



AES 2017 International Conference on Automotive Audio

Dates: September 8th-10th, 2017

Location: Burlingame, San Francisco, CA, USA

Friday, September 8	
8:00 AM	Conference Registration Open [Regency Foyer] Demo & Exhibition Open - Regency Ballroom [All Day]
8:15 AM	
8:30 AM	
8:45 AM	
9:00 AM	<u>Opening Comments</u> [Harbour Room] Conference Chairman: Dr. Alfred J. Svobodnik (MVOID Group)
9:15 AM	<u>Keynote 1:</u> [Harbour Room] Armin Prommersberger, Chris Ludwig (Harman) In Car UX – the Deep Immersion Experience Far Beyond Sound
9:30 AM	
9:45 AM	
10:00 AM	Morning Coffee [Regency Ballroom]
10:15 AM	
10:30 AM	<u>Paper Session 1:</u> [Harbour Room] Sound Reproduction in Cars - Spatial/Spectral (Part 1) Virtual Acoustics
10:45 AM	
11:00 AM	
11:15 AM	
11:30 AM	
11:45 AM	Lunch [Regency Ballroom]
12:00 PM	
12:15 PM	
12:30 PM	
12:45 PM	
1:00 PM	
1:15 PM	<u>Paper Session 2:</u> [Harbour Room] Sound Reproduction in Cars - ANC
1:30 PM	
1:45 PM	
2:00 PM	
2:15 PM	
2:30 PM	
2:45 PM	
3:00 PM	Afternoon Coffee [Regency Ballroom]
3:15 PM	<u>Tutorial 1:</u> [Harbour Room] Jayant Datta + Dan Foley This is Not your Father’s AM Car Radio – Characterizing Audio Performance of Today’s Multi-layered Infotainment Systems
3:30 PM	
3:45 PM	
4:00 PM	
4:15 PM	<u>Paper Session 3:</u> [Harbour Room] Sound Reproduction in Cars - Spatial/Spectral (Part 2)
4:30 PM	
4:45 PM	
5:00 PM	Break
5:15 PM	
5:30 PM	
5:45 PM	
6:00 PM	Evening Reception [Regency Ballroom]
6:15 PM	
6:30 PM	
6:45 PM	
7:00 PM	
7:15 PM	
Day 1's Session ends at 5:30pm Join us for a Casual Reception in the Regency Ballroom demo and exhibition space	



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9:00 - 9:15 AM	<u>Opening Comments</u>	Conference Chairman: Dr. Alfred J. Svobodnik (MVOID Group)
9:15 -10:00 AM	<u>Keynote 1:</u> [Harbour Room] In Car UX – the Deep Immersion Experience Far Beyond Sound	Armin Prommersberger Senior Vice President of Technology Lifestyle Audio, Harman Chris Ludwig and, Senior Director of the EPIC Experience Team, Harman
10:00 AM	Morning Coffee [Regency Ballroom]	
10:30AM - 12:00PM	<u>Paper Session 1:</u> [Harbour Room] Sound Reproduction in Cars - Spatial/Spectral (Part 1) Virtual Acoustics	Methods for Low Bitrate Coding Enhancement Part I: Spectral Restoration by Patrick Gampp, Christian Uhle, Oliver Hellmuth, Peter Prokein, Jürgen Herre, Sascha Disch, Julia Havenstein, and Antonios Karampouriotis - Fraunhofer Institute, and University of Erlangen Self-Driving Cars: A Renaissance for Spatial Sound? by Jeffrey Read - Perfect Surround, Ltd. and Andy Wehmeyer - Audio Frog On Acoustical Modeling and Validation of Automotive Loudspeaker Grilles by Martin Olsen, Peter John Chapman, and Michael Strauss - Harman Lifestyle Audio and Harman Virtual Product Development
12:00 PM	Lunch [Regency Ballroom]	
1:00 - 3:00 PM	<u>Paper Session 2:</u> [Harbour Room] Sound Reproduction in Cars - ANC	Measurement environments for automotive microphones by Christoph Frank - Harman Automated system test for car engine order cancellers by Dr. Victor Kalinichenko - ASK Industries, GmbH Active Road Noise Cancelation – off-the-shelf digital audio amplifier platform by Juergen Zollner, Nikos Zafeiropoulos, Markus Christoph, and Vasudev Kandade Rajan - Harman Active Sound Quality Control Based on Individual Subjective Preference by Kenta Murai, Shunsuke Ishimitsu, Naoaki Shibatani, Yoshihiro Aramaki, Toshimasa Takagi, Kazuki Yoshida, Kenta Suzuki, and Takanori Chino - Hiroshima City University and Suzuki Motor Corporation
3:00 PM	Afternoon Coffee [Regency Ballroom]	
3:30 - 4:30 PM	<u>Tutorial 1:</u> [Harbour Room] This is Not your Father's AM Car Radio – Characterizing Audio Performance of Today's Multi-layered Infotainment Systems	Jayant Datta, and Dan Foley - Audio Precision
4:30 -5:30 PM	<u>Paper Session 3:</u> [Harbour Room] Sound Reproduction in Cars - Spatial/Spectral (Part 2)	Smart Audio - Adaptive Multichannel Loudness Control in Car Environment by Peter Poers - Jünger Audio GmbH Methods for Low Bitrate Coding Enhancement Part II: Spatial Enhancement by Christian Uhle, Patrick Gampp, Oliver Hellmuth, Peter Prokein, Jürgen Herre, Sascha Disch, Julia Havenstein, and Antonios Karampouriotis - Fraunhofer Institute, and University of Erlangen
5:30 PM	Break	
6:30 - 7:30 PM	Evening Reception [Regency Ballroom]	
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Saturday, September 9	
8:00 AM	Demo & Exhibition Open - Regency Ballroom [All Day]
8:15 AM	
8:30 AM	
8:45 AM	
9:00 AM	<u>Opening Comments</u> [Harbour Room] Conference Vice-Chairman: Roger Shively (JJR Acoustics)
9:15 AM	<u>Keynote 2:</u> [Harbour Room] Sebastian Scharrer (Fraunhofer) Autonomous Cars and Their Demand for High Audio Quality in Entertainment and Communication
9:30 AM	
9:45 AM	
10:00 AM	Morning Coffee [Regency Ballroom]
10:15 AM	<u>Paper Session 4:</u> [Harbour Room] End of Line Test Evaluation of Sound Quality
10:30 AM	
10:45 AM	
11:00 AM	
11:15 AM	<u>Tutorial 2:</u> [Harbour Room] Mads Herring Jensen Modeling of Car Cabin Acoustics
11:30 AM	
11:45 AM	
12:00 PM	
12:15 PM	Lunch [Regency Ballroom]
12:30 PM	
12:45 PM	
1:00 PM	
1:15 PM	<u>Paper Session 5:</u> [Harbour Room] System Architecture & Hardware
1:30 PM	
1:45 PM	
2:00 PM	
2:15 PM	
2:30 PM	
2:45 PM	Afternoon Coffee [Regency Ballroom]
3:00 PM	
3:15 PM	
3:30 PM	<u>Panel Discussion 1:</u> [Harbour Room] Sound Design of Automotive Sound Systems Moderator: Greg Sikora (Harman) Aris Rodis (Bentley), Adrian Bahne (Dirac), Brad Hamme (Harman), Arndt Hensgens (Harman), Marc Levasseur (MVOID)
3:45 PM	
4:00 PM	
4:15 PM	
4:30 PM	
4:45 PM	Break
5:00 PM	
5:15 PM	
5:30 PM	Evening Reception [Regency Ballroom]
5:45 PM	
6:00 PM	
6:15 PM	Banquet [Regency Ballroom]
6:30 PM	
6:45 PM	
7:00 PM	
7:15 PM	Social Event
7:30 PM	
7:45 PM	
8:00 PM	
Day 2's Session ends at 5:00pm Join us for a Reception, Banquet, and Social Event in the Regency Ballroom demo and exhibition space	



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9:15 -10:00 AM	<u>Keynote 2:</u> [Harbour Room] Sebastian Scharrer (Fraunhofer) Autonomous Cars and Their Demand for High Audio Quality in Entertainment and Communication	Sebastian Scharrer - Automotive Audio Division / R&D Product Manager - Fraunhofer IIS
10:00 AM	Morning Coffee [Regency Ballroom]	
10:30 - 11:30AM	<u>Paper Session 4:</u> [Harbour Room] End of Line Test Evaluation of Sound Quality	Loudspeakers Performance Variance Due to Components and Assembly Process - Field Assessment by Maria Costanza Bellini , and Angelo Farina - University of Parma Audio System Evaluation with Music Signals by Wolfgang Klippel , and Stefan Irrgang - Klippel
11:30AM - 12:30PM	<u>Tutorial 2:</u> [Harbour Room] Modeling of Car Cabin Acoustics	Mads Herring Jensen - COMSOL
12:30 - 1:30 PM	Lunch [Regency Ballroom]	
1:30 - 3:00 PM	<u>Paper Session 5:</u> [Harbour Room] System Architecture & Hardware	Multicore SOC processors: performance, analysis and optimization by Paul Beckmann - DSP Concepts Introducing the Automotive Audio Bus A2B by Martin Kessler Near-field tangential particle velocities: piston radiator vs. QRD phased linear array by Toby Gifford , Malcolm Duffield , and Joseph Hayes
3:00 PM	Afternoon Coffee [Regency Ballroom]	
3:30 -5:00 PM	<u>Panel Discussion 1:</u> [Harbour Room] Sound Design of Automotive Sound Systems	<i>Moderator :</i> Greg Sikora (Harman) Aris Rodis (Bentley), Adrian Bahne (Dirac), Brad Hamme (Harman), Arndt Hensgens (Harman), Marc Levasseur (MVOID)
5:00 PM	Break	
6:00 - 6:30 PM	Evening Reception [Regency Ballroom]	
6:30 - 7:30 PM	Banquet [Regency Ballroom]	
7:30 - 8:00 PM	Social Event	
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Sunday, September 10	
8:00 AM	Demo & Exhibition Open - Regency Ballroom [All Day]
8:15 AM	
8:30 AM	
8:45 AM	
9:00 AM	
9:15 AM	
9:30 AM	<u>Opening Comments</u> [Harbour Room] Conference Vice-Chairman: Bjarke Bovbjerg (Dynaudio)
9:45 AM	<u>Invited Paper:</u> [Harbour Room] Rolf Schirmacher (Müller-BBM) Integration of Active Noise Control in Future IVI System Designs – How to Deal with Low Latency Requirements?
10:00 AM	
10:15 AM	
10:30 AM	Morning Coffee [Regency Ballroom]
10:45 AM	
11:00 AM	Workshop: [Harbour Room] Sound, Safety, and Electric Vehicles Man Made Music: Joel Douek, Creative Director, VR and Technology, Co-Founder, EccoVR Brian Scherman, Producer + Director of Technology
11:15 AM	
11:30 AM	
11:45 AM	
12:00 PM	
12:15 PM	Lunch [Regency Ballroom]
12:30 PM	
12:45 PM	
1:00 PM	
1:15 PM	<u>Tutorial 3:</u> [Harbour Room] Stefan Irrgang (Klippel) In-situ Production Test of Car Audio Systems
1:30 PM	
1:45 PM	
2:00 PM	
2:15 PM	
2:30 PM	<u>Panel Discussion 2:</u> [Harbour Room] MAX SPL! Rafael Kassier (Harman)
2:45 PM	
3:00 PM	
3:15 PM	
3:30 PM	<u>Farewell!</u> [Harbour Room] Conference Chairman: Dr. Alfred J. Svobodnik (MVOID Group)
3:45 PM	
4:00 PM	Demo / Exhibition Tear Down & Load-out [Regency Ballroom]
4:15 PM	
4:30 PM	
4:45 PM	
5:00 PM	
Day 3's Session ends at 4:00pm Thank you, and Save Travels!	



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9:30 - 9:45 AM	<u>Opening Comments</u>	Conference Vice- Chairman: Bjarke Bovbjerg (Dynaudio)
9:45 -10:30 AM	<u>Invited Paper:</u> [Harbour Room] Integration of Active Noise Control in Future IVI System Designs – How to Deal with Low Latency Requirements?	Rolf Schirmacher - Active Sound Technology Managing Director - Müller-BBM
10:30 AM	Morning Coffee [Regency Ballroom]	
11:00AM - 12:00PM	<u>Workshop:</u> [Harbour Room] Sound, Safety, and Electric Vehicles	Man Made Music: Joel Douek , Creative Director, VR and Technology, Co-Founder, EccoVR and, Brian Scherman , Producer + Director of Technology
12:00 - 1:00 PM	Lunch [Regency Ballroom]	
1:00 - 2:00 PM	<u>Tutorial 3:</u> [Harbour Room] In-situ Production Test of Car Audio Systems	Stefan Irrgang (Klippel)
2:00 - 3:30 PM	<u>Panel Discussion 2:</u> [Harbour Room] MAX SPL!	<i>Moderator</i> : Rafael Kassier (Harman)
3:30 - 4:00 PM	<u>Farewell</u>	Conference Chairman: Dr. Alfred J. Svobodnik (MVOID Group)
Day 3's Session ends at 4:00pm Thank you, and Save Travels!		



Friday, September 8 - Keynote, Tutorial, & Papers	
9:15 -10:00 AM	<p align="center"><u>Keynote 1:</u> [Harbour Room]</p> <p align="center">"In Car UX – the Deep Immersion Experience Far Beyond Sound" Armin Prommersberger Senior Vice President of Technology Lifestyle Audio, Harman Chris Ludwig and, Senior Director of the EPIC Experience Team, Harman</p> <p>As the automobile industry is undergoing disruptive change with the autonomous driving casting its shadows ahead, automotive suppliers and OEMs explore new opportunities to shape the future of in-car UX. We are at an inflection point within the auto industry, where the passenger experience is becoming just as important to consumers as speed and performance. The availability of autonomous features is reinventing the way people spend time in their car.</p> <p>In their keynote, Armin Prommersberger, Sr. Vice President Technology and Chris Ludwig, Sr. Director EPIC UX of HARMAN's Lifestyle Audio Division, will show what needs to be considered beyond audio to fully exploit the potential of in-car UX. Furthermore, they will discuss ways to really achieve a deeply immersive experience for all car passengers and outline a roadmap for the industry.</p>
10:30AM - 12:00PM	<p align="center"><u>Paper Session 1:</u> [Harbour Room] Sound Reproduction in Cars - Spatial/Spectral (Part 1) Virtual Acoustics</p> <p align="center">"Methods for Low Bitrate Coding Enhancement Part I: Spectral Restoration" by Patrick Gampp, Christian Uhle, Oliver Hellmuth, Peter Prokein, Jürgen Herre, Sascha Disch, Julia Havenstein, and Antonios Karampourniotis - Fraunhofer Institute, and University of Erlangen</p> <p>Perceptual audio coders are widely used when storage space or streaming bandwidth for audio content is limited. If the used bitrate is low, various coding artifacts can be introduced that degrade the perceived audio quality. A suite of algorithms has been developed to conceal these coding artifacts and to improve the perceived sound quality in automotive environments. This paper is a continuation of a previous paper and introduces two post-processing algorithms for restoring the spatial signal quality of decoded compressed audio signals. Both algorithms work single-ended, i.e. without access to the bitrate or other side information. The merit of the algorithms is demonstrated by listening tests. A second part of the paper describes algorithms that enhance the spatial image.</p>
	<p align="center">"Self-Driving Cars: A Renaissance for Spatial Sound?" by Jeffrey Read - Perfect Surround, Ltd. and Andy Wehmeyer - Audio Frog</p> <p>For the first time since the invention of the automobile over 100 years ago, automated and self-driving cars are creating new and radically different concepts for car seating layouts as well as alternative ownership models. These trends will create new rules for which lanes self-driving cars can occupy. Four new forces; self-driving cars, the requirement that people can sit anywhere in a car, the need for rapid layout configurability, and new ownership models all are upending what automotive audio systems will actually need to do. Through illustrations of actual self-driving car prototype designs, mathematical formulas and future-sound layouts, this paper identifies the emerging trends, issues, future needs, challenges and discusses the key capabilities that audio systems will need to achieve in order to deliver high quality sound to any listener location within a self-driving car. This approach has also been proven to work today – dramatically improving sound quality in traditional car seating layouts, thereby making the migration to self-driving cars even easier.</p>
	<p align="center">"On Acoustical Modeling and Validation of Automotive Loudspeaker Grilles" by Martin Olsen, Peter John Chapman, and Michael Strauss - Harman Lifestyle Audio and Harman Virtual Product Development</p> <p>This paper addresses prediction techniques for evaluating the consequences of adding a grille assembly onto a loudspeaker. Numerical modeling is applied in order to assess the acoustical effects imposed on the loudspeaker sub-system defined as a loudspeaker, interface, and grille. Investigations are performed in a virtual infinite baffle scenario under semi-anechoic conditions, where various modeling aspects are included in the studies. The predictions are shown to accurately reproduce the prominent features of the sub-system when compared with experimental data. The paper highlights the intricacies of both measurement and correct modeling of the geometry of the parts and their acoustic properties – particularly at higher audio frequencies.</p>



Friday, September 8 - Keynote, Tutorial, & Papers	
1:00 - 3:00 PM	<p><u>Paper Session 2: [Harbour Room]</u> Sound Reproduction in Cars - ANC</p>
	<p>"Measurement Environments for Automotive Microphones" by Christoph Frank - Harman</p> <p>This paper is a summary of acoustic measurement environments used for automotive microphones. Different environments are presented so that the right method can be found according to the microphones specification. The summary also shows why different measurement environments need to be used for the main types of microphones in automotive applications such as hands-free communication and active noise control.</p>
	<p>"Automated System Test for Car Engine Order Cancellers" by Dr. Victor Kalinichenko - ASK Industries, GmbH</p> <p>This paper considers errors occurring during the design, implementation and testing of Engine Order Cancellation systems (EOC). Special attention is drawn to the black-box tests using industrial computer for modeling the acoustical environment of the car, engine noises, CAN-signals and for evaluating the quality of the system. It is shown that using computer based tests allow detecting problems that either cannot or very hardly can be detected during in-car tests. Block diagram of the automated EOC test system is given. Comprehensive analysis of circumstances that can lead to the problems in EOC is done. Tests for their automatic detection are described.</p>
	<p>"Active Sound Quality Control Based on Individual Subjective Preference " by Kenta Murai, Shunsuke Ishimitsu, Naoaki Shibatani, Yoshihiro Aramaki, Toshimasa Takagi, Kazuki Yoshida, Kenta Suzuki, and Takanori Chino - Hiroshima City University and Suzuki Motor Corporation</p> <p>We propose an algorithm for amplifying and reducing the engine-specific order components. From the simulation results, the engine-specific order components' sound amplification and reduction similar to that achieved with an equalizer were confirmed with the proposed algorithm. In addition, the auditory impressions of engine sound controlled by ASQC were investigated using psychoacoustic measurements. Thirteen stimuli were obtained by applying ASQC with several order components and amplification or reduction levels. The following stimuli were presented to 10 healthy volunteers; control order components and levels of amplification or reduction were set at first, second, and both first and second-order components, and 10 or 20 dB, respectively. The scale values of preference for each stimulus were obtained by Scheffe's paired comparison tests. When the reduction level increased, the preference was decreased or increased from the reference sound. Further, when the amplification-level increased, the preference was decreased from the reference sound. These results indicated that the control corresponding to the individual is important for improvements in auditory impressions. To solve these problems, ASQC was developed to adjust to individual preferences. The individual preferences of sound were connected to each driver's driving pattern using deep learning. Thus, we developed an ASQC system, which enables the automatic generation of individual sound preferences.</p>
	<p>"Active Road Noise Cancellation – Off-the-Shelf Digital Audio Amplifier Platform" by Juergen Zollner, Nikos Zafeiropoulos, Markus Christoph, and Vasudev Kandade Rajan - Harman</p> <p>The presented active road noise control (ARNC) system uses multichannel reference signals provided by digital automotive accelerometer sensors strategically placed on hub, suspension, and/or chassis to predict the structure born road noise transferred from the tires into the cabin. Omni-directional microphones installed in the vehicle roofline, close to the passenger's ears, are used as error microphones. Once activated, the system is minimizing the road noise and establishing a quiet zone in the proximity of these locations. Only the standard built-in vehicle loudspeakers are used as actuators. The presented digital audio amplifier platform compromise the complete multichannel control and update algorithm processing in parallel with an audio processing. Several road noise scenarios from different vehicles are used to indicate state-of-the-art road noise reduction performance.</p>



Friday, September 8 - Keynote, Tutorial, & Papers	
3:30 - 4:30 PM	<p><u>Tutorial 1:</u> [Harbour Room]</p> <p>"This is Not your Father's AM Car Radio – Characterizing Audio Performance of Today's Multi-layered Infotainment Systems" Jayant Datta, and Dan Foley - Audio Precision</p> <p>Today's state of the art automotive sound systems are extremely sophisticated, and, complicated to design. Thorough testing and verification of these designs pose considerable challenges. It is necessary to be versatile in multiple domains (digital, analog, acoustic and wireless). One has to be aware of the interactions in these complicated system designs. This tutorial introduces the system designer and implementer to various tools that may be used to verify the design and performance of the functional blocks that go into making the complete automotive audio system.</p>
4:30 - 5:30 PM	<p><u>Paper Session 3:</u> [Harbour Room] Sound Reproduction in Cars - Spatial/Spectral (Part 2)</p> <p>"Smart Audio - Adaptive Multichannel Loudness Control in Car Environment" by Peter Poers - Jünger Audio GmbH</p> <p>Smart Audio is gaining more and more attention in broadcast and media production industry. The Smart Audio concept is to utilizing real time processing algorithms that are both intelligent and adaptive. Those algorithms are perfectly prepared to be used in car environment for automated adaptive loudness-based audio control. Smart Audio Procedures needs to be integrated into head units or intelligent amplifiers. The Paper will present some dedicated and proofed algorithms and practical use cases for Smart Audio Procedures in Car Environment.</p>
	<p>"Methods for Low Bitrate Coding Enhancement Part II: Spatial Enhancement" by Christian Uhle, Patrick Gamp, Oliver Hellmuth, Peter Prokein, Jürgen Herre, Sascha Disch, Julia Havenstein, and Antonios Karampourniotis - Fraunhofer Institute, and University of Erlangen</p> <p>Perceptual audio coders are widely used when storage space or streaming bandwidth for audio content is limited. If the used bitrate is low, various coding artifacts can be introduced that degrade the perceived audio quality. A suite of algorithms has been developed to conceal these coding artifacts and to improve the perceived sound quality in automotive environments. This paper is a continuation of a previous paper and introduces two post-processing algorithms for restoring the spatial signal quality of decoded compressed audio signals. Both algorithms work single-ended, i.e. without access to the bitrate or other side information. The merit of the algorithms is demonstrated by listening tests. A previous paper presents algorithms that enhance the timbral sound characteristics.</p>



Saturday, September 9 - Keynote, Tutorial, Papers, & Panel Discussion	
9:15 - 10:00 AM	<u>Keynote 2:</u> [Harbour Room]
	<p>"Autonomous Cars and Their Demand for High Audio Quality in Entertainment and Communication" Sebastian Scharrer - Automotive Audio Division / R&D Product Manager - Fraunhofer IIS</p> <p>Richard Branson, founder of Virgin and 400 other companies elucidates: "If you aren't making a difference in other people's lives, you shouldn't be in business – it's that simple." Fraunhofer IIS started its journey by inventing MP3, a format which changed the way how music is consumed by billions of people today.</p> <p>Having developed the high-end 3D sound algorithm Symphoria, Fraunhofer IIS raises the quality of music played back in a car close to reality.</p> <p>There are good grounds for wondering - what's next?</p> <p>The struggle for more Watts and loudspeakers will not necessarily lead to a better sound experience. New aspects are taking center stage and will establish a distinctness between the manufacturers in the future.</p> <p>The tasks we are performing while driving will change fundamentally against the background of vehicle automation. Besides the possibility to work and make phone calls while driving, passenger expectations will shift towards high-quality media consumption. This keynote will emphasize some areas which will have remarkable potential for improvement.</p>
10:30 - 11:30 AM	<u>Paper Session 4:</u> [Harbour Room] End of Line Test Evaluation of Sound Quality
	<p>"Loudspeakers Performance Variance Due to Components and Assembly Process - Field Assessment" by Maria Costanza Bellini, and Angelo Farina - University of Parma</p> <p>This paper is the continuation of the study presented at the past convention "AES Berlin 2017 – 142nd International Convention" regarding the main causes of scrap during the production of a typical midrange loudspeaker. Various samples with reference and modified components parameters have been built and characterized in terms of frequency response, total harmonic distortion and electrical-mechanical parameters. In addition, a second set of samples has been built using reference components but varying the assembly process parameters and these samples also have been characterized as the previous ones. After measurements performed both in an anechoic chamber and in a real production line, a new set of measurements has been done inside a production car, in order to check if the results obtained in the preceding study would have been confirmed by field measurements. In more detail, authors aim was to verify that critical components individuated in the former paper would also have a relevant role after samples installation in a vehicle.</p>
	<p>"Audio System Evaluation with Music Signals" by Wolfgang Klippel, and Stefan Irrgang - Klippel</p> <p>Synthetic test signals, such as multi-tone signals or sweeps, are mostly used for the development and end-of-line testing of components and the complete audio systems in cars. Those signals provide objective, reproducible and interpretable test results in a short time. In contrast, the customer uses the audio system to reproduce music and speech, which are non-stationary signals with complex spectral and temporal properties. This paper discusses measurement methods that can be used for assessing the performance of the audio system by using any synthetic and natural (music) stimuli. A new technique based on adaptive modeling of the linear time variant distortion is used to combine physical and perceptual evaluation of the residual nonlinear distortion.</p>
11:30AM - 12:30PM	<u>Tutorial 2:</u> [Harbour Room]
	<p>"Modeling of Car Cabin Acoustics" Mads Herring Jensen - COMSOL</p> <p>In this workshop we will cover the basic concept used when modeling car cabin acoustics. This includes the source specification, boundary conditions, porous material models, as well as choice of the appropriate numerical method. Depending on the frequency range studied methods include finite elements, boundary elements, or ray tracing. Detailed multiphysics sub-models can be used to model the loudspeaker system and characterize it as a source. The software package COMSOL Multiphysics will be used as the simulation tool in the examples presented.</p>



Saturday, September 9 - Keynote, Tutorial, Papers, & Panel Discussion	
1:30 - 3:00 PM	<p>Paper Session 5: [Harbour Room] System Architecture & Hardware</p>
	<p>"Multicore SOC Processors: Performance, Analysis and Optimization" by Paul Beckmann - DSP Concepts</p> <p>Automotive OEMs are (finally) starting to consider using centralized processing to implement all features of their infotainment systems, using a single System on a Chip (SoC) that integrates all audio processing in a single unit rather than spreading it out among multiple components. They are taking a cue from consumer products, such as mobile and PCs, which have been using this approach for years. OEMs are motivated to make the change primarily by cost savings and reduced development cost. It also leads to a simpler and more modern software architecture, which lends itself more readily to over-the-air updates. These SoCs are still relatively new, and many engineers are unsure about their performance capabilities, especially when implementing premium and high-end audio systems with more features and more sophisticated audio processing. This paper benchmarks the audio processing capabilities of several current automotive SoCs and compares their performance to traditional DSPs. We also consider multicore architectures and variability in cycle timing due to caches and process scheduling.</p>
	<p>"Introducing the Automotive Audio Bus A2B" by Martin Kessler</p> <p>A2B is a de-facto digital audio communication standard developed to introduce digital microphones to the car. Multiple microphone arrays can be connected to the same, daisy chained cable which carries both digital microphone signals (up to 32 channels) and phantom power. The bi-directional digital audio bus system is also found in head unit to amplifier connections. This paper explains the capabilities of A2B and how it works. It illustrates how the low latency A2B bus enables new applications like in-car communication and noise cancellation. The paper will also demonstrate how easy it is to use the A2B bus to bi-directionally transmit synchronous audio data (I2S/TDM-to-I2S/TDM) and control/status information (I2C-to-I2C) over multiple bus-nodes.</p>
	<p>"Near-field Tangential Particle Velocities: Piston Radiator vs. QRD Phased Linear Array" by Toby Gifford, Malcolm Duffield, and Joseph Hayes</p> <p>Loudspeakers in cars are constrained in size and placement. As such, near-field and mid-field sound properties are of interest. The near-field of a circular piston in an infinite baffle is well studied, and often used as an approximate model for a loudspeaker. Whilst it's SPL directivity pattern is well understood, it's polar pattern of particle velocity direction has received less attention. We calculate the radial and tangential components of the piston model's particle velocity field, and find that tangential velocity dominates at particular angles for a given piston frequency. These polar positions relate to the 'dips' in the SPL directivity pattern. Contrasting these results with the sound-field of a linear array of spherical drivers having phase delays determined by a QRD sequence, we find the QRD array yields greater uniformity in both SPL directivity and particle velocity direction.</p>
3:30 - 5:00 PM	<p>Panel Discussion 1: [Harbour Room] Sound Design of Automotive Sound Systems</p> <p>Moderator: Greg Sikora (Harman)</p> <p>Aris Rodis (Bentley), Adrian Bahne (Dirac), Brad Hamme (Harman), Arndt Hensgens (Harman), Marc Levasseur (MVOID)</p> <p>In this panel discussion, automotive acoustics experts will debate general sound design philosophy and methods and dive into specific aspects of the process. Some of the discussed topics will cover – system design history, working with customers and concept cars, brand specific sound targets, sound stage concepts, integration of low frequency sources, mechanical integrity vs sound quality, dynamic system behavior, source up-mix and sound spatialization, speed-based system equalization, etc. Our panelists will discuss how different tools and business environment affect approach to system design sound tuning - from manual tuning, through computer-aided systems to full sound tuning solutions and virtual development. Pros and cons will be debated.</p>



Sunday, September 10 - Invited Paper, Papers, Workshop, Tutorial, & Panel Discussion	
9:45 -10:30 AM	<p style="text-align: center;"><u>Invited Paper:</u> [Harbour Room]</p> <p style="text-align: center;">"Integration of Active Noise Control in Future IVI System Designs – How to Deal with Low Latency Requirements?"</p> <p style="text-align: center;">Rolf Schirmacher - Active Sound Technology Managing Director - Müller-BBM</p> <p>Active Noise Control (ANC) is a closed-loop control technology to reduce vehicle interior noise that, among others, requires some amplifier and speaker system. Thus it is well suited for integration within In-Vehicle Infotainment (IVI) systems comprising of an audio subsystem. However, as it is a closed-loop control system, ANC has strong requirements on the audio signal path and processing latency – probably one of the tightest by today's audio applications. Thus low latency designs of the overall ANC related signal path is of utmost importance in any IVI system.</p> <p>Current trends in IVI system designs often lead to large latencies as latency is of minor importance in most applications like infotainment sound reproduction. These include, among others, large block-size processing for advanced signal processing algorithms, driver delays for consumer operating systems, „app-style“ audio system implementations sometimes even running on virtual instances and driver/hardware/architecture-related latencies for some media-related bus systems.</p> <p>The paper gives introductory background on the ANC system need for low latencies, and reviews some typical IVI system trends with their impact on latencies. Based on the overall latency budget and different components' achievable latencies, concepts of ANC integration in overall IVI system designs are presented. Dedicated processing cores within low-latency signal flows show up to be a specially well suited solution for ANC integration independent of main application processing cores or major audio DSPs and even networked audio systems can achieve the required latencies if designed correctly. Suitable designs can be achieved with dedicated processors as well as with carefully integrated computing resources within major SoCs while overall signal flow design glitches, often based on poor decisions in early project phases, might easily jeopardize ANC capabilities of the end-product.</p>
11:00AM - 12:00PM	<p style="text-align: center;"><u>Workshop:</u> [Harbour Room] Sound, Safety, and Electric Vehicles</p> <p style="text-align: center;">Man Made Music: Joel Douek, Creative Director, VR and Technology, Co-Founder, EccoVR and, Brian Scherman, Producer + Director of Technology</p> <p>As a leading strategic sound and music studio, Man Made Music is bringing two decades of experience creating iconic sound and music for entertainment, general market brands, physical installations and virtual reality projects to the field of automotive audio. Focusing on the future of sound for electric vehicles, Man Made Music is uniquely positioned to address the challenges of new International Standards for EV sound: how to implement with available technology, the often contradictory demands of safety and noise pollution, the aesthetic and emotional effects of sound on pedestrians, and the branding opportunities for car makers</p>



ABSTRACTS

Sunday, September 10 - Invited Paper, Papers, Workshop, Tutorial, & Panel Discussion	
1:00 - 2:00 PM	<p style="text-align: center;"><u>Tutorial 3:</u> [Harbour Room]</p> <p style="text-align: center;">"In-situ Production Test of Car Audio Systems" by Stefan Irrgang (Klippel)</p> <p>Checking the sound quality of a car audio system at the end of the production line (in-situ EOL test) is mandatory to satisfy rising customer expectations and to ensure consistent, high audio quality in delivered cars. While 100% testing of transducers and subcomponents is state of the art, there is no objective, commonly used end-of-line test for complete cars. However, the pre-testing of components is not sufficient, e.g. defects may easily be caused by improper mounting of speakers or interior panels.</p> <p>The fundamental frequency response, sensitivity, harmonic and intermodulation distortion as well as spatial characteristics are very important in the design phase but are less critical in car manufacturing. Even if those characteristics vary beyond defined limits, it is rather difficult for the customer to rate the quality as bad.</p> <p>This is quite different for excessive distortion generated by defects (e.g. „rub and buzz“) of the sound reproduction system and parasitic vibration (buzzing) caused by improper mounting of interior car components (loose parts, grill, windows, panels, ...). Those defects have a high impact on sound quality, are clearly audible by customers and are perceived as unnatural and annoying.</p> <p>In this tutorial, existing methods for sound quality assurance in cars are discussed and new methods are presented combining highly sensitive defect detection in an industrial environment, root cause analysis for failures and assistance for meaningful limit definition.</p>
2:00 - 3:30 PM	<p style="text-align: center;"><u>Panel Discussion 2:</u> [Harbour Room] MAX SPL !</p> <p style="text-align: center;"><i>Moderator:</i> Rafael Kassier (Harman)</p> <p>Sound pressure levels in today’s premium factory-installed sound systems can be potentially very high – possibly even damaging to the hearing of the occupants! This panel discussion will start with an overview of the legal landscape of safe playback levels for installed sound systems, and an overview of some acoustic SPL measurements from real-world sound systems. Some of the world’s leading experts in sound system integration from automotive manufacturers and suppliers will then discuss with the audience about how these issues are dealt with in practice. The goals of this discussion are to shine a spotlight on this particularly important issue, and to demonstrate the need for a set of guidelines for the industry.</p>