AES 36th INTERNATIONAL CONFERENCE

Automotive Audio—Sound in Motion

	Tuesday, June 2nd	Wednesday, June 3rd	Thursday, June 4th	
08:30	Registration	Registration	Registration	
09:00	**Opening Remarks and Keynote Address**	**Objective and Subjective testing and evaluation**	**Volume and Equalization processing for the Automotive Environment** -Panel Discussion-	
09:30				
10:00				
10:30	Coffee Break / Demonstrations	Coffee Break / Demonstrations	Coffee Break / Demonstrations	
11:00	**Safety, Systems and Signal Processing**	**Very small room acoustics**	**The Art and Science of Automotive Audio Evaluations** -Panel Discussion-	
11:30				
12:00	Lunch / Demonstrations	Lunch / Demonstrations	Lunch / Demonstrations	
12:30				
13:00	**Systems Integration**			
13:30		**Signal Processing** **Multi-Channel Sound**		
14:00			**In-Vehicle Technology Demonstrations** **Free to attend, Open to all** **Location Ritz-Carlton Car Park**	**Tutorial Ported Loudspeakers**
14:30				
15:00	Coffee Break / Demonstrations			
15:30	**Amplifiers, Loudspeakers and Microphones**	Coffee Break / Demonstrations		**Tutorial Common Autosound Errors**
16:00		**Signal Processing Hands-Free and Active Noise Cancellation**		
16:30				**Tutorial Spatial Hearing**
17:00				
17:30		**Reception**		
18:00	**Reception / Light Dinner**			
18:30				
19:00		**Banquet**	Both the In-Vehicle Technology Demonstrations and Tutorial Sessions are open to non-conference attendees at no charge	
20:00				

TECHNICAL SESSIONS

Tuesday, June 2 **9:00 am**

OPENING REMARKS AND KEYNOTE ADDRESS

Opening Remarks—Alan Trevena

Keynote Address—William M. Hartmann

"Sound Localization—Multiple Modes in the Auditory System"

Tuesday, June 2

PRODUCT DEMONSTRATIONS

Exhibitors will give product demonstrations and discuss their services and technologies throughout the entire conference.

D-1 DLC Design

DLC Design presents the Perceptual Transfer Function Measurement System (PTF). The company offers a series of one day seminars on listening technology, surround sound, car audio tuner secrets, car audio system design, and psychoacoustics. Services include audio performance reports for automotive audio systems, measurement system design, and loudspeaker drive unit design.

D-2 G.R.A.S.

Products include a broad range of standard measurement microphones and preamplifiers (designed and manufactured in accordance with international standards) and a wide range of specialized transducers and accessories for specific applications such as sound intensity microphones, artificial ears, ear and mouth simulators, telephone-testing equipment, HATS, pistonphones, and calibrators.

D-3 Payton Group

Payton is an international group of companies handling and promoting magnetic components, with sales offices and plants in Israel, Europe, the United States, and the Far East. As a global leader of both conventional and planar transformers, with more than 15 years of research and development experience, Payton offers a wide range of custom-designed products that meet all the requirements and standards for a variety of specific product applications.

D-4 Prism

Prism Sound, a manufacturer of audio test solutions for acoustic and electronic applications is presenting a new lower-cost, analog-only version of its groundbreaking dScope Series III audio analysis platform. Demonstrations include simultaneously testing audio performance and RDS functionality of an FM receiver using the dScope analyzer to generate a stereo multiplexed signal incorporating multitone test signals and encoded RDS data.

Tuesday, June 2 **11:00 am**

PAPER SESSION 1: SAFETY, SYSTEMS, AND SIGNAL PROCESSING

1-1 Designing Interior Audio Cues for Hybrid and Electric Vehicles—*Diana Siwiak, Frankie James*, GM Advanced Technology Silicon Valley Office (ATSVO), Palo Alto, CA, USA

The advent of new propulsion technologies (e.g., hybrid, plug-in hybrid, fuel cell, and electric) changes the vehicle noise signature dramatically. Traditional powertrain sounds disappear and new sounds become audible, including those from alternative propulsion systems, power converters, and from the car's structure itself due to road noise, tire sounds, and vibration from the body frame. In the face of such developments, feedback to the driver regarding vehicle state is greatly changed, which may cause confusion and frustration. Our work explores the addition of sound cues to a vehicle's interior environment to increase drivers' aural feedback for states such as "ready to go," "systems off," and "alert." We discuss the design and evaluation of such cues for an electric vehicle and relate this to background research in the areas of psychoacoustics, sonic branding, and auditory interfaces.

1-2 Digital Audio Watermarking with Semi-Blind Detection for In-Car and Domestic Music Content Identification—*Ron Healy, Joe Timoney*, National University of Ireland, Maynooth, Co. Kildare, Ireland

Recent developments in audio watermarking techniques have gone some way toward promoting an industry-wide acceptance of digital audio watermarking as a process that will eventually be used in all audio (and video) production. The predominant focus of such watermarking research has been in the area of content protection, because the prevention of illegal copying is an area of concern for content owners. However, digital audio watermarking may also be used for other purposes, such as the added-value option of real-time content identification of music. While computer-based users of music enjoy the opportunity to identify unknown audio using online tools, identification of audio in an offline domestic or in-car scenario is not so easily achieved. This paper discusses an area of digital audio watermarking that would facilitate real-time in-car identification of the artists, title, and/or other meta-data relating to music being broadcast by radio.

Tuesday, June 2 **1:00 pm**

PAPER SESSION 2: SYSTEMS INTEGRATION

2-1 MOST—The Audio/Video Backbone of the Car—*Henry Muyshondt, Clif Sanchez*, SMSC, Austin, TX, USA

MOST—Media Oriented Systems Transport—is used in several million vehicles from car makers such as Audi, BMW, Daimler, Toyota, Hyundai/Kia, and others; and been established as the de-facto standard for multimedia networking in vehicles. MOST is a synchronous network that can also carry asynchronous and isochronous data streams. It supports copy protection so that it can carry commercial content such as that stored on DVD or Blu-ray discs. MOST defines a physical layer as well as a software framework for interconnecting multimedia devices. At the physical layer, MOST includes channels for synchronous streaming, as well as mechanisms for transporting data that is not synchronous with the network. The latest generation even includes an Ethernet channel that allows MOST to provide an automotive-grade Ethernet physical layer that runs in parallel with the other channels, and support for Discrete Frame

Isochronous channels that tunnel asynchronous clocks along with the data. MOST also includes a real-time control channel. The synchronous nature of MOST results in very low clock jitter between devices connected to it. Buffering and sample rate conversion are not required for signals at the network sampling rate. Isochronous mechanisms allow signals at different sampling rates to be transmitted too. Deterministic delays and low latency connections enable MOST to be used for real-time audio/video (A/V) applications. This paper describes MOST, its high level features and a system based on its technology.

2-2 Retention of Factory Rear-Seat Entertainment/ Video Systems When Replacing the Factory Head Unit—*Christopher Pearson*, Best Buy Corporate, Richfield, MN, USA

The retention of factory (OEM) rear-seat mobile video systems is an important concern when replacing the factory head unit with an aftermarket one. There are a number of different factory video systems, and the degree of communication between factory head unit and video controller varies greatly. Although this discussion is not likely to be on the radar of most AES members, it just might prove interesting to some to see the different methods the aftermarket uses to overcome the challenges supplied by automakers. As the implementation of vehicle data buses becomes more common and further ingrained in vehicle electronics, the need to integrate into them properly becomes crucial. Data systems like Controller Area Network, LAN, and msCAN all present similar, yet also different, difficulties to communicate with. It's often found a factory video system will not even turn on after removal of its factory head unit. The first consideration is how to send the appropriate "turn on" signal to the video system. Sometimes the video systems need only to see a 12V (or sometimes 5V) turn on signal on one particular wire to activate, other times there is a data signal controlling the turn on action. Many vehicles require completely ad hoc solutions, often involving the relocation and rewiring of the factory head unit. While this may seem an intimidating modification to many, the wiring is entirely straightforward. There are also applications popular enough to have aftermarket parts available which communicate to the vehicle's data bus directly.

2-3 Mobile Internet Audio: A Report on the State of Technology—*Kevin Heber*, Panasonic Automotive Systems, Southfield, MI, USA

Given recent trends in wireless communication toward broader coverage and higher downlink speeds, we must consider that wireless data, and in particular the ubiquitous availability of the Internet to the mobile consumer, will begin to eclipse the significance of other audio sources in the mobile environment, and will eventually render optical media, AM/FM, HD/DAB, and satellite radio obsolete.

2-4 Latest Developments in Low Bit-Rate and High-Quality Multichannel Automotive Audio—*Marc Gayer*,[1] *Robert Bleidt*[2]
[1]Fraunhofer Institute for Integrated Circuits, Erlangen Germany
[2]Fraunhofer USA Digital Media Technologies, San Jose, CA, USA

In 2006, the ISO/MPEG standardization group finalized the MPEG Surround specification that allows for efficient and backward compatible compression of high-quality multichannel sound using parametric coding techniques. Since then the MPEG Surround standard has been included in a number of digital broadcast standards as the multichannel audio codec of choice and its use in electronic music distribution and media players is underway. This paper summarizes the technical background of MPEG Surround and discusses its use in digital broadcast systems with a special focus on automotive applications such as car radio receivers, rear seat entertainment, and portable music player docking stations in the car.

Tuesday, June 2 3:30 pm

PAPER SESSION 3: AMPLIFIERS, LOUDSPEAKERS, AND MICROPHONES

3-1 Active Electromagnetic Interference Cancelation for Automotive Switch-Mode Audio Power Amplifiers—*Arnold Knott*,[1,2] *Gerhard Pfaffinger*,[1] *Michael A. E. Andersen*[2]
[1]Harman/Becker Automotive Systems GmbH, Straubing, Germany
[2]Technical University of Denmark, Lyngby, Denmark

Recent trends in the automotive audio industry have shown the importance of active noise cancelation (ANC) for major improvements in mobile entertainment environments. These approaches target the acoustical noise in the cabin and superimpose an inverse noise signal to cancel disturbances. Electromagnetic interference between switch-mode audio power amplifiers and receivers show the same physical obstacle as the described ANC endeavors are targeting. The principle of active electromagnetic interference cancelation (AEC) is derived in this paper on a theoretical basis with verifications in simulation and experiment. The resulting switch-mode audio power amplifier of this experiment keeps its high efficiency and is able to deliver the signal with less than 0.1 percent distortion, while improving the source of electromagnetic interference by 15 dB.

3-2 A Fully Digital Single Chip 4x100w Class D Amplifier with High Immunity to the Demodulation Filter Effects—*Pietro Adduci*,[1] *Edoardo Botti*,[1] *Giovanni Gonano*,[1] *Enrico Dallago*,[2] *Giuseppe Venchi*[2]
[1]STMicroelectronics, Milan, Italy
[2]University of Pavia, Pavia, Italy

Nowadays, high energetic efficiency is a key requirement for both integrated circuits and electronic systems. This is particularly true for automotive applications, since the amount of electronics inside a vehicle is constantly growing. This trend is expected to strengthen with the spread of hybrid and electrical vehicles, hence the effort to improve efficiency in this field is well justified. This paper presents a single chip, 4x100 W BTL, Class-D audio amplifier based on PWM modulation. The high integration level and the on-board signal processing allow excellent audio performances to be achieved, with a dynamic range of about 108 dB and a total harmonic distortion of about 0.03 percent. Thanks to the digital signal input and a feedback strategy in the power stage that makes the amplifier robust with respect to the output filter non-idealities the number and size of the external components is minimized. A number of features were also included to reduce EMI, making the system compliant with the stringent limits typical of automotive applications. These characteristics altogether mitigate the drawbacks of Class-D amplifiers and favor its diffusion.

3-3 Spatial Harmonic Analysis of Unidirectional Microphones for Use in Superdirective Beamformers —*René Derkx*, Philips Research Laboratories, Eindhoven, The Netherlands

In hands-free communication for automotive applications, a lot of diffuse-noise is present in the microphone signal, originating from the wind, engine, and tires. This results in a microphone signal that has a very poor signal-to-noise ratio (SNR), even when the microphone is placed relatively close to the speaking person. To enhance the SNR, microphone arrays with superdirective beamforming techniques can be applied. Second-order superdirective beamformers can be constructed by using at least two closely spaced unidirectional microphones in end-fire configuration, where the wavelength of interest is much larger than the spacing of the array. However, in this case, it is very important that the polar responses of the individual microphone elements are closely matched in both magnitude and phase, especially in the lower frequency-range. In this paper we introduce a technique based on a spatial harmonic decomposition of the polar response of individual unidirectional microphone elements and propose a strategy to match multiple elements.

3-4 An Ironless Large Displacement Flat Piston Loudspeaker—*Mathias Remy*,[1,2] *Guy Lemarquand*,[1] *Gael Guyader*,[2] *Bernard Castagnede*[1]
[1]Laboratoire d'Acoustic de l'Universite du Maine, Le Mans Cedex, France
[2]Technocentre Renault, Guyancourt, France

This paper presents a small wideband loudspeaker. Particular efforts have been made to reduce the nonlinearities of the loudspeaker as much as possible. The motor structure is completely ironless, the elastomer suspensions are replaced by ferrofluid seals and a monobloc carbon foam piston substitutes the traditional conic membrane. The circular radiating surface, which is flat, has a radius equal to only 2 cm. Therefore, in order to obtain a sufficient sound pressure level at low frequencies, large displacements of the piston are necessary. After a detailed description of each part of the loudspeaker, theoretical results of the expected performances of this transducer are given.

Wednesday, June 3

PRODUCT DEMONSTRATIONS

Product demonstrations run throughout the conference.

Wednesday, June 3 9:00 am

PAPER SESSION 4: OBJECTIVE AND SUBJECTIVE TESTING AND EVALUATION

4-1 Ensuring Accurate Playback and Analysis of Binaural Recordings for Automotive Sound Systems—*Dan Foley*,[1] *Christopher J. Struck*[2]
[1]Foley & Associates, Marlborough, MA, USA
[2]CJS Labs, San Francisco, CA, USA

Binaural recording and playback technology has enabled audio engineers to make great improvements in automotive sound system performance without incurring the expense and time of continuously developing and refining physical prototype systems. However when analyzing binaural recordings using listening panels or frequency analysis instrumentation, care should be taken to ensure the binaural recording and its rendering accurately convey the spatial and frequency content of the automotive sound system. This paper is intended for those new to the field and outlines issues associated with binaural recording and headphone-based playback systems and how to account for HRTF variations of humans compared to those of binaural recording manikins.

4-2 Whole-Body Vibration Associated with Low-Frequency Audio Reproduction Influences Preferred Equalization—*William Martens*,[1] *Hideki Sakanashi*,[1] *Wieslaw Woszczyk*,[1] *Sean E. Olive*[2]
[1]McGill University, Montreal, Canada
[2]Harman International Corp., Northridge, CA, USA

This study investigated the influence of whole-body vibration (delivered via the floor and the seat on which participants were situated) on preferred equalization for binaural recordings of musical sound reproduced via an automotive audio system. It was hypothesized that low-frequency musical sound signals (below 80 Hz) reproduced as structural vibration would shift an observer's preferred level of low-frequency sound in the binaurally-captured automotive audio reproduction. To test this hypothesis, an adaptive staircase method was used to track preferred levels of low-frequency audio reproduced binaurally via headphones in two different vibration conditions, nominally termed high-vibration and low-vibration (the latter being 12 dB lower than the high-vibration level). Data from 6 observers showed that preferred levels for headphone-delivered low-frequency audio signals were reduced as vibration levels were increased for all 4 musical programs tested. The results of this study imply that such vibration should not be ignored in future use of binaural simulation for the evaluation of automotive audio reproduction.

4-3 Validation of a Binaural Car Scanning Measurement System for Subjective Evaluation of Automotive Audio Systems—*Sean Olive, Todd Welti*, Harman International Corp., Northridge, CA, USA

The paper reports the results of a series of validation listening tests aimed at measuring the accuracy of a proprietary binaural car scanning (BCS) system. Trained listeners gave preference ratings for different equalizations of an automotive audio system auditioned both in situ (in the car) and through a calibrated binaural car scanning measurement and playback system. The two playback methods produced essentially the same results for mono, stereo, and multichannel playback conditions. The results show evidence that a properly calibrated BCS system can produce accurate and valid measurements of automotive audio sound quality with the added benefits that they are better controlled than conventional in situ tests.

Wednesday, June 3 11:00 am

PAPER SESSION 5: VERY SMALL ROOM ACOUSTICS

5-1 Approach to Sound Field Analysis and Simulation Inside a Car Cabin—*Michael Strauß*,[1,2] *Johannes Nowak*,[1] *Diemer de Vries*[2]
[1]Fraunhofer Institute for Digital Media Technology, Ilmenau, Germany
[2]Technical University Delft, Delft, The Netherlands

This paper focuses on the use of spatial sound field analysis methods for acoustical investigations inside small enclosures. A measurement-based approach is

proposed for evaluating the sound propagation process within automotive spaces. Therefore the impulse responses of distinct loudspeakers were recorded at a dense microphone grid. At first the reliability of the recorded impulse response data set is checked, measurement error sources are identified, and a compensation of temperature drift, which can occur in practice during the measurement task, is described. Applying these corrections provides an improved multichannel impulse response data set which is now ready to use for further investigations. Some examples of the results of a time domain simulation, based on these measurement data sets, are discussed.

5-2 Virtual Development of Mercedes Premium Audio Systems—*Alfred Svobodnik*,[1] *Gabriel Ruiz*[2]
[1]Harman International, Vienna, Austria
[2]Harman International, Bridgend, Wales, UK

This paper deals with the virtual development of automotive audio systems. A framework and process flow for digital prototyping of loudspeakers, packaging, and the in-situ situation in the car cabin is presented. Finally the audio system, solely described by computer models, is virtually tuned and auralized long before a single piece of hardware exists. This digital model of an automotive audio system is achieved by extensive use of matrix methods, especially finite and boundary element methods and finite difference schemes as well. First we will give a short overview about the theory of the numerical methods used for such predictive engineering tasks. However, the main focus is to show typical applications. So we will then describe the modeling of loudspeakers, modeling of the packaging situation (i.e., built-in situation of the loudspeaker in the car, interaction with enclosures), and a full system model simulating the radiation of loudspeakers into the car cabin. Finally we will present the auralization of such an audio systems by means of a binaural playback system. Additionally we will make some remarks on the business benefits of these methods and we will also address uncertainties in our simulation model which are inherent to every modeling approach.

Wednesday, June 3 1:30 pm

PAPER SESSION 6: SIGNAL PROCESSING: MULTICHANNEL SOUND

6-1 Automotive Audio Equalization— *Stefania Cecchi*,[1] *Lorenzo Palestini*,[1] *Paolo Peretti*,[1] *Francesco Piazza*,[1] *Ferruccio Bettarelli*,[2] *Romolo Toppi*[3]
[1]Università Politecnica delle Marche, Ancona (AN), Italy
[2]Leaff Engineering, Porto Potenza Picena (MC), Italy
[3]FAITAL S.p.a., S. Donato Milanese (MI), Italy

In the last several years, automotive audio applications have been receiving increasing interest: due to traffic congestion and growing distance from home to the workplace, a car is nowadays the most used audio listening environment. In this context, audio equalization is a relevant and challenging issue because the car cockpit is far from being an ideal listening environment. In this paper a valid approach comprising fixed and adaptive equalization (implemented on a PC platform) is presented, offering a custom graphical user interface the user can interact with. To validate the proposed approach, the system has been installed inside a real car with professional audio equipment. Simulated and real in-car tests have been performed and their results will be reported.

6-2 The hArtes CarLab: Hardware Implementation and Algorithm Development —*Francesco Piazza*,[1] *Stefania Cecchi*,[1] *Lorenzo Palestini*,[1] *Ariano Lattanzi*,[2] *Ferruccio Bettarelli*,[2] *Francois Capman*,[3] *Simon Thabuteau*,[3] *Christophe Levy*,[4] *Jean-Francois Bonastre*,[4] *Romolo Toppi*[5]
[1]Università Politecnica delle Marche, Ancona (AN), Italy
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[4]Université d'Avignon et des Pays de Vaucluse, Avignon, France
[5]FAITAL S.p.a., S. Donato Milanese (MI), Italy

In the last decade Car Infotainment Systems (CIS) have been gaining great attention by the scientific and industrial community: in this context, within the European hArtes Project, an advanced CIS (ACIS) has been designed. The system offers several functionalities employing professional audio equipment and PCs able to manage different I/O audio channels and to provide a large computing capability for complex audio algorithms. The overall architecture is based on NU-Tech platform that manages the whole system from professional equipment to audio streaming and processing. The system has been therefore devised as a real audio laboratory (hArtes CarLab) for audio algorithm exploration and validation, providing a remote access to all the system functionalities. In this paper starting from the hardware description, a complete set of algorithms to enhance audio reproduction, hands-free communication, and interactivity through speaker and speech recognition features is discussed in relation to the NU-Tech framework.

6-3 Sound Field Control Using a Limited Number of Loudspeakers—*Mathias Johansson, Lars-Johan Brännmark, Adrian Bahne, Mikael Sternad*, Dirac Research AB, Uppsala, Sweden

We treat the problem of optimizing N digital filters for a sound system consisting of N loudspeaker inputs and M measurement output positions, with the objective of creating a target sound field described by M prescribed transfer functions, one for each measurement position. We pose the problem in a control-theoretic framework, with the main interest on practical car audio systems, i.e., where $N << M$. The solution is verified in listening experiments and by objective means. It is shown that the proposed framework provides a unified solution to the problem of equalizer design, crossover design, delay, and level calibration, sum-response optimization, and up-mixing (the process of routing 2-channel or 5.1-channel source material to N loudspeaker outputs).

6-4 PC-Based Prototyping of Audio Applications Using Model-Based Design—*Mark Corless*,[1] *Arvind Ananthan*[2]
[1]The MathWorks, MI, USA
[2]The MathWorks, MA, USA

Personal computers (PCs) are increasingly being used as the primary development environment for creating,

designing, and simulating audio algorithms and complete audio systems with live inputs from multichannel audio devices. In this paper we show how audio algorithms can be designed and simulated in a textual and graphical modeling environment for a PC. These models interface with typical multichannel audio devices through PortAudio, which enables communication with standard audio interfaces, such as Direct Sound, WDM-KS, and ASIO. The paper further delves into some typical challenges that engineers face when working with a live multichannel audio algorithm simulation, namely, channel synchronization, dropped frames, and latency issues. We also demonstrate a technique for minimizing and measuring roundtrip latency. We used three sets of audio device hardware for our experiments—Behringer UCA202, M-Audio Delta 66, and M-Audio Firewire 410—to stream live audio through the simulation model. The example used throughout this paper is an automatic gain control algorithm that is modeled using a combination of Simulink, Signal Processing Blockset, Stateflow, and Embedded MATLAB code. Prototyping in this environment can enable designers to explore ideas and verify the correctness of their design early in the design cycle, thus reducing design iterations during the final stages where problems are typically more expensive to resolve.

Wednesday, June 3 **4:00 pm**

PAPER SESSION 7:
HANDS-FREE AND ACTIVE NOISE CANCELLATION

7-1 Talk-and-Push (TAP) – Toward More Natural Speech Dialog Initiation—*Balázs Fodor, David Scheler, Suhadi Suhadi, Tim Fingscheidt*, Technische Universität Braunschweig, Braunschweig, Germany

Speech dialog system users often times issue their commands before or during push-to-speak (PTS) button use. This leads to degraded system performance already in the first turn. We propose a system called talk-and-push (TAP) that allows the user to start talking before or after pushing the PTS button, as is common when tapping on someone's shoulder. An acoustic echo cancellation optimized for in-car use reduces FM radio echoes, so that no muting of the FM radio signal is necessary. A notch filter to remove the beep, buffering of the speech signal, and an intelligent noise robust voice activity detection that signals the start of utterance to the automatic speech recognizer are further core components of our proposed system. Significant word error rate improvements vs. state of the art with muted FM radio signals are reported.

7-2 Wideband Speech Communications: The Good, the Bad, and the Ugly—*Scott Pennock, Phil Hetherington*, QNX Software Systems (Wavemakers), Vancouver, British Columbia, Canada

Traditionally, speech communications over a telephone network has been narrowband (300–3400 Hz). However, the historical reasons for transmitting narrowband no longer apply to today's digital networks. Wideband (50–7000 Hz) speech communications is coming online, and it is just a matter of time before it becomes the most common way to communicate. Wideband speech has a lot of "good" to offer. It can increase intelligibility/comprehension, reduce driver distraction, create a better "sense of presence" (that is, sound more like face-to-face conversation), make it easier to identify the far-end talker, and help enable spatial auditory displays. Unfortunately, wideband speech also has the potential for some "bad." People are more sensitive to wideband echo, and some echo cancellers may have a harder time with these signals. Noise is also more of an issue, since extending the frequency range allows more noise to be transmitted and users are more sensitive to this additional noise. To address these potential issues, vehicle platforms will require good electro-acoustic design, as well as high-performance acoustic echo cancellation (AEC) and noise reduction (NR) algorithms. There is also the "ugly." The switch to wideband won't happen overnight and a long transition period will likely ensue. Neither the standards community nor the telecommunications industry has addressed interoperability issues with existing narrowband systems—issues such as maintaining consistent loudness and quality over mixed connections. Bandwidth extension techniques will become even more important in mixed connections. This paper will review the benefits, challenges, and unresolved issues with wideband speech communications in an automotive environment.

Thursday, June 4 **9:00 am**

PANEL DISCUSSION 1

Volume and Equalization Processing for the Automotive Environment–*Richard Stroud*, Stroud Audio (chair), *David Clark*, DLC Design, *Robert Klacza*, Chrysler LLC, *Tim Nind*, Harman Becker Automotive Systems, *Tom Nousaine*, Listening Technology

The automotive listening environment is typically degraded by noise. Listening to music in the presence of noise can be enhanced by processing methods including volume-compensated bass boosting and noise-controlled volume compression. The workshop will discuss these and other methodologies developed to deal with vehicle noise.

Thursday, June 4 **11:00 am**

PANEL DISCUSSION 2

The Art and Science of Automotive Audio Evaluations–*Kristina Busenitz*, PMMR Solutions (chair), *Sean Olive*, Harman International, *David Clark*, DLC Design, *Michael Karesh*, TrueDelta

A great deal of attention has been spent over the course of the past few years on the robustness of our sound quality subjective evaluation tests, methods that we use, and types of listener panels. But there has been little attention focused on the appropriate ways to use the outcome of testing information, whether it is by trained listening panels, individuals, or consumers. Presenters in this workshop will share academic and industry experience in how our data is used and should be viewed by the automotive industry. Time will be allotted for discussion by attendees and panelists.

Thursday, June 4 **2:00 pm**

IN-VEHICLE DEMONSTRATIONS

Free to all attendees. At Ritz Carlton Car Park.

V-1 Fraunhofer

Fraunhofer's demonstration will feature MPEG Surround, the new ISO standard delivering iPod-compatible, high-quality surround sound at stereo bit-rates. MPEG Surround is a part of many new digital broadcasting standards and also offers consumers the opportunity to stream or download music or movies in surround. In the car, attendees will have the chance to compare MPEG Surround at 64 or 320 kb/s to the original recordings, and also to hear the MPEG Surround binaural mode over ordinary earphones using Fraunhofer's iPhone app.

V-2 Harman International

Harman will present the Hyundai Genesis with the Lexicon 7.1 Discrete Premium Surround Sound System.

V-3 Listening Technology

Tom Nousaine will present a current model vehicle exhibiting common tuning errors. This demonstration will be featured in the tutorial Common Autosound Errors.

Thursday, June 4 **2:00 pm**

TUTORIALS

Free to all attendees. These will held in the lecture room and run in conjuction with the in-vehicle demos.

T-1 PORTED LOUDSPEAKERS–*Mark Navarre*, Automotive Multimedia Solutions

T-2 COMMON AUTOSOUND ERRORS–*Tom Nousaine*, Listening Technology

T-3 SPATIAL HEARING–*James "JJ" Johnson*, DTS Neural

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Papers Chair: **John Stewart**, Harman International
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