

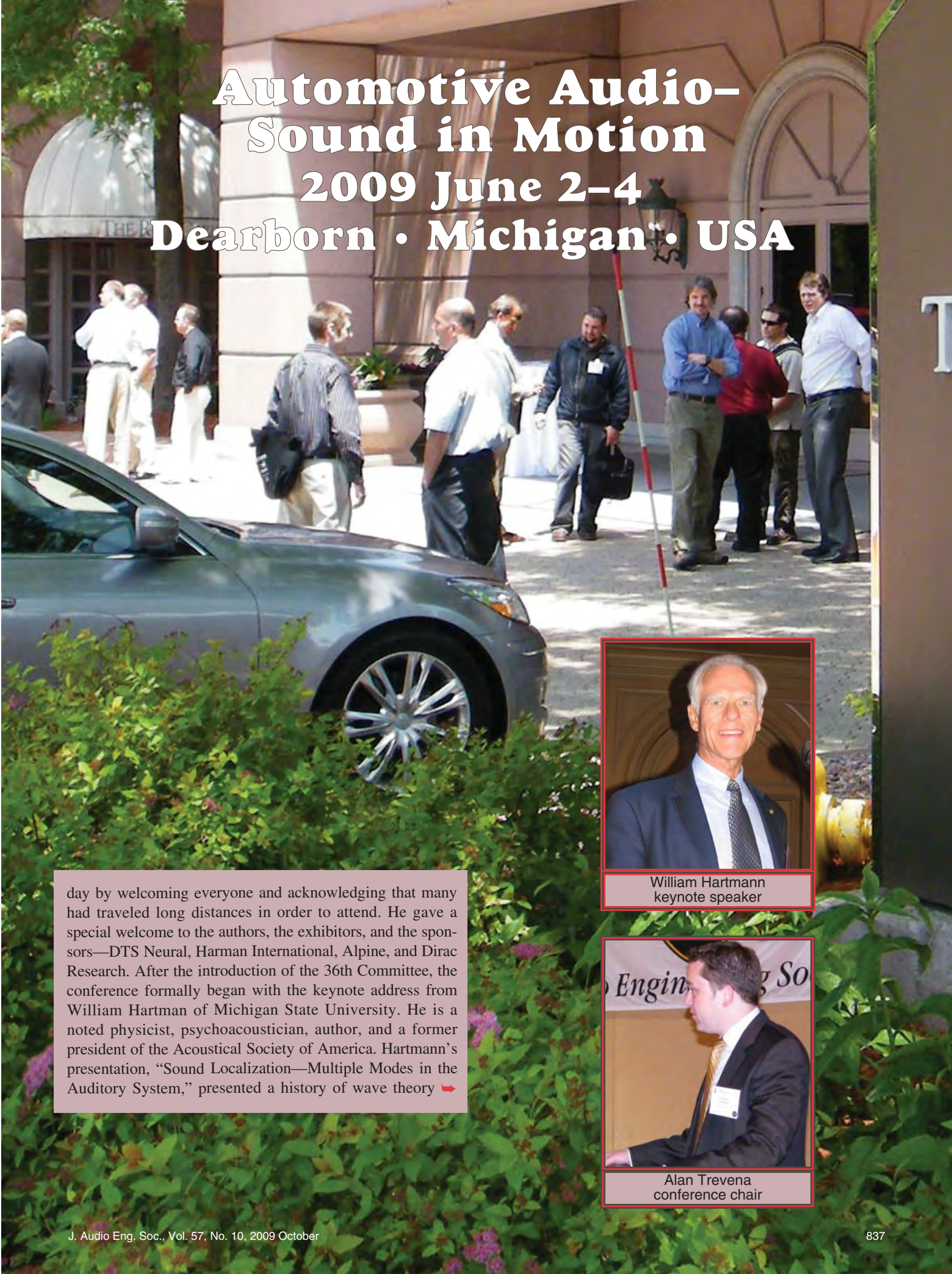
# AES 36<sup>th</sup> INTERNATIONAL CONFERENCE

**T**he Audio Engineering Society held its first automotive audio conference in June, the AES 36th International Conference, *Automotive Audio—Sound in Motion*. The three-day event was held at the Ritz Carlton Hotel in Dearborn, Michigan, in the heartland of the U.S. automotive industry. Over 80 engineers, research scientists, and industry professionals attended. Many were from the local automotive community, but some traveled from Europe and even Australia to join the conference. Considering the distressed state of the global automotive industry, attendance was sig-

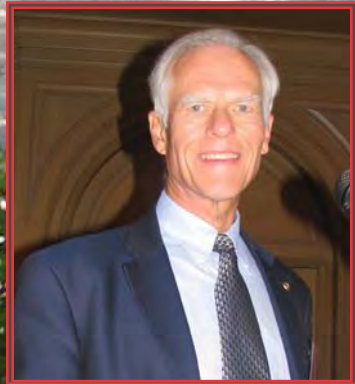
nificantly higher than the committee had anticipated, clearly showing the need for a conference on this topic. Over the first two days, 20 papers were presented in 7 paper sessions on topics ranging from soundfield control to switch-mode audio power amplifiers. The third day hosted two panel discussions in the morning, and the afternoon was opened up for anyone to attend the in-vehicle demonstrations and tutorial sessions occurring simultaneously. Another 25 engineers and students attended the third afternoon.

Alan Trevena, 36th chair, opened the conference on Tues-

# Automotive Audio- Sound in Motion 2009 June 2-4 Dearborn • Michigan • USA



day by welcoming everyone and acknowledging that many had traveled long distances in order to attend. He gave a special welcome to the authors, the exhibitors, and the sponsors—DTS Neural, Harman International, Alpine, and Dirac Research. After the introduction of the 36th Committee, the conference formally began with the keynote address from William Hartman of Michigan State University. He is a noted physicist, psychoacoustician, author, and a former president of the Acoustical Society of America. Hartmann's presentation, "Sound Localization—Multiple Modes in the Auditory System," presented a history of wave theory ➔



William Hartmann  
keynote speaker



Alan Trevena  
conference chair

**Authors**



Some of the authors who presented papers: from left, top row, Robert Bleidt, Arnold Knott, and Frankie James; 2nd row, Kevin Heber, Sean Olive, and Michael Strauss; 3rd row, Dan Foley, Henry Muyshondt, and Christopher Pearson; 4th row, Scott Pennock, Alfred Svobodnik, and Rene Derkx; 5th row, David Scheler, Francesco Piazza, and Paolo Peretti; bottom row, Mark Corless, Mathias Johansson, and Pietro Adduci.

and psychoacoustics leading up to the current understanding of auditory perception. He presented historical developments such as the Arago/Poisson bright spot, discussed the Precedence effect, and was able to demonstrate the Franssen effect to the audience. His presentation provided a valuable introduction to the topics of the day. His explanation of how the brain processes interaural time delay and interaural level difference was extremely well received by the conference attendees. It was shown that these cues must agree for proper sound localization to occur and that there is large variation among listeners in their ability to process these cues. As a result, it was surmised that providing satisfactory localization performance to an entire population of listeners is an extremely difficult endeavor.

John Stewart, papers chair, put together a highly relevant and focused technical program. The first paper session concerned safety, systems and signal processing. Frankie James, General Motors, presented research into interior audio cues for hybrid and electric vehicles. James and her colleagues proposed a series of sound cues to be added to vehicles that replace traditional cues such as engine cranking, acceleration, and ignition on and off. In development of these new cues, demographics, brand identity, and psychoacoustics were all considered. The next paper focused on a digital audio watermarking scheme to add program information to music broadcast over radio. Ron Healy from the National University of Ireland presented a robust watermarking scheme with very low audibility, ideal for in-vehicle reproduction where online song identification is currently unavailable.

The systems integration paper session was opened by Henry Muyshondt, SMSC, Austin, Texas. He presented a high-level overview of MOST (Media Oriented Systems Transport) and its application in many of today's automobiles. Currently 16 automobile manufacturers have adopted MOST architecture for their multimedia and entertainment systems. Muyshondt presented both the physical layer and the software framework for interconnecting multimedia devices on the bus. Isochronous mechanisms allow signals at different sampling rates to be transmitted, and deterministic delays and low-latency connections enable MOST to be used for real-time audio/video applications. Christopher Pearson, Best Buy Corporate, Richfield, Minnesota, continued the systems integration theme, presenting solutions for installing aftermarket head-units in vehicles with OEM rear seat entertainment (RSE). A series of solutions were presented including aftermarket communication boxes to interface with the vehicle bus and a solution that retains the original factory head unit so that the necessary wake-up commands can be sent to the RSE system.

Kevin Heber, Panasonic Automotive Systems, Southfield, Michigan, reported on mobile Internet audio. Heber suggested that given the prevalence of mobile Internet, Audio over IP (AoIP) is fast becoming a significant music delivery mechanism and may eventually render current, more traditional radio broadcast obsolete. The systems integration session was concluded by

Robert Bleidt, Fraunhofer USA Digital Media Technologies, San Jose, California, with the presentation “Latest Developments in Low Bit-Rate and High-Quality Multichannel Automotive Audio.” Bleidt discussed the work of the ISO/MPEG Standardization Group in developing the MPEG Surround specification and the features and advantages of this new surround algorithm. Attendees were able to experience MPEG Surround for themselves on Thursday afternoon in the demo vehicle supplied by Fraunhofer.

The session on amplifiers, loudspeakers, and microphones rounded out the technical program for the first day. Arnold Knott of Harman/Becker Automotive Systems GmbH and the Technical University of Denmark presented “Active Electromagnetic Interference Cancellation for Automotive Switch-Mode Audio Power Amplifiers.” Knott’s novel approach centers on active cancellation of electromagnetic interference. Experimental results show a 15-dB improvement while delivering a signal with less than 0.1 percent distortion. The switch-mode amplifier theme continued with the presentation “A Fully Digital Single Chip 4X100W Class D Amplifier with High Immunity to the Demodulation Filter Effects” by Pietro Adduci, STMicroelectronics, Milan, Italy. This highly integrated solution utilizes digital input, onboard signal processing, and feedback in the PWM power stage to



At the registration desk: from left, Dick Stroud, Mari Trevena, Kelley Walker, William Tyler Walker, and David Carlstrom.

reduce the EMI to levels demanded in the modern automobile.

The final paper of the day was “Spatial Harmonic Analysis of Unidirectional Microphones for Use in Superdirective Beamformers” by Rene Derkx, Philips Research Laboratories, Eindhoven, The Netherlands. He presented a method for selecting microphones with similar polar responses in both magnitude and phase. The analysis technique and curve-fitting procedure focuses on the lower frequency →



36th Committee: from left, David Clark, John Stewart, Tim Nind, David Carlstrom, Alan Trevena, Mari Trevena, William Tyler Walker, Tom Nousaine, Kristina Busenitz, Dick Stroud, and Mark Navarre.

**Exhibits**

- 1 G.R.A.S
- 2 Prism Sound
- 3 DLC Design
- 4 Payton Group



binaural recording and playback will ultimately depend upon the match between the head and pinnae used during the recording and the head and pinnae of the individual listening at playback. Sean Olive, Harman International Corp., Northridge, California, presented “Whole-Body Vibration Associated with Low-Frequency Audio Reproduction Influences Preferred Equalization.” In this study, Olive and colleagues from McGill University constructed a platform that enabled them to introduce vibrations. A chair was placed onto the platform for listening to audio reproduced over headphones.

range occupied by human speech. Wide variation was found even in capsules of the same type, stressing the importance of this type of analysis if superdirective beamforming is to be successfully implemented as a method to improve the signal-to-noise ratio in automotive hands-free systems.

Wednesday began with three papers on the topic of objective and subjective testing and evaluation. Dan Foley, Foley & Associates, Marlborough, Massachusetts, presented “Ensuring Accurate Playback and Analysis of Binaural Recordings for Automotive Sound Systems.” He outlined issues with binaural recording. For example; real-ear recordings are subject to head movement and probe microphone equalization. Foley explained that the results obtained with

The study found evidence to support the hypothesis that structure-borne vibration can be an acceptable substitute for low-frequency audio when reproduced over headphones for the same musical sound signals. The binaural theme was continued in the presentation by Todd Welti, also of Harman, “Validation of a Binaural Car Scanning (BCS) Measurement System for Subjective Evaluation of Automotive Audio Systems.” Results of listener preferences in-situ and listening through the BCS system over headphones were compared. It was found that the affect of the playback method has no statistically significant impact on the test results.

The next session was devoted to very small room acous-

tics. Michael Strauss, Fraunhofer Institute for Digital Media Technology and the Technical University of Delft, presented “Approach to Sound Field Analysis and Simulation Inside a Car Cabin.” Strauss proposed a measurement-based approach to evaluate the sound propagation inside an automobile. Measurements were made on a two-dimensional grid on the listening plane inside the vehicle. Data sets were recorded separately for each loudspeaker and fed into a simulation environment. The soundfield for any combination of loudspeakers with individual gains and delays can then be simulated.


Alfred Svobodnik, Harman International, presented “Virtual Development of Mercedes Premium Audio Systems.” He presented a complex model of a vehicle audio system through coupled electrical-mechanical-acoustical simulations. The model is used to calculate the binaural room impulse response long before the first prototype vehicle is available. Engineers can then listen to the virtual automotive audio system through a binaural playback system with head-tracking.

The first session on Wednesday afternoon was Signal Processing: Multichannel Sound, which included “Automotive Audio Equalization,” “The hArtes CarLab,” “Sound Field Control Using a Limited Number of Loudspeakers,” and “PC-Based Prototyping of Audio Applications Using a Model-Based Design.” Mathias Johansson, Dirac Research AB, Uppsala, Sweden, presented the soundfield control paper. He discussed the theory behind developing a soundfield based on the transfer function between current loudspeaker and measurement microphone locations and simulated loudspeakers in a virtual listening room. The resulting new soundfield is said to yield a common natural experience for all listening locations within the vehicle.



Tom Nousaine (left) and Jim Johnston presented tutorials on Thursday afternoon.

The final papers session, devoted to hands-free and active noise cancellation, consisted of two papers: “Wideband Speech Communications: The Good, the Bad, and the Ugly” and “Talk-and-Push (TAP)—Toward More Natural Speech Dialog Initiation.” The latter paper, presented by David Scheler of the Technical University of Rauschewig, Germany, explored the possibility of creating a more natural hands-free speech experience in the vehicle. Currently there is an unnatural delay when the user must push the button, wait for a beep, and then speak. Scheler presented a method for a more natural scheme, akin to tapping someone on the shoulder. The goal being to allow the user to start talking before or after pushing the PTS button.

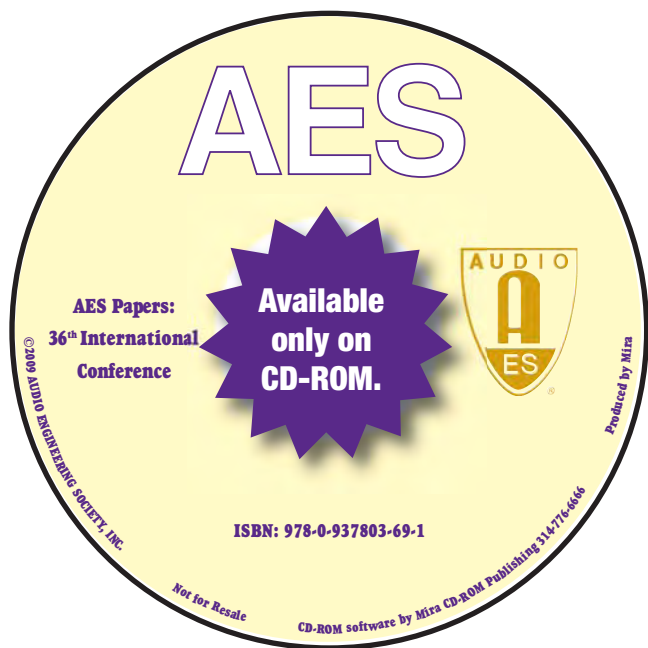
On Thursday morning there were two panel discussions in which all the panelists delivered thought-provoking presentations inspiring a tremendous level of audience participation. Richard Stroud, Stroud Audio, chaired the first panel, *Volume and Equalization Processing for the Automotive Environment*. The panelists—David Clark of DLC Design, Robert Klacza of Chrysler, Tom Nousaine of Listening 



The panel discussion *Volume and Equalization Processing for the Automotive Environment* included, from left, Tom Nousaine, Roger Shively, Robert Klacza, David Clark, and Dick Stroud.



The panel discussion *The Art and Science of Automotive Audio Evaluations* included, from left, Sean Olive, Michael Karesh, David Clark, and Kristina Busenitz.



## THE PROCEEDINGS OF THE AES 36<sup>th</sup> INTERNATIONAL CONFERENCE



Many people acquire completely new audio systems in their automobiles every 3 to 5 years, so that automotive audio must constantly be at the cutting edge of technology to meet the demands of discerning consumers. The 21 papers from this conference describe the ongoing research being done in seven key areas: safety, systems, and signal processing; systems integration; amplifiers, loudspeakers, and microphones; objective and subjective testing and evaluation; very small room acoustics; signal processing for multichannel audio; and hands-free and active noise cancellation. Available only on CD-ROM.

**Purchase online at**

[www.aes.org/publications/conferences](http://www.aes.org/publications/conferences)

**For more information email Donna Vivero at [DMV@aes.org](mailto:DMV@aes.org) or call +1 212 661 8528, ext. 42.**



Technology, and Roger Shively of Harman International—discussed methodologies developed to deal with vehicle noise. Kristina Busenitz of PMMR Solutions, chaired the second panel discussion, *The Art and Science of Automotive Audio Evaluations*. She and her panelists—Sean Olive of Harman, David Clark of DLC Design, and Michael Karesh of TrueDelta—shared how data from subjective evaluation testing is used by manufacturers.

The beautiful, sunny weather on Thursday afternoon enabled the attendees to get outside to see and hear the sound systems in demonstration vehicles provided by Harman International, Dirac Research, Fraunhofer Institute, Alpine Electronics, and Listening Technology. This final informal afternoon was opened up to local engineers and students who were not able to attend the full conference.

There were also two tutorial sessions on Thursday afternoon. Tom Nousaine, Listening Technology, presented “Common Autosound Errors.” Nousaine also had a demonstration vehicle available to help demonstrate many of the effects he presented. James “JJ” Johnson, DTS Neural Audio, presented a tutorial on spatial hearing.

Throughout the conference table-top exhibits were available for all attendees to review during coffee breaks and lunch periods. The exhibitors were the Payton Group, DLC Design, Prism Sound, and G.R.A.S. The attendees appreciated the chance to learn about their products and services.

Many people contributed to making this conference a success. The conference committee worked hard for over three years to put the event together. John Stewart, papers chair, arranged the call for papers, managed the peer-review process, and recruited the session chairs. In addition, Tyler Walker organized the sponsors as well as the demo vehicles and table-top exhibits. Richard Stroud was conference treasurer, Tom Nousaine oversaw PR, Mark Navarre helped with the technical program, Mari Trevena designed the website and dealt with many administrative needs in the run-up and during the conference. David Carlstrom, David Clark, Tim Nind, and Kristina Busenitz helped with conference planning and on-site support. We thank them for all their hard work. Thanks also go to the authors for their research and papers, to the panelists and tutorial presenters for their insightful presentations, and to the sponsors (DTS Neural, Alpine Electronics, Dirac Research, and Harman International) for their financial assistance.

*Editor’s note: The CD-ROM of conference papers can be purchased at [www.aes.org/publications/conferences](http://www.aes.org/publications/conferences).*