercial GIS tools for data preprocessing limitations of light versions have to be considered.

Th. 14:50 Gutenberg Assessment of noise . . .

An innovative G.I.S. tool for environmental noise management

Bernard Miège, Jacques Sampic, Eric Premat
CETE

The Technical Studies Centre of Equipment of Lyon (CETE de Lyon) has been requested by the Departmental Direction of Equipment of Isère to build up a Geographical Information System collecting all the information related to noise on the 36 km long network of Grenoble's highways. The goal is to establish a reference state and to allow for setting and following up a program and a set of noise action plans according to the European Noise Directive 2002/49/EC. The achieved database is made up of three topics. Some basic data are given concerning urbanization around the road network, noise sensitivity in these areas, traffic distribution and history, existing noise shielding devices classified by categories (noise barriers, building insulation, road pavementsoe) with detailed information (size, pictures, oe). A second topic shows the results of noise measurements and the extension of these results using a noise propagation model based on the New French Method for Noise Prediction. This gives rise to a classification of the road network into around 30 homogeneous areas in terms of noise exposure and potential noise abatement measures. The last topic describes and assesses some action plans designed in order to reach a goal of acoustical comfort in the highways' vicinity. Since the achievement of this G.I.S. tool, the Departmental Direction of Equipment of Isère has set up an important program of actions for several years based on the results of this work and consisting in settling efficient acoustical road pavements on the whole network, building noise barriers and enhancing façade insulation.

Th. 15:10 Gutenberg Assessment of noise . . .

Large scale noise mapping in GIS

Florian Pfäfflin, Volker Diegmann
IVU Umwelt GmbH

Acoustic models used in simulation of environmental noise impact have become ever larger during recent years. This puts new demands on software strategies and handling of input data. Often, using existing data from Geographic Information Systems

(GIS) is the only economic approach to create large-scale acoustic models. IVU Umwelt GmbH and Stapelfeldt Ingenieurgesellschaft present the integration of a complex suite of programs for environmental analysis (LimA) into ESRI's ArcGIS. LimA calculation modules are called via the GIS user interface to analyze acoustic and solar radiation conditions. Direct interaction with the LimA calculation core is possible to support user requests for instant calculations. The integration of LimA in a GIS provides advantages in several aspects of any noise mapping projects, in particular large-scale. GIS and LimA facilities of defining new object types and attributes help to simplify customization demands, e. g. define road, rail or industry source objects with specific emission parameters. Calculation results of noise levels and noise exposure indicators are directly available within the GIS for analyses and presentation. By merging the results with other information in the GIS, further conclusions, e. g. impact analyses or determining which kind of road causes dominant noise levels, can easily be made. The combination of LimA and GIS has been successfully employed in a project for a federal state of Germany. Noise levels induced by road traffic were calculated in a 20m-raster for an area of 18,000km^2. In the calculation, the entire road network, totaling 26,000km, terrain and residential areas were considered.

Experiences with large Scale and City Noise Mapping

Wolfgang Probst

Accon GmbG

Many problems arise when noise maps for large areas or for cities with 100 000s of buildings shall be calculated. A tremendous amount of time and money can be wasted if the description depth of the model is not aligned between different parts of the model or between noise types. Data acquisition should always take into account the intended use of the model and the sensitivity of the result in relation to this description depth. But even in the case of noise mapping according to the requirements stated in the EU-directive it is worth to think about the usability of the digital model of a city for other tasks. The value of a city model depends on the manual work necessary to keep it up to date and to adapt it to changed environmental conditions. If the time schedule for trains changes each year, it is extremely time saving when these schedules can be used as spread sheets and be linked to the whole railway system with all track sections automatically. With roads the time variation of parameters is not so critical. But even there it might be advantageous to store traffic and road data outside in databases. Interactive Noise Maps that are presented via

Internet are an invaluable information tool. Experience with such presentations (e.g. http://www.accon.de) show that many earlier objections of city administrations about making people too worried about noise problems have no realistic background if some precautions are taken. Some of these requirements, precautions and general conditions for the success of a noise mapping project are presented.

Th. 15:50 Gutenberg Assessment of noise . . .

About noise metrics and acoustic impacts

Michel Maurin
INRETS

Today everyone may emphasize the important number of acoustic indices or noise metrics (Liénard, Smith, Vallet, van den Berg, Maurin 2002). In this paper we try to understand the situation. It is useful to enlarge the acoustic viewpoint and to consider the framework of environmental nuisances, following an examination of input data families, and of necessary main steps for environmental impact indicators building, (Maurin 2003). It is classical to say (or remind) that noise metrics are referenced to man (as some units do like meter but also lux, foot, thumb, span, "coudée" oe), here with the p0 constant and the first spectral weightings. But after that there had been a confusion between reference to man and the "man's response", PNdB for instance, and noys and PSIL, oe. Probably a latent confusion, but which truly yielded and yields as many metrological references as particular responses ; and then providing the "babelization" into acoustic units. The paper enlightens the confusion between physical, conventional references, and the specific situations, impacts and responses. It recalls the "major effort" requested in FICON report to connect physical exposure and impact.

Th. 8:30 Kleber Sonic boom

Numerical Simulation of Sonic Boom

François Coulouvrat
Centre National de la Recherche Scientifique

A review of sonic boom modeling and numerical simulation is presented, illustrated by outputs of the new software BANGV. Attention is drawn on recent advances in sonic boom modeling. Coupling between CFD and atmospherical propagation shows how to supersede the use of Whitham's function. The influence of meteorological variability outlines the lateral behaviour of sonic boom in an upward or downward refracting atmosphere. The rise time as influenced by molecular relaxation is modeled by a shock structure analysis, which emphasizes a critical value of the shock amplitude related to nitrogen relaxation. Penetration of sonic

boom into the shadow zone is shown to be influenced by effective sound speed gradient, and, in the vicinity of the cut-off, by the ground impedance. Focusing associated to large scale manoeuvers (acceleration, turns) is modeled by the transsonic nonlinear Tricomi equation. The question of sonic boom minimization will finally be briefly discussed. [Work supported by Airbus France SAS, Ministère de la Recherche and Commission Européenne - contract SOBER G4RD-CT-2000-00398].

Th. 8:50 Kleber Sonic boom

A 10-year statistics of sonic boom carpets based on meteorological ERA data and numerical calculations

Reinhard Blumrich, Dietrich Heimann
Institut für Physik der Atmosphäre, Deutsches Zentrum für Luft- und Raumfahrt

In the framework of the Sonic Boom European Research Programme (SOBER) financed by the EU, the propagation of a (primary) sonic-boom emerging from a high-flying aircraft has been investigated. A statistical analysis of the meteorological variability and its influence on the sonic boom characteristics, i.e. the sound immission on the ground, has been carried out. The investigations are based on a full ten-year set of ERA-15 data (years 1984 to 1993) of an area in the St.George's Channel. The sonic boom propagation has been calculated using an advanced ray-tracing algorithm. The large amount of data has been reduced to shape parameter which have been analysed using e.g. frequency distributions, cross correlations, and cluster analysis. The frequency distributions of the meteorological data show no significant variation with respect to the daytime and only a few significant variations with respect to the season. The correlation of the acoustic and the meteorological parameters show the specific influence of several meteorological parameter on the sonic boom. A classification of the meteorological data has been carried out in order to be able to represent the whole sonic boom statistics by means of a few data sets.

Th. 9:10 Kleber Sonic boom

Focusing of sonic boom at caustics induced by flight maneuvers

Régis Marchiano, François Coulouvrat, Jean-Louis Thomas
Centre National de la Recherche Scientifique

A future civil supersonic aircraft faces the formidable challenge to overcome the key environmental issue of reducing sonic boom. The most intense one results from its focusing on caustics (fold or cusp) produced by aircraft maneuvers like transonic acceleration

or turns. The classical modeling consists in introducing diffraction and local nonlinearities around the caustics. The pressure field is then governed by the nonlinear Tricomi equation for the fold caustic, and by the Khokhlov-Zabolotskaya equation for the cusp caustic. These two equations have been solved numerically recently. In order to confirm the theory and validate the numerical codes, experiments are necessary. An experimental set-up has been built to scale the focusing of sonic boom at 1:100 000 with ultrasonic shock waves in a water tank instead of sonic boom in air. The field pattern specific of caustics is synthesized by a large piezo-electric array using the inverse filter technique. In the vicinity of the caustic, the acoustic field is measured and compared favourably with the numerical simulations. 'This investigation has been carried out under 'SOBER' a contract awarded by the European Commission, contract number G4RD-CT-2000-00398 and with financial support of french ministery of research.'

Th. 9:30 Kleber Sonic boom

Statistical analysis of N-waves characteristics after propagation in a turbulent media

Sébastien Ollivier, Philippe Blanc-Benon
Centre Acoustique - Ecole Centrale de Lyon

Turbulence plays a role in the propagation and the distortion of sonic booms but its influence is still not modelled accurately. One reason for this situation is the lack of controlled experimental data which can be used for comparison with theoretical or numerical results. In order to study the influence of turbulence on the propagation of acoustic N-waves, we conducted laboratory-scale experiments. An electrical spark source has been designed to generate N-waves, and two setups are used to study separately the influence of temperature or velocity random fluctuations. For both setups the spectrum and characteristic lengths of the turbulence have been measured. In this paper, we present the statistical analysis of the mean values and higher moments of the usual parameters used to describe sonic boom signatures (peak pressure, rise time, duration, arrival time) for the waveforms measured after propagation in the thermal or the kinetic turbulence. Mean results are in accordance with previous numerical or experimental works. Some examples of random focusing have been observed. Since the characteristics of the turbulent media have been measured, the data can be also compared to existing theoretical models. Data show that the increase of the rise time and the decrease of the peak pressure could be linked to the probability of occurrence of caustics. This work is partly supported by the European Community (SOBER project, Contract No. G4RD-CT-2000-00398) and by Ministère de la Recherche et des Nouvelles Technologies (decision No. 00 T0116).

Th. 9:50 Kleber Sonic boom

Effects of Surface Roughness and Turbulence on Propagation of Shock Waves above a Curved Surface

Qin Qin, Keith Attenborough, Sébastien Ollivier, Philippe Blanc-Benon
The Acoustic Research Centre

Laboratory experiments using an electric spark source of acoustic shock waves have been used to study the influence of refraction and diffraction on propagation of sonic booms. Curved surfaces were constructed in the anechoic laboratory at ECL to simulate atmospheric refraction effects and a heated grid was used to generate turbulence. The curved surface was either smooth or rough. The propagation of the shock wave was measured under different scattering and refracting conditions using a 1/8" B&K microphone array. The rise time, the peak pressure, and the spectrum of the received acoustic shock have been investigated. The resulting data indicate that surface roughness decreases the peak sound pressure levels measured in the deep shadow zone by up to 2.6 dB while the turbulence increases the peak sound pressure levels by 5 dB for the same receiver. In the illuminated zone, surface roughness increases the peak sound pressure level by 1dB and steepens the shock wave whereas turbulence decreases the peak sound pressure level by 2 dB. These results show that there are significant effects due to ground roughness and atmospheric turbulence on the propagation of broadband shock waves in the atmosphere.

Th. 10:10 Kleber Sonic boom

Effective Impedance of Rough Sea Surfaces

Patrice Boulanger, Keith Attenborough
The University of Hull

Sonic boom characteristics are likely to be modified during near-grazing propagation above a rough sea surface. Two methods of calculating the effective impedance spectra of acoustically-hard, randomly-rough, two-dimensional surfaces have been explored. The first method uses the complex excess attenuation spectrum predicted by a Boundary Element Method (BEM) input to the classical expression for the sound field due to a point source above a smooth impedance plane which is solved subsequently for effective impedance roots identified by a winding number integral method. The second method is based on an analytical theory in which the contributions from random distributions of surface scatterers are summed to obtain the total scattered field. Measured data for the complex excess attenuation above 2-D randomly-rough surfaces formed by semi-cylinders

and wedges have been used to deduce effective impedance spectra that are compared to predictions. The analytical theory gives relatively poor predictions. On the other hand BEM-deduced effective impedance spectra agree tolerably well with measured data. Simple polynomials have been found to fit BEM-deduced spectra for surfaces formed by intersecting parabolas corresponding to sea states from 2 to 7 (roughness heights up to 7.5m) for five incidence angles. The overall trends in the polynomial coefficients are consistent with the expected decrease in effective impedance with increasing grazing incidence angles and roughness scale. It is predicted that the effects of the sea surface roughness on sonic boom profiles and rise time are comparable to those due to turbulence and molecular relaxation effects.

Th. 10:30 Kleber Sonic boom

Propagation of nonlinear acoustic signals through inhomogeneous moving media

Philippe Blanc-Benon, Vera Khokhlova, Mikhail Averianov, Laurent Dallois, Robin Cleveland

Department of Acoustics, Physics Faculty, Moscow State University

Nonlinear propagation of intense acoustic waves through inhomogeneous medium is an important problem for many modern applications including sonic booms in a turbulent atmosphere, explosive waves in a fluctuating ocean, and intense ultrasound and shock waves in biological tissue. Two different types of inhomogeneities are of importance: scalar inhomogeneities (spatial distribution of sound speed and density), for example, due to temperature variations in the medium or variations in tissue type; and vector inhomogeneities (spatial distribution of particle velocity), for example, due to the presence of vortices or flow in the medium. In all of these problems the combined effects of inhomogeneities, diffraction, and nonlinear propagation determine the peak and average characteristics of the acoustic field. A complete theoretical model that includes all the above mentioned phenomena is very complicated for analysis, thus most results to date have been obtained for simplified models. In this work, a new nonlinear parabolic wave equation with inclusion of both scalar and vortex inhomogeneities is presented. Numerical solutions of the equation for a fully three dimensional formulation, arbitrary initial periodic or single shock waveforms are described. Typical problems of linear and nonlinear propagation of acoustic signals in media with thermal or vortex inhomogeneities are investigated in order to better understand how the combined effects of inhomogeneities, diffraction, and nonlinear propagation determine the overall peak and average parameters of the acoustic

field and to distinguish the impact of scalar- and vector-type inhomogeneities on the wave propagation.

Th. 13:50 Kleber Sonic boom

Secondary Sonic Boom Modelling for Realistic Atmospheric Conditions

Laurent Dallois, Philippe Blanc-Benon, Julian Scott, Uwe Berger, David Allwright, Katarina Kaouri
Centre Acoustique - Ecole Centrale de Lyon

The propagation of the secondary sonic boom is studied using atmospheric models up to the thermosphere. By solving temporal ray equations, the secondary carpet position is investigated. An amplitude equation including nonlinearity, absorption and relaxation by various chemical species is coupled to the ray solver in order to get informations on the amplitude and on the frequency of the sonic boom at the ground level. Using this propagation model and a realistic atmospheric model, the seasonal dependencies of the secondary sonic boom are investigated. We observed multipath arrivals, directly linked to wind field or 3D inhomogeneities. Our simulation emphasized also the role played by the wind structure of the stratopause. Our results are intended to be compared to recorded signals of secondary sonic booms showing low amplitudes and low frequencies. Their rumbling noise can be interpreted as a summation of sonic arrivals over different acoustic paths. This work is supported by the European Community project SOBER (contract No. G4RD-CT-2000-00398).

Th. 14:10 Kleber Sonic boom

Numerical modelling of infrasound propagation at very long distance

Pierre-Franck Piserchia, Roger Roche
CEA

Compliance with the Comprehensive Nuclear-Test-Ban Treaty (CTBT) in the atmosphere will be monitored by a worldwide network of infrasound stations. The infrasound network will consist of 60 stations equipped with microbarographs in order to measure small changes in the air pressure in the frequency range 0.02 to 4 Hz. They are characterized by a good sensitivity (18 dB below the minimum acoustic noise), and by a large dynamic (80 dB). By the application of array techniques, it is possible to determine the direction of pressure pulses caused by small explosions in the atmosphere, as well as shock waves caused by supersonic aircraft exceeding the sound velocity or meteorites entering the earth's atmosphere. To take into account the nonlinear phenomena at the source and during the propagation, we

are developing a numerical approach to solve the Euler nonlinear equation. In a first step, in the linear domain, this method is compared with two other numerical modeling approaches based on the ray tracing technique and the parabolic approach. In our test case, the source is on the ground and generates a 1 Pa pressure pulse centered at the frequency of 0.1 Hz. We considerer an infrasound propagation over a distance of 500 km and an atmosphere height of 200 Km. In a further step, the source level will be increased to study non-linear phenomena.

Th. 14:30 Kleber Sonic boom

Low boom airplane design process at Dassault Aviation

Zdenek Johan, Marie-Jose Manfredi, Nicolas Héron, Michel Ravachol
Dassault Aviation

Dassault Aviation as civil aircraft manufacturer studies the feasibility of a supersonic business jet and tries to federate in an Integrated Project (HISAC call2) the European competencies to answer to the problems of noise, emissions and sonic boom. One of the methodologies used to predict this last constraint consists of using CFD results as inputs for a propagation code based on a ray-tracing algorithm. This method was used in a 5th PCRD project (SOBER) and is part of a design toolbox dedicated to the evaluation and/or to the optimization of supersonic aircraft. For the low boom design process, sonic boom wave forms are given as input criteria of an optimisation loop. We will present during this meeting some results obtained using this approach: sonic boom levels are predicted as a function of aircraft shapes, flight conditions or manoeuvers. The inverse problem will also be looked at. This presentation will also highlight some numerical difficulties as the pertinence of sonic boom evaluations depends strongly on what is extracted from the flow computation. CFD results have to be assessed according to the numerical scheme or mesh refinement. Trade-offs have to be made when it comes to extracting a pressure distribution from the CFD results: One would want to extract the pressure as close to the airplane as possible since this is the zone where the CFD results have undergone the lesser numerical diffusion. Unfortunately, the equations solved for the propagation are not correct in the vicinity of the aircraft.

Th. 14:50 Kleber Sonic boom

Influence of Liquid Injection at the Nose of a Supersonic Aircraft on the Sonic Boom

Itham Salah El Din, Anton Lebedev, Thierry Alziary De Roquefort
Laboratoire d'Etudes Aérodynamiques

The objective of this study is to investigate the influence of liquid injection at the nose of a supersonic aircraft on the near field and ground pressure signature. An experimental study is performed in a small supersonic tunnel ($150x150mm^2$) at Mach 2 using a generic model aircraft with a double sweep delta wing. The pressure measurements provide the near field signature around the aircraft on a cylinder at a distance 1.7L where L is the length of the model. A numerical code is then used to find the extrapolated signal at ground level. The method involves two steps: first, the far field signature corresponding to the near field data set is computed using a matching method. Then the theory for non linear acoustic propagation through a non uniform medium is used to find the ground signature. A significant influence of liquid injection is observed, hence opening a possibility of reduction of the sonic boom. Detailed analysis of the aspect of the signal with and without injection can be found in the final paper.

Th. 15:10 Kleber Sonic boom

Sonic boom: ISL studies from the 60's to the early 70's

Armand Dancer, Pierre Naz
I.S.L. : Institut franco-allemand de Recherche de Saint Louis

Some of the ISL studies made in the past years on sonic boom are presented here. These studies have been initiated during the development of the supersonic civil aircrafts (in the 60's) to answer the questions: is there a risk for structures or for human beings when exposed to sonic boom overpressure? The propagation of the sonic boom as a function of the meteorological conditions was studied and different simulators for physical experiments and physiological observations were built at ISL. No physical harm was observed on human beings. However, depending on the parameters (peak pressure, rise time, duration...) of the sonic boom, startle reaction may induce psycho-acoustical annoyance.

Th. 15:30 Kleber Sonic boom

Determination of physical criteria in the study of the sonic boom loudness

Guy Rabau, Sabine Meunier, Philippe Blanc-Benon, Yvan Maurel
LMA CNRS

The sonic boom generated by an aircraft at supersonic speed is very annoying. Loudness is known to be the most important parameter for annoyance. Then, the aim of this study is to determine how loudness of sonic boom varies with the physical parameters of the sound and then how annoyance varies. A sonic boom is a signal with high impulsive feature. Its principal characteristics are a very large amplitude, superior to 100 Pa, and a very short duration of the order of few millisecondes with 2 abrupt variations of amplitude (wave in " N "). Our preceeding studies on impulsive sounds have shown that the loudness depends essentially on 2 physical parameters that are the energy and the extinction time of the signal. A simple mathematical law links those two physical parameters to the global loudness. By analogy with those studies on impulsive sounds we extract specific physical parameters from the signals of sonic boom. Perceptive test with the help of a dedicated cabin specifically built for an accurate restitution of sonic booms have been done. This allow us to classify different physical parameters in order to know which of them are important for the perception of the level of sonic booms.

Th. 15:50 Kleber Sonic boom

Inverse Filter Optimisation Applied to Sonic Booms Reproduction

Yvan Maurel, Jean-Christophe Béra, Michel Sunyach
Centre Acoustique - Ecole Centrale de Lyon

The aim of this study is to reproduce accurately the waveforms of sonic booms in order to conduct psychoacoustic test on the subjective evaluation of the impact of this kind of sound upon our hearing perception. Only the reproduction process will be presented. This application would require infinite bandwidth transducers as the signals involved are extremely impulsive and have a large bandwidth (especially in the low frequencies range). To overcome this technical limitation, the transducers need to be carefully identified by experimental measurements in order to determine their inverse filters. Then the signals can be well preprocessed before applying them on the system input. The goal is to actually measure its acoustic twin on the output with a microphone. An electrodynamic closed-headphone coupled to an acoustic artificial head has been studied. Its transfer function has

been measured by applying different test-signals on the input to minimize measurement errors upon the whole frequency-band (0 to 20 kHz). The inverse filter has been computed by two different numerical approaches: the direct-inverse method which consists in directly inverting the transfer function, and the Singular Value Decomposition method which gives a more precise inverse filter by inverting only the actually measured transfer function (non-inversion of measurement noises). These two analytical methods have been experimentally compared. The high-fidelity condition can then be implemented by convoluting the signals by the temporal-inverse response of the system before sending to the system input. The stability of reversibility process has been researched.

Th. 8:30 Oberlin Psychoac. methods in musical acoustics

Study of the brightness of trumpets' sound by analysing impedance curves

Jean-François Petiot, Emilie Poirson, Joel Gilbert
LAUM

In order to isolate and finely control the influencing variables of the timbre quality of brass instruments, we developed a trumpet mouthpiece with a depth that can be easily and continuously adjusted from 'deep' to 'shallow'. Using this device and the same trumpet, we generated a set of instruments with notably different acoustical behaviour, varying only the internal geometry of the mouthpiece. This set of instruments has been evaluated by two ways: - a subjective study of the timbre of the instruments has been carried out via hearing tests with a set of subjects. The sounds have been generated by a trumpet player and by an artificial mouth. The rating of the brightness of the sounds has been asked to the subjects. - the input impedance of each instrument has been measured. In this paper, we present in which extend information extracted from the impedance curves can be used to predict the brightness. For this, the resonance frequencies of the impedance curve are analysed by principal component analysis. The brightness scores are interpreted by the principal components via multiple regression technique. As a result, a very good correlation between the rating of the brightness and the positions in the factorial space is observed.

Th. 8:50 Oberlin Psychoac. methods in musical acoustics

Psychoacoustical Analysis in Practical Use for Evaluation of Musical Instruments

Michael Baltrusch
Institut für Musikinstrumentenbau

Objektiv evaluation of musical instruments is mainly based on properties of the transferfunction. From this function parameters are extracted which indicate acoustical properties. So a comparison of instruments becomes very simple. Only a subjectiv assessment of instruments, concerning acoustical properties, leads to the appropiate significance of objektiv acoustical parameters. Therefore the parameters are scaled by the ear-relatet properties and perception. Predicted soundproperies derived from the transferfunction are not allways reliable. Instruments for instance Tongue-instruments, which do not allow to measure the transferfunction, are evaluated using the instrument sound. This contribution will present some impressions about the useof psychoacoustic methods to evalutate musical instruments based on some examples.

Th. 9:10 Oberlin Psychoac. methods in musical acoustics

Vibration and Sound of the Indian Tabla

Helmut Fleischer
University of the Federal Armed Forces Munich

The smaller instrument of the drum pair in traditional Indian music is called tabla. It is frequently referred to as the little sister of the European timpani because it makes also use of a closed kettle. In contrast to the timpani, however, the head of the tabla is not homogeneous but consists of different layers, above all a central 'black patch'. By means of Laser vibrometry the vibration behaviour of a tabla head was investigated. Additionally, the acoustic signals of two tonal strokes, tun and na, were analysed as well by FFT as by an aurally-related analysis software. In relation to a musical instrument, the latter one proved to be superior to the FFT as it accounts for (1) the critical band resolution of human audition, (2) the extraction of partial tones and (3) the effect of spectral masking. In order to focus on the relevant vibrations of a musical instrument, an apt psychoacoustically-based analysis represents an extremely powerful tool. Especially the simulation of masking is the key to reduce the physical information to its aurally-relevant core.

Th. 9:30 Oberlin Psychoac. methods in musical acoustics

Evaluation of Musical Sounds by Means of Psychoacoustical Methods

Gunter Ziegenhals
Institut für Musikinstrumentenbau

The properties pitch and response of musical instruments are described well by means of known methods of measurement and evaluation. In the case of sound evaluation we don?t find such results. Often indirect sizes like frequency response or mode shapes are measured and the sound properties are deduced from this sizes. But there are aurally-related signal analysis methods like loudness or sharpness since more then fifteen years. We could not find many papers about the application of these methods to musical sounds. One meaning is that the known aurally related methods only operate in cases of technical noises. The paper describe some examples of application and compare to the results of traditionally acoustical measurements.

Th. 9:50 Oberlin Psychoac. methods in musical acoustics

Auditory Spectrograms and Auditory Contours in Musical Acoustics

Peter Daniel
CORTEX INSTRUMENTS GmbH

Conventional Fast Fourier Transform is a useful tool for analysis of the physics of musical instruments. For the visualization of the perceived sounds they fall short as they do not model the time and frequency resolution and masking properties of the human ear. Requirement for the visualization of musical signals is a signal analysis modeling the information processing of the ear. Auditory spectrograms allow to calculate spectrograms with a time- and frequency resolution according to the human ear. Redundant information can be extracted by time- and frequency contourization of the auditory spectrogram in analogy to contours of the visual system. Contours and/or auditory spectrograms can be resynthesised confirming that only aurally relevant information were extracted. The visualization by contours allows intuitively to grasp the important components of a sound. Contributions of parts of a musical signal to the overall sound can be easily auralized by editing and resynthesising them. Resynthesis of time contours alone allows e.g. to auralize impulsive components separately from the tonal components. Further processing of the contours determines tonal parts in form of tracks and allows to separate different streams. The theory starting with the work of Terhardt will be reviewed and a wide range of applications are shown.

Th. 10:10 Oberlin Psychoac. methods in musical acoustics

Relationship between Auditory Information Processing and Perceptual Evaluations of Musical Instruments

Miriam Valenzuela
InPersonIC Corporation

A model describing the processes involved in the perceptual evaluation of musical instruments is presented. The model is based on a hierarchical model of sensory information processing proposed by Terhardt (1992). Accordingly, the information-carrying perceptual attributes that are important for the evaluation of musical instruments are extracted from the sound signal in a series of knowledge-based decision processes. Investigations with a variety of musical instruments have emphasized the importance of the model in finding responses to typical questions of musical acoustics such as (a) which signal parameters are characteristic for the sound of a specific instrument (identification) or a family of musical instruments (recognition), (b) which signal parameters are characteristic for the sound quality of an instrument, and (c) which physical changes in an instrument lead to which audible changes. The perceptual attributes responsible for dissimilarity and sound quality judgments of single tones, for example, are primarily the basic auditory sensations (e.g. sharpness, tonalness, openness, fluctuation strength, etc.). The identification and recognition of single musical tones seem to involve, among others, the sensations of spectral pitch, virtual pitch and impulsiveness. Most importantly, the model and the experimental results confirm that there is a close relationship between the processing of information in the ear and the evaluation of musical instruments. This advocates for an increased application of psychoacoustic know-how in musical acoustics.

Th. 13:50 Oberlin Sleep, noise and health

Consequences of Chronic Insomnia: Effects on Performance, Psychiatric and Medical Morbity - an overview

Dieter Riemann
Universitaetsklinik fuer Psychiatrie und Psychosomatik Abteilung fuer Psychiatrie und Psychotherapie mit Poliklinik ,

Chronic insomnia afflicts approximately 5 to 10% of the adult population in Western industrialized countries. It may be triggered environmentally, for example by noise, or it may be secondary for example due to psychiatric/organic illnesses or the intake of prescribed/illicit drugs. It can also occur as primary insomnia, then due to a psychophysiological hyperarousal process. Especially for primary insomnia, the sequelae of the disorder for

performance, psychiatric and medical morbidity have been investigated. Concerning aspects of performance, studies describing the effects of primary insomnia are scarce. It does not seem to lead to increased daytime sleepiness, but rather to the opposite. Neuropsychological consequences seem to be only of a minor nature. No data exist that prove definitely that primary insomnia is accompanied by general psychosocial impairements, though some studies hint to that issue. Studies dealing with the interplay between primary insomnia and psychiatric diseases, especially depression, have been published increasingly in recent years and indicate that patients with primary insomnia during the course of their disorder are at a hightened risk of developing a major depression. The picture is less clear with respect to medical morbidity: primary insomnia seems to lead to a hightened utilization of health services and an increased frequency of diagnostic and therapeutic interventions, especially the intake of hypnotic drugs. There is, however, no proof yet that primary insomnia is coupled with an increased frequency of cardiovascular diseases or a weakening of immune functions.

Th. 14:10 Oberlin Sleep, noise and health

Exploring the relationship between noise-disturbed sleep and long-term health effects

Alain Muzet
CNRS

Sleep disturbance due to noise is one of the most frequent complaints of populations living in noisy areas. Sleep quality can be evaluated by both instrumental and subjective measures. The physiological structure of sleep can be quantified by several parameters such as sleep onset latency, sleep duration, time spent in each stage of sleep. Subjective measures are subject's own evaluation of sleep quality as well as next day possible aftereffects. Annoyance due to ambient noise may be often seen as the visible part of a greater problem. A certain amount of habituation to noise does exist. If the noise load is not in excess, subjective habituation can occur in a few days or weeks. However, this habituation is not complete and the measured modifications of the autonomic functions, such as cardiovascular responses, still remained unchanged over long periods of exposure. It is believed that such long term effect could lead to permanent cardiovascular system impairment. However, to date, there is no evidence of conclusive effect of chronic exposure to noise during sleep on cardiovascular diseases. The main difficulty is to separate cumulative effects of noise-exposure at night from the global exposure to other environmental factors (including noise) over the 24-hour period. To our knowledge, no epidemiological study has tried to

specifically answer this question of the effects of noise exposure during the night compared to the more global daily exposure.

Th. 14:30 Oberlin Sleep, noise and health

Night noise and health - First Results of the WHO LARES study

Xavier Bonnefoy

WHO European center for Environment and health, Bonn office

The World Health Organization's Regional Office for Europe, Bonn Office has coordinated a large study (LARES) to evaluate the health impact of housing conditions in eight European cities. Living and housing conditions are the basis for many aspects that affect residential health: indoor air quality, accidents, noise etc. are only a few of the possible health threats to be found in dwellings. Mental and social health are both affected by the living conditions but no straightforward mechanisms have yet been established. Although such impacts are broadly accepted, the concrete relationship between housing quality and well being has so far not been fully understood. First results of the survey point out, that noise or "noise comfort" plays a decisive role in the general relationship between housing conditions and health. In particular night noise exposure (and therefore noise induced sleep disturbances) has to be assessed as a serious risk factor for domestic accidents and as a threat for health, especially for stress related diseases. The design of the LARES study and the first findings related to nocturnal noise will be presented.

Th. 14:50 Oberlin Sleep, noise and health

Effects on health of nocturnal traffic noise - sound level at subjects'home versus self-reported sleep disturbances -

Christian Maschke

FBB - Maschke

Recent epidemiological studies support the assumption that nightly road traffic noise exposure plays a more fundamental role in the emergence of health disorders than noise during the daytime - particularly in relation to the cardiovascular and respiratory systems. It can be assumed that disturbed sleep patterns are an impairment to health in the long run. In these terms, the usefulness of self-reported sleep disturbances is at the center of the discussion. An aspect to the discussion is the direct comparison between nocturnal noise exposure (equivalent continuous sound pressure level) in front of the windows of the subjects' home and the self-reported sleep disturbances with respect to possible negative effects on health. The presented findings are based on the Spandau Health Survey, which, independent of noise exposure

during the night, also considers self-reported sleep disturbances as an risk factor for stress related diseases.

Th. 15:10 Oberlin Sleep, noise and health

Sleep Quality and Nightly Aircraft Noise: Methods and Preliminary Results of a Long-term Experimental Field Study

Mark Brink, Katja Wirth, Christoph Schierz
Swiss Federal Institute of Technology Zurich

The study focuses on the sleep quality impact of aircraft noise at sleep onset in the evening and before wakeup in the morning. Experiments take place in the subjects homes and run for 30 nights each. This experimental period is longer than in most other comparable studies and allows for the assessment of long term and habituation effects. 64 subjects are contributing to a total of 1920 nights. The study is based on a three-factor design with repeated measures: Timely distribution of noise (evening vs. morning), maximum sound level (Lmax(slow) of 50 vs. 60 dB(A)) and number of noise events per night (8 vs. 16). Either at the beginning or towards the end of the night, within a 90-minute period, prerecorded aircraft noise events are played back from a loudspeaker in the bedroom. Street traffic noise (matching the sound energy of 8 x 60 dB(A) aircraft noise events) has been added to the design and is played back at two evenings and mornings. The nightly sequence of factor combinations is balanced over all subjects and each subject is administered the same total amount of noise. Physiological as well as self-reported psychological reaction patterns are measured as dependent variables. A non-intrusive recording system for sleep physiology (actimetry, cardiac and respiratory parameters) has been developed. The measuring principle is based on the vibrations caused by the cardiac and respiratory system that propagate through the body and are coupled to the mattress and the bed. These are detected by pressure sensitive sensors installed below the bed-posts.

Th. 15:30 Oberlin Sleep, noise and health

Aircraft Noise Annoyance at Different Times of Day

Katja Wirth, Mark Brink, Christoph Schierz
Swiss Federal Institute of Technology Zurich

Several studies have shown that aircraft noise reactions are related to the time of day: At same noise levels, night-time annoyance is above day-time annoyance (e.g. Kastka, 2000; Höger et al., 2002). Furthermore, there exists an annoyance-profile during the day, with different annoyance-peaks, being partly independent from the noise level (e.g. Felscher-Suhr et al., 1996). The Swiss Noise Study 2000, carried out around the airport Zurich in 2001, confirmed these findings (Wirth et al., 2002, 2003). On

this background, our question is: Which factors influence the variation of the annoyance judgment during the day? On the basis of the data of the Swiss Noise Study 2000, answers to this question are sought. In this survey subjects were asked about the reasonability of aircraft noise at different periods of time. It can be shown that the Leq of the corresponding day period plays not an important role for the reasonability judgment. Especially in the early morning, subjects seem not to refer to the noise level at this period when rating the reasonability of aircraft noise. The influence of moderator variables is much more important. Possible interpretations will be discussed.

Th. 8:30 Arp 1 Vibration from railway lines

The influence of the track on railway induced ground vibration

Lutz Auersch
Bundesanstalt für Materialforschung und -prüfung

Theoetical and experimental results about the influence of the track on railway induced ground vibration are presented. A combined boundary - finite element method had been delopped to calculate the vibrations of different flexible or rigid structures on the soil. Railway tracks have been thoroughly investigated by this method. It will be shown what are the differences of the dynamic track compliances due to additional concrete plates (slab track for example) and additional elastic elements such as rail pads or ballast mats. Some simpler theoretical models are discussed, too: The structure-soil interaction of an infinite plate (as firstly discussed accoustically by M. Heckl) and the rail bedded on a chain of masses and viscoelastic springs which is used instead of a 3-dimensional track-soil model to calculate the insertion loss, the load reduction and load distribution of aelastic elements. Finally, the analysis of the dynamic train-track interaction yields the dynamic axle loads which are the cause of the ground vibrations near the railway line. Railway induced ground vibrations have been measured at many places during the last two decades. Some experimental results are shown to prove the theoretical consequences and to demonstrate the influence of the track on the ground vibration.

Th. 8:50 Arp 1 Vibration from railway lines

Determination of the Static Stiffnes of Resilient Rail Fastener in Built-in Conditions

Friedrich Krüger, Heinz Becker
STUVA e.V.

The insertion loss of a resilient rail fastener depends on its static and dynamic stiffnes. In practice the stiffness of one or several

items can be obtained by measurements in a lab using a hydraulic zylinder. The stiffness in built-in conditions can be different from the measured stiffness in the lab according to the prestressing of the rail and the rail fastener itself. There will be presented some results of measured static (and dynamic) stiffness. The results measured in the lab will be compared with the results measured in build-in conditions on the line (tunnel and at grade). In addition the chosen facility is described for the measuring of the static stiffness.

Th. 9:10 Arp 1 Vibration from railway lines

Vibrations of traffic, from the source to the recipient, the problem of resonances

Gérard Rutishauser
Rustishauser Ingenieurbüro für Bau, Verkehr und Umwelt GmbH

Vibrations of traffic cause an increasing and more and more remarkable influence over the environment. Most people affected by clearly perceptible vibrations feel disturbed. Many effects of resonances are important for the emergence and transmission of vibrations. The dynamic forces of the wheel-rail-system regarding the railway depend on the dynamic interaction of track and ground. Particular measures can influence this interaction positively. Such measures are for example ballast mats or elastic under sleeper mats.
The smoothness of the surface and the elasticity of the ground are decisive parameters of the excitations of vibrations regarding the traffic. A smooth surface is the best measure to limit the immission for the immediate surrounding.
The transmission of vibrations in a building is also characterised by resonances. Most important are the resonance frequencies of a floor. Measuring data out of substantial data bases show some clear conformities to a proposed calculation model. Nevertheless, the data are widely spread. However, they help to reduce the considerable uncertainty of predictions in the future.

Th. 9:30 Arp 1 Vibration from railway lines

Mitigation of Vibrations Considering Different Types of Trainsets

Rudolf Liegl, Ulrich Möhler
Moehler + Partner

The attenuation of structure-borne noise caused by trains moving in tunnels nearby residential areas is essential in order to avoid disturbances in the neighbourhood. The effectiveness of protective measures is commonly described in terms of insertion loss and resonance frequency, both - among others - depending on the stiffness of the bearing and the unsprung mass of the

wheelset. The results of current vibration measurements on the one hand indicate reduced vibrational excitation caused by modern lightweight trainsets. On the other hand metrological determinations in an existing railway-tunnel show a reduced effectiveness of the protective measures. The results of the measurements are presented and compared to calculated values. With reference to ongoing construction works consequences particularly with regard to the dimensioning of protective measures are discussed.

Th. 9:50 Arp 1 Vibration from railway lines

Aboveground Low Vibration Emission Ballasted Track with Concrete Trough

Frank Müller-Boruttau, Volker Rosenthal, Norbert Breitsamter
imb-dynamik

Measures for the mitigation of vibration emission from aboveground railway traffic are urgently needed. A newly developed type of aboveground ballasted track fulfills this need. A solid concrete trough supports and contains a standard ballasted track on a ballast mat. The trough confines the ballast. Thus an extremely stable ballast bed is achieved, resulting in a very smooth, high quality track with low emission and next to zero maintenance costs. The insertion losses due to a) trough bending stiffness, b) ballast mat and mass impedance, c) track quality improvement are explained. A 4 km double track section was installed on the new Karlsruhe-Basel line next to Baden-Baden. A very demanding insertion loss limit had to be met: in the frequency range 10 - 50 cyc/s only positive insertion loss values were to be accepted. An overall insertion loss of at least 4,5 dB had to be achieved on widely varying subsoil conditions. Measurements obtained with regular trains did show that the requirements were surpassed: An insertion loss average of 7,5 dB was achieved. Based on the measurement results and iSi calculations (imb-dynamik train-track simulation model) predictions were made of achievable insertion losses for variations of a) trough properties, b) subgrade conditions, c) ballast mat properties. The resulting mitigations of vibration and secondary noise level together with very competitive costs make this new permanent way a tool adaptable even to difficult environmental conditions.

Th. 10:10 Arp 1 Vibration from railway lines

Development of a New Low Vibration Track System for the Vienna Underground

Paul Berger, Dieter Pichler, Wolfgang Unterberger
FCP - Fritsch, Chiari & Partner ZT GmbH

The Vienna Metro Corporation "Wiener Linien" uses a vibration and ground-borne noise attenuating ballast-less track system for its tunnel lines. This system, known as "Wiener Oberbau" - "Viennese superstructure" - was developed in the 1970s. Its ability to reduce vibrations and ground-borne noise has served the Viennese metro well during this period, with only minimal complaints by residents. However, some disadvantages caused the Wiener Linien to consider the development of a new track system: problems were encountered with the durability of the mineralised-wool mats used as an elastic layer between rail slab and foundation beam, the light-weight sleepers were found to be prone to material fatigue and the open drainage ditch had to be covered to prevent a safety hazard to firemen and escaping passengers in case of emergency. Therefore the Wiener Linien established a working group of experts to develop a new ballast-less track system. This system was to be based on the fundamental principles and noise and vibration mitigating features of the "Wiener Oberbau" but had to avoid its shortcomings. Following a pre-selection procedure, the work focused on two ballast-less track types. For these two systems, a 300 m long test track was constructed. To determine the system best suited for the Vienna metro the testing and evaluation programme consisted of an evaluation of the construction process, tests with extensive measurements of deformations, contact pressures, vibrations and noise (minimum standard was the noise and vibration attenuating capacity of the "Wiener Oberbau") and a comparison of the life-cycle costs.

Th. 10:30 Arp 1 Vibration from railway lines

Mass-spring-system installed in a tunnel on the high-speed line Köln-Rhein/Main

Udo Lenz
Ing.-Büro Uderstädt + Partner

Railway and tram tracks induce vibrations, which cause structure-borne immissions of noises and vibrations. On the new high-speed track between Cologne and Frankfurt are several tunnels. A tunnel close to St. Augustin was build directly under existing houses. A mass-spring-system manufactured by the Ed. Züblin AG was installed in this section for the protection of the adjacent residents. The tunnelled route is driven on with a speed of 220

km/h. The reinforced concrete slabs of the system have an average thickness of 45 cm. Measurements in the tunnel and in affected buildings show the mass-spring-system works effec-tively and achieves a successful vibration mitigation. The passage of trains causes no noticeable vibrations in the affected buildings. (Lecture in German)

Th. 13:50 Arp 1 Vibration from railway lines

Structure-borne noise from railways - a case study

Michel Villot
CSTB

The case of the Massena train station in Paris is presented. In this station, the train tracks are at ground level and a passenger transit room (going to an underground subway nearby) is located right under the tracks, under a thick concrete floor. The insertion of a ballast mat between ballast and concrete floor has been studied in order to decrease the vibration levels of the floor and the noise radiated into the transit room. A simplified (infinite) multilayer model ballast - ballast mat - concrete floor has been used to choose the proper mat. Moreover, it has been possible to make measurements before and after inserting the ballast mat and to compare the experimental insertion loss with the theoretical one given by the ballast mat producer.

Th. 14:10 Arp 1 Vibration from railway lines

Vibration Control in a tunnel under an office rehabilitation project

Marc Asselineau, Stéphane Mercier
Peutz & Associés

During the preparatory work for the Universal 1900 exposition, the line between the Paris railway stations of Austerlitz and Orsay was rerouted into a tunnel under the administrative building of the station. A century latter, this building is being turned into a high class office rental project, and the structure borne noise from trains turned from synonym of wealth to nuisance. Due to the fact that part of the building is preserved it was not deemed possible to implement vibration control measures on the building. Therefore vibration control had to be implemented under the track. Due to the restricted loading gauge in this old tunnel, custom tailored vibration control measures had to be implemented. Basically, these called for a resilient mat under and on each side of the ballast, with careful consideration being given to the overall thickness as it could eventually foul the loading gauge. This paper describes the preliminary diagnosis prior to designing the vibration control measures, then the specification and the implementation of those measures, and finally the commissioning measurements.

Th. 14:30 Arp 1 Vibration from railway lines

Track isolation in a light rail tunnel in downtown Berlin

Stephan Achilles, Rüdiger Wettschureck
GuD Geotechnik und Dynamik Consult GmbH

Presently, a number of high-profile buildings are being built on Berlin's Potsdamer Platz, which was previously bisected by the Berlin Wall. Five of the structures under construction are located in the immediate vicinity of an existing light rail tunnel. Based on vibration measurements carried out before construction was commenced, unacceptable levels of secondary airborne noise emission were prognosticated. After careful consideration of the possible construction countermeasures, the costs and the related construction times, the decision was made to isolate the tracks using ballast mats (BM). Calculation of the level of structure-borne noise isolation to be achieved with the BM, i.e. their insertion loss, indicated that the required level of isolation could only be achieved with the use of particularly high-quality elastomer materials. In cooperation with the clients, project management and experts, it was possible to negotiate a contract between the five investors for the joint financing and award of contract for this track isolation project, and to execute the project in the third quarter of 2002. This isolation project is outstanding in terms of its size (a total of 1,080 m of track with 9 switches and 2 crossings). Subsequent to installation of the track isolation measures, follow-on measurements were conducted in the adjacent buildings, to determine the effectiveness of the isolation system. Based on the results of the vibration measurements in the semi-finished structures it is possible to estimate the expected level of structure-borne noise emissions. The results are presented in this paper.

Th. 8:30 Arp 2 Application of psychoacoustics II

Optimal Coding of Stereo (OCS)

Jeroen Breebaart, Steven Van De Par, Armin Kohlrausch
Philips Research Eindhoven

Audio coders aim at transmission and storage bandwidth reduction with a minimum of perceptual quality loss. The information reduction relies on two principles: removal of redundant information and exploitation of (perceptually) irrelevant information. For stereo audio material, a limited repertoire of methods to exploit across-channel redundancy and perceptual irrelevancy is currently used. Well-known techniques are so-called mid-side coding and 'intensity stereo', which exploit across-channel correlation and the human insensitivity to phase differences at high

frequencies, respectively. The result is a two-channel representation, where the monaural as well as the spatial properties are encoded in both channels. In contrast, the OCS algorithm completely separates monaural and spatial information by representing a stereo signal by a monaural channel plus a limited amount of side information covering the spatial properties. This is achieved by analyzing and parameterizing of the perceptually relevant spatial properties of the incoming stereo audio content, combined with the generation of a mono downmix of the two input channels. This mono signal can be encoded using any existing coding technique. In addition, the spatial parameters are coded and combined with the encoded mono signal to form a total output bitstream. At the decoder side, the mono signal is decoded and the spatial properties are reinstated according to the transmitted spatial parameters to form a stereo output signal. Listening tests have revealed that a spatial parameter bitstream of less than 10 kbits/s is sufficient for high-quality audio, which leads to a significant bit-rate reduction compared to present-day stereo coding algorithms.

Th. 8:50 Arp 2 Application of psychoacoustics II

Automatic noise substitution in natural audio signals

Janto Skowronek, Steven Van De Par
Philips Research Eindhoven

One key concept in audio coding is to remove signal redundancies during the encoding by transforming the signal into a more bit-rate efficient representation. A difficult signal type for some audio coders are noisy or noise-like audio signals, for instance unvoiced parts of speech, due to their high entropy. A waveform description of these noisy signals typically requires a high bit-rate. One possibility to handle this problem is to consider that the human auditory system is not able to distinguish between two realisations of noise, provided that the temporal and spectral envelopes of both noises are the same. Thus, if the noisy parts of an audio signal can be automatically classified, only their temporal and spectral envelope have to be encoded and not the signal part itself which is usually more expensive in terms of bitrate. Following this idea, an existing auditory model was adapted in order to get a psychoacoustically motivated signal representation. Based on this signal representation, a decision variable was derived that was used to identify noisy parts in the time-frequency domain and replace them with synthesized noise. In this way, audio signals were created which allowed an evaluation of the noise substitution algorithm in a listening test with several subjects. Results showed that for stationary signals, an audio quality could be

obtained that was comparable to that obtained with an MPEG 1 Layer III codec for 96 kbit/sec mono.

Th. 9:10 Arp 2 Application of psychoacoustics II

Loudspeaker Frequency Response Targets at High Frequencies

Gerhard Krump
FH Deggendorf

For tuning a loudspeaker box system targets of frequency response curves are very important. Should the speaker system have a neutral tuning with linear frequency response over complete frequency range or an increase of high frequency level to equalize the lower sensitivity of ear? Is then a lower loudspeaker level round 3.5 kHz necessary to reduce the higher hearing sensi-tivity caused by ear tube resonance? In order to receive a quantitative answer different tracks with a prepared music sequence were created on a CD by increasing and decreasing frequency response levels at 3.5, 8, 12, and 16 kHz with a Q-factor of 0.7 in steps of 1.5 dB. Ten test persons have estimated the sound of the tracks produced by a loudspeaker box with flat frequency response regarding brilliance, sharpness and high frequency reproduction with dif-ferent test procedures. Further they have choosen the track with the preferred sound. The results of the different test methods will be compared and proper frequency response targets will be discussed in consideration of the measured threshold in quiet of the test persons.

Th. 9:30 Arp 2 Application of psychoacoustics II

Perceptive and objective evaluation of loudspeakers

Mathieu Lavandier, Philippe Herzog, Sabine Meunier
LMA CNRS

Normalized measurements used nowadays to compare loudspeakers are only based on a few physical characteristics (frequency response, directivity, sensibility,...). The perception of reproduced sound is not considered, although listening is the final goal of audio sources. Without tools to assess the perceived result of their work, audio professionals are restricted in the improvements that they could give to their products. Aiming to a wider evaluation of reproduced sound, we decided to evaluate a panel of loudspeakers in two parallel ways : objective measurements and perceptive ones. The 'objective' study involves advanced physical measurements and signal processing, such as correlation, transfer, and time-frequency analysis which should allow a more accurate characterization of the sound radiated by loudspeakers. The 'perceptive" study is based on psychoacoustical measurements. Perceptive attributes are determined that are

responsible for our evaluation of an audio source. The goal of our research is to find correlations between the dimensions revealed by these two types of measurements. First, we will present the experimental protocol chosen. It is compatible with both physical and psychoacoustical measurements as we want to correlate their results. It allows to compare different loudspeakers, at the same position in an usual room, during a unique set of the psychoacoustical experiment. Secondly, the first results of the two types of measurements will be shown. They focus on the study of the restitution of timbre so the spatial dimension of sound reproduction will not be considered here. At the end, both measurement will be compared.

Th. 9:50 Arp 2 Application of psychoacoustics II

Evaluation of the Influence of Various Dispersions on Acoustical Perception using Experiment Design

Vincent Koehl, Etienne Parizet
Lab. Vibrations Acoustique, INSA Lyon - Bât. 303

The aim of this study is to know whether the experiment design method can be helpful to evaluate the impact of various dispersions on acoustical perception or not. The noise stemmed from an electric machine has been recorded with parametric variations. Six parameters, considered as relevant ones and taking three levels each, have been selected. The nature of those parameters is a mechanical one (axes alignment and dynamic balance, distance between gearsoe). An experiment design has been realized according to Taguchi's table, in order to estimate the effects of those parameters with a reasonable number of sound records. Some questions have then been asked to listeners regarding their impressions on the similarity between sounds during perceptive tests. The effects of parameters have been deduced from those answers. Using these effects, it should be possible to predict listeners' answers on any parameters configuration. Unfortunately, interactions between parameters have been highlighted, so that reliable predictions are not possible at this step of the study. Other tests have then been carried out in order to estimate the effects of interactions. The prediction of listeners' answers becomes a reliable one when taking those additionnal effects into account. The experiment design method is then an efficient tool to make accurate predictions with a low number of preliminary measurements.

Th. 10:10 Arp 2 Application of psychoacoustics II

Perception of Sounds Radiated From a Vibrating Plate : Comparison of Structural Parameters Influences

Julien Faure, Catherine Marquis-Favre
ENTPE-DGCB-LASH

In previous studies, the effects of a plate structural parameters on sound perception have been assessed. These assessments have been achieved by studying each one of the structural parameters separately. For each parameter, a sound perception test with at least six stimuli submitted by pairs has been carried out. This test has led to the representation of the stimuli in their perceptual space and then to the identification of sound characteristics which have played a role on perception. It has also permitted one to calculate preference scores for each studied structural parameters value. The main advantage of this approach is the good accuracy of the perceptual evaluation which has led to relevant conclusions to improve acoustic comfort. Its disadvantage is the difficulty of doing comparisons of the relative results obtained by the numerous sound perception tests and so the difficulty of concluding about the relative importance of structural parameters on sound perception. The present paper shows how this kind of comparison can be possible. A synthesis of the effects of glass and steel plates structural parameters on sound perception will be given. These parameters will be classified in order of their importance on sound perception. This classification is helpful in the choice of relevant parameters in the framework of sound design or sound quality improvement.

Th. 10:30 Arp 2 Application of psychoacoustics II

Can we hear the complexity of vibrating plates ?

Florence Demirdjian, Dominique Habault, Sabine Meunier, Georges Canévet
LMA CNRS

The present work is related to the field of psychomechanics, the aim of which is to establish correlations between acoustical and perceptual attributes of sounds radiated by a vibrating structure and the mechanical parameters of that structure. As a case study, we examine the vibrations of a plate excited by a transient point force. This raises an optimization problem for sound synthesis, since we need to find a compromise between the level of accuracy (and time cost) required for a valid modeling of the plate, and the perceptual realism of the synthesized sounds resulting from the corresponding calculations. Two main aspects are considered. Firstly, we wished to know whether a plate with a variable thickness can be modeled by a constant-thickness plate

that would be equivalent, from a perceptual point of view, in terms of the radiated sounds. If so, such equivalence would greatly reduce the complexity of the model. We performed calculations on both types of plates, and ran psychoacoustic tests on the respective sounds to evaluate their similarity. Perceptual criteria could be identified, that allowed us to define an "equivalent thickness". Secondly, we recorded acoustic impact responses of actual plates, with constant thickness, and then compared the recorded sounds to the synthetic sounds produced by our model, again using psychoacoustic tests of similarity. These tests help to determine which parameters are relevant for auditory similarity, and thus provide hints for improving or optimizing our theoretical models.

Th. 13:50 Arp 2 Application of psychoacoustics II

On the Possible Role of Acoustics for Multimodal Analysis and Recognition of Human Behavior in Smart Environments

Gerhard Rigoll

Institute for Human-Machine-Communication

The analysis and recognition of human behavior and action in smart environments is a new challenging discipline in the area of multimodal interfaces. Smart environments are environments that are capable of interacting with the user or supporting the actions of the user. Examples for such anvironments are e.g. Smart Homes, Smart Offices, or Smart Meeting Rooms. In all those environments, a new trend in human-machine-communication is to enable the user to interact with the devices and the equipment of the room. For that purpose, the smart environment has to be aware of the presence of the user(s) and to be able to detect their current actions. For instance, if a user in a smart home intends to go to his TV set or points towards it, the smart room should recognize such a behavior and switch on the TV. Also verbal actions of the user are crucial for detecting his intentions, and therefore, speech recognition in rooms is an important discipline for such a research purpose, which automatically involves the use of room acoustics for recognition. Room acoustics will also play a major role in audio-visual tracking of the users, since their position has to be always known. In this talk, some examples for the possible use of acoustics will be presented in the framework of a recently started large EU-funded integrated project on smart meeting rooms and the construction of a multimodal meeting browser for the transcription and exploration of such meetings.

Th. 14:10 Arp 2 Application of psychoacoustics II

Acoustic simulation in realistic 3D virtual scenes

Thierry Cathala, Pierre Naz, Patrick Gozard
OKTAL SE

The simulation workshop CHORALE is used by government services and industrial companies for multisensor simulations in realistic 3D virtual scenes (in the visible, infrared and EM spectrum and now acoustic signal too). For acoustic simulations, the need is, for example, the detection of moving vehicles in 3D scenes. This article describes the acoustic model in CHORALE. The 3D scene is described by a set of polygons. Each polygon is characterized by its acoustic resistivity or its complex impedance. Sound sources are associated with moving vehicles and are characterized by their spectra and directivities. A microphone sensor is defined by its position, its frequency band and its sensitivity. The purpose of the acoustic simulation is to calculate the incoming acoustic pressure on microphone sensors. CHORALE is based on a generic kernel consisting of functionalities. This kernel possesses original capabilities: computation time is nearly independent on the scene complexity especially the number of polygons, databases are enhanced by precise physical data, special mechanisms of antialiasing have been developed that enable to consider very accurate details. The ray tracer takes into account the wave geometrical divergence, the atmospherical absorption, the attenuation of sound due to trees and forests, the wind and Doppler effects, the sound diffraction by edges (hill, wall, oe) and the sound wave refraction due to air temperature gradients. Finally, the article describes a validation test based on the results of international acoustic detection experiment TG25.

Th. 14:30 Arp 2 Application of psychoacoustics II

Influence of frequency and magnitude on the perception of vertical whole-body vibration

Michael Bellmann, Volker Mellert, Hermann Remmers, Reinhard Weber
itap GmbH - Institut für technische und angewandte Physik

The interest in human response to vibration becomes more and more public because the number of mechanized sources of vibrations in daily life have enlarged and the number of exposed persons has increased. Existing standards, for example, ISO 2631-1/2 (1997, 1989), refer to sinusoidal (deterministic) excitation base on vibration perception in buildings. These standards address, i.e., perception thresholds of whole-body vibrations in all directions or equivalent-comfort contours. Existing data in literature on the perception of sinusoidal whole-body vibration show

considerable differences to the present standards. However, data from different laboratories deviate from each other too, probably due to differences of the used psychophysical measurement method. Additionally, incomplete details exist in the literature for basic experiments like difference thresholds (JND). Nevertheless, the benefit of more and better information and knowledge about the perception of vibrations allows to improve human response to vibration models (HRVM) so that 'well-being' would increase and the annoyance experienced from vibrations would be reduced. Furthermore, revised designs and standards could be developed on the basis of improved HRVM and psychophysical data. In the present study, some results from vertical whole-body vibration perception experiments like perception thresholds, JND in level and frequency, as well as equal-vibration level contours are presented. These data are determined with new and reliable psychophysical measurement methods which minimize the influence of measurement parameters on the results. The experiments are conducted in the frequency range from 5 to 100 Hz.

Th. 14:50 Arp 2 Application of psychoacoustics II

Thoughts about Optimization with Subjective Design Goals (with Examples from Acoustics)

Peter Költzsch, Volker Bormann
Technische Universität Dresden

For a machine, the optimal developmental goal can be established by the highest efficiency or the least fuel consumption. These criteria can be judged objectively. If there are more criteria crucially, then the Pareto Optimization might be an initial step for such a solution, or the human has to make a decision based on his purpose. Compared with acoustics, there are numerous problems, where the achievement of 'objective optimization' rests (almost) exclusively on subjective evaluation. A classical problem is the good concert hall acoustics; however, optimal adjustment of hearing aids, subjective evaluation of walking noise, and the quality of loudspeakers or musical instruments, are further examples. There are methodological questions for such optimization problems: What exactly is that subjective criteria for the establishment of the optimal result? Is the subjective evaluation, with regard to design goals, only the expression for a still unfinished scientifically cognitive process? Which influence does the test person's skills (experts, nonprofessionals) have on the optimal result? Why do the experts' judgments scatter more frequently, and why do nonprofessionals' judgments match better? Why do nonprofessionals find the same optimal or even better results as experts do for some optimization problems, with limited knowledge or rather bounded rationality? How must nonprofessionals

be asked? Optimizations with subjective design goals are multi-criterially, fuzzily, and they are an example for the problem of bounded rationality. About those thoughts (questions mentioned above), a project has been prepared together with psychologists.

Th. 15:10 Arp 2 Application of psychoacoustics II

Modeling Loudness Enhancement

Daniel Oberfeld
Psychologisches Institut der Johannes Gutenberg-Universität Mainz

Oberfeld (2003) proposed that loudness matches to short tones in the presence of a forward masker can be understood by assuming that 1. listeners use a weighted average between masker and target loudness in producing the loudness match and that 2. the weight given to masker loudness depends on the perceptual similarity between masker and target. Data from experiments varying masker-target level difference independently of target level supported this view. Loudness enhancement was a non-monotonic function of the level difference. In this paper, a quantitative model based on the above assumptions presented. In the first step, loudness representations for masker and target are computed according to Zwislocki's (1965) loudness function. In the computation of the weighted average, masker loudness receives less weight if masker and target are perceptually different. Masker weight is maximum if masker level equals target level and all other stimulus parameters (e.g., duration) are identical for masker and target. The model uses three free parameters only (maximum masker weight, a parameter representing the effect of masker-target level difference, and a bias parameter). It produced a reasonable fit to data from Zeng (1994) and Oberfeld (2003). Despite its simple structure, the model can account for a) the non-monotonic relation between loudness enhancement and masker-target level difference (the mid-difference hump) b) the so-called midlevel hump (enhancement caused by an intense masker is greatest at intermediate target levels), and c) the observation that for a given masker-target level difference loudness enhancement is less pronounced at low than at intermediate and high target levels. Implications for intensity resolution are discussed.

Th. 15:30 Arp 2 Application of psychoacoustics II

Probabilistic Choice Models for Psychological Scaling

Florian Wickelmaier, Christian Schmid
Aalborg University

When scaling perceived magnitudes, it is common practice to employ direct rating scales, asking subjects either for a numerical or a verbal label which is later transformed into a number for further processing. The validity of scales obtained in this manner is, however, doubtful. Probabilistic choice models provide a powerful alternative to direct scaling procedures. Here, the task for the subject is to choose one stimulus at a time from a pair. Subsequently, a psychological model of the subject's decision strategy is formulated, which leads to a ratio scale of the stimuli. Once a model is specified, standard statistical theory can be used to obtain maximum likelihood estimates of the parameter values, estimate their covariance matrix, apply various hypothesis tests, and to compare different models with respect to their validity. Until recently, the lack of special-purpose software prohibited wide application of the more sophisticated choice models, such as elimination by aspects (EBA) or preference trees. Now that such tools are available [Wickelmaier & Schmid, Behav. Res. Meth. Instr. Comp. (in press)], probabilistic choice models could become more important in applied research. The modeling approach is demonstrated using an example from sound-quality evaluation, where the unpleasantness of twelve environmental sounds was represented by a preference tree.

Th. 8:30 Arp 3 Combined noise evaluation

Combined noise effects and noise protection planning - the need of regulation

Ulrich Moehler
Moehler + Partner

The noise protection planning in context with construction of new or existing traffic routes in Germany is considered isolated for each traffic noise source, the considerartion of combined noise sources ist not regulated. On behalf of some examples, the effects of the isolated consideration of noise sources will be demonstrated and some possiblilties to avoid these will be discussed

Th. 8:50 Arp 3 Combined noise evaluation

Concepts for estimating the total annoyance in residential settings containing two noise sources

Rainer Guski
Faculty for Psychology, Ruhr-University

Administrators in industrialized countries are often faced with the task of estimating the effect of two or more noise sources on the ‚total annoyance" of residents. Since laboratory experiments do not seem adequate, well controlled field studies are rare, and both lab and field studies show conflicting results, the administrative task has to be done from the desk, using certain assumptions and a theoretical concept. In the past, several models have been proposed, e.g., energy summation, annoyance summation, energy difference, and dominant source. The main concepts discussed today make at least three assumptions: (1) The relation between integrated noise levels of a single source and integrated annoyance judgments of this source is different for different noise sources. (2) The annoyance judgment related to a specific source is indenpendent from the annoyance judgment related to a second source. (3) The noise level of a specific source can be converted to the noise level of a reference source, using annoyance equivalents. These and other assumptions are discussed in the present paper.

Th. 9:10 Arp 3 Combined noise evaluation

Are different noise sources judged independently from each other?

Katja Wirth, Mark Brink, Christoph Schierz
Swiss Federal Institute of Technology Zurich

Within the Swiss Noise Study 2000, an aircraft noise annoyance survey has been carried out. In August 2001, 1826 persons in the surroundings of the airport Zurich filled out a noise annoyance questionnaire. Several aircraft noise measures were calculated for each subject. Even if the main topic of this study was aircraft noise annoyance, the annoyance of other noise sources (aircraft, road traffic, railway, work) was surveyed, too. Analyses show that the annoyance judgment of different noise sources are not independent from each other, even if it was controlled for noise sensitivity. The results of the corresponding path analyses and regression models will be presented. On the basis of the existing literature about combined noise sources, different interpretations of these findings will be discussed.

Th. 9:30 Arp 3 Combined noise evaluation

Nocturnal noise from different sources and sleep disturbances - best practice, background and gaps in knowledge -

Christian Maschke
FBB - Maschke

It is undisputed in noise effect research, that an effect orientated summary of sound levels for exposed persons is urgently needed in order to judge complex noise situation correctly with regards well being or health (Acceptor approach). This also applies to nightly noise exposure and its adverse effects on sleep. The data available for source related sleep disturbances is however modest by comparison with "noise annoyance". In accordance with the summary model of 'annoyance', the interaction of nightly noise sources can be considered by sleep disturbance orientated effect-levels. References to the approach arise from studies regarding noise induced sleep disturbances when the results are subdivided into different noise sources. The calculated results, however, have to be interpreted with caution since sum effects are very complex and generally accepted dose response curves are lacking.

Th. 9:50 Arp 3 Combined noise evaluation

Study of various situations of dominance of combined noise sources (road and railway)

Eva Walker, Manon Raimbault, Cora Cremezi-Charlet
SNCF - Direction de la Recherche et de la Technologie

Previous studies on the evaluation of combined noise sources show that it is useful to distinguish various classes of dominance, according to a difference $>$5 dB between the levels of each source (road or rail). In order to improve the evaluation of these situations, several classes of dominance were compared according to the characteristics of their temporal criteria for various periods of the day (graph of LAeq time pattern and several calculated acoustic indices). The analyses confirm that the situations of combined noise sources are characterized in various ways depending on their exposure to the noise, since classes of dominance are not only shaped by the difference in sound level (LAeq) but also by features related to the sound signal itself, such as the outline, the kind, the duration and the level of emergences. The dominance of railway and road noise are thus fairly determined by this characteristics. On the other hand, the situations with no dominance have different sub-classes according to the position of the roadway and the railway facing the building. The analysis of these situations is then similar either to the dominance

of railway or road, depending on the various cases of positioning studied. These results consequently demonstrate the limits of usual physical descriptors to distinguish various situations of combined noise sources.

Th. 10:10 Arp 3 Combined noise evaluation

New indicators for time patterns of combined noise sources (road and railway)

Manon Raimbault, Eva Walker, Catherine Lavandier, Cora Cremezi-Charlet
INRETS

Previous studies on combined noise sources show an ambiguity in the evaluation of the temporal characteristics of road traffic noise (continuous but also discontinuous for short periods) versus railway noise (short, abrupt but also recurring for a long period). To pursue this issue further, listening tests were carried out in a semi-anechoic room. Sound stimuli were shaped mixing noises of trains (high speed train, regional and suburban trains, freight) with various road traffic types (with or without truck presence). Both measurements and investigations show that temporal features are more marked in distinguishing train noises. The assessment of railway noise is characterized by the identification of a noise source, related to specific time patterns, whereas road traffic noise is mainly described through expressions related to space. The recognition or not of truck presence is then a second criterion for characterising various categories of traffic. In the same time, the study of acoustic descriptors reveals the inadequacy of the usual codings of noise sources, based on the analysis of the LAeq time pattern. In view of these results, new temporal indicators are needed to describe each phenomenon respectively. However, analysis of the judgements of the time patterns shows variations between subjects, which are problematic for shaping annoyance indicators.

Th. 10:30 Arp 3 Combined noise evaluation

Correcting DNL so it works–better

Paul Schomer
Schomer and Associates

Day-night average sound level (DNL) is commonly used to quantify and assess environmental noise. A keystone to noise assessment is the dose-response relationship. Typically one predicts something like the percent of a community that is ?highly annoyed? versus DNL. However, the dose-response relationship is not an absolute; there is great scatter to the data on which it is

based. In an attempt to reduce the scatter to the DNL data, several USA agencies (EPA, FAA, etc.) suggested the use of ?normalized? DNL?but it was never used. Normalized DNL is the basic DNL value with a number of adjustments added to account for specific biases, such as community response bias, source characteristic and type biases, and time-period biases. This paper reviews and analyzes the concepts inherent in normalized DNL and provides an updated set of normalization factors that can reduce the scatter to dose-response relationships. Several of these normalizations are contained in the new ISO 1996-1:2003.

Poster Sessions

Poster Tuesday Poster I

Untersuchungen zur Variation der Klangbildeigenschaften von Kopfhörern - Investigations in variations of headphones tone coloration

Florian, M. König
Ultrasone AG

Headphones are working as head-related sound sources at the human outer ear. The tone coloration has to be neutral and loudspeaker compatible as recommended at the CCIR 708 for flat diffuse-field transfer functions (DFTF). Some variation factors influence this transfer functions in a practice use: The individual outer ear or pinna transfer function (OETF) as a part of the head-related transfer function (HRTF) and the principle of the headphones acoustic reinforcing device in front of the pinna. Examples for this are open/closed or supra-/circum aural headphones and the speaker placement nearby the auditory canel). Statistics on several thousand users of headphones offered significant more fluctuating tone coloration effects by statments of to much or less high frequency range as explained by a 'rough' or 'damped' sound quality for one created circum-aural, open headphone for in-front-localisation (HFI) apart from another HFI's and normal headphone developments. It was investigated over seven persons in an open supra-aural and a closed circum-aural HFI (centric and damped speaker or driver placement) and an open circum-aural HFI (de-centric speaker placement) and a normal open, circum-aural headphone (centric speaker placement). The intention of this work was to research and show the basics of this extraordinary sound effect in head-related reproduction of sound. So the tone coloration was no subjective testing persons result, but a greater intensive influence of the anatomic pinna construction working together with the sound source placement as a varying acoustic filter unit (compare with a higher standard deviation value around 6 kHz).

Poster Tuesday Poster I

A New Method For Elevation Panning Reducing The Size Of The Resulting Auditory Events

Reinhard Gretzki, Andreas Silzle
former: Institut für Kommunikationsakustik

Panning between two vertically arranged loudspeakers results in an auditory event that can cover almost the whole spanned angle. Additionally, these vertically arranged loudspeakers cause audible comb filtering if listeners are not equally spaced from each

loudspeaker (some centimetres displacement is sufficient). Usually, these effects are reduced by increasing the number of loudspeakers. The present method diminishes the spatial extent of the auditory event to a great degree without increasing the number of loudspeakers. Also, the comb filter effects occurring with misplaced/moving listeners are equally reduced.

Poster Tuesday Poster I

Modeling of Silicon Microphone Systems
Heinz-Theo Mammen, Werner John
Fraunhofer IZM

Being an integral part of the product development the simulation of micro systems has become more and more important during the last years. It allows to speed up the development cycles for micro systems, because it helps to reduce the number of necessary prototypes being manufactured. In the intended contribution simulation models will be presented, which describe the transmission behaviour of micro mechanical silicon condenser microphones in the far field. Microphones with omni-directional and bi-directional directivity will be considered as well as microphone arrays. It will be shown how the simulation models can be used to support the development process already in an early stage. The main aims are to begin with to forecast the behaviour of the microphones and secondly to realize quickly how constructional modifications effect the microphones transmission behaviour in order to be able to optimise it more tightly focused. Additionally it is dealt with the demands these two aims make on the modelling process itself, before the implementation of the models in Matlab is presented. The implementation was done in a matter that makes it easy to parameterise and structurally modify the models.

Poster Tuesday Poster I

An operationally applicable tool for sound immission evaluation including the atmospheric excess attenuation of sound
Astrid Ziemann, Kati Balogh, Andreas Pittelkau, Klaus Arnold, Armin Raabe
Institut für Meteorologie, Universität Leipzig

An important task of the environmental protection is the control and forecast of sound immission near inhabited areas. Here an operationally applicable method to estimate the sound immission outgoing from one sound source and including the atmospheric effects is presented. This method is used to evaluate the actual "sonic weather" in comparison to a "sonic climatology" lasting over several years. For these purposes a sound propagation

model based on the geometric acoustics is applied. This sound-ray model calculates the excess attenuation due to the refraction of sound rays according to a given thermal stratification and wind vector profile in the atmosphere. The needed input data especially for the sound propagation forecast can be provided by atmospheric models with a highly temporal and spatial availability. Measured data, e.g. from radiosonde measurements, are especially qualified for sonic-climatological investigations. To provide such a sonic climatology it is necessary to study the different atmospheric situations separately by the sound-ray model and to average the resulting meteorological sound attenuation maps afterwards. To evaluate the actual sonic weather in comparison to the averaged sound propagation situation an operationally applicable tool was developed. A data base of atmospheric excess attenuation maps in a range of 15 km around the sound source was calculated with the sound propagation model outgoing from 1551 characteristic atmospheric structures with different temperature and wind profiles. The influence of the refracting atmosphere on the sound immission can be evaluated with the visualization software MetaVIS.

Poster Tuesday Poster I

Aircraft noise prediction based on aircard mix divided into 2 groups

Thomas Meyer, Matthias Bosse

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At DAGA 2001 (published in DAGA report 2002), measurement results of more than 100.000 aircraft noise events were presented allowing to derive a stable value of noise emission for a group of aircraft types with similar engine power. This value resulted from measuring data with distances between 400 m and 1300 m of starting aircraft resp. between 130 m and 530 m of landing aircraft. The evaluation based on the diminuation of maximum noise levels with the distance as published in AzB (guidance established in Germany for calculation of aircraft noise). The accuracy of the evaluated sound power was within the limits of ± 1 dB(A). The group of aircraft examined in this study covers between 30 and 70 % of the total aircraft mix at all civil airports. An additional study was made recently in order to examine under which conditions it is possible to calculate a total noise immission including as a second group the rest of the regarded total aircraft mix allowing a difference of less than ± 1 dB(A) in comparison with the measured L_{eq} noise immission values of the regarded total aircraft mix. It was found that this is possible by adding a constant value for the sound power of group 2 in relation to group 1 independent from different noise emissions and percentages of

the aircraft types included in the second group. The results are given based on every of 52 different days within the first half-year 2003. The days were chosen with dominating traffic directions. In such days 4 different measuring points for landing resp. 5 different measuring points for starting aircraft were included in the study.

Poster Tuesday Poster I

Aproximation of Costs for improvement programs at innercity Roads

Priska Plüss, Peter Mohler
Amt für Umwelt und Energie Basel-Stadt

Traffic noise levels excedes at 30% of all housings along the main roads, the noise exposure limits. Using the digital noise exposure register and the known costs of earlier improvement programmes, the oncoming costs for the improvement of all housings can be estimated with high confidence.

Poster Tuesday Poster I

Traffic noise: Standardized messurements versus Calculation

Priska Plüss, Peter Mohler
Amt für Umwelt und Energie Basel-Stadt

In Switzerland the noise exposure level is expressed in an average anual value. Short term mesurements have to be standardised using a comparison between the average traffic and the traffic during the mesurement. A study shows that this standardisation leads to exposure levels more insecure than calculated values.

Poster Tuesday Poster I

Reactive Noise Control By Means Of Cavities Excited By Air Flow

Bénédicte Hayne, Jean - Louis Tebec
ENSAM

Air traffic gives rise to high noise levels that cause intense annoyance to local populations. Although over time aircraft noise has been considerably reduced, the growth in size and the increase in number of aeroplanes bodes ill for noise pollution. Presently, new guidelines and legislation outline more drastic rules : objectives defined in 2002 require a 3dB cut in noise pollution. That's why manufacturers have kept working for many years on landing and take-off noise as well as on aerodynamic and engine noise. A major breakthrough came for noise reduction with the

conception of double flow engines at high ratio dilution. As regards fan noise, it is contained by the use of absorbent materials covering the engine housing. This material, chosen because of its high-mechanical-performance properties has a honeycomb form. Perforation of the outside coating brings about significant improvement in noise radiation although the feature is still imperfectly understood. Our study focuses on experimental demonstrations pertaining to the physical characteristics found in the honeycomb material considered as a Helmholtz type cavity network. We demonstrate the reactive nature of these cavities as they undergo the pressure of sound waves and air flow, a second major factor acting upon the cavities. A test bench makes it possible to measure the acoustic reduction obtained by air flow and to show the feature of reactive noise control when both features concur.

Poster Tuesday Poster I

Silencers for exhaust gas stacks of a power station
Dietmar Eckoldt, Norbert Rambausek, Jürgen Hemsing
Fraunhofer Institut Bauphysik

9 MW oil burning engines are not only producing energy but also waste gas and noise. The waste gas stacks are equipped with high attenuation silencers. In order to fulfil the acoustic requirements in the low frequency range too, a combination of reactive silencers and porous absorbers is installed. The gas temperature is about 280°C and the required attenuation is more than 40 dB in all octave bands including the 31 Hz band. The poster presents the principle of the solution and the acoustic results measured both at the construction site and under operation.

Poster Tuesday Poster I

A Compact silencer for heating systems
Karlheinz Bay, Michael Krämer, Peter Brandstätt
Fraunhofer Institut Bauphysik

The noise in oil or gas boiler exhaust vents is mainly of a broadband nature. The burner casing or the firing frequency of engine driven power stations can add a characteristic resonance and tonal components at low frequencies. In order to meet the acoustic requirements at the exit of the chimney, silencers are required for these low frequencies. A compact silencer unit, combining a porous and an active sound absorber is presented. The design of such silencers and the attenuation in the low and mid frequency range obtained from measurements are discussed.

Poster Tuesday Poster I

Study of the acoustic treatment of a workshop of small household appliances

C. Millard, H. Campagna, Henri-Simon Arbey
DBVib

En prévision de la mise en place de la future législation sur le bruit en milieu de travail, l'étude acoustique d'un atelier a été entreprise. L'atelier mesure 84 m de longueur et 28 m de largeur, il comprend 3 travées disposées longitudinalement, séparées par deux allées de 2,2m de largeur.

La simulation la plus efficace a consisté à privilégier le traitement des zones les plus critiques puis à envisager des actions de réduction du bruit à la source : -mise en place de matériau amortissant sur les goulottes, de carters 3 côtés autour des moteurs, de caissons insonorisants - modification des carters existants - amortissement des chutes de pièces - suppression des fuites d'air comprimé.
Des gains notables sont observés, puisque le niveau sonore ne dépasse 80 dB(A) que dans une zone de l'atelier très réduite.

L'utilisation de la méthodologie d'acoustique prévisionnelle, a permis : i) d'identifier et de quantifier les sources de bruit, ii) de proposer des solutions d'amélioration de l'ambiance sonore, iii) de trouver la solution la plus performante à coût objectif fixé

Référence : C.Millard, Etude acoustique d'un atelier, démarche méthodologique. Fiche n°132

Poster Tuesday Poster I

Filter Bank Analyser Using Programmable IIR Filters

Gaël Nini, Véronique Zimpfer-Jost, Karl Buck
I.S.L. : Institut franco-allemand de Recherche de Saint Louis

We have developed a programmable digital filter which is based on an enhanced IIR algorithm. This filter has a 80 dB dynamics. Its characteristics allow to use it to build a filter bank analyser. A filter bank analyser is made of contiguous band-pass filters which process the signal and give the level of each band corresponding to 1/3 octave. To analyse a signal in the band 20 Hz - 11 000 Hz we have used 27 pass-band filters. We have developed a board including 9 filters and I/O to interface the system with a control device. We have chosen and programmed a FPGA to do it. Each filter has been adjusted to the existing 1/3 octave standards.

Poster Tuesday Poster I

Extended Impedance Tube Measurements of Porous Absorbers

Ennes Sarradj, Jörn Hübelt, Emad Elsaghir, Peter Holstein
Gesellschaft fuer Akustikforschung Dresden m.b.H.

Samples of porous absorbers are commonly characterised by their absorption coefficient and surface impedance. For measurements, standard Kundt's tube or impedance tube method is used. In the paper, the use of extended measurement techniques to get the characteristic impedance and the propagation constant is demonstrated. It is shown that to know these parameters is advantageous as they provide information about the material rather than the sample.

Poster Tuesday Poster I

Transducer emitter-receiver system for a pulsed ultrasonic fluxmeter

Philippe Schmitt, Stéphane Fischer
IMFS UMR7507 - ULP/CNRS

The knowledge of the velocity fields in the flows and of the mechanical interactions between a fluid and suspended particles is a base of many engineer disciplines: chemical engineering, cleansing, sedimentology, biological engineering, fluid rheology in general. The aim of this project is the development of a fluxmeter for measuring instantaneous velocity, concentration and granulometry profiles of particle loaded fluids both in ducts or open channel flows. The first application will be the pollutants flow measurement in waste water. The measurement principle of the system is based on ultrasonic pulsing in the flow. A prototype was developed consisting in an ultrasonic transducer, an electronic emitter-receiver device and computer-driven signal processing. The measurement principle is based on the frequency modulation (Doppler effect) and the amplitude modulation (Mie theory) of an ultrasonic wave diffused by the suspended particles of the fluid. The paper presents the design features of the system. It describes the block diagram of the front-end electronic and it's principle of operation. Optimisation of power transfer to the transducer in emission and low noise amplification in reception are detailed. Performances of the whole acquisition chain are given, and the dedicated signal processing used for optimisation of real-time velocity profile are explained. Finally, several applications using this fluxmeter are discussed. Especially instantaneous velocity measurements in physic conditions with spectral ambiguity, and possible studies for concentration and granulometry profiles of particles in suspension in the fluid.

Poster Tuesday Poster I

Large-scale Impedance tubes

Walter Schneider, Michael Leistner, Frank Zickmantel, Richard Tippkemper
Fraunhofer Institut Bauphysik

The development of structured and resonance type absorbers requires new test methods to assess their acoustic properties such as the absorption coefficient. This has been accomplished by new impedance tubes of a size from 200 x 200 mm up to 1600 x 1200 mm cross-section for the installation of large specimens. The poster presents the design and implementation of the tubes together with the measurement equipment employing a multi-microphone technique and FFT-analysis of the sound signals.

Poster Tuesday Poster I

Communication Room Acoustics in Passive Cooled Buildings

Detlef Hennings
(free-lance scientist)

Many up to date buildings are cooled during summer without active cooling devices just through the building's optimized thermal behaviour. An essential feature to achieve this is the thermal storage capability of the building. In most cases passive cooling simply requires uncovered concrete ceilings which prohibits acoustic absorbers at the ceiling. Rooms for human communication (e.g. conference rooms) meeting the passive cooling requirements have been studied using acoustics simulation software. Several measures for speech transition quality (e.g. center times) show that the reflective concrete ceiling is an advantage for communication (as could have been expected). A comparison of different absorber positions (walls, floor, ceiling) shows that absorbers mounted at walls will lead to a better acoustic quality than other absorber positions at equal equivalent absorber surface. Thus passive cooling and good acoustic quality for communication can be achieved at the same time. In addition, auralization samples of the analysed rooms were checked for their usefulness in order to make decisions in the planning process easier. A blind test showed that each of the involved persons (all without acoustic education) could discriminate the acoustic quality of different absorber positions by comparing a set of binaurally auralized samples and answering adequate questions. Experimental verification of the simulation results will be carried out with built example rooms in the near future.

Poster Tuesday Poster I

Acoustics of Classrooms in brazilian public Schools - A Case Study in Curitiba

Carmen Loro, Paulo Zannin
Universidade Federal do Parana - Laboratório de Acustica - Dept° de Engenharia Mecanica

ACOUSTICS OF CLASSROOMS IN BRAZILIAN PUBLIC SCHOOLS - A CASE STUDY IN CURITIBA The acoustic quality of a standard classroom (Standard 23) of the public school system in the city of Curitiba has been evaluated. This standard is so defined: it has a central circulation aisle, with two classrooms in each side, a total of four classrooms per edification. Each room has windows to the outside, and to the internal aisle. Additionally, the aisle has a 6-m high zenithal skylight, together composing the building's main lighting and ventilation system. The planning of STANDARD 23 has considered lighting and ventilation, but has forgotten the acoustic quality of the classrooms. In order to assay the acoustic quality of the classrooms, measurements have been performed under several conditions, using the Building Acoustics System of Brüel & Kjaer. The measured reverberation time (RT) of the 4 classrooms for a frequency of 500 Hz was: 1.65s (classroom empty), 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 a RT between 0.8 and 1.0 s, to allow for adequate inteligibility. Background noise in an empty room was 63.3 dB(A), a value above the limit established by the brazilian standard of acoustic confort: 40 dB(A). The reaction of students and teachers has indicated that the main source of acoustic disconfort is the noise generated by the neighboring classrooms.

Poster Tuesday Poster I

Effect of ETHICS on the flanking transmission of outer walls

Lutz Weber
Fraunhofer Institut Bauphysik

External thermal insulation composite systems (ETHICS) are attached to the outer walls of buildings. They consist of a heat insulating layer (mostly mineral wool or polystyrene) which is fixed to the outside of the wall and covered by a plaster coat. Apart from their main purpose - the enhancement of heat insulation - ETHICS also change the acoustical properties of the supporting wall. Not only the direct sound transmission is concerned (the weighted sound reduction index can change from -10 dB to +20 dB), but also the flanking transmission of the wall. Until now the knowledge about the flanking transmission of outer walls with

ETHICS is only small. To learn more about the acoustical behaviour, measurements on various ETHICS in combination with different supporting walls have been carried out. The measuring results show, that the flanking transmission of massive walls is much less affected by ETHICS than the direct transmission. From the measurements, which are confirmed by calculations according to EN 12354-1, information about the relevant transmission pathes can be derived. A description of the measurements and a summary of the main results are presented.

Poster Tuesday Poster I

Measurement of waste water noise according to EN 14366
Lutz Weber, Joachim Mohr, Pascal Teller
Fraunhofer Institut Bauphysik

Water installations and, especially, waste water installations can be very annoying sources of noise in buildings. Therefore, many manufacturers of waste water systems perform tests to check the acoustical quality of their products. The measurements are carried out in a special test facility, which consists of two rooms separated by an installation wall. The system under test is fixed to one side of the installation wall and the resulting sound level produced by a constant flow of water inside of the system is measured in the room behind the wall. Since February 2002 the measuring method for waste water noise is explicitly specified by the new European standard EN 14366 "Laboratory measurement of noise from waste water installations" (draft). The main difference between the new standard and the previous procedure is the separation of the waste water noise into an airborne and a structure-borne component. In addition, the measuring results are related to a standardized (fictitious) installation wall by means of the structural sensitivity of the real wall in order to get comparable results in all test facilities. First practical experiences with the new standard are reported including a comparison with the previous measuring method and a discussion of the applicability of EN 14366 within the frame of the German requirements for installation noise (DIN 4109).

Poster Tuesday Poster I

Measurements of room acoustic parameters in auditoriums by simulating the audience by molton cloth
Stefan Birnstingl, Maria Fellner, Franz Graf
Joanneum Research

Until now several measurements of room acoustic parameters have been published, where concert halls with and without audience have been measured. Hidaka/Nishishara/Beranek (JASA 2001) and Lorenz/Breuer (DAGA 2003) additionally have used a

special japanese cloth covering the seats for simulation of the occupied state. In this poster similar measurements using another cloth named molton are published. This cloth is often used for example in theatre and stage design, it is very easy to get and reasonably priced. Room acoustic measurements are made in auditoriums, music rehearsal rooms and concert halls. Results of the occupied, the unoccupied and the "audience simulated" state are compared.

Poster Tuesday Poster I

New room acoustic design concepts for rehearsal rooms
Horst Drotleff, Xueqin Zha, Helmut Fuchs, Xiaoru Zhou
Fraunhofer Institut Bauphysik

The philosophy about the acoustics in rehearsal rooms has changed. As work places for musicians and singers, they should not be built or restored to simu-late a specific auditorium for opera or concert performances, not only because of the totally different spatial conditions but also of the completely different act-ing environments. The room acoustic environment should ensure that musi-cians are able to hear, assess and control their own playing or singing while listening and differentiating the sounds of all other members of an ensemble. An often encountered situation is the masking of the sound produced by strings due to the dominant brass and percussion instruments. It must also enable an undisturbed communication and interaction between the various instruments and the conductor. This may be achieved by a novel concept incorporating in-novative absorber and reflector modules which damp the low frequency re-sponse of the room, take care of an even distribution of the sounds of the dif-ferent instrument groups and, most importantly, improve the transmission to the conductor. A proper room acoustic design may also help to reduce high aver-age sound pressure levels, which is the inevitable result of poor music intelligi-bility within an ensemble.

Poster Tuesday Poster I

On the use of micro-perforated sails in assembly rooms
Roman Wack, Helmut Fuchs
Fraunhofer Institut Bauphysik

Nowadays trends in architecture create buildings which exhibit a higher ratio than in the past of reflecting surfaces which cannot be used for acoustic design purposes. Such surfaces are for example: transparent fronts and walls or ther-mal-active concrete ceilings. In order to achieve a reasonable acoustic comfort in these buildings, a transparent absorber often is needed. Micro-perforated transparent sails have proven very useful to realise an acoustic design in aforementioned rooms. Results of several

successfully completed projects are discussed, among them the "Schlüterhof" in the Deutsches Historisches Mu-seum, Berlin.

Poster Tuesday Poster I

Supplementary acoustic measures in the congress centre of the Bundesministerium für Wirtschaft und Arbeit, Berlin

Michael Leistner, Helmut Fuchs
Fraunhofer Institut Bauphysik

The great hall in the main building of the former Kaiser Wilhelm Akademie, to-day's Federal Ministry of Economics and Labour, had been reconstructed and converted into a congress centre. During this process, only little attention had been paid to room acoustic design. Consequently, vehement complaints arose about the poor speech intelligibility. Adequate room acoustic conditions were obtained by the additional installation of highly effective low-frequency and broadband absorbers of a novel construction.

Poster Tuesday Poster I

Novel room acoustic measures in demanding projects of interior design and construction

Jochen Renz, Helmut Fuchs, Horst Drotleff
RENZ GmbH

In modern interior design one typically encounters a high percentage of acous-tically reflecting surfaces like large windows or concrete ceilings. Acoustic broadband damping down to low frequencies is essential in such environments in order to achieve adequate acoustic comfort. New concepts of integration of highly effective broadband sound absorbers into demanding interior design are shown, be it as single modules or integral parts of walls or ceilings.

Poster Tuesday Poster I

The new StoSilent A-Tec Panel suspended ceiling system

Markus Lenzer, Helmut Fuchs, Christian Hoppe
Verotec GmbH

A novel suspended ceiling employs open-pore foam made of recycled glass. Its surface facing the room is covered by a glass-fibre fleece on which a thin, acoustically transparent, plaster is applied in order to yield a large, smooth and jointless appearance. The acoustic performance of this construction element compares favourably with that of conventional acoustic ceilings with a slight shift of its absorption maximum towards lower frequencies. Examples of installations in high-demand communication rooms are discussed.

Poster Tuesday Poster I

Improving the acoustics of laminate floor coverings by means of damping materials

Christine Patsouras, Klaus Pfaffelhuber, Dimitrios Patsouras, Ernst Hotz
AKsys GmbH

According to a preliminary norm of the Association of European Producers of Laminate Flooring (EPLF Norm 021029-1) the loudness should be used to evaluate the quality of a laminate floor by walking across it. Corresponding to this norm, the laminate floor has to be excited by a tapping machine and the caused loudness in the same room has to be calculated according to Zwicker (DIN 45631). In the following the results of a laminate floor without any damping material will be compared to those of the same floor covered on the bottom side with a damping material frequently used in the automotive industry.

Poster Tuesday Poster I

What about standards concerning speech intelligibility in large public areas?

Claude Legros
Université Toulouse II, Laboratoire d'Acoustique (LAUTM)

The intelligibility of speech has got a renewed interest by the last decades, for individual security reasons. In public areas, auditory warning or emergency signals are generally spread around by the way of public adress systems. Their qualities are strongly variable from one to another, and so are the rooms in which the messages are sent.

It is not enough to take care of the public adress system itself as long as the problem is much more wide. One must take into account the whole process to estimate the global quality of the auditory signals. At the beginning of the process, there is the speaker who has a great importance, according to his personal caracteristics such as: speed of speech, accentoe. Standards never say nothing about this aspect of the problem. The electronic arrangement begins to be in standards, in a quite satisfactorily way. The weak point remains the way the messages are given to the listeners. The reason is that this process mix a lot of parameters not easily standardisable: the loudspeakers, the acoustics of the room and building, the noises which can be stationary or not, the positions of the listenersoe Recently, some standards have been generated, and the present work will discuss their terms, in order to show if they are conveniently applicable or not. Finally, some proposals will be presented, in order to make standards easier to apply.

Poster Tuesday Poster I

Application of micro-perforated stretched ceilings

Christian Nocke, Catja Hilge
Akustikbüro Oldenburg

In 2001 a new product based on the theory of micro-perforated sound absorbers has been introduced. The thin foil of a stretched ceiling has been micro-perforated. Stretched membrane ceilings are a popular product with regard to modern architecture worldwide since more than 25 years. However, so far only optical and other aspects of the product were generally of interest.

A brief introduction of the underlying theory of micro-perforated sound absorbers according to D.-Y. Maa will be given. Results of independent qualification measurements of various assemblies will be shown. Furthermore different applications in various rooms will be presented.

Poster Wednesday Poster II

Speech processing in noise for cochlear implants using a modified channel picking strategy

Artmut Meister, Hasso Von Wedel, Martin Walger
Jean-Uhrmacher-Institut für klinische HNO-Forschung, University of Cologne

Speech perception in noise is a crucial problem for hearing impaired persons. Modern conventional hearing aids offer various techniques, such as beamforming or one-microphone noise suppression methods. These techniques are not established in cochlear implants (CI). Commercially available CIs have up to 22 channels or electrodes, respectively. Various processing strategies such as CIS or SPEAK are used. Since not all of the electrodes must be stimulated at the same time in order to yield optimum speech intelligibility, channel picking strategies choosing a limited number of electrodes are applied. The presentation describes an approach towards speech processing in cochlear implants based on a modified channel picking strategy. The experiments were conducted using a simulation of the signal processing of cochlear implants and were performed with normal hearing subjects. The stimulation of the cochlea via electrodes was modelled with amplitude-modulated sinusoidal carriers of constant frequencies representing a 20 channel CI. Thus, the technique is comparable to methods described by McAulay and Quatiery, also referred to as MQ-models. The rationale behind testing the signal processing with normal hearing subjects is that performance of implanted patients depends on various parameters and commonly shows large interindividual scatter. The experiments were

conducted with several noise-signals (narrow band, speech-like) and various signal-to-noise ratios. It turned out that the modified strategy reveals improvement of speech intelligibility for narrow-band noises and unfavourable SNRs. Since the method reveals further potential for improvement it might be promising for enhancing speech perception in cochlear implants. Refinement of the strategy and evaluation with CI users is subject to subsequent studies.

Poster Wednesday Poster II

The influence of dynamic compression in hearing aids on directional hearing in the horizontal plane

Sharbal Musa Shufani, Martin Walger, Hasso Von Wedel, Artmut Meister

Jean-Uhrmacher-Institut für klinische HNO-Forschung, University of Cologne

The perception of the direction of sounds depends on several parameters, such as interaural time differences (ITD) and interaural level differences (ILD). In order to restore loudness perception a dynamic compression is installed in nonlinear hearing aids. Since compression alters the signal levels presented to both ears, influences on directional hearing are possible. The effects of compression time constants and compression ratios were examined using a hearing aid simulator based on a digital signal processor (Motorola DSP 56009 AVM). The two audio-channels of the DSP simulate bilateral hearing aid provision. The acoustic stimuli were generated via soundcard and processed by the DSP using different compression parameters (compression ratios of 3:1 and 8:1, attack time constants of 2, 20, and 200 ms). Release time was held constant at 500 ms. Measurements with normal hearing subjects revealed decreased lateralisation when ILDs were used as cues whilst no effect occurred when applying ITDs. This held true for high compression ratios and short attack times and can be explained with the altered amplitudes of the signals. In an additional investigation, the position of a sound source was simulated using head-related transfer functions (HRTF), thus considering ILDs and ITDs simultaneously. HRTFs from -60 to +60 deg. with steps of 15 deg. were considered. Again, the ability to localise sounds was decreased with increasing compression ratio and shorter attack time constants mainly due to the effect on the ILDs. The presentation shows the results of the various experiments and discusses outcomes gained with hearing impaired subjects.

Poster Wednesday Poster II

Testsignals and Measurement Procedures for the Evaluation of Modern Hearing Aids

Hans Wilhelm Gierlich
HEAD acoustics GmbH

In modern DSP-based hearing aids a variety of signal processing procedures can be found. Basically they can be separated in algorithms, which have long term effects and algorithms which have instantaneous effects, e.g. working on syllables of voice signals. Furthermore most of the procedures work in different frequency bands. For the evaluation of the system performance -besides speech signals- different test signals are discussed which more reliably may used in order to evaluate the system behavior. Different test signals, providing different speech like properties will be introduced. Based on the different test signals different analysis techniques can be applied which are different to the ones used traditionally for hearing aids. The evaluation of hearing aids using the different test signals and procedures will be shown.

Poster Wednesday Poster II

Study On Gearbox Rattle Noise In Automobiles

Muriel Barthod, Jean - Louis Tebec, Jean Christophe Pin
ENSAM

Automobile noise has been considerably reduced as interest in environmental concerns as well as a need for more acoustic comfort have increased. One source of noise in a car, among many, is associated with powertrain. With improvement in engine design, the perception of noise that went formerly unnoticed has become a problem, such as gearbox noise, a well-known source of irritation detrimental to vehicle comfort. One such case is the noise, referred to as 'rattle noise', caused by fluctuations in engine torque. These fluctuations generate considerable shock, typically irregular in nature being the result of multitudinous factors. The study, explains the mechanical features involved when gear teeth knock, with attention paid to both causes and prevailing gear box conditions when this happens, leading to a better understanding of the problem. The first stage entails test bench conceptualizing and materializing to reproduce, (using simplified gearboxes), all the angular oscillations coming from the transmission shaft by changing any temporal or frequency characteristics so as to study the rattle noise in all possible configurations. The study allowed us to monitor the influence of range, frequency composition and harmonic component phases involved in the acyclism at the threshold level of rattle. It becomes henceforth

possible to determine at which point rattle occurs in each engine architecture in the cinematic transmission chain of each vehicle.

Poster Wednesday Poster II

Engine sound noise - Apart from so-called Engine order analysis

Norio Kubo, Volker Mellert, Reinhard Weber, Jens Meschke
Volkswagen AG

Improvement of car engine sound plays a great role in its development nowadays, especially sporty cars and luxurious cars. Therefore it is necessary to understand the underlying auditory features of perception to sporty and luxurious sound. Firstly in this research the meaning of sporty and luxurious impression are investigated with a number of test persons. Secondly the time-dependent spectral change of an engine noise due to acceller-ation is investigated. Interesting correlation between a 'sporty' percept and transient properties of the sound pressure signal is observed. Additionally, a principal component analysis of ques-tionnaire indicates good correlation between well-known station-ary psychoacoustic parameters (loudness, roughness) and the over-all 'luxurious' impression. The sporty or luxurious impres-sion of an engine noise is additionally investigated with synthetic sounds in which the relevant and time-varying features are sys-tematically adjusted.

Poster Wednesday Poster II

Flight Simulations: Influence of Environmental Factors on Passenger Comfort

Christian König, Ingo Baumann, Sandra Buss, Nils Freese, Sylke Hallmann, Roland Kruse, Volker Mellert, Reinhard Weber
Carl von Ossietzky Universität Oldenburg

There is a number of factors that influence the passenger com-fort in an aircraft cabin. The influence of environmental variables - noise and vibration, temperature and relative humidity - on pas-sengers comfort is analysed in the EU-Project FACE (Friendly Aircraft Cabin Environment). An environmental comfort index (ECI) to describe the influence of the environmental variables on passenger comfort is important for the manufactures of air-crafts. Because the environmental variables cannot be varied adequately in real flights the effect of varied environmental con-ditions on passengers are examined in a cabin simulator at Wat-ford, UK with 364 test persons. In order to arrange a realistic simulation there are flight attendances and food services during the tests. Each environmental parameter was set independent to three different values. This leads to 27 different environmen-tal conditions. It has been attempted to predict the overall cabin

comfort with a linear model. The parameters of the linear model are the direct ratings of the environmental variables. [FACE is funded by the European Community under the 'Competitive and Sustainable Growth' Program, Project Nr. GDR1-2001-40205]

Poster Wednesday Poster II

Acoustical Post-Evaluation applied to the neighborhoods of a small airport

Marta R.V Macedo, Jules Ghislain Slama
Centro de Tecnologia, Sala G210

During the year 2001, ICAO, the International Civil Aviation Organization has proposed the A33/7 resolution where the multidisciplinary concept of balanced approach is presented. Then it become important to develop new tools to be used for a general analysis of the environmental noise impact produced on airport surrounding populations. The Acoustical Post-occupation Evaluation (POE Acoustics) applied to the airports surroundings constitutes an appropriate tool which can be used to understand the interrelation between the many factors that constitute this complex matter. The post-occupancy evaluation is compost of a set of actions destined to study a urban or architectural situation. In Acoustical POE, four approaches, technical-constructive, technical-physical, technical-functional and technical-behavioral, are considered, from which it is possible to study the many elements that constitute the sonorous environmental impact in an airport surroundings This work, presents a case study for Jacarepaguá Airport, a small airport which is situated in the city of Rio de Janeiro and in which an increasing demand of small airplanes and helicopters flights exists. In addition, it is being studied the possibility of increasing its track from 900 m to 1200 m. The noise footprints for the studied area were developed using INM and HNM software's, considering the noise levels in L_{dn} and $L_{A,eq}$, respectively adopted by the Brazilian aeronautical legislation and the NBR - 10151 Acoustics - Evaluation of noise in inhabited areas aiming the comfort of the community - Procedure, willing to identify the affected areas.

Poster Wednesday Poster II

Sensibility Studies in Airport Noise

Jules Ghislain Slama, Rita De Cássia Cordeiro Nogueira, Téo Cerqueira Revoredo
Centro de Tecnologia, Sala G210

This paper presents the methodology used in Aircraft Noise Sensitivity Studies developed by the Environmental Acoustics Group of COPPE/UFRJ for INFRAERO, the company which manages

66 of the biggest Brazilian airports. Five critical airports, considering the environmental noise impact, had been selected in a previous stage considering the number of people exposed to a level superior to 65dB(A) and the area contained in the curve DNL=65dB(A). For the noise sensitivity studies, the cost function used was the area contained in the curve DNL = 65dB(A). The airport parameters adopted for the studies are the number of night and day movements for Chapter 2 and Chapter 3 (or chapter 4) airplanes [3]. The relative sensitivity coefficients had been determined studying the variations of the curves areas versus the variation of the airports parameters. The results of this work will be used to help decisions on the management of the airports, regarding the noise matter. The softwares used to determine the noise curves (Footprints) were the Integrated Noise Model (INM), HNM (Heliport Noise Model) and the NMPLOT.

Poster Wednesday Poster II

Practical applications for in-flight and wind-tunnel testing using innovative surface microphone

Bernard Ginn, Niels Bøgholm, Peter Henning
Brüel & Kjær

The measurement of flow induced noise in flight and also in wind-tunnels presents a number of problems. The presence of the measurement device itself in the flow can create turbulence which can interfere with the measurement. Several solutions exist at present including pressure transducers and the insertion of plastic tubing to act as probe microphones. The solution described here is a circular device with a very low profile denoted as a surface microphone. It can be integrated into a fairing to minimise obstruction due to air flow. The device has the usual wide dynamic range of a traditional microphone and can be equipped with TEDS to simplify the installation procedure. The paper describes the innovation design of the construction together with results from practical measurements from in flight and wind tunnel testing.

Poster Wednesday Poster II

Free-field test facilities in the new VW Acoustics Centre

Gerhard Babuke, Xueqin Zha, Walter Schneider
Fraunhofer Institut Bauphysik

The Acoustics Centre AKZ occupies 2600 m^2 ground area and a building vol-ume of 36000 m^3 offering space for two four-wheel drive roller test beds, a tyre noise test bed, two engine test beds, a drive train test bed and a window test bed for the investigation of the attenuation and damping properties of compo-nents. All test

beds are realized as semi-anechoic rooms with innovate Broadband-Compact-Absorbers as wall linings. The first three of these test beds fulfil free-field requirements set by VW with tolerances of $\pm$ 1 dB for 100 Hz to 16 kHz and $\pm$ 2.5 dB for 40 Hz to 80 Hz that even surpass those set by ISO 3745.

Poster Wednesday Poster II

Noise reduction and anechoic linings in aeroacoustic wind tunnels

Alexander Lecheler, Gerhard Babuke, Peter Brandstätt, Dietmar Eckoldt
FAIST Anlagenbau GmbH

The increasing demand for noise reduction and sound design at vehicles requires adequate test conditions in wind tunnels and test beds. The Fraunhofer IBP has developed a special broadband resonant absorber that shows high absorption efficiency down to 20 Hz with a total lining thickness of only 250 mm and an even surface. This Broadband Compact Absorber has been applied in silencers and linings at the duct and plenum walls to the wind tunnels of Audi in Ingolstadt, at DaimlerChrysler in Auburn Hills and the plenum of the wind tunnel of PSA, Renault and CNAM in Paris. The paper will present the construction, layout and performance of these new absorbers together with measurements showing the freefield conditions achieved in these large facilities.

Poster Wednesday Poster II

Tuning of Musical Glasses

Thomas Guignard, Vincent Martin
Ecole Polytechnique Fédérale de Lausanne

The glasses composing a musical instrument – such as the glass harp – are tuned by mechanically removing material near the stem. What are the models and methods that could help understand this technique? In a first approach, the glass has the shape of a cylinder, obtained by the rotation of a beam of constant width. Resting upon analytic works published in the 80s, the contribution of the vibrational mode of this beam to the mode of the entire glass is identified. Thus, only the vibration of the single beam is studied. Then, the tuning process is modeled by an uniform variation of the beam's width. By using an analytical approach on the one hand and a quite sober finite element method on the other, the percentage of removed material is associated to the diminishing of the beam's eigenfrequency. This first step proves to be essential before any further investigation of the subject can be carried out.

Poster Wednesday Poster II

Study of the input acoustic impedance of a vibrating cylindrical shell: consequences on clarinet-like instrument oscillations

Ruben Pico Vila, François Gautier, Joel Gilbert
LAUM

The influence of the wall vibrations on the acoustic behavior of wind instruments is an open question. The first aim of this paper consists on providing a model of the input acoustic impedance of a vibrating cylindrical shell. The second aim is to estimate the consequences of wall vibrations on clarinet-like instruments oscillations, taking into account the impedance in time-domain simulations. The standpoint is the development of a vibroacoustic model of the instrument, assuming that it can be approximated to a simply-supported thin-walled cylindrical shell. This model provides an expression of the input acoustic impedance of the vibrating cylinder from the shell motion equation and an integro-modal expansion of the inner pressure field. The wall vibration effect can be interpreted as a small correction of the acoustic input impedance of a rigid shell with similar geometrical and mechanical features and similar boundary conditions. A simplified model of clarinet-like instruments permits simulating the self-sustained oscillations. The input acoustic impedance of the instrument, calculated by means of the vibroacoustic model constitutes the numerical entrance of the time-domain. Results corresponding to different configurations defined by a parametrical study are compared with the 'rigid reference'.

Poster Wednesday Poster II

Perceptual Spaces of Verbal Attributes Used for Description of Musical Sound Timbre in Czech Language

Ondrej Moravec, Jan Stepanek
Academy of Performing Arts in Prague

The words used for description of musical sound timbre were acquired. The research was carried out among people with active relation to the music (instrument players, conductors, composers, sound engineers etc.). In written questionnary each respondent have stated the words he uses for timbre description and relations among those words. Frequency vocabularies and perceptual spaces of verbal attributes over all respondents and over the selected respondent groups were calculated from acquired data. Similarity of vocabularies and spaces and their differencies in dependency on the respondent group were studied. Twenty five representative verbal attributes were selected for non-listening pair dissimilarity test. The selection of attributes

was made with respect to their frequency of occurance, to their location in perceptual space and to differencies among vocabularies and perceptual spaces of respective respondent groups. Selected groups of respondents (e. g. bow instrument players, wind instrument players, sound engineers...) have taken part in the dissimilarity test. Results of the test (dissimilarity matrices) were processed using latent class approach (CLASCAL). Resulting respondent classes are compared with original respondent groups. Class perceptual spaces of verbal attributes are also compared and discussed.

Poster Wednesday Poster II

A specific cabin for restitution of sonic boom : application for perceptive tests

Guy Rabau, Philippe Herzog
LMA CNRS

The aim of our work is to study loudness and annoyance of sonic boom. For that a specific listening tool must be designed. This is necessary because most of the power of the sonic boom is at very low frequencies, around 3Hz. Such low frequencies are perceived by the whole human body, then to assess the annoyance of sonic booms through listening tests requires to immerse the listener in a field as close as possible to the field in actual situations. Conversely, the strong transients existing in sonic booms lead to a significant spectrum content at higher frequencies. Together, these two aspects put a very high stress on the reproduction system, which has to reproduce the test signals with a high fidelity from very low to high frequencies. The first design of this tool is made of a closed cabin which walls recovered with absorbing materials, so it can be considered as almost semi-anechoic at high frequencies. At lower frequencies, a multi-channel loudspeaker system generates a high volumic velocity by driving loudspeakers mounted in the walls of the closed volume, leading to a high pressure down to very low frequencies. Performances of the simulation has been checked through measurements and psychoacoustic tests.

Poster Wednesday Poster II

Principles of Auditory Object Formation: On the Influence of Spatial Information on Onset Detection

Othmar Schimmel, Armin Kohlrausch
Technische Universiteit Eindhoven

The ability to segregate and identify sound sources in an auditory scene comes naturally to most people. In 'Auditory Scene Analysis', this ability of a human listener to group signal components and consequentially separate discrete sources from a complex

mixture of sounds is the focus for research on perceptual stream segregation, or auditory object formation. By making use of interaural disparities in binaural hearing (the main cues for localization of a sound source), the auditory system becomes more robust in grouping signal components. However, from the available literature, it is difficult to decide whether localization cues support grouping of signal components, or whether grouping of signal components by onset detection is a prerequisite for localization of the auditory object. This contribution describes the results of an experiment which explored the principles of auditory object formation by quantifying the relations between spatial localization and onset detection. In the experiment, subjects were asked to temporally adjust a wide-band noise target to fit the meter of a regular series of four marker pulses, in a continuous wide-band noise masker. Four different methods for lateralization (ITDs, ILDs, realistic combinations of ITDs and ILDs, and HRTFs) were applied to the target. After establishing the individual detection thresholds of the target for each spatial condition, the adjustment was performed for several target levels around its threshold. The hypothesis, that for a better detection of the target's onset its positioning would be more accurate, was confirmed, and an influence of spatial information in this paradigm was established.

Poster Wednesday Poster II

Individual differences in integrating loudness over time

Benjamin Pedersen, Wolfgang Ellermeier
Sound Quality Research Unit, Dept. of Acoustics

An experiment was conducted to examine how people integrate level information to obtain an overall loudness percept. The stimuli used were broadband noises of one second duration with random level changes occurring every 0.1 s. Ten normal-hearing listeners participated in the experiment. Unlike in earlier work using two-interval forced-choice procedures (Ellermeier & Schrödl, DAGA 2000, pp. 169-173), in the present experiments listeners simply classified a single level-fluctuating noise-burst as being either 'soft' or 'loud', thus minimizing the role of potential memory effects. Data collected over a few thousand such trials were analysed using a statistical procedure that assigns weights to the ten temporal segments constituting each noise burst. The weight patterns derived for the participants turned out to be highly individual, the ratios of the temporal weights varying by as much as a factor of four. Furthermore, giving trial-by-trial feedback significantly affected the outcome when compared to a no-feedback condition. These results suggest that temporal integration of loudness cannot be solely explained by sensory factors,

but that judgmental processes will have to be taken into account even when describing overall loudness judgments of short level-fluctuating sounds.

Poster Wednesday Poster II

Examination of Binaural Activity Patterns

Wolfgang Heß
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Computational models of localization, which simulate the human auditory system qualitatively, can be used to evaluate the acoustical properties of a room. For analysis purposes, head-related room impulse responses of different types of rooms were captured in five degree steps with a rotating dummy head, which was placed on a manikin. To be able to predict the acoustical quality of a room, several attributes and characteristics in the 3-dimensional lateralization/activity/time-plots, the so-called binaural activity patterns, were investigated and quantified.

Poster Wednesday Poster II

The Microphone and Artificial Head Sound Pressure Measurement

Zdenek Otcenasek
Academy of Performing Arts

The variation of the sound pressure in the same position in front of loudspeaker in anechoic room was studied for different types of measurement. Three types of the artificial head, two types of the microphone and one human head were used. The measurements were carried out over the audio frequencies for various angle among the line connecting the sound source with the recording position and the line normal to the plane of the recording microphone membrane or to the plane of head pinna. The differences between results of measurement mentioned above are discussed.

Poster Wednesday Poster II

Evaluation of Blind Source Separation Methods in Acoustics
Roger Boustany, Jérôme Antoni
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Blind source separation (BSS) is a signal processing technique which consists in recovering a set of unobserved signals (called sources) given only a set of measured signals (called observations) arising when the sources are mixed by passage through some unknown medium. Although the term blind indicates the fact that neither the sources nor the mixing structure are known a priori, several assumptions must be made regarding both. Most of the existing methods rest on the mutual statistical independence of the sources and on the linearity of the mixing channel. Moreover, depending on the field of application, the mixture model may be either instantaneous or convolutive. Many algorithms were developed in order to separate each type of mixture. Our work is organized as follows. First, we present an overview of the BSS problem and methods for the instantaneous and the convolutive mixtures. Then, we describe several experiments conducted on real acoustical signals mixed in an anechoic room and a reverberant room. Finally, we evaluate the performance of some BSS algorithms by means of measures of the distortion and the quality of separation.

Poster Wednesday Poster II

Effects of Filterbank Compensation for Spectral Limiting
Peter Derleth
Phonak AG

One main functionality of hearing aids is to amplify an input signal. In practice, the amount of gain applied to the input signal varies with frequency and time. To prevent discomfort (or even damage) from the listener, it has to be guaranteed that the level of the output signal (input signal + gain) does not exceed a certain level, i.e. the output signal has to be limited. In case of a multi-frequency-channel-system with non-overlapping channels, output limiting can be performed in each channel separately. For a system with overlapping channels, however, the effective limiting level for each channel depends also on the amount of gain in the neighboring channels. Methods to compensate for these effects introduced by the filterbank are presented and compared to the standard condition without a filterbank compensation.

Poster Wednesday Poster II

Simulation of flow and acoustics in the vocal tract

Peter Birkholz, Dietmar Jackèl
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Apart from a few exceptions, it is still a common practice to treat speech production in articulatory models of the vocal tract as a purely acoustic problem. One of the reasons for this is that there are well established techniques for calculating the sound field in the vocal tract which produce remarkable results for voiced sounds. It is still difficult, however, to treat the production of voiceless fricatives and plosives in a similar confident way. This is due to the fact that these sounds involve fluid motion effects in the vocal tract which are not accounted for by the acoustic equations. To tackle this problem, we extend the familiar lumped transmission-line model (TLM) by a new 'resistance'-element, which allows for the inclusion of simple flow-effects, e.g. the Bernoulli-effect or shock losses after sudden expansions in the vocal tract, without to disturb the fundamental network structure. Therefore, we derive the equation of motion (one-dimensional Navier-Stokes equation) from the first principles of fluid dynamics and apply an appropriate local discretization schema without to neglect higher order terms in the differential equation. We are currently implementing a time-domain simulation of the extended TLM in an effort to synthesize all relevant speech sounds, including fricatives, in one consistent model.

Poster Wednesday Poster II

Intrinsic pitch in German: Examining the overall fundamental frequency contour of the vowel

Daniel Pape, Christine Mooshammer
ZAS Berlin

The phenomenon of intrinsic pitch, i.e. the fundamental frequency (f0) difference between high and low vowels, has been found in a variety of languages (Whalen and Levitt 1995) and is therefore discussed as a universal characteristic. It is widely agreed that intrinsic pitch can be attributed to differences in tongue height. Contrary to that explanation Fischer-Jørgenson (1990) and Mooshammer et al (2001) found for German tense and lax vowels similar f0 values although the vowels show differences in tongue height. Since in Mooshammer et al. f0 was only considered at the articulatory defined mid of the vowel, in the current study we will investigate the whole f0 contour of the vowel for the same dataset. Results of the current study give evidence that lax vowels start with a higher f0 than their tense counterparts.

However, standard deviations are considerably high due to varying f0 range. We observed frequently errors of the f0 tracking algorithms due to noise at the beginning of the vowel. In addition, the maximum of the f0 contour at the end of the vowel was often interrupted by the following voiceless stop. In order to eliminate these factors we carried out a second experiment. The f0 range was controlled, consonants preceding the vowel were varied between /p,b,f,v,m/ in order to compare the effects of consonantal induced f0 variation. The consonant following the vowel was always nasal to avoid interruption on the rising f0 contour as in the first experiment. For reliable f0 values we recorded EGG simultaneously. Results of the second experiment will also be presented at the conference.

Poster Wednesday Poster II

Parameter Estimation of Vocal Tract Models for SPEAK

Frank Ranostaj, Arild Lacroix
IAP/Johann Wolfgang Goethe-Universität

SPEAK is a multimedia system for the investigation and demonstration of speech acoustics and speech production. The focus is hereby on discrete time acoustical models of the vocal tract. These models approximate the slope of the crosssection of the vocal tract by piecewise homogenous tubes. It is shown for these models, how the crosssectional area is estimated by appropiate algorithms out of speech signals of vowels, voiced and unvoiced fricatives. Additionally to a good spectral and auditory similaritiy also a morphological similarity to the vocal tract shape can be achieved. SPEAK can be interactivly controlled by parameters e.g. of the vocal tract model and the results are displayed immediately or produced auditive. Especialy there is the possibilty of visualizing the crosssectional area and transfer charakteristic of the vocal tract model for currently uttered speech simultaneously.

Poster Wednesday Poster II

Influence of the Wheel Diameter on the Curve Squealing of Railway Vehicles

Eric Cataldi-Spinola, Christoph Glocker, Rossano Stefanelli, Mathias Götsch
ETH Zürich, IMES-Zentrum für Mechanik

The noise emission of railway-wheels plays an important role in curve squealing. Therefore, it is important to know the eigenmodes and frequencies of the wheel. Due to abrasion, wheels need to have regular maintenance reprofiling and this causes a reduction of the wheel-diameter. In the current paper, the effect of diameter reduction on the eigenfrequencies has been studied

numerically using a finite element model of the wheel. The numerical results are validated by full scale measurements of the eigenfrequencies and eigenmodes of the wheel. This study has verified that the frequency associated to a specific eigenform may considerably shift during the life of a wheel. Frequency variations up to 12 % have been found both numerically and experimentally. This indicates that for the investigation of curve squealing, the varying diameter of the wheel should be taken into account because of its influence on the wheel's vibrational characteristics.

Poster Wednesday Poster II

Field Measurements on Curve Squealing - The Influence of the Wheel Diameter

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ETH Zürich, IMES-Zentrum für Mechanik

Curve squealing is an issue getting more and more important for railway operators. Thus efforts to understand this phenomenon are increasing. In this context ETH Zurich and the Swiss Federal Railways (SBB) initiated a collaboration on this topic. The aim of the collaboration is to understand the causes of the phenomenon. An important part of the studies are field measurements of various types. Correlations between occurrence of curve squealing, running speed, running behavior of each boogie and weather conditions are investigated. Recent research is focusing on the question, which modes of vibration and eigenfrequencies are active during curve squealing. The present essay presents correlations between occurrence and frequency of squealing versus wheel diameter. Therefore squealing behavior of driving trailers of suburban trains was monitored. At the same time wheel diameter, train speed and weather conditions were recorded. This gave the possibility to infer from Finite Element modeling which mode of vibration was involved in curve squealing. First results show that various modes are involved. Results are discussed relating to the importance of the occurrence of curve squealing.

Poster Wednesday Poster II

Distress caused by high energy impulse noise

Silvester Siegmann, Heinz Brinkmann, Tatjana Burchardt, Thomas Muth, Klaus Siegmund, Elisabeth Borsch-Galetke
Universitätsklinikum Düsseldorf

Noise as a potential cause for dysfunction in the cardiovascular system, in particular for heart attack, is still controversial. The objective of this study is to evaluate the association between high energy impulse and certain specific parameters. 25 men's reaction to impulse noise between 137 dB (duration 19.3 msec)

and 168 dB (duration 5.4 msec) were analyzed in four different series of experiments. The following parameters were determined: fingerpulse, adrenalin, noradrenalin, and magnesium in the plasma as well as influencing factors from the psychological standpoint (annoyance, reasonability, damage to health). A significant decrease of the fingerpulse-amplitude is shown after 4 seconds with a maximum after 6-8 seconds of noise related stress. The strongest decrease is measured at 145 dB (duration 16.6 msec). Concentration of adrenalin declines at any impulse level. The level of noradrenalin increases up to 9.2 % at 145 dB in comparison to the initial value (p=0.016). Before and after stress application the magnesium level increases (statistically significant at 168 dB (p= 0.026), statistical trend at 145 dB (p=0.068)). The strongest annoyance is measured at 168 dB and drops with cumulative distance ($p<0{,}001$). A significant correlation is shown between estimation of health damage and impulse level (differences for the answers of both questions are highly significant (Chi2-test, two-sided, $p<0.001$). High energy exposure induces changes of biochemical stress indicators depending on the impulse level. Concentration of noradrenalin shows an association to the fingerpulse amplitude. Changes of adrenalin concentration assume an interaction between physical impulses and psychomental stress disorder.

Poster Wednesday Poster II

DNA damage as a result of intensive impulse noise

Silvester Siegmann, Hans-Bernd Prisack, Tatjana Burchardt, Klaus Siegmund, Elisabeth Borsch-Galetke, Hans Bojar
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Employees of numerous industries are exposed to intensive impulse noise. Impulse noise may cause changes to isolated cell cultures through temporary compression and decompression. The effects of impulse noise to isolated lymphocytes and lung cells were analyzed. These cells were exposed to 3 impulse levels within 30 minutes (Lmax $\sim$ 170 dB). Total RNA was isolated, amplified, and labeled by an Enzo® BioArrayTM HighYieldTM RNA Transkript Labeling Kit. Labeled probes were analyzed by Affymetrix chips and the expression was compared with the RNA-profile of PHA-stimulated, unexposed probes. 41.9 % of 12.625 known lymphocytal genes were detected. 7.6 % of these genes were upregulated, 1.8 % were downregulated. Only 22 genes were 2x upregulated and 4 genes more than 2x downregulated like isoformes of the Cytochrome P450 and the Metallothionin-Gene. 44.2 % of 22.283 known genes of the lung cells (distal located human epithelial cells) were detected significantly. 1.3 %

of these genes were upregulated, whereas 2.7 % were downregulated. 7 genes were 2x upregulated and 33 genes more than 2x downregulated. Interestingly, these genes belong to the isoformes of the Cytochrome P450 and the Metallothionin gene as well. In conclusion, impulse noise induces cellular reactions comparable to oxidative stress reaction. In the future, evaluation of impulse noise working environment e.g. in the metal processing industry or by weapon noise in the german federal army should consider potential reactions on the cellular level.

Poster Thursday Poster III

Seismo-acoustic detection of land mines

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The detection of shallow-buried land mines can be performed by measuring the vibrations of the soil. At ISL, we have used an airborne acoustical signal of high level to produce soil vibrations. These vibrations have been measured with the help of a laser vibrometer. Because the mine container presents mechanical characteristics which differ from those of the surrounding soil, it modifies locally the vibration pattern of the soil surface. The first results indicate that shallow-buried land mines can be detected by this non-invasive method.

Poster Thursday Poster III

Validation of Travel Time Tomography by Comparing with Conventional in situ Measurements

Danny Daniel, Klaus Arnold, Astrid Ziemann, Armin Raabe, Manuela Barth, Kati Balogh
Institut für Meteorologie, Universität Leipzig

The method of sounding tomography uses acoustical signals from several external source (transmitter) which are detected with umpteen receivers. By inverting a number of single measurements were get information about the spatial distribution of the investigated measurands, whose quality depends on the uncertainties at determination of input parameters (travel time, distance) and on the recoverable resolution. In contrast to travel time tomography ascertaining wind velocities, the air temperatures deviate systematically from the conventional in situ measurements (e.g. Ultra Sonic Anemometer, Pt100- probes). These deviations are significant in particular during more intense short wave radiation and at high wind velocities. The reasons for this are either systematically deviations at the calculation of the meteorological parameters from the travel time and/or deficiencies in the conventional in situ measurements. The intention is by means of systematique experimental inquiries to investigate the reasons of

these varieties in the air temperature. In this context, by comparing measurement at a field of view ranging 140 x 160 m2 in a period of four weeks were researched, how different wind direction and wind velocities have an effect on the resulting air temperature and how large the differences in observed temperature between measuring system depending on change of the meteorological conditions are, especially during short wave radiation. Furthermore it is set up to resolve if during the determination of the air temperature from the acoustic virtual temperature the value of the specific heat has to be adjusted.

Poster Thursday Poster III

Spatial mapping of temperature and wind fields using sound propagation

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The acoustic time tomography is presented as an experimental technique for remote monitoring of spatially averaged meteorological quantities, such as the air temperature and the horizontal wind speed. This ground-based remote sensing technique uses the nearly horizontal propagation of sound waves in the atmospheric surface layer. Here the acoustic travel time tomography was applied by measuring the elapsed time at defined propagation paths between several sound sources and receivers. The knowledge of the sound path length has enabled us to determine the acoustic velocity along the propagation path. Because each single measurement includes information on the properties of the atmospheric layer through which the sound propagates, a tomographic inversion algorithm is able to provide a spatial mapping of meteorological data derived from the measured acoustic parameters. One fundamental difficulty is the separation of the different influences on the measured sound velocity. Under the assumption of a constant humidity, the effects of the air temperature and wind vector on the acoustic velocity can be divided. Thereto several separation methods are tested and their advantages and limitations are discussed. Applying these techniques, a horizontal section through the atmospheric surface layer with an spatial extension of several hundred meters and a resolution of a couple of decametres for the air temperature and wind speed can be provided. Depending on the environmental conditions and the measuring set-up specificities of 0.3 K (temperature) and 0.3 m/s (wind speed) are attainable. Some applications of the acoustic tomography during meteorological field experiments are shown.

Poster Thursday Poster III

Excess attenuation of sound due to the atmospheric influence on sound propagation

Kati Balogh, Astrid Ziemann, Klaus Arnold, Armin Raabe
Institut für Meteorologie, Universität Leipzig

The attenuation of sound is not only based on the spherical divergence, but also on atmospheric influences, e.g. the spatio-temporally variable gradients of temperature and wind vector, and on the effects of the different ground surface properties. In the presented study the excess attenuation of sound due to the refraction of sound rays propagating trough a vertically stratified atmosphere was experimentally and numerically estimated to quantify the correlation between the acoustic and meteorological parameters. Thereby, the method of acoustic tomography was used to measure the travel time and the relative sound amplitude of sound signals propagating on distances between 90 and 300 m. With these measurements the attenuations for relative sound levels were calculated for different sound paths in different directions regarding the wind direction. To further investigate the detected correlation between the meteorological attenuation and the changing vertical gradients of temperature and wind vector the experimental results were compared with the output of a sound propagation model. The model traces sound rays through a moving stratified atmosphere. In contrast to the usual application of the refraction law to the normal of the wave, the presented model uses a refraction law directly developed for the sound ray propagation. It is able to estimate the excess attenuation due to the atmospheric refraction over a perfectly reflecting or absorbing ground surface. Furthermore the estimated meteorological attenuation was compared with the usually applied VDI-guideline 2714 to estimate its application range under different meteorological conditions.

Poster Thursday Poster III

Analysis of Energy Flow and Energy Densities for One-Dimensional Acoustic Fields

Cédric Devaux, Nicolas Joly, Jean-Claude Pascal
LAUM

Energy methods have proved to be an efficient technique to model acoustics or structure vibrations in the high frequency range. For any frequency in one-dimensional systems, an exact energy formulation is available to model power transfers for structural acoustics in dissipative media. However, this energy

formulation, based on kinetic- and strain- energy densities, involves equations of higher order, more variables, and more complex boundary conditions than the usual displacement formulation. In the same way, energy densities and structural intensity fields present higher complexity than the displacement field, with components at small space scale (typically the half wave length) or large scale (linked to the dissipative properties of the material). With the objective to select the only components contributing to large scale variations, acoustic energy fields are analyzed in terms of forward and backward waves, or propagative and standing components in unloaded portions of one-dimensional structures. To take into account acoustic sources in the large scale of energy fields, the different contributions of external sources are analyzed, for energy densities and structural intensity, in the case of concentrated loads.

Poster Thursday Poster III

Continuous driving noise measurement equipement : aerodynamic noise due to the wind drag on microphones

Didier Boze
LABO REG. PONTS ET CHAUSSEES AUTUN

The laboratoires des ponts et chaussées network are working on continuous driving noise measurement equipement. This equipement is for people working on publical issues and caracterises acoustic properties of road materials. This equipement is componed of a special car on which are fixed 3 microphones, among which there is a lateral microphonic system, put as described in ISO 11819-2 norm, and linked on a data acquisition system. Numerous studies work on interference noise reduction during the record of noise level created by the wheels on road. The laboratory of Autun studies the aerodynamic noise due to the wind drag on microphones in a varaible speed flow simulating the displacement of a car from 50 to 100 km/h. The experiments show the necessity of protecting microphones and the presence of a turbulent flow which speed profiles and pressures field are highly dependent on protection's Cx. The aerodynamics phenomena have a direct impact on produced interference noise which change in terms of level and spectral composition from one tested protection to another. In the same time, racing circuit tests show air flow speed gets weaker than car speed when closer to protections, hence a relative noise immunity on temporal measurements. Nevertheless the spectral contribution of these noises is concentrated on low frequencies and can penalize following analyses. So, use of streamlined shape against wind made of acoustically invisible material, is the solution experimented todays.

Poster Thursday Poster III

Analysis of structure borne transmission in a high-speed train

Pascal Bouvet
VIBRATEC

SEA (Statistical Energy Analysis) models are used in the railway industry for airborne noise analysis in the passenger area. These models are generally reliable at high frequencies, where transmission of airborne noise from the vehicle exterior is the dominant transmission path. However, at low and mid frequencies, the structure borne noise transmission path becomes significant. The Energy Flow Method (EFM) is a computationally efficient method, by which the results of a Finite Element Analysis (FEA) may be post-processed to form energy flow models. It can be used to study structure borne transmission in coupled structures, based on a modal description of the global structure.
This paper presents an industrial application of these techniques, for the analysis of structure borne transmission in a high speed train. The standard SEA model for air-borne noise analysis is quickly presented. For structure-borne analysis, the EFM is used to form an inverse SEA model, which in turns allows to calculate Coupling Loss Factors between structural sub-systems. The methodologies to define appropriate SEA structural sub-systems are also discussed.

Poster Thursday Poster III

High Order Finite Element Methods for Acoustics

Sebastien Jund, Stephanie Salmon, Eric Sonnendrucker
IRMA

High order finite elements for acoustics. This project is a part of a french-german cooperation DFG-CNRS on 'Noise Generation in Turbulent Flows'. Our objective is to study and predict the noise generation induced by the flow and to find new noise reduction concepts. Thus we are interested in very precise numerical methods for wave propagation. First, we are developing numerical schemes of high order to solve the second order wave equation on unstructured grids. These schemes should be sufficiently compact to obtain a good resolution with a small number of grid points and designed such that the dispersion and dissipation errors are low. We have opted for the use of continuous Lagrangian polynomial finite element methods in space (implemented for any arbitrary high degree) which are well adapted for unstructured grids, coupled with high order ADER schemes in time.

Poster Thursday Poster III

Vibration of Thin Plates under General Boundary Conditions

Ralph Haberkern

Fraunhofer Institut Bauphysik

Besides its elastic properties, the boundary conditions of a wall play an important role for its eigenvibrations. For simplicity's sake, the thin-plate assumption is made. However, the classical boundary conditions 'free', 'simple support', 'clamped' are not general and not sufficient to catch certain effects that occur in practice. Especially, the energy dissipation on the boundary is not contained. This effect requires a general elastic coupling between the wall and its surroundings. Additionally, practical situations motivate the attachment of bars along the boundaries, to account for additional torsional-rod and bending-beam resistance and inertia. The nature of a general elastic coupling and bar couplings is explored. The truly local boundary conditions are identified and a method to determine the eigenvibrations of such plates is demonstrated. By adaptation of constants the measured eigenmodes of a wall in the sound-transmission test facility are approximated.

Poster Thursday Poster III

Calculated and Measured Turbulent Noise in a Strongly Swirling Isothermal Jet

Peter Habisreuther, Oliver Petsch, Henning Bockhorn, Horst Büchner

Engler-Bunte-Institut / Lehrstuhl für Verbrennungstechnik, Universität Karlsruhe

The most common technique, used for flame stabilization in industrial combustion devices, is the application of highly swirling inflows. As such inflows produce at least one recirculation zone and, in conjunction with that, high velocity gradients and turbulence intensities, swirling flows normally constitute a great source of turbulent noise. Although it is well known that different types of swirl generation result in different radial profiles of circumferential velocity and, as a consequence, different tendency to enhance or suppress turbulent motion, few is known on the dependence of noise generation with respect to the type of swirl generation and burner outlet geometries. Recent advances in CFD-calculation methods encourage the application of numerical techniques such as DNS and LES for the determination of aerodynamic sound. As a first advance to the problem outlined above, the current investigations show results of LES calculations of a strongly swirling isothermal flow emerging into a combustion chamber compared

with measured sound pressure values. Spectra of calculated values of static pressure and velocity show a distinct peak value at a characteristic frequency in the burner nozzle and in the ambient combustion chamber flow. These self sustaining flow instabilities can, similar to frequencies observed in experiments, be correlated to global inflow parameters. In addition to that, experimental investigations are carried out to measure noise characteristics a well as the formation of coherent flow structures, contributing strongly to the overall noise emissions.

Poster Thursday Poster III

Numerical Experiments on Time Reversal Localization of Impulse Sources in an Open Space

Jean-Marc Parot
LaRAMA / IFMA

The time reversal principle is a possible way to propagate backwards to the noise sources. The measured signal is backpropagated by computation. According to Fink's mostly experimental works for point-like sources, the reversed wave must focus on the source. In the present work, we will test this idea by simulating simple but non obvious situations: a point source surrounded by buildings or a spherical radiating surface in an open space. A very low number of point receivers is used, 3 or 4. Wave fronts redirected back from these transducers, following direct, reflected or diffracted paths, focus on the source, whether it is seen or kept out of the receiver's sight. With a conveniently chosen criterion, based on the time duration of the reversed signal, we are able to localize the source.

Poster Thursday Poster III

An Educational Model for Acoustic Tomographic Imaging

Peter Holstein, Manuela Barth, Armin Raabe
SINUS Messtechnik GmbH

A model apparatus is presented which has been especially designed for educational purposes and experimental testing of tomographic algorithms. The system is similar to an acoustic tomographic system which has been developed to observe local differences in the sound speed in order to recalculate images of physical parameters which influence the sound speed fields under natural conditions. This technique has been extended to a more general environment. The basis is an acoustic multi-channel spectrometer operating in the audio range. The model spectrometer completely controls the acoustical experiment (emission and reception). The modular approach is implemented over several levels including the real-time DSP-software, the driver for the acoustic spectrometer and the data-processing

concept. The controlling software and the algorithmic part have been developed within the framework of a general toolbox concept for acoustic spectrometers. The extension of the transportable model enables frequency- and travel-time scaled experiments within the audio and near-ultrasonic range. Different tomographic algorithms can be experimentally verified and optimised due to the modular structure, which enables the easy replacement of code modules. Possible physical effects which can be investigated even under laboratory conditions include the reconstruction of temperature fields and flow fields.

Poster Thursday Poster III

Time Reversal of Ultrasonic Waves through Phononic Crystals

François Van Der Biest, Gillian Boccara, Arnaud Tourin, Mathias Fink
ESPCI - LOA

Phononic band gap crystals are periodic structures, analogous to photonic crystals for electromagnetic waves, that forbid propagation of acoustic waves for a certain range of frequencies. We present here time-reversal experiments performed through 2D phononic crystals consisting of periodic square arrangements of steel rods immersed in water. The rod diameter is 0.8 mm while the lattice constant is 1.5 mm. Such crystals exhibit a stop band around 500 KHz in the [10] direction. Using a transducer working around 500 kHz, we send a short pulse into such a crystal. Inside the stop band, no propagating modes exists but tunneling is involved. Thus using a receiving transducer array with the same central frequency as the source, it is possible to measure a transmitted wave which comes from the conversion of the evanescent waves into propagating modes at the output of the sample. This wave is then time-reversed and back-propagated. Both time compression and spatial focusing are quantified.

Poster Thursday Poster III

Dust Figures in Kundt's Tube - Investigations on the Formation of Ripples

Julia Moldenhauer, Kai Stratmann
Carl von Ossietzky Universität Oldenburg

Apart from its technical application, Kundt's Tube is a well-known demonstration experiment in acoustics. It is used to visualize standing sound waves. Already its inventor August Kundt described the self- organisation of dust inside the tube to ripple structures. In the beginning of the 20th century, these structures were subject of numerous investigations in order to explain their origin. Andrade presented in the 1930s an explanation for the

formation of ripples. Visualizing the motion of the air indicates vortex systems as the cause of these structures, which develop around the dust particles in the sound field. Modern measurement and visualization methods support these findings, and beyond that give new interesting insight into the origin of the dust figures.

Poster Thursday Poster III

A time domain characterization of porous materials at audio frequency

Naima Sebaa, Zine El Abiddine Fellah, Mohamed Fellah, Walter Lauriks, Claude Depollier, Jean Yves Chapelon
National Institute of Health and Medical Research, INSERM Unit 556

An audio frequency method of evaluating the acoustic parameters of porous materials saturated by air (or any other gas) is discussed. The method is based on experimental detection of waves reflected and transmitted at normal incidence by the material. This method is based on a temporal model of direct and inverse scattering problems for the propagation of transient audio frequency waves in a homogeneous isotropic slab of porous material with a rigid frame. This time domain model of wave propagation takes into account the inertial, viscous and thermal losses of the medium. The main results is the determination of the permeability, tortuosity and Young modulus of the porous material. Tests are performed using industrial plastic foams. Experimental and numerical results, and prospects are discussed.

Poster Thursday Poster III

The Dynamic Radiation Force on Cylinder: Theory and Simulations

Farid G. Mitri, Shigao Chen, Zine El Abiddine Fellah, Philippe Trompette, Jean Yves Chapelon
National Institute of Health and Medical Research, INSERM Unit 556

The theory of the dynamic radiation force Yd experienced by an infinite cylinder is presented. Analytical solutions of the equations for the dynamic radiation force are derived. The equations enable analytical radiation force dependencies on the acoustic field and medium parameters. The case of compressional and shear waves absorption in the solid material of the cylinder is also discussed. The results of numerical calculations are presented, indicating the ways in which the form of the frequency dependence of the dynamic radiation force function Yd for cylindrical targets is affected by variations in the material parameters of the cylinder. The case of lossless and lossy materials is considered.

The results are of interest in view of the dynamic radiation force to determine the vibrating velocity of a cylinder immersed in water or embedded in any lossy medium in order to determine its local visco-elastic parameters.

Poster Thursday Poster III

Optimisation of damping layer placement in structures
Goran Pavic
Lab. Vibrations Acoustique, INSA Lyon - Bât. 303

The paper addresses the problem of finding an optimum placement of damping layers in an elastic vibrating structure. It is shown that the structure-borne intensity divergence can serve as a guiding quantity for this task. The established relationship between the structure-borne intensity and the potential energy of vibration is further used to make the method operative. The performance of the intensity divergence technique is assessed by virtual experiments done on a beam. It has been demonstrated that the developed technique gives correct results in a short period of time.

Poster Thursday Poster III

Meaning of projectile sound by shooting sound emissions
Lothar Förster, Rainer Kubicek, Reinhard Müller
-

There are only two factors that are decisive for the emergence of the projectile sound and the area that is covered when the projectile sound spreads. These are the speed of the projectile and the length of its flight path. For various projectile speeds that can be assigned to three different cases the theoretically expected distributions of the projectile sound levels are discussed and then compared with the actually measured ones.

Poster Thursday Poster III

Determination of the dispersion curves in a noisy shallow water waveguide

Didier Cassereau
ESPCI - LOA

Wave propagation in a shallow water oceanic environment is usually considered in the general frame of acoustic waveguides. The determination of the waveguide properties without any a priori knowledge of the environment is well-known to be a difficult task. More particularly, the measurement of the waveguide wave numbers from a synthetic aperture array requires high-resolution algorithm. In the recent past, various algorithms have been proposed to determine the wave numbers from experimental or simulated data, like the eigen-matrix pencil method [I-Tai Lu *et al.*, J. Acoust. Soc. Am. **104** (1), 1998]. In this work, we propose to use our algorithm to calculate from time-domain experimental and simulated data the dispersion curves that describe the modal propagation in the waveguide. To this goal, we consider a moving source that transmits regularly a pulsed signal received after propagation through the waveguide on an array of receivers. From the received transient signals, we calculate the wave numbers for all frequencies inside the bandwidth of the source-receiver system. This procedure provides to the dispersion curves corresponding to the different modes in the waveguide in the considered bandwidth. The wavenumber inversion is run on simulated data that can be altered with random noise. We analyse the robustness of the inversion algorithm as a function of the noise level and the length of the synthetic aperture array. We also propose a noise reduction method based on holographic array processing that correlates the signals measured on all the elements of the receiving array.

Poster Thursday Poster III

Performing Quantitative Ultrasonic Tomography using Wavelets Analysis

Philippe Lasaygues
LMA CNRS

Quantitative ultrasonic tomography is used to long bones imaging. In previous works, we showed that an iterative tool might be used to provide, from reflection tomography, qualitative images of the shape of the object, and to provide, from transmission tomography, quantitative images of the velocity map. Both tomographies are based on ultrasonic propagation in bones, particularly perturbed by this high-contrasted heterogeneous medium.

Reflected and transmitted signal are composed of several packages of waves, which had followed various pathways within the cortical shell of long bones. Signal and image processing have a large important part in the complete process. To improve reflection tomography and shape recognition, we used a novel image-processing tool that improves the resolution and, so, the cortical thickness measurement. This image processing is very simple and allows us to initialise the transmission tomography, based on the knowledge of the geometrical properties. The procedure are also based on the knowledge of the acoustical properties of the body because the Time-Of-Flight measured on the extracted ultrasonic signal are related to the useful velocities of the ultrasonic waves throughout the shell. To optimise our signal processing, we propose a novel algorithm based on the wavelet analysis tool adapted to ultrasonic signals that allow the transmitted signals to be cleaned and filtered and the useful information to be separated from the unwanted noise.

Poster Thursday Poster III

Geometrical and acoustical properties identification of high-contrasted bodies using multi-parametric imaging

Loic Lemarrec, Philippe Lasaygues, Jean-Pierre Lefebvre
LMA CNRS

We are concerned by the ultrasonic characterization and identification of the mean-mechanical properties of high-contrast non-circular tubes such as human long bones. Under conditions, scatterer is considered as a weak-heterogeneous and non-absorbing elastic material and we assume that the shell of tube (cortical of the bone) filled by an isotropic medium. In this paper, we present original steps to solve this multi-parametric problem. First, in the forward problem, experimental and numerical (finite element method) measurements predict the scattered ultrasonic field. Second, the inverse problem is solved by a strategy based on an approximation of the scattering medium by a canonical solution. Its scattered field is an analytical modal solution using a Rayleigh-Fourier method. The main advantage of this method is that it can be used even in the case of high impedance contrast. The inversion process is based on the analysis of the discrepancy between estimated and predicted fields. The behavior of the estimation according to a priori is studied in order to achieve a quantitative shape and material properties reconstruction process. Numerical and experimental results are presented. Original conclusions will be brought on the contribution of this multi-parametric method to bone tomographic imaging.

Poster Thursday Poster III

Acoustic Wave Propagation in Functionally Graded Material (FGM) Cylinders

Lahoucine Elmaimouni, Jean-Etienne Lefebvre, Tadeusz Gryba, Victor Zhang
IEMN - DOAE Université de Valenciennes

FGMs are composite materials intentionally designed so that they possess desirable properties for specific applications, often to withstand high-temperature-gradient environments while maintaining their structural integrity. The mechanical properties of cylindrical structure made of FGM vary continuously in the macroscopic sense from one surface to the other, for example all ceramic to all stainless steel. In the application of these structures to aerospace, nuclear and automobile industries, analysis of acoustic wave propagation is of great importance. In this approach, we have developed an exact solution to calculate the dispersion curves in FGM cylinders of various geometries. A FGM cylinder made up of stainless steel and silicon nitride is described. The radial variation laws of Young's modulus, Poisson ratio and mass density are given, the position-dependent stiffness constants are then deduced. The equations of motion are solved by expanding each mechanical displacement component using Legendre polynomials and harmonic functions. For numerical calculations, the order of the expansion is truncated to some value N. The solution converges within a very low number N of terms. The numerical dispersion curves are presented and compared with earlier published results showing an excellent agreement. Advantages and limitations of the approach are also presented.

Poster Thursday Poster III

Measurement of the ultrasonic attenuation in viscous fluids by using a transient technique

Hakim Djelouah, Assia Oudina, Hassina Khelladi, Djema Belgroune
Faculté de Physique

In the ultrasonic techniques usually used for the measurements of the attenuation, correcting terms are often introduced in order to minimise the diffraction effects. Here, we take advantage of the particularities of the transient mode in order to deduce the attenuation coefficient by using the plane wave model without using any diffraction correcting term. First, a theoretical model of the diffraction of ultrasonic waves propagating in viscous media, is developed by using the formulation of the diffracted field under the form of a convolution. It is shown that that when a rigid

target of small size is placed near a transducer, the detected reflected wave consists of three impulses. Only, the first of these impulses corresponds to a plane wave coming from the projection of the target on the surface of the transducer. The others results from the diffraction from the edge of the radiating source. The method principle consists in obtaining the attenuation coefficient after selecting only the first impulse which corresponds to the plane wave, avoiding thus any corrective diffraction term. Some experimental results obtained with glycerine, paraffin oil and castor oil at different temperatures will be presented and compared with the values obtained by other techniques. The principal advantage of this method is that the measurements are carried out in the near field of a plane transducer, thus avoiding the encountered problems of alignment when the measurements are made in the far field, and the attenuation is determined over a wide frequency band with only one measurement.

Poster Thursday Poster III

Caractérisation de Cibles et Défauts dans les Matériaux par la T.G.D.

Rachid Louni
Faculté de Physique - USTHB

La détection, la caractérisation et l'identification d'objets cibles ou la localisation de défauts d'homogénéité dans les matériaux ou dans les pièces usinées en industrie, occupent une place fondamentale dans les applications des techniques ultrasonores. L'utilisation de la Théorie Géométrique de la Diffraction (T.G.D.) dans ce domaine est une idée relativement récente. Cette théorie, alliée aux techniques de la spectroscopie ultrasonore, nous a permis de caractériser les dimensions et l'orientation de cibles ou de défauts de différentes formes géométriques, usinés ou insérés dans des matrices d'aluminium. Les résultats obtenus dans notre travail sont encourageants et montrent tout l'intérêt que peut susciter cette technique de mesure. D'autant plus qu'elle est relativement facile à mettre en œuvre et avec des moyens à usage courant.

Poster Thursday Poster III

Acoustical measurements in poroelastic materials performed with an hybrid ultrasonic method

Mohamed Saied, Bernard Castagnède, Alexei Moussatov, Vitali Gusev, Vincent Tournat
LAUM

A new hybrid ultrasonic technique is used to generate planar sound waves from powerful low frequency ultrasound being amplitude modulated. These audio plane waves are then utilized

to perform fine metrological measurements on poroelastic media, such as felt materials. In the present work several configurations are described both in retrodiffusion and in transmission within the tested material. In any case, one uses a 1/2 inch B&K audio microphone for detection and an hand-made piezoelectric transducer for generation of the ultrasonic amplitude modulated waves. In the transmission configuration, dispersion curves have been obtained on various felt plates over the 4-40 kHz bandwidth, and the experimental results have been compared with the well-known Biot-Johnson-Allard 'equivalent fluid' theoretical model. For retrodiffusion measurements, the coefficient of reflection has been measured on the very same plates for a similar bandwidth. These results exhibit some frequency dependent oscillations which are due to constructive and partially destructive interferences within the porous plates. Agreement between numerical predictions and experimental data is generally fair, in some cases being excellent. Other ancillary measurements based on the Hilbert transform of the transfer function between the incident and the reflected wave will also be presented and discussed for some significant results.

Poster Thursday Poster III

Comparative Study of the Weldings NDT Results by Ultrasounds and Radioscopy

Ali Badidi Bouda, Rafik Halimi, Ahmed Mebtouche, Mourad Benzohra, Amar Benchaala
Centre de Soudage et Controle CSC

ABSTRACT Non destructive testing of welded joints, which are the most vulnerable parts in the industrial facilities is requested more and more. The techniques of NDT the most used in these cases is radiography and the ultrasounds. In this article we were interested in the non destructive testing of joints welded out of stainless steel used regularly for certification of levels I and II NDT operators .These parts contain the most current defects like the cracks, the lacks of fusion which are harmful defects and inclusions which in general are tolerated until a certain concentration. The ultrasonic inspection was carry out by two methods per contact and in immersion by using transducers of different frequencies. These tests showed that the results on the detection and the dimensioning of certain defects can be influenced by changing the testing method or simply by modifying one or more parameters of control. This can have serious consequences on the result of a control. The samples controlled by ultrasounds were controlled by radioscopy for confirmation and comparison.

Poster Thursday Poster III

Observations of Slow Emergences of an Inertial Ultrasonic Cavitation Field Produced by Chopped Ultrasounds

Stéphane Labouret, Jacques Frohly
Service de Physique-Electricité, Institut Meurice

The ultrasonic cavitation behaviour is observed since the beginning of the ultrasonic irradiation (frequency = 1 MHz) by means of both the measurement of both the liquid void rate and the acoustic spectrum which is recorded in the liquid. When the ultrasound irradiation is performed in chopped mode (silence duration = pulse duration), it is observed 2 regimes called A and B. The A regime is characterised by a slow increase of the void rate and the presence of harmonics and under-harmonics in the acoustic spectrum, and corresponds essentially to the presence of stable cavitation bubbles. The B regime that follows the A regime, displays a strong increase of the void rate and a broadband cavitation noise in he acoustic spectrum. The B regime corresponds to an inertial cavitation field. The transition from the A regime to the B regime occurs with a delay that depends on the chopping frequency. Furthermore, the transition duration is short (relatively to our measurement resolution, round to 1 second) for the majority of the chopping frequencies considered. Notwithstanding, we will present examples for which the transition develops over durations up to tens seconds.

Poster Thursday Poster III

Suppression of intra-plate echoes when focusing through a titanium Fabry Perot: comparison between inverse filter and time reversal cavity

Francois Vignon, Alejandro Saez, Jean Francois Aubry, Didier Cassereau, Mathias Fink
ESPCI - LOA

When focusing through plates or tubes the presence of multiple interfaces induces reflected wave fronts that follow the main wave front. Adaptive focusing techniques can be used to cancel the echoes. For that purpose, two linear arrays of transducers have been placed on each side of a titanium plate acting like an ultrasonic Fabry-Perot. Three propagation operators have been acquired: the transmission H from one array to the other and the two reflection operators K1 and K2 acquired by each array.
Theoretically, the echoes can be suppressed by using a complete cavity with transducers surrounding the plate. In this experiment, the two arrays are recording the field along a sufficient surface to cancel the echoes (20dB decrease). Parallel to this work, thanks to the inversion of the H matrix, the echoes have been

cancelled by using the inverse filter technique. Thus, the inverse filter achieves echoes cancellation by using only the transmitted fields, whereas time reversal also needs the reflected fields. Signals emitted with both techniques are compared in order to explain how the focusing is achieved in both cases. In fact, transmit and reflected wave fronts are related by the Stokes relations, explaining how the transmitted wavefront includes information on the reflected one.
Thanks to finite differences simulations, the experiment has been numerically modeled. The reconstructed movie of the propagation of the emitted wave fronts inside the plate gives a clear illustration of the focusing techniques.

Poster Thursday Poster III

Scaling of Stability Limits by Use of Universal Flame Transfer Functions

Martin Lohrmann, Nikolaos Zarzalis, Horst Büchner
Universität Karlsruhe, Engler-Bunte-Institut, Bereich Verbrennungstechnik

For the improvement of the efficiency of gas turbines a further increase of the pressure ratio becomes necessary and therefore, the preheating temperatures of the combustion air are increasing, too. Especially, highly turbulent swirl-stabilized flames, favoured for gas turbine applications, are often prone to self-sustained, periodic combustion instabilities. This increased tendency to the formation of flame/pressure oscillations is primarily caused by high volumetric reaction densities of premixed swirl flames and - consequently - reduced delay times and "faster" responses of the flame to disturbances of the mixture mass flow rate. Today, theoretical models for the quantitative prediction of flame dynamics of turbulent premixed flames in dependence on relevant operation parameters are still missing in literature. In particular, the impact of the turbulent burning velocity on the axial position of the main reaction zone and hence, on the delay time of the flame - required for the fulfilment of Rayleighìs phase criterion - can not be predicted quantitatively. By theoretical considerations of the flame geometry of steady-state turbulent premixed flames a physical model was derived and validated with measurements of flame transfer functions under well-defined forced, pulsating conditions. Now, the model enables to predict the delay times of the flames and consequently, the entire phase angle function j(f) of the turbulent swirl flames in dependence on the relevant operation parameters (e.g. equivalence ratio, thermal load, preheating temperature or fuel type). Thus, it is now possible to scale and

predict the stability limits for the formation of periodic combustion instabilities of lean-premixed combustors with swirl-stabilized flames.

Poster Thursday Poster III

Thermoacoustic refrigeration : optimisation of the particle velocity as a function of the acoustic pressure

Pierrick Lotton, Bertrand Lihoreau, Etienne Gaviot, Michel Bruneau, Vitali Gusev
LAUM

Classical thermoacoustic refrigerators mainly consist of a thermoacoustic core (a stack of plates with heat exchangers at both ends) strategically located in an acoustic standing wave resonator (half- or quarter-wavelength). In this resonator, the acoustic pressure p and the particle velocity v are not independent, and their relative phase phi is equal to $\pm$ pi/2 (for pure standing wave). Practically, for a given acoustic excitation, the acoustic field (p, v, phi) used for the thermoacoustic process is essentially governed by the geometry of the device and then does not necessarily optimises the thermodynamic properties. The aim of this work is to study the theoretical behaviour of a thermoacoustic device in which p, v and phi are considered as independent and adjustable (using adapted shapes for example). The expressions of the thermoacoustic quantities of interest (namely the temperature difference between the ends of the stack, the thermoacoustic energy flux and the coefficient of performance) are written and discussed in order to reach the optimum of the quantities of interest for the application considered. A comparison with the case of a classical standing wave refrigerator is done. It is shown that the standing wave device operates with a velocity which is closed to the theoretical optimal one only for a high drive ratio. At lower level, the parameters which permit an optimisation are discussed. Moreover, it is shown as well that the optimal value of the relative phase between pressure and velocity is never equal to $\pm$ pi/2.

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How to reach Strasbourg

by plane: Strasbourg international airport located at Entzheim. Car parks, taxis and bus-shuttle (3 per hour) to the city centre.
for information about shuttles (prices, schedule): http://www.strasbourg.aeroport.fr/

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by train: Strasbourg, one of the most important railway stations of France, is connected by direct links to numerous cities of France (Paris, Lyon, Marseille, Nice, Montpellier, Nîmes, Lille , Bordeaux, Nantes and Toulouse are added in summer).
Strasbourg is also situated at the intersection of big international axes and also benefits from quality links with numerous European cities (Brussels, Luxemburg, Basel, Bern, Zurich, Stuttgart, Munich, Saarbrücken, Salzburg, Vienna, Milan, Rome, etc).

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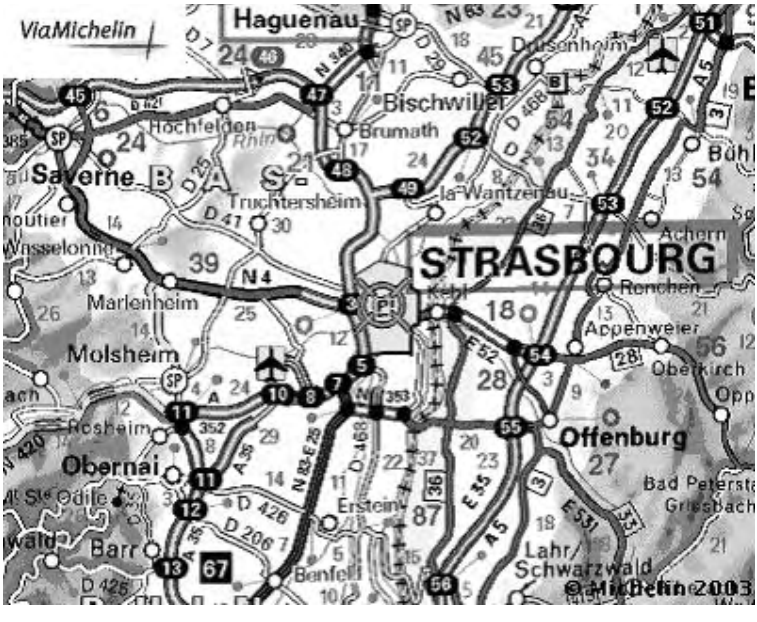
by road: The French freeway network: to the west and to the north, the A4, A34, A31 and A32 freeways permit easy access of Strasbourg from Paris, Amsterdam, Bruxelles, Luxembourg et Bonn via Metz and Sarrebruck. To the south, the axis Strasbourg-Mulhouse, and the A36 intersection of the A6 freeway of Beaune opens routes in direction of Italy and Spain.
The German freeway: this European network permits access to Hamburg, Frankfurt, Basel, Geneva and Milan is less than 15 minutes from Strasbourg via Kehl.



Maps of Strasbourg

In Strasbourg, how to reach the "'Palais de la Musique et des Congrès"'?

by car from the motorway:

- coming from the north: A4 direction Strasbourg – Colmar
  exit 1 Wacken (Cronenbourg – place des Halle
  direction Wacken the Place de Bordeaux – Palais des Congrès institutiones européennes
- coming from the south: A35 direction Strasbourg – Paris – Nancy – Metz
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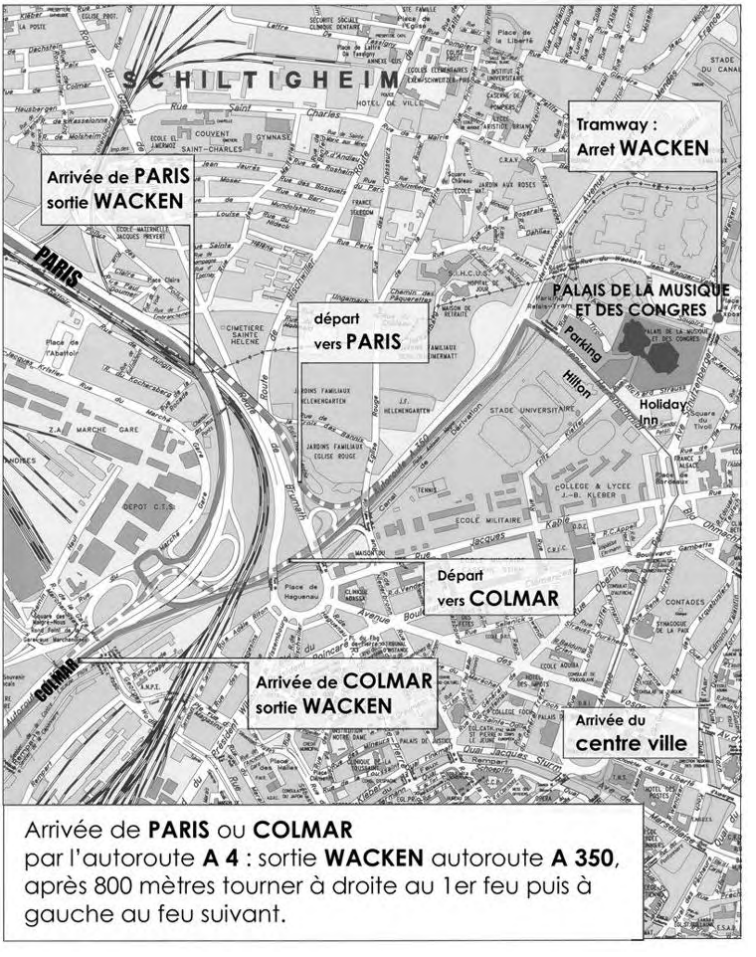
  direction Wacken then Place de Bordeaux – Palais des Congrès



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by tram (Strassenbahn) or city bus:
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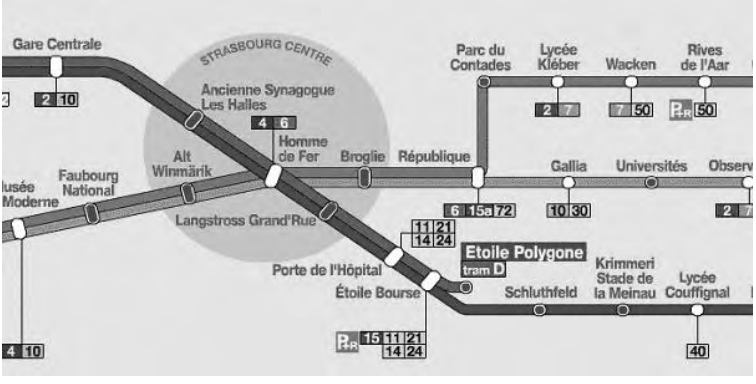
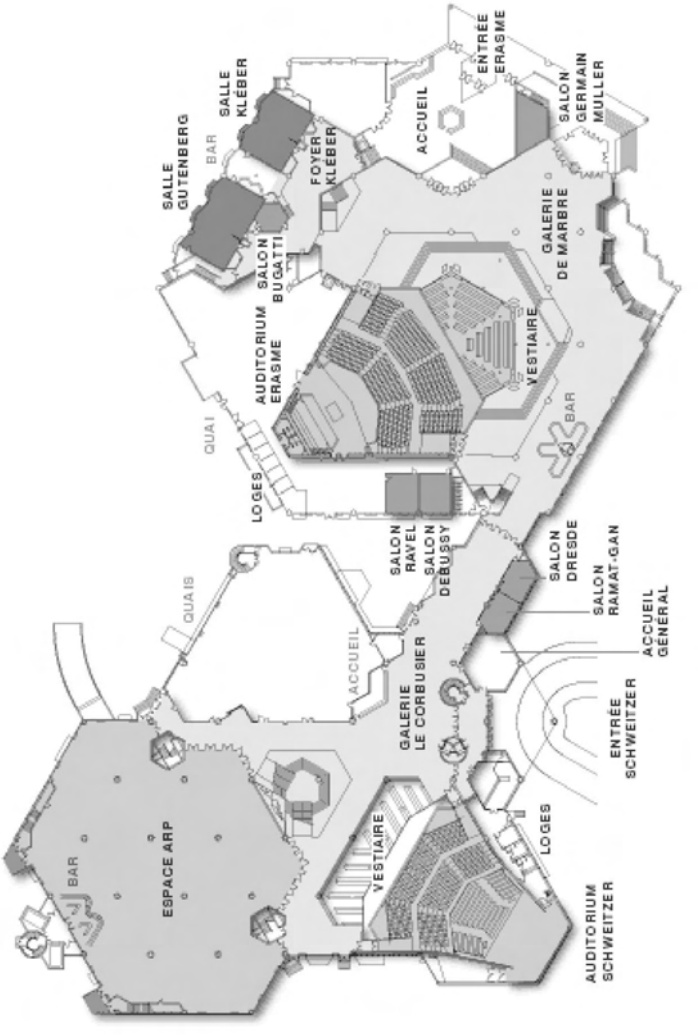
Reach "L'Homme de fer"tramway station
Take line B to "Hoenheim Gare"
Stop at "Wacken"station.
Public transportation tickets can be bought at automatic machines in each tramway station (multilingual machines) and tobacco-, press shops.
Prices:

- oneway 1.2 EURO
- book of tickets: 5 EURO/ 5 tickes
- 24 hour tickets – no limitations of journey: 3 EUROEuro).

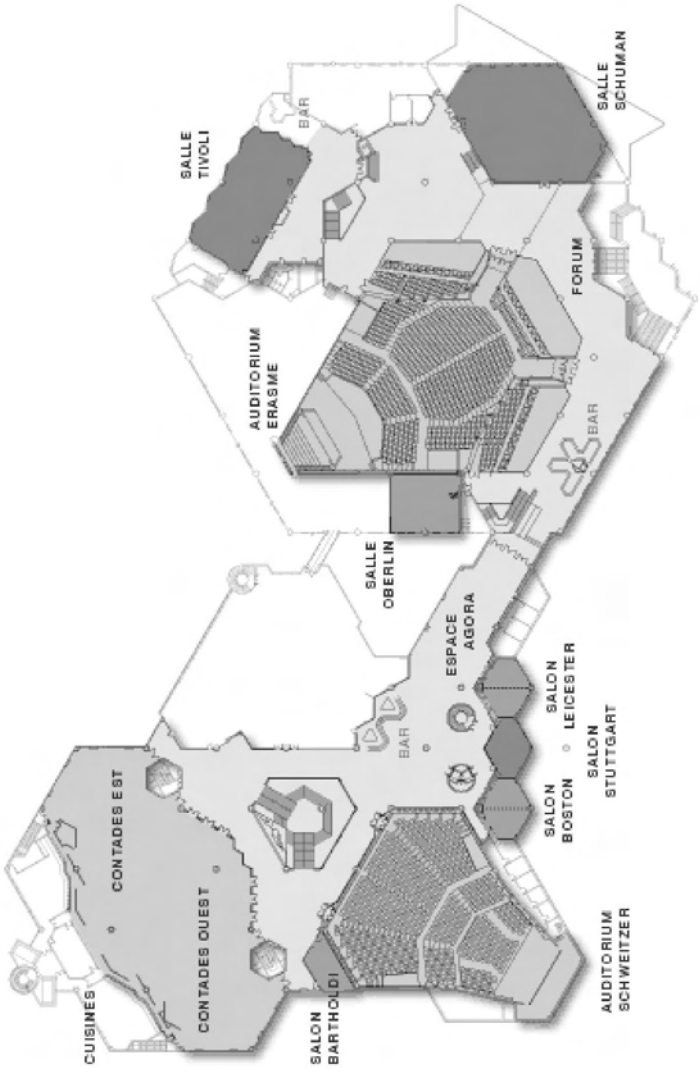


Maps of congress centre

Ground floor



First floor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