# AES 59th International Conference
Sound Reinforcement
Engineering and Technology

Montreal, Canada 15–17 July 2015

CONFERENCE REPORT

The 59th AES International Conference, Sound Reinforcement Engineering and Technology, was held July 15–17, 2015. The conference was hosted by McGill University's Schulich School of Music in the beautiful city of Montreal, Quebec, Canada. The conference was the first in over 25 years dedicated to large-scale sound reinforcement, public address, and live sound, and just the third AES conference held in Canada. The prior conferences held in Canada were "Audio in Digital Times" held in Toronto, May 1989, and "Multichannel Audio the New Reality", held in Banff May, June 2003.

The conference venue was The Elizabeth Wirth Music Building, sessions were held in the 180-seat Tanna Schulich recital hall, and the Multi-Media Room (MMR), an experimental laboratory and performance space. The building lobby doubled as a reception space where morning coffee, lunch, and coffee breaks were served by the welcoming, friendly staff and students. The Wirth Opera Studio provided space for sponsors to showcase their latest product offerings, and one of the recording studios, Studio 22, was used for a demonstration. In short, a modern venue perfectly suited to this conference.
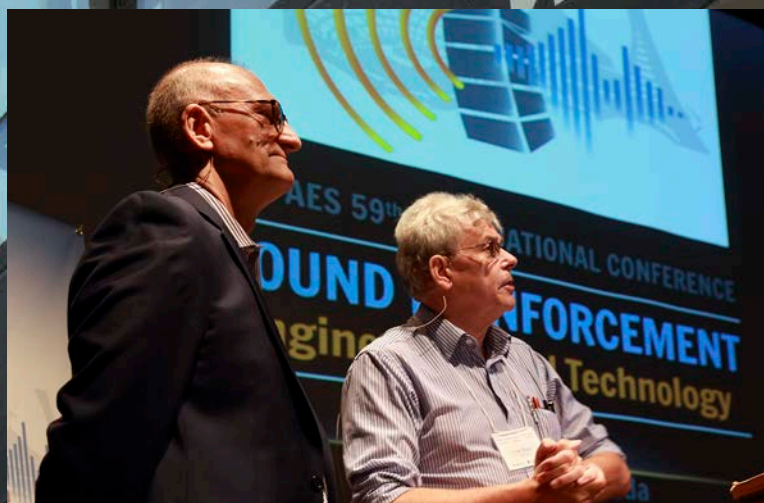
Conference chairs
Wieslaw Woszczyk, left, and
Peter Mapp greet the audience
at the opening of the event.

The conference chairs enjoy a beer during the informal
reception before the conference starts.

Sponsored by

Two years of planning and preparation by cochairs Peter Mapp and Wieslaw Woszczyk went into the event, which attracted in excess of 150 attendees from as far away as Korea, New Zealand, Japan, Brazil, and Australia. The conference had originally been conceived as a workshop/tutorial-based conference. Workshop chair Richard King worked tirelessly to coordinate a program consisting of 15 workshops, 9 tutorials, and 3 paper sessions complemented by a variety of tours, demonstrations, and social functions.

Prior to the "official" conference, a special pre-conference day included tours of McGill University, McGill's Centre for Interdisciplinary Research in Music Media and Technology, Sound Recording Program Facilities, CBC Studios, the Société des Arts Technologiques, and a pre-conference reception.

The aim of the conference was "to create a forum for all professionals working in or around the area of installed and live performance sound to share and advance techniques, technology, and discuss current and future platforms for system applications. The goal of this three-day event was to establish a higher standard for live sound and to promote education, exploration, and innovation under the leadership of the best practitioners and technology developers in the field."

CONFERENCE OPENING

Peter Mapp began the proceedings by welcoming everyone, stating that some of the top experts in the field were at the conference and encouraging everyone to take the opportunity to seek them out and talk about their respective area of expertise. The podium was then handed over to Wieslaw Woszczyk who also welcomed everyone and pointed out that the conference sponsors are among the leaders of the sound reinforcement industry. He stated that the conference was going to be a "summit of technology, engineering, and applications" and expressed his hope that new innovations would spring out of this gathering.

Woszczyk talked about how he could inspire forward movement in this business. For this he looked to the past and the beginnings of sound reinforcement, to an innovation in audio engineering from 100 years ago, the Blathaller speaker as patented by Hanns Reigger in 1924. After explaining the basic construction of the Blathaller, and playing a recording of an original implementation of the design, Woszczyk declared the 59th International Conference on Sound Reinforcement Engineering and Technology open.

OPENING LECTURE

Peter Mapp then presented the opening lecture titled "Speech Intelligibility in Sound Reinforcement—Making it Happen," opening with the statement "if a sound system is not intelligible, then there is not much point in having it." Mapp then went on to state that intelligibility is not a black and white parameter, that there are many "shades of gray." A huge number of venues have sound reinforcement and public address systems, sound reinforcement defined as live sound being reinforced and public address as having no acoustic source audible to the listener, for example a paging system. In all cases speech content needs to be intelligible, but not to the same degree.

Mapp went on to explain that speech intelligibility is a highly nonlinear process and discussed contributing factors such as noise, echoes, distortion, and the fact that speech is very robust and has inbuilt redundancy. Small changes in signal-to-noise ratio, direct-to-reverberant ratio, and equalization can have a significant effect. These factors were then explored in detail, laying the groundwork for how speech intelligibility is measured and the basis for the Speech Transmission Index or STI. The new STI intelligibility scale was then introduced that better defines the varying degrees of intelligibility and is more descriptive when compared to the old scale. Scale categories and the type of venue where they apply were presented.

While reverberation time is often associated with intelligibility, the point was made that there is no specific relationship between the two. The inverse relationship between intelligibility and distance from the source was presented. The frequency contribution in the speech spectrum was compared to the octave band contribution to speech intelligibility; it was noted that the SPL of speech is greatest in the 250-Hz octave, while the octave centered at 2 kHz contributes most to intelligibility. The effect of signal-to-noise ratio on intelligibility was presented. It was noted that this effect is dependent on the sound pressure level and that listener preference may not be for a linear relationship. The recognition of words as a function of frequency was discussed. The effects of reverberation time and age on intelligibility were discussed.

DAY 1 SESSIONS

Session 2 was a tutorial by Dave Gunness of Fulcrum Acoustic. His presentation was titled "Loudspeaker Measurements and the Future or Understanding Loudspeaker Specifications and Performance by Applying Frequency Aggregation." Dave introduced the concept of frequency aggregation and made the observation that most measures of loudspeaker performance do not consider the response to complex signals like music. Equalized sensitivity and real world max. SPL were presented as the basis of a methodology for understanding real world loudspeaker performance.

In Session 3, Joe Ciaudelli and Volker Schmitt presented a tutorial on wireless microphones. Joe covered the recent and upcoming changes in RF spectrum policy and discussed the impact on wireless microphone operation. Of particular importance, the 600-MHz band will become unavailable to wireless microphones in about three
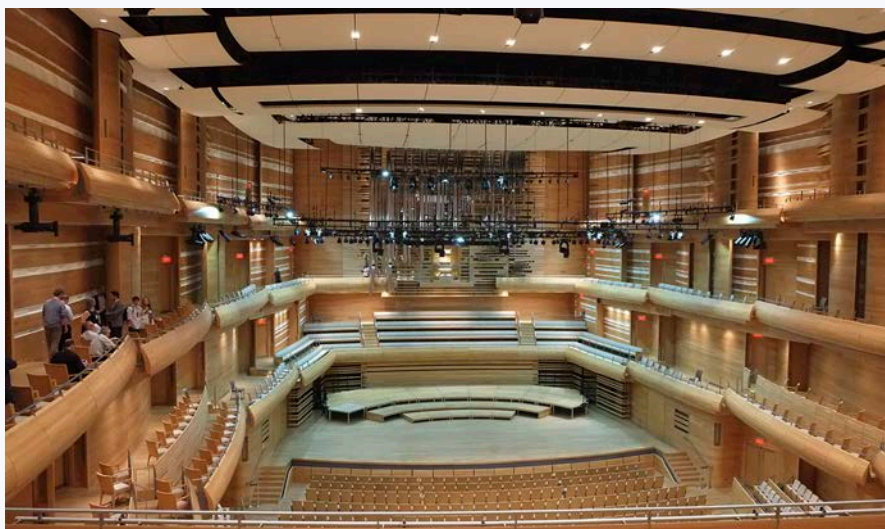

Dave Gunness explains loudspeaker measurements.

Joe Ciaudelli speaks on changes in wireless spectrum policy.

An audience member poses a question during lively discussions.

The Maison Symphonique during a tour by delegates on Day 1 of the conference

Bob McCarthy explains sound system tuning, past, present and future during his keynote.

years, although other bands may become available. Spectrum sharing will become the new norm, and licensed operation will become increasingly important. Joe also discussed white space devices and showed examples of wireless microphone protected areas.

Volker Schmitt discussed digital audio wireless transmission. He presented its advantages, talked about the different types of RF modulation, and discussed the challenges of transmitting high data-rate digital audio signals.

Session 4 combined a nicely prepared box lunch with a tour of the Maison Symphonique, organized by committee member Martha de Francisco. A short walk from the conference venue, The Maison Symphonique is a 2100-seat concert hall located in the Place des Arts. It was designed to showcase acoustic music of all genres and features a purpose-built organ designed by the house of Casavant, one of the world's premier organ builders and located just a few miles away in the city of Saint-Hyacinthe. Maison Symphonique organist Jacquelin Rochette described some of the unique features of the instrument, then played several short pieces to showcase the instrument and the acoustics of the hall.

Upon our return to the conference venue, the keynote address was given by Bob McCarthy of Meyer Sound on the topic of sound system tuning and optimization: past, present, and future. He began by asking the question "what is system optimization?" He then reviewed system optimization goals such as maximum uniformity, maximum SPL capability, minimum phase variance, and minimum latency, making the point that maximum uniformity should be the primary goal. McCarthy went on to discuss intelligent sound design. He provided a brief history of sound system measurement instruments and techniques, focusing on the SIMM system, then concluded his presentation with a discussion of optimizations methods.

Session 6 was a tutorial on steered line arrays by Evert Start of Duran Audio/JBL. He began by defining an array and introduced the

The Multi Media Room or MMR hosted most of the panel discussions and demonstrations

topic of beamforming, noting that there are two main ways to achieve beamforming: mechanical, altering the physical shape of the array and or the spacing of drivers, and electronic, control by DSP of individual or groups of loudspeaker drivers. A detailed discussion of the physics applicable to these two methods followed. The reason for, and the factors involved in directivity control was presented followed by some historical examples. The principles and properties of beam steering and beam shaping were introduced and several examples provided. The effect of mounting height on coverage, dispersion, direct-to-reverberant ratio, and intelligibility was presented. Controlling bass was the next topic with basic concepts introduced, followed by discussion of acoustic modeling of subwoofer arrays.

Session 7 was the first workshop of the conference with Ralph Heinz, Graham Hendry, Evert Start, and Peter Mapp discussing steered line arrays. Numerous examples of situations where steered line arrays are used were presented and discussed. The session concluded with an extremely effective demonstration of a steered array by Graham Hendry of Tannoy.

Session 8 was a multipaper presentation on the topic of sound reinforcement: past, present, and future. Johannes Mulder from Murdoch University, Australia, presented "Early History of Amplified Music: Transectorial Innovation and Decentralized Development." David Scheirman presented "Large-Scale Loudspeaker Arrays; Past, Present, and Future: Part 1 Control Systems and Audio Networking; Part 2 Electroacoustic Considerations." Bob McCarthy of Meyer Sound returned to the stage to present "Case Study; Design and Optimization of a Concert Hall Sound System." The session was chaired by Kurt Graffy of ARUP Acoustics.

The final session of the day was a workshop on 3D impulse measurements by Malcom Dunn of IRIS. Impulse responses describe the sound field at a position in a room. Omnidirectional measurements have been conducted since the 1900s, and since the 1970s

Kurt Graffy, vice chair of the AES Technical Committee on Acoustics and Sound Reinforcement, speaks on auralization.

Kevin Kimmel , right foreground, demonstrates a Yamaha digital mixing console in the sponsor area.

Richard King, workshops cochair, tells the audience about upcoming workshops and tours.

directional microphones have been used to quantify lateral energy. The 3D impulse response includes directional information. Direction is a critical part of our perception of sound and the 3D impulse response helps us to understand the interaction between a source and the room. Dunn explained the process of capturing the 3D response using a tetrahedral microphone array in a room excited by an exponentially swept sine wave, the nature of the data obtained, and how it is processed and displayed in a useful manner. Several case studies were presented and the interaction of the measurements with drawing programs and other software was discussed.

DAY 2 SESSIONS

Day 2 began with a workshop presented by TC-ASR cochair Kurt Graffy on sound system modeling and auralization, past and progress. He began by referring to the last AES conference on sound reinforcement (Nashville, Tennessee, May 1988) where several acoustic modeling programs were presented. He noted that 10 years later, modeling had progressed significantly, albeit with equally significant computer challenges. A discussion of the factors involved in modeling followed, with a comprehensive investigation into the amount of detail needed to produce accurate results. Blended models and parametric analysis was introduced, measured vs. modeled methods compared, and the impact of diffusion and diffraction discussed. Auralization was defined and the various parameters affecting its successful implementation were discussed at length. Examples of successful room designs produced using these methods were presented.

Session 11 produced the first concurrent session of the conference, with Paper Session 2 being held in the Tanna recital hall, and Workshop 4 in the MMR. The paper session titled "New Technology in Sound Reinforcement" was chaired by Eddy Brixen. Frank Schultz from the University of Rostock Germany presented "Evaluation Strategies for the Optimization of Line Source Arrays." Neils Adelman-Larsen from Flex Acoustics, Denmark presented "New Technologies for Passive Low Frequency Absorption and Case Studies in Sound Reinforcement Applications." Deiter Leckschat from Düsseldorf University of Applied Sciences presented "Suitability of Folded Ribbon High-Frequency Drivers for High Power Sound Reinforcement Systems."

A concurrent workshop was presented by James Bottrill of Ampetronic, who discussed the design, implementation, and verification of assistive listening systems, focusing on inductive loop systems. Noting that an aging population with age-related hearing loss presents a growing need for such systems, he discussed where they are currently implemented and noted several unique and innovative applications.

Session 12 was a tutorial by Jamie Anderson of Rational Acoustics on the optimization and measurement of sound systems. Anderson talked about the importance of knowing your job in the context of where you fit in the design and implementation process, and how we get from concept to final use. System alignment was discussed at length including how and why we make decisions, and how to make use of the tools available. Methodologies and best practices were presented along with examples of both.

Meanwhile, in Studio 22 a demonstration of spatial sound reinforcement for open air installations was available on a drop-in basis from 11 am to 2 pm. Javier Frutos Banilla of Fraunhofer IDMT led the demonstration.

Session 13 was a workshop on low-frequency optimization and bass control. Merlijn van Veen began by conducting a refresher on summation and reviewing the characteristics of subwoofers, establishing the need for low-frequency control, and finally looked at current typical solutions. He concluded by noting that vertical and horizontal arrays benefit from cardioids subwoofers or configurations over omnidirectional subwoofers.

Part 2 of this workshop featured Niels Adelman-Larsen of Flex Acoustics, who introduced an innovative acoustic absorber. The

inflatable product is permanently installed in the ceiling of a hall. Absorption coefficients are varied by inflating or deflating the device, altering the acoustics of the space.

The lunch hour following Session 13 was designated as a "Catch-Up & Ask The Experts" where attendees were provided the opportunity to meet and ask questions of presenters. This format was repeated on Friday.

Session 14 featured Eddie Brixen who presented a tutorial on sound reinforcement and microphones. He began by noting with humor that most sound reinforcement systems work perfectly until a microphone is connected. He reviewed the challenges of microphones in a sound reinforcement application such as sufficient amplification, stage monitoring, source separation, the need to accommodate recording and broadcast needs, challenging venues, and weather. An examination of microphone designs and their characteristics followed, along with recommendations for best practices in selecting and using microphones.

Session 15 was the conference's second concurrent session. Daniel Steele, a Ph.D. candidate at McGill, presented "Mixed Methods Impact Study of a Musical Installation in an Urban Park." His study centers around the idea of a "Musikiosk," a sound system installed in a gazebo at a local park fed by an unsupervised public-facing audio input. Park patrons can connect to the sound system at will during certain hours of the day. The use of the system, as well as the reactions of park patrons and neighboring residents, will be studied with the goal of providing urban planners with actionable data.

A concurrent session was a workshop by Michal Pettersen of Shure, Inc. who presented a case history of the venerable Shure SM57 microphone and its use by the White House.

Session 16 Workshop 7 continued the afternoon's microphone theme. Michael Militzer of Microtech Gefell introduced the KEM 975 line array microphone, discussed the underlying theory, provided several examples of its uses, and passed a sample around the room for everyone to look at. Joe Ciaudelli of Sennheiser did the same with the innovative MKH-800 twin dual-output multipattern micro-

A tour heads off from the Elizabeth Wirth Music Building at McGill.

Delegates enjoy the banquet, with committee members George Massenburg and Martha de Francisco in foreground.

A workshop panel on steered line arrays: from left, Peter Mapp, Evert Start, Ralph Heinz and Graham Hendry.

phone, whose pattern can be controlled remotely. Eddy Brixen concluded the workshop with a discussion on proper use of lavaliere microphones.

Session 16 Workshop 8 explored audio networks and signal distribution. Moderator George Massenburg led panel members Johan Wadsten, Michal Jurewicz, and Patrick Killianey in a lively discussion of digital audio networks, which centered on the importance of master clock election.

Tony Mott of T.G. Baker Sound, Ltd. presented the final session of the day, "Case History of Installing Networked Systems in Three Sports Stadiums." He went on to describe the evolution of an English Premiership stadium and the corresponding evolution of the sound system, which in its final configuration contains 26 DSPs distributed throughout the facility and interconnected by a CobraNet System. The second example was The National Rugby and Football Stadium in Ireland. A description of the 3-D model used for the design of the system was provided. 25 rack locations with 40 DSPs are interconnected using BSS BLU-link, a dedicated fiber optic ring using gigabit Ethernet technology. The final example was the National Indoor Sports Arena and Velodrome, Scotland. A Dante Network connects multiple venues with a total of 20 paging zones with local sources available in each venue. The Dante Network is connected by a dual fiber optic ring, and the Dante network can also be connected to the house network via a VPN allowing remote audio to be easily injected into the system.

Day 2's program concluded with attendees heading to the elegant and stately McGill Faculty Club for a cocktail hour and banquet. After a wonderfully prepared meal, David Scheirman, speaking on behalf of the AES Board of Governors, thanked George Massenberg, the sponsors, and the committee for the splendid banquet and flaw-less conference. George Massenberg then took the floor and in a well received speech, recognized the conference chairs, thanked the conference committee, numerous volunteers and sponsors, then proposed a toast to all, which received a rousing "hear-hear." After the

meal attendees were invited upstairs for drinks and snooker. Needless to say, a good time was had by all.

DAY 3 SESSIONS

The final day of the conference began with a workshop entitled "Sound Reinforcement Console Design—Now and in the Future." Moderated by Richard King, panel members Bob Snelgrove of Digico, Don Wershba of SSL, and Kevin Kimmel of Yamaha, showed the latest innovations in console design and gave their opinions on future developments.

Session 20, Workshop 11 was a mixing workshop/tutorial by Buford Jones of Meyer Sound. Jones' credits include tours with many notable performers: Linda Ronstadt, ZZ Top, Eric Clapton, and Julio Iglesias to name but a few. He gave us a brief history of his career before launching a discussion on the definition and importance of a sound mixer, making the point that a love of music is paramount. He chronicled the development of mixing equipment from the 1970s to today's digital consoles and software mixers, before posing the question "will we soon reach a point where the sound mixer will carry his own console?" He went on to discuss "linear" or equal amplitude sound systems, controlling sub-bass system output levels, gain structure, signal processing, and plugins. He continued his presentation with mixing suggestions, techniques, procedures, and best practices, and closed with the final thought, "protect your hearing."

In Session 21 Workshop 12 Susan E. Rodgers gave a presentation titled "Hidden Hearing Loss: The Search for the Origin of Common Hearing Disorders." Hearing thresholds as measured by audiograms cannot account for common hearing complaints such as tinnitus (i.e., ringing in the head), hyperacusis (i.e., overly sensitive response to sound in certain frequency bands), and poor speech-in-noise perception. Recent findings suggest that noise exposure and/or natural aging may degrade the auditory nerve in the absence of cochlear damage, accounting for the perceptual difficulties labeled "hidden" hearing loss. Auditory nerve damage appears in the auditory brainstem response (ABR) as reduced amplitude and latency of neural spike activity. Exhaustion and long term stress can increase the risk of hearing damage due to noise exposure.

Session 22 was a tutorial by Ryan Stables of Birmingham City University on semantic audio engineering and live sound reinforcement. Semantic audio deals with extracting meaning from musical signals. Applications include cover song identification, music transcription and score alignment, automated remixing/reproduction systems, digital archiving and retrieval, performance analysis, tutorials, and simulation. An example noted that engineers (and musicians) talk in a language that sometimes is difficult to define computationally: "The bass needs to be tighter, and the piano more chocolaty." These terms have a complex, nonlinear relationship with the equipment and the corresponding variable parameters (compressors, gain, etc.). Semantic audio strives to define this relationship. The SAFE Project was introduced and session analytics discussed. A paragraph is not enough to explore this complex and interesting topic. For more information visit http://www.semanticaudio.co.uk/

Concurrently with Sessions 21 and 22 was a tour of Solotech, a behind-the-scenes look at how one organization provides expertise and equipment rentals and sales in the areas of audio, video, lighting, and control systems for live events. The tour was hosted by Francois Desjardins, who along with the various members of the Solotech team answered questions about all aspects of their operations on local and international levels.

In Session 23 Workshop 13 Steve Barbar of LARS presented several case histories of installed network sound systems. Making

Wieslaw Woszczyk (center) with international liaison committee member, Sungyoung Kim (left) and Japanese delegate, Masahiro Ikeda (right).

the point that, until recently, electronic architecture and sound reinforcement systems were usually segregated. With advancements in DSP and network delivery it is now possible to merge the two functions. He also pointed out that the need for an audio network typically involves larger systems where control areas are separated by distance and audio is used for multiple purposes, i.e., recording and broadcast. Detailed examples were given.

Session 24 brought the final concurrent session of the conference. In the MMR Julien Laval and François Montignies of L'Acoustics presented "Case History of Sound System Design and Intelligibility in Sports Facilities," while Ben Kok presented a tutorial on electroacoustic enhancement systems in the Tanna Recital hall. Also called electronic architecture, the purpose of such systems is to adapt the acoustic environment of a given space to the requirements of the performance. Basic concepts such as reverberation, early reflections and direction, were presented. Different manufacturers use different methods of accomplishing acoustic enhancement. Their pros and cons were discussed.

The subsequent session continued with the theme of electroacoustic enhancement. Ben Kok moderated a panel consisting of Wieslaw Woszczyk, Jung Wook Hong, Masahiro Ikeda, and Doyuen Ko. McGill University's Active Acoustic Enhancement system was highlighted. The Virtual Acoustics Technology Lab has created a method recreating the acoustic environment of a given space (such

The assembled conference attendees holding court with Queen Victoria outside the Schulich School of Music.

The Eric Harding Quintet entertains the conference on the last day.

George Massenberg, left, mixing the Eric Harding Quintet.

as a concert hall or cathedral) in its lab. Best practices of capturing the impulse responses of the original space was presented, followed by the process of recreating the sound field in the remote room. Results of listening tests and examples of uses were discussed. A demonstration of the system in operation followed the presentation.

Hiro Ikeda of Yamaha then presented "A Future Without Feedback?" a discussion of the Yamaha Active Field Control System. He discussed the feedback problems associated with acoustic enhancement systems and various means of addressing those problems. Several examples of installed AFC systems were presented.

The final session of the conference was a multipaper presentation on reverberation enhancement chaired by Bruce Olson. Sebastian Schiect representing The University of Erlangen-Nuremburg and Fraunhofer IIS presented "Reverberation Enhancement Systems with Time-Varying Mixing Matrices." Song Chon from Ohio State University presented "Listeners Response to String Quartet Performances Recorded in Virtual Acoustics." Doyuen Ko from Belmont University presented "Evaluation of a New Active Acoustics System in Music Performance of String Quartets."

The proceedings then moved to the MMR for the final event of the conference, a concert by the Eric Harding String Quartet, performed with acoustic enhancement so that conference attendees could experience the effects first hand. At the conclusion of the concert, chairs Peter Mapp and Wieslaw Woszczyk thanked everyone and declared the conference closed. Peter remarked that sound reinforcement at the conference was the best he had experienced at an AES event.

Editor's note: Papers from this conference can be downloaded from the AES E-Library at: http://www.aes.org/e-lib/. The presentation slides, conference photos, and audio recordings of talks will be available on the 59th AES Conference website in early January 2016.