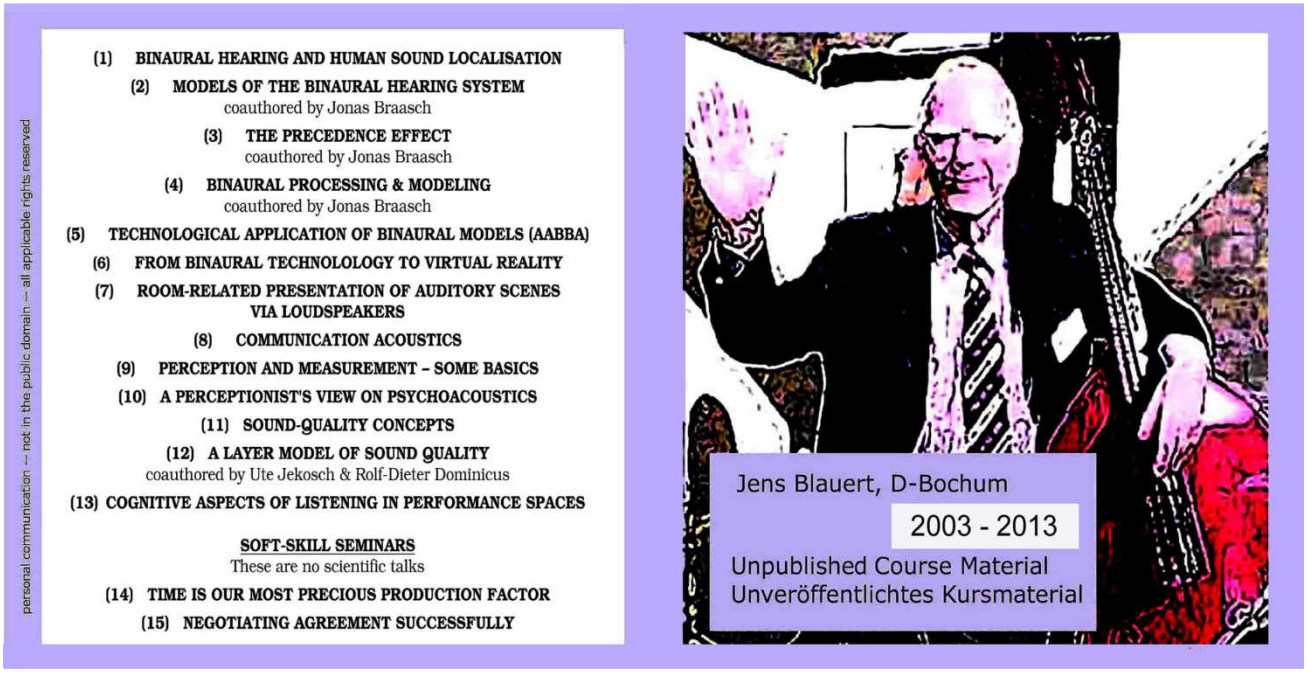

Jens Blauert – Abstracts of Seminars & Talks

Note: Slides, sound tracks (English, German) and additional material for these seminars is available on a DVD. In case of interest, please contact <*jens.blauert@rub.de*>

(1) BINAURAL HEARING AND HUMAN SOUND LOCALISATION

In this lecture a tutorial overview on the basic psychoacoustic facts of sound localisation and binaural signal enhancement is provided. The following fields arel specifically addressed.

- Directional Hearing in the Median Sagittal Plane,
- Directional Hearing with Sounds from Lateral Directions,
- Distance Perception and Inside-the-Head Locatedness,
- Summing Localisation,
- Auditory Precedence,
- The Effect of Interaural Decorrelation,
- Binaural Signal Detection and Suppression of Reverberance.

(2) MODELS OF THE BINAURAL HEARING SYSTEM

Co-authored by Jonas Braasch

Computer models of the signal processing in the human auditory system are a very complex issue but currently quite a number of researcher are active in this field as it relates to number of interesting technological applications. This talk provides an introduction to the field.

- Prominent Features of Binaural Hearing
- Architecture of a Model of Binaural Hearing
- The *Jeffress* Processor
- The *Lindemann/Gaik* Extensions
- Interpreting Binaural Activity
- The Effect of Interaural Incoherence
- Binaural Speech Enhancement
- Problems of Current Binaural Models
- Future Work

(3) THE PRECEDENCE EFFECT

coauthored by Jonas Braasch

The acoustic modality is of paramount importance for human inter-individual communication. Consequently, the human auditory system is highly differentiated and able to perform sophisticated tasks such as the identification, recognition and segregation of concurrent sound sources in acoustically adverse conditions - e.g., in reverberant or noisy environments. To this end the different stages of the system at peripheral, sub-cortical and cortical level act in a coordinated manner.

In this lecture we take the auditory Precedence Effect as an example to discuss the role of the different stages of the auditory system in complex sound-localisation tasks. Further, we consider different strategies of modelling auditory functions.

(4) BINAURAL PROCESSING & MODELING

coauthored by Jonas Braasch

Note: This seminar combines material from (2) & (3)

The human binaural system, although using input from only two sensors, spaced about 14 cm apart, has a number of astonishing capabilities, such as precise localisation of sound sources, analysis of auditory scenes and segregation of auditory streams, suppression of reverberance, noise and colouration, enhancement of desired talkers against undesired ones, providing spatial impression and the sense of immersion. To mimic these capabilities technologically, models of the binaural system using digital signal processing have been built and are constantly being improved. Modern models have a bottom-up, signal- driven part, complemented by a hypothesis- driven, top-down part. The bottom-up part typically contains the following modules: external ears, middle ears and cochleae - further, modules for monaural pre-processing and subsequent binaural processing. The output of the bottom-up part is usually conceptualized as a binaural activity map, which may physiologically be situated at midbrain level.

While the bottom-up part evaluates sound fields regarding the positions and the perceptual attributes of sounds, it takes further processing steps to assign meaning to the binaural activities. To this end a transition from signal processing to symbol processing, following a process of object building, has to be accomplished. Finally, the sets of symbols have to be interpreted by cognitive processes. In this presentation, the current state of the art of models of binaural hearing will be reviewed and their potential regarding practical application will be discussed. Generic application areas are, for example, aural virtual environments, hearing aids, assessment of product-sound quality, room acoustics, speech technology, audio technology, robotic ears and tool for research into auditory physiology and perception. The talk will relate to activities of AABBA, an open international circle of researchers with a special interest in the application of binaural models.

(5) TECHNOLOGICAL APPLICATION OF BINAURAL MODELS (*AABBA*)

AABBA is an intellectual grouping with the goal of collaborating on the application of computational models of human binaural hearing. The grouping has compiled a battery of common software components for setting-up dedicated full-scale binaural models for various technological applications - particularly in areas related to communication acoustics, such as quality assessment of audio channels and loudspeakers as well as rooms for acoustical performances, assessment of disorders of binaural hearing, assessment of speech-understanding capabilities in acoustically adverse surroundings, auditory-scene mapping, assessment of spatial properties of product sounds as well as of the sense of envelopment and immersion, analysis of human spatial hearing in a multimodal world with, for example, the listeners moving in space and/or receiving additional visual and/or tactile cues.

A book with the reports of the first work period of *AABBA* (2009–2013) has been published by Springer under the title: "The Technology of Binaural Listening" (Jens Blauert ed., ISBN 978-3-642-37761-7).

(6) FROM BINAURAL TECHNOLOLOGY TO VIRTUAL REALITY

Virtual Reality (VR) refers to a technology where the sensory input into human beings is generated by computers. As this computer- generated input can be formed to be physiologically adequate, e.g. like sensory input from the real world, immersion and, consequently, the perception of presence can be created for the subjects who are exposed to it.

Binaural Technology is an indispensable enabling technology for Virtual Reality as it lays the foundations for any realistic auditory representation. Consequently, there is hardly an advanced Virtual-Reality system which does not take advantage of Binaural Technology. Binaural Technology, on the other hand, is quite a complex field in itself.

In the lecture basic principles of Binaural Technology are reviewed in the light of their application to Virtual Reality.

(7) ROOM-RELATED PRESENTATION OF AUDITORY SCENES VIA LOUDSPEAKERS

In this lecture, currently available methods for room-related loudspeaker reproduction are presented, critically discussed and compared. A focus is put on their application in Virtual-Reality systems. The following methods are covered:

Stereophony, as based on
- – Amplitude Differences (e.g., *Blumlein*)
- – Additional Time Differences (e.g., *ORTF*)

Surround Sound, as based on
- – Amplitude Panning (e.g., Vector Based, First-Order *Ambisonics*)
- – Holophony (e.g., Higher-Order *Ambisonics*, *Wave-Field Synthesis*)
- – Cue-Selection Procedures (e.g., *DirAC*)

(8) COMMUNICATION ACOUSTICS

Those aspects of acoustics which concern the relations of acoustics to the information and communication technologies are now frequently called "Communication Acoustics". After a short review of the history of this field, relevant results from recent research at the Institute of Communication Acoustics at the Ruhr-University of Bochum, Germany, will be reported.

This work can be seen in the light of the research areas of Computational Auditory Scene Analysis (CASA) and Auditory Virtual Environments (AVE) - both dealing with the parametric representation of auditory scenes. Recent application opportunities and future trends will be discussed.

It will be argued that modern communication-acoustical systems - which are often only embedded components in more complex communication systems - require more and more built-in explicit knowledge. Among other things, the development of such components and systems calls for data and knowledge from the cognitive sciences.

Today's programs for education in communication engineering and communication acoustics do often not yet take sufficient account of this trend.

(9) PERCEPTION AND MEASUREMENT – SOME BASICS

Perceptual objects can be subject to measurement as well as physical objects. To accept this fact one may, however, require a broader definition of measurement than is commonly used in physics. Based on such a broader definition, an introduction to the so-called psychometric methods will be given.

The fundamental ideas behind indirect scaling – as based on nominal and ordinal judgments – and direct scaling – as based on categorical and ratio judgments – will be explained. Some remarks on multi-dimensional analysis and scaling will be included. Further, the problems of individuality and context-sensitivity of psychometric responses will be touched upon.

(10) A PERCEPTIONIST'S VIEW ON PSYCHOACOUSTICS

Psychoacoustics is traditionally based on a world model that assumes a physical world, existing independently of any observer – the so-called objective world. Being exposed to this world, an observer is impinged upon by a variety of stimuli reaching his/her sensory organs. These stimuli, if physiologically adequate, may cause biological transduction and signal processing in the sensory organs and its afferent pathways in such a way that finally a specific excitation of the cortex takes place which results in sensations to appear in the observer's perceptual world. The sensations are understood as being subjective, since they require an observer to participate.

This world model – also known as (objectivistic) realism – reaches its limits when it comes to explaining more complex phenomena of perception. Thereupon, in this paper, an alternative world model is emphasized and applied to psychoacoustics, and is called the perceptionist's model. Like realism, perceptionism has a long tradition in epistemology. It appears to be suitable to improve our understanding of perceptual organization.

(11) SOUND-QUALITY CONCEPTS

It is the aim of the this lecture to make audio engineers and acoustical consultants more aware of the various components and processes involved in the formation of sound quality.

The lecture starts with a criticism of basic psychoacoustics by showing that any assumption of unbiased psychoacoustic quantities is unrealistic. Psychoacoustic perceptual attributes are in fact context and meaning dependent. Results from noise research will be used to demonstrate this in a figurative way.

The second section of the talk points out the position of psychoacoustics in the concert of sciences and arts. Thereby a stringently phenomenal view will be presented in form of a line of arguments that is solely based on actual perception and not on fiction. In this way, the place and role of subjectivity in acoustics and audio engineering will be determined. Virtual reality will be used as an illustrating example.

The third section starts with the introduction of the "character" of sounds and then moves on to different aspects of sound "quality", such as product-sound quality, auditory-scene quality, sound-transmission quality and sound quality as such. Special effort is put into an attempt to discuss the different aspects of sound quality in a concerted way, such as to show that the general procedure in which sound quality is formed is relatively invariant across specific applications. Rather, it is predominantly the character of the references for the quality judgements that requires adaptation to specific applications and users at issue. In this way one arrives at the structure of a model of the processes involved in sound-quality evaluation and assessment that can take subjectivity into proper account. Finally, an architecture for a universal quality recognizer is proposed.

The fourth section deals exemplarily with sound quality in spaces for musical performances. Once again, the question of proper references turns out to be crucial for any further analysis. To this end, a hierarchical order for references based on the amount of abstraction is discussed in some detail. Consequently, efforts are to be taken to explore and assess these references systematically. Issues like typicalness, functional adequacy, aesthetic form, and tradition are touched upon.

(12) A LAYER MODEL OF SOUND QUALITY

Co-authored by Ute Jekosch & Rolf-Dieter Dominicus

Sound-quality is a multi-layered phenomenon. In the current lecture it is attempted to order the layers from the point of view of perceptionism. Perceptionism states that the world - including the aural world - is exclusively constituted by the totality of what is consciously perceived. In this contribution we start with discussing a categorization of the world into things, feelings and thoughts. As to the thoughts (ideas, concepts, notions) a focus is put on layers of different degree of abstraction (individual concepts, collective concepts and final concepts). Based on this subdivision, a layer model of "sound quality" is proposed.

According to the different degree of abstraction, different sets of references and different evaluation and assessment methods are to be employed. The following quality layers are identified: auditive quality, aural-scene quality, acoustic quality and aural-communication quality. Auditory quality is concerned with basic psychoacoustic attributes, aural-scene quality includes the processes of object formation (incl. Gestalt rules), acoustic quality deals with the physical aspects, that is, mechanical waves and vibrations in elastic media - as far as they are correlated with auditory events. Aural-communication quality, finally, aims at the function of auditory events and series of auditory evens as sign carries and, such, as elements of communication.

(13) COGNITIVE ASPECTS OF LISTENING IN PERFORMANCE SPACES

The so-called "Quality of the Acoustics" is an important determinant of how we are listening in performance spaces. Although the term of often used both in science and in practice, it is often not well defined. A closer look shows, however, that the quality of the acoustics is a complex and multi-layered phenomenon. When analyzing or modeling the formation process of the quality of the acoustics, a variety of quality elements and quality features have to be taken into account, whereby the actual relevance and salience of each of them is situation and user specific.

In this lecture we present the architecture of a general conceptual model of the quality-formation process and identify an adequate system of classes of references involved, thereby considering aspects of psychoacoustics, sensory psychology, physics, and the information sciences. Effort will be put into an attempt of discussing the different aspects of sound quality in a unified way, such that the general concept of acoustics quality does not change due to a specific application or a specific listener. Rather, it is only the frame of reference that has to be adapted specifically to a particular application. Some frequent problems regarding the identification and specification of proper references are discussed in detail. The issue of objectivity will be considered in this context.

The discussion of the model will reveal its cross-cultural, universal validity, making it a proper conceptual framework for ordering and analyzing the elements of the quality of the acoustics in a broad range of performance spaces from the ancient ages up to modern times.

SOFT-SKILL SEMINARS

(14) TIME IS OUR MOST PRECIOUS PRODUCTION FACTOR

– A Time-Management Report –

Note: This is not a scientific talk

PhD students have the task of reaching a clearly-defined goal within a time span of a few years, namely, being successfully promoted to a doctoral degree. This goal requires a considerable amount of self organization.

In this talk, different methods will be analysed that the author's doctoral students have employed intuitively to this end. These methods will be compared to those which experts of professional time management recommend and teach, such as effective goal setting and proper development of prioritized to-do-lists and work schedules. Bad habits like over-scheduling and procrastination will be analysed and methods to overcome them suggested. Consequences for effective supervision of doctoral work will be discussed.

(15) NEGOTIATING AGREEMENT SUCCESSFULLY

Note: This is not a scientific talk

The Harvard Negotiation Project started in the 1970ties and deals continually with all levels of negation and conflict resolution. It offers a number of very practical advices for this purpose, such as:

- Separate people from the problem
- Focus on interests, not positions
- Work together to create options that will satisfy both parties
- With people, who are more powerful, refuse to play by the rules or resort to "dirty" tricks

In the seminar, after an introduction to the basics of the method, application of these are discussed and further advices considered.

READING THE WORLD WITH TWO EARS

(ADDENDUM 2017 LONDON ICSV))

Modern communication-acoustical systems – now often realized as embedded components in more complex communication systems – contain an ever growing amount of built-in explicit knowledge as well as the capability of autonomous-learning. In other words,

Communication Acoustics Gets
Cognitive!

In this context, current results from the EU-Project TWO!EARS (ICT-618075) are reported here. In a model of binaural listening, which the project has built, elements of linear binaural auditory signal processing are augmented by several feedback loops and by cognitive components that represent ground-truth knowledge and enable built-in learning algorithms. In one of the demonstration scenarios of the project, a robot analyses a search-and-rescue scene with multiple active sound sources, identifies and localizes potential victims in it and, subsequently, performs appropriate rescue actions.