were examined by laboratory tests. To simulate a 3-dimensional sound field, the 6-channel recording/reproduction technique was applied and the incident direction of the test sounds was varied in twelve horizontal directions.

4pPPc39. Development of pure-tone auditory threshold in school children. Reinhard Müller (University of Giessen, Aulweg 123, 35392 Giessen, Germany, reinhard.mueller@audio.med.uni-giessen.de)

The overwhelming majority of publications concerning hearing in children is related to diseases, but normal development of hearing attracts little attention. Normal hearing, as defined by ISO 7029, refers to persons at the age of 18. While aging effects of hearing may be estimated by the use of formulas, children are not included. A field-study at a primary school in Germany showed a notably lower hearing sensitivity for children than for young adults. First graders did not hear well, but auditory performance improved with rising age. For validating this result, the first graders of the field study were again tested 3 years later. The second tests showed the expected improvement of their hearing threshold. So the hearing sense starts not with the full capability but underlies a certain development. Maybe training effects are the key to understanding this topic, as in other human skills.

4pPPc40. Problems in sound quality evaluation in Brazil: general or cultural ones? Stephan Paul (Lab. of Vibrations and Acoustics, Fed. Univ. of Santa Catarina, CTC, EMC, Campus Trindade, 88040 Florianópolis, Brazil, stephan.paul.acoustic@gmail.com)

Within modern sound engineering the individual perception of sound events has to be considered. Within sound and vibration related research all over the world several instruments were already developed, but this instruments are subject to several restrictions, especially their language. When sound evaluations are to be made in Brazil adequate evaluation instruments are necessary. This article is intended to discuss some of the problems encountered by the author and its co-workers when developing assessment procedures and especially instruments for evaluation of sound quality with Brazilian subjects. Especially the work undertaken to study descriptors for sound and vibration and the problems resulting in this work will be discussed. We consider the present congress, with participants from all over the world, to be a suitable platform to discuss some of the problems and results obtained.

THURSDAY AFTERNOON, 3 JULY 2008 P2-C, LEVEL 2, 3:40 TO 5:20 P.M.

Session 4pPPd

Psychological and Physiological Acoustics: Auditory Perception of Sound Source Properties II (Poster Session)

John Neuhoff, Cochair
The College of Wooster

Anna Preis, Cochair
Institute of Acoustics, Adam Mickiewicz University

All posters will be on display from 3:40 p.m. to 5:20 p.m. To allow contributors an opportunity to see other posters, contributors of odd-numbered papers will be at their posters from 3:40 p.m. to 4:30 p.m. and contributors of even-numbered papers will be at their posters from 4:30 p.m. to 5:20 p.m.

Contributed Papers

4pPPd1. Auditory-guided reaching movements in the peripersonal frontal space. Florian Dramas (IRIT, Univ. Toulouse 3 - INPT - Univ. Toulouse 1 - CNRS Equipe Diamant, Univ. Paul Sabatier, 31062 Toulouse, France, florian.dramas@irit.fr), Brian F. Katz (LIMSI-CNRS, B.P. 133, 91403 Orsay, France, brian.katz@limsi.fr), Christophe Jouffrais (IRIT, Univ. Toulouse 3 - INPT - Univ. Toulouse 1 - CNRS Equipe Diamant, Univ. Paul Sabatier, 31062 Toulouse, France, jouffrais@irit.fr)

Previous studies on auditory localization processes have shown that humans can localize sound sources accurately, including distance in certain situations. Few studies have examined auditory localization by binaural mechanisms in the peripersonal space. Numerous studies have examined auditory localization through verbal report or various pointing movements. This study examines the precision of hand ″reaching″ movement towards an auditory object. An experimental platform (semicircle, radius 1m) was constructed with 35 small loudspeakers placed under an acoustically transparent grid. Blindfolded subjects were seated within the platform at table height. Test protocol consisted of a brief audio stimulus presented via a single loudspeaker followed by the subject placing their index finger (preferred hand) at the location of the sound object. Optical finger tracking was used during the course of the experiment. Two test variables were investigated: different audio stimuli, Gaussian noise bursts varying the number and the duration of each burst; room acoustic conditions, with and without acoustical damping for reflection suppression. Preliminary results show precision of localization does not grow indefinitely with the number of burst repetitions but reaches a limit. Azimuth precision remains accurate, even with short burst conditions, contrary to the distance perception which increases with the stimuli duration.

4pPPd2. In-situ observation of the perceptive process linked to dashboard tapping sounds. Francois Montignies (Renault Technocentre, FR TCR LAB 252, 1 avenue du Golf, 78288 Guyancourt Cedex, France, francois.montignies@insa-lyon.fr), Valery Nosulenko (Institute of Psychology, Russian Academy of Science, 129366 Moscow, Russian Federation, valery.nosulenko@gmail.com), Etienne Parizet (Laboratoire Vibrations Acoustique, Insa Lyon, 25 bis, av. J. Capelle, 69621 Villeurbanne Cedex, France, etienne.parizet@insa-lyon.fr)

It is well-known that in show-rooms some people might tap on the dashboard of vehicles. The aim of this study was to determine the importance of this phenomenon and to identify which properties of the vehicle are perceived through the sound thus produced. An ethomethodological observation

was conducted to collect data about the action/perception process of a subject exploring a static vehicle. The work was based on the methodology developed by Nosulenko and Saymolenko to evaluate perceived quality using free verbalisations in a comparison task. 52 naive subjects were placed in ecologically valid conditions. Their task consisted in freely exploring two vehicles and selecting their preferred one. From a qualitative analysis of audiovisual recordings, a data base was built. It linked verbalisations, operations and perceived objects, and allowed the quantification of indicators related to activity and perception. The analysis of operations validated that the tapping operation was not anecdotal. Moreover, dashboard was one of the main perceived objects linked to to the auditive dimension. Finally, a significative effect of the tapping operation on the evaluation of dashboard material quality was observed, suggesting an implicite influence of sound on this perceived property.

4pPPd3. Hemispheric Differences in the Recognition of Environmental Sounds. Julio Gonzalez (Universitat Jaume I, Dept. Psicologia Basica, Clinica y Psicobiologia, Campus Riu Sec. Facultad CC. Humanas y Sociales, 12071 Castellon de la Plana, Spain, gonzalez@psb.uji.es), Conor T. McLennan (Cleveland State University, Dpt. Psychology, 2121 Euclid Ave. CB 175, Cleveland, OH 44115, USA, c.mclennan@csuohio.edu)

In the visual domain, Marsolek and colleagues have provided support for their claim that two dissociable and parallel neural subsystems underlie abstract and specific object recognition [Marsolek, 1999; Marsolek & Burgund, 2003]. According to their dissociable subsystems theory, an abstract-category subsystem operates more effectively in the left hemisphere (LH) and is less sensitive to the specific surface characteristics of the stimuli, whereas a specific-exemplar subsystem operates more effectively in the right hemisphere (RH) and is more sensitive to specific stimulus characteristics. In the present study, we tested this hypothesis in the auditory domain by conducting 2 long-term repetition-priming experiments on the recognition of environmental sounds. Participants attempted to identify target sounds from an initial 750 ms sound stem. Target stems were primed by either an identical or a different exemplar sound (e.g., the same or different tokens of a bagpipe). Target stems were presented monaurally in both experiments; however, in Exp. 2 white noise was simultaneously administered to the opposite ear. Our results are consistent with Marsolek's framework. In particular, in both experiments an exemplar specificity effect was obtained when the sounds were presented to the left ear (RH), but not when the sounds were presented to the right ear (LH).

4pPPd4. Perception of speech properties from extremely brief segments. Sue Harding (Sheffield University, Computer Science Department, Regent Court, 211 Portobello St., S1 4DP Sheffield, UK, s.harding@dcs.shef.ac.uk), Martin Cooke (Sheffield University, Computer Science Department, Regent Court, 211 Portobello St., S1 4DP Sheffield, UK, m.cooke@dcs.shef.ac.uk)

A glance at a visual scene enables observers to become rapidly aware of its most important characteristics. Here, we describe experiments using very brief segments of natural speech which demonstrate that a surprising amount of information can be determined from only a few milliseconds of the auditory signal. Segments with durations ranging from 2.5 to 80 ms were extracted from six vowels and six fricatives spoken by males and females. Listeners identified the phoneme and/or gender, or whether a vowel or consonant had been presented. While listeners' performance dropped close to chance for the 2.5 ms stimuli for most tasks, for the vowel/fricative distinction listeners obtained scores above 70% even for such short segments. Listeners performed well above chance for the 10 ms stimuli for three out of four tasks. Combining results within tasks showed that listeners also distinguished voiced from unvoiced phonemes in less than 10 ms. Threshold values from logistic fits indicate the order in which information becomes available: vowel/fricative distinction (3.0 ms), voicing distinction (6.7 ms), phoneme identification (11.9 ms) and gender identification (15.3 ms). By exploiting the ″gist″ of an auditory scene, listeners may be able to deploy prior knowledge rapidly to constrain further interpretation.

4pPPd5. Comparison of headphones and equalization for virtual auditory source localization. David Schonstein (Arkamys, 5 rue Frédéric Bastiat, 75008 Paris, France, dschonstein@arkamys.com), Laurent Ferré (LIMSI-CNRS, B.P. 133, 91403 Orsay, France, laurent.ferre @limsi.fr), Brian F. Katz (LIMSI-CNRS, B.P. 133, 91403 Orsay, France, brian.katz@limsi.fr)

This study investigates the variation in localization performance between different headphone styles. Eight different headphones (including various in-ear, circumaural open and closed, and bone conduction headphones) were tested. In addition, the effect of headphone equalization (aiming to produce an approximately flat frequency response) was investigated. Localization was examined for 24 locations distributed on a sphere surrounding the listener. A single subject participated in the study using a single chosen non-individual HRTF set. Each location was repeated 6 times, resulting in a total of 144 localization reports. Overall, results were relatively consistent for 3 out of the 8 headphones tested. For these headphones, there was no significant difference in lateral angle error, associated with ITD and ILD cues. Polar angle errors, associated with the cone of confusion, however did vary significantly for these headphones. The headphone equalization had varying effects on localization accuracy depending on the headphone. Globally, headphone equalization showed no significant effect on localization accuracy. The results serve as a preliminary investigation, highlighting consistent results for only a select group of headphones tested for effective sound rendering in virtual auditory space. In addition, the results suggest that headphone equalization has a minimal influence on localization accuracy under these conditions.

4pPPd6. Perception of Sound Source Distance and Loudness in a Coherent Field of a Reverberant Field. Yoshifumi Hara (Kogakuin University, 1-24-2, Nishi-Shinjuku, Shinjuku-ku, 185-0012 Tokyo, Japan, kuro5hiron@ymail.plala.or.jp), Yoshinori Takahashi (Kogakuin University, 1-24-2, Nishi-Shinjuku, Shinjuku-ku, 185-0012 Tokyo, Japan, yoshinori@ieee.org), Hiroaki Nomura (Kure National College of Technology, 2-2-11, Aga-Minami Kure City, 737-8506 Hiroshima, Japan, hnomura@kure-nct.ac.jp), Mikio Tohyama (Waseda University, 1-3-10, Bldg. 29-7, Nishi-Waseda, Shinjuku-ku, 169-0051 Tokyo, Japan, m_tohyama@waseda.jp), Kazunori Miyoshi (Kogakuin University, 1-24-2, Nishi-Shinjuku, Shinjuku-ku, 185-0012 Tokyo, Japan, miyoshi@cc .kogakuin.ac.jp)

Perception of reverberant sound field changes with a sound source distance (SSD). This article describes SSD perception in a coherent region close to the sound source in the reverberation field. We performed listening tests for SSD perception and loudness of speech and carried out transfer functions analysis using a reverberant room. We confirm that both SSD perception and loudness are correlated to the standard deviation of the magnitude frequency response of the transfer function in the coherent region. That is SSD erception and loudness increase as SSD becomes long in the coherent region. However loudness decreases in an incoherent region. Consequently, we surmise SSD perception in the coherent region might be due to increase in loudness.

4pPPd7. The influence of pinna position on head-related transfer function. Przemyslaw Plaskota (Wroclaw University of Technology, Wybrzeze Wyspianskiego 27, 50-370 Wroclaw, Poland, przemyslaw.plaskota@pwr.wroc.pl), Andrzej B. Dobrucki (Wroclaw University of Technology, Wybrzeze Wyspianskiego 27, 50-370 Wroclaw, Poland, andrzej.dobrucki@pwr.wroc.pl)

The changes of spectrum of sound at listener ear are one of the major cues for sound source localization. Head Related Transfer-Function (HRTF) describes the influence of torso, head and pinna on sound spectrum. It is possible to recognize HRTF using computational method, e.g. Boundary Elements Method (BEM). The numerical model used for calculation of HRTF is constructed by transfer geometrical shape of head and pinna into numerical domain. Important question during geometry reconstruction process is

the accuracy of shape mapping. The pinna has significant influence on HRFT. In the paper, the influence of accuracy of pinna geometry transformation and pinna position on HRTF is presented. Particularly, the pinna flare angle, pinna rotation angle and position of ear entrance were taking into considerations. Measurements have been done on numerical model with the invariable pinna and head shapes, using BEM method.

4pPPd8. Environmental Enrichment Increases Response Strength And Paired-Pulse Depression Of Auditory Cortex Neurons. Cherie R. Percaccio (Univ. of Texas, 800 W. Campbell Rd, Richardson, TX 75080, USA, cheriep@u.washington.edu), Autumn L. Pruette (Univ. of Texas, 800 W. Campbell Rd, Richardson, TX 75080, USA, autumn.pruette@utsouthwestern.edu), Shilpa T. Mistry (Univ. of Texas, 800 W. Campbell Rd, Richardson, TX 75080, USA, shilpa.mistry@utsouthwestern.edu), Yeting H. Chen (Univ. of Texas, 800 W. Campbell Rd, Richardson, TX 75080, USA, superhelen@gmail.com), Daniel L. Rathbun (Univ. of Texas, 800 W. Campbell Rd, Richardson, TX 75080, USA, dlrathbun@ucdavis.edu), Michael P. Kilgard (Univ. of Texas, 800 W. Campbell Rd, Richardson, TX 75080, USA, kilgard@utdallas.edu)

A wide variety of sensory gating impairments have been associated with autism. Abnormal brain development may alter patterns of interaction between the child and the environment and hinder the acquisition of critical language skills. After several months of therapy, autistic symptoms may subside as children advance to higher cognitive stages. This study modeled the physiological changes associated with therapy-related gains in children by investigating enrichment-induced plasticity in rat auditory cortex. Evoked potential response strength and paired-pulse depression were enhanced by exposure to an enriched environment and degraded by exposure to a standard environment. While neither exercise nor social stimulation, specifically, resulted in any plasticity, rats that heard the enriched environment from a distance also exhibited enhanced responses. The degree of enrichment-induced plasticity was not reduced by a substantial and persistent cholinergic deficit. The finding that enrichment increases response strength and paired-pulse depression in the auditory cortex of rats is consistent with earlier clinical observations, suggesting that proper sensory development is necessary for higher cognitive processes. In the future we will investigate if clinical gains during and after therapy are associated with increased event-related potential discrimination and hemispheric localization of speech stimuli in children with autism.

4pPPd9. Directional loudness measurements for a multichannel system. Densil Cabrera (University of Sydney, Faculty of Architecture, Design and Planning, NSW 2006 Sydney, Australia, densil@usyd.edu.au), Luis Miranda (University of Sydney, Faculty of Architecture, Design and Planning, NSW 2006 Sydney, Australia, lmir9852@mail.usyd.edu.au), Ian Dash (Australian Broadcasting Corporation, Technology Research & Standards, Level 11, Ultimo Building, 2001 Sydney, Australia, Dash.Ian@abc.net.au)

Loudness matching listening tests were conducted to quantify the difference in loudness level from a constant signal played from various horizontal directions. The multichannel system used for this tests was a 5-channel system, set up according to the ITU Recommendation BS.116-1 Methods for the subjective assessment of small impairments in audio systems including multichannel sound systems and the test signals were octave bands of noise with centre frequencies from 63 Hz to 8000 Hz. These tests were conducted as part of ongoing research for the ITU Recommendation BS.1770 Algorithms to measure audio programme loudness and true-peak level. The aim of this experiment is to contribute to the design of a loudness meter by providing channel weightings, and results indicate that listeners are more sensitive to the surround channels than the other channels in the mid and high frequency range.

4pPPd10. Investigating the potential of human echolocation in virtual sonic trigonometry. Flaithri E. Neff (University College Cork, Western Road, IRL Cork, Ireland, fn2@cs.ucc.ie), Ian Pitt (University College Cork, Western Road, IRL Cork, Ireland, i.pitt@cs.ucc.ie)

Describing a mathematical problem often involves visual diagrams. For blind students this accentuates the challenges they face. Projects such as LAMBDA have used linear speech and Braille to convey algebraic equations. However, spatial features, for example in trigonometry, are difficult to map to a linear-based system. Traditional tactile methods (e.g. German film) convey simple shapes but need Braille support and speech-tactile interfaces (e.g. NOMAD) require unconventional equipment. Cognitive issues regarding tactile interpretation of 3D shapes also persist. Blind students interact regularly with speech technology and audio games. This exposure means that the auditory system is potentially becoming accustomed to sonic interpretation of computer-based information. Some of our research has looked at expanding the sonic environment to include spatial information aimed at trigonometry. The next stage is to provide interactive user control. Our system is based on a user interface model in order to consider the cognitive issues involved. We use Microsoft's XNA/XACT environment to create our auditory scene. In this paper we discuss how to implement sonic-based user interaction while further simplifying our auditory scene. In order to achieve this, we examine the potential of human echolocation to orient within the virtual walls and corners of a triangle.

4pPPd11. Toward synthesis tools using 'evocation' as control parameters. Adrien Merer (CNRS-LMA, 31, chemin Joseph Aiguier, 13402 Marseille, France, merer@lma.cnrs-mrs.fr), Mitsuko Aramaki (CNRS - INCM and Université de Provence, 31, chemin Joseph Aiguier, 13402 Marseille, France, aramaki@lma.cnrs-mrs.fr), Richard Kronland-Martinet (CNRS-LMA, 31, chemin Joseph Aiguier, 13402 Marseille, France, kronland@lma.cnrs-mrs.fr), Solvi Ystad (CNRS-LMA, 31, chemin Joseph Aiguier, 13402 Marseille, France, ystad@lma.cnrs-mrs.fr)

This study addresses the design of synthesis tool controlled by high-level parameters, such as mental evocations induced by sounds. As a first approach, we considered sounds evoking motions and we addressed 3 main questions: What are the different categories of motion? What are the common acoustic features of sounds within a category? How to synthesize sounds that evokes specific motions? We gathered samples used by electro-acoustic music composers as a framework for their compositions and synthesized sounds. Then we effectuated a two-steps listening test. The first part aims at determining these different motion categories. It consisted in a free categorization task in which listeners build their own groups of sounds as function of evoked motions. The second part aims at determining a set of sounds characteristic of each of these categories. It consisted in a constrained categorization task with predefined categories represented by prototypical sounds (deduced from free categorization task). We used a feature selection method to highlight most relevant signal descriptors for each category. Finally, designing a synthesis tool implies the calibration of these descriptors (a specific range of values for each category) and their control (leading to address the inverse problem). These aspects are currently being investigated.

4pPPd12. Human recognition by active and passive acoustic signatures. Alexander Ekimov (University of Mississippi, NCPA, 1 Coliseum Drive, University, MS 38677, USA, aekimov@olemiss.edu), James M. Sabatier (University of Mississippi, NCPA, 1 Coliseum Drive, University, MS 38677, USA, sabatier@olemiss.edu)

Recognition of different sensed objects is a problem that often appears in practice. One of the solutions is based on analysis of the signatures of the specific objects. This method was applied for the acoustic detection of walking humans. Human footsteps excite envelopes of broadband acoustic signals in the air due to periodic friction forces between the foot and the ground/floor. The repetition frequency of these envelopes is equal to the footstep rate and usually lies below 3 Hz. High frequencies in these envelopes allow detection and localization of a walker using a narrowband ultrasonic receiver with a high directivity pattern. Consequently, periodic low frequency human motion results in passive ultrasonic detection using this

method. This motion has also unique Doppler signatures and is measured using ultrasonic sonar. Common analyses of passive and Doppler signatures allow the extraction of the specific cadence in human motion and recognition of a human while rejecting other moving or stationary objects. [Work supported by Department of the Army, Army Research Office contract W911NF-04-1-0190].

4pPPd13. Strategic listener movement in a model of auditory distance perception. Yan-Chen Lu (Sheffield University, Computer Science Department, Regent Court, 211 Portobello St., S1 4DP Sheffield, UK, y.c.lu@dcs.shef.ac.uk), Martin Cooke (Sheffield University, Computer Science Department, Regent Court, 211 Portobello St., S1 4DP Sheffield, UK, m.cooke@dcs.shef.ac.uk)

A mobile listener has the potential to exploit dynamic auditory cues to judge sound source distance. One such cue is motion parallax, which employs a sequence of azimuth estimates from interaural time differences to triangulate sound source location. However, distortions due to reverberation and competing sources complicate matters, so it is of interest to know what active strategies listeners might adopt to arrive at robust location estimates. One hypothesis is that not all listener motion trajectories are equally-beneficial for distance estimation. Trajectories designed via certain optimisation criteria might lead to faster and more robust estimates in a wider range of environments. Eight listener motion strategies were tested, from naive approaches such as random walks and head-rotation only to more sophisticated techniques based on sequential Monte Carlo methods. In the latter case, strategies included movement towards the expected source location, or in the most informative direction, or movement reducing overall uncertainty. Evaluation in a simulated acoustic environment with single sources under both anechoic and reverberant conditions demonstrated that moving towards the most likely source location led to the most accurate estimation of distance and subsequent tracking of a moving source. Significant problems remain in estimating distance in multi-source conditions.

Session 4pSAa

Structural Acoustics and Vibration, Computational Acoustics, and EURONOISE: Efficient Boundary Element Methods II (Poster Session)

Ramani Duraiswami, Cochair
University of Maryland Institute for Advanced Computer Studies

Haike Brick, Cochair
TFH Berlin - University of Applied Sciences

All posters will be on display from 3:40 p.m. to 5:20 p.m. To allow contributors an opportunity to see other posters, contributors of odd-numbered papers will be at their posters from 3:40 p.m. to 4:30 p.m. and contributors of even-numbered papers will be at their posters from 4:30 p.m. to 5:20 p.m.

Contributed Papers

4pSAa1. Application of the fast multipole method for solving very large acoustic radiation problems. Raphael Hallez (LMS International, Researchpark Z1, Interleuvenlaan 68, 3001 Leuven, Belgium, raphael.hallez @lmsintl.com), Koen De Langhe (LMS International, Researchpark Z1, Interleuvenlaan 68, 3001 Leuven, Belgium, koen.delanghe@lmsintl .com), Michel Tournour (LMS International, Researchpark Z1, Interleuvenlaan 68, 3001 Leuven, Belgium, michel.tournour@lmsintl.com), Toufic Abboud (IMACS, Ecole Polytechnique, 91128 Palaiseau Cedex, France, abboud@imacs.polytechnique.fr)

Boundary element method is well known and extensively used to solve acoustic radiation problems. It is especially appropriated for exterior radiation since the fluid domain does not need to be meshed, as opposed to the finite element method. However, the mathematical formulation leads to a dense matrix system of equations. Therefore, the size of the model increases drastically as the frequency of analysis increases and huge computer resources are required to solve complex models in the mid-frequency range. The fast multipole method can be used to extend the boundary element model and solve such problems. For a model with N nodes, this technique brings the number of operations down to O(N*LogN) instead of O(N**3) for conventional boundary elements. This new methodology has been applied here to study the acoustic radiation of a complete car in the mid-frequency range. The accuracy of the results as well as the computation time demonstrate the great potential of this new method to solve very large acoustic radiation problems.

4pSAa2. FE-Model Reduction for FE-BE Coupling with Large Fluid-Structure Interfaces. Michael Junge (Institute of Applied and Experimental Mechanics, University of Stuttgart, Pfaffenwaldring 9, 70550 Stuttgart, Germany, junge@iam.uni-stuttgart.de), Jens Becker (Institute of Applied and Experimental Mechanics, University of Stuttgart, Pfaffenwaldring 9, 70550 Stuttgart, Germany, becker@iam.uni-stuttgart.de), Dominik Brunner (Institute of Applied and Experimental Mechanics, University of Stuttgart, Pfaffenwaldring 9, 70550 Stuttgart, Germany, brunner@iam.uni-stuttgart.de), Lothar Gaul (Institute of Applied and Experimental Mechanics, University of Stuttgart, Pfaffenwaldring 9, 70550 Stuttgart, Germany, gaul@iam.uni-stuttgart.de)

For the finite element method model, reduction techniques exist to represent the dynamic behavior of component substructures. Depending on the type of reduction method, the reduction basis contains constraint or attachment modes, which are computed for all structural degrees of freedom on an interface. The interface can either be defined by adjacent substructures or by coupling interfaces to other physical domains, as it is the case for FE-BE coupled systems. A large interface thus leads to an increased size of the reduced order model and limits standard model reduction techniques to applications with small interfaces. In this work, interface reduction methods are investigated. Here, the size of the reduced order model is decreased by reducing the number of retained interface modes, while marginally increasing the reduction error. A direct reduction method based on strain--energy considerations is presented. Additionally, an iterative reduction scheme is pro-