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ALMA Winter Symposium 2013

by Rob Baum (Washington; www.PacificAudioConsulting.com, and VP-Americas, ALMA)

ALMA (Association of Loudspeaker Manufacturing & Acoustics International; www.ALMAInternational.org) is a 51-year-old not-for-profit trade association dedicated to the design, test and manufacture of speakers. ALMA's annual Winter Symposium, held in Las Vegas, NV, the two days before CES, comprises seminars, papers, tutorials and a small exhibit area where finished speakers, speaker parts and materials, design and test tools were on display. ALMA offers high-quality program material and access to leading engineers in the audio business.

Floyd Toole and Sean Olive are the Lennon and McCartney of speaker measurements — the pair coauthoring a prolific string of hit AES papers over more than two decades. Their rigorous research has significantly advanced the industry's understanding of how to use trained listeners with normal hearing to subjectively test speaker performance and preferability, correlating those results with speaker design targets that likely will lead to higher consumer acceptance.

With the last decade's growth of portable audio hardware and the iTunes ecosystem, and more recently smartphones with music-player

features, the headphone market has radically expanded. The time is right for new research to do for headphones what Toole and Olive did for speakers. However, headphones come in several distinct varieties (over the ear, on the ear, and in the ear) and ears vary significantly from person to person. Plus, consumers want devices that are both comfortable and increasingly fashionable. So the task is not easy.

Harman's Sean Olive and Todd Welti reported on the relationship between headphones' perceived and measured sound-quality. The goal was to find a set of acoustical measurements that correlate and predict trained-listener sound quality ratings. "The current state of headphone measurement research does not lend itself to consensus on what the ideal target frequency response should be ... because the scientific research has not been done to identify it." They found that a flat "perceived spectral balance" was the most preferred.

An additional paper on headphones by CJS Labs' Christopher Struck gave a good overview of headphone and headset acoustics. Struck reviewed the basic concepts underlying headphone and headset measurements, and the various types of fixtures used in such tests.

Steve Temme, Pascal Brunet and Parastoo Qarabaqi (Listen; www.ListenInc.com/us) presented on measurement of harmonic-distortion audibility, using a simplified psychoacoustic model. This is important because engineers should focus on fixing the distortion problems that are perceptually most significant to the listener. Listen's Perceptual THD measurement is based on the PEAQ (perceptual evaluation of audio quality; <http://EN.Wikipedia.org/wiki/PEAQ>) from the ITU, which models mean opinion scores (MOS) as used in telecom testing.

As the speaker market has shifted from large floor-standing stereo speakers in the living room (from ~1950s) to increasingly smaller pairs of on-stand or shelf speakers, then small multichannel systems, and finally to speakers embedded in devices like phones and i-docks, engineers have sought to get more bass from a given-size driver and box — a pursuit featured in two papers. Atlantic Technology's (www.AtlanticTechnology.com) Boaz Shalev presented details on the H-PAS system, an inverted horn with the woofer at the wide mouth and a port at the narrow throat, which is claimed to deliver more bass.

Ole Wolff's (www.OWolff.com) Jeffrey Xia and Lee Guio described an ultracompact (~5mm) dynamic driver for earbuds, part of an ongoing race throughout the industry to shrink dynamic transducers for earbuds, smartphones and other handheld devices.

David Knobloch and Wolfgang Klippel (Klippel GmbH; www.Klippel.de) discussed modeling the large-signal behavior of microspeakers, whose nonlinearities include force factor (electrodynamical force and nonlinear damping), compliance (the restoring force of the suspension), and mechanical resistance (nonlinear damping).

For engineers designing docking speaker systems for iPhone 5s, which use a new ("Lightning") eight-pin connector lacking analog audio output, Pulsus Technologies' (<http://Pulsus.co.kr>) John Oh introduced a new all-in-one system-on-a-chip to make it relatively painless.

For quick quality-testing of speaker suspension parts, Robert Werner and Klippel showcased a new Klippel test module that offers effective, robust and simple dynamic testing of spiders, cones and domes prior to finished-driver assembly.

Dyne Analytics' (<http://DyneAnalytics.com>) Dan Wiggins and Mark Beach delivered a tutorial on MoTIV, their loudspeaker motor magnetics modeling software. Using templates for typical motor geometries, magnets, voicecoils, formers, and other components, MoTIV makes it relatively simple to design a speaker motor. MoTIV achieves speed and ease of use by sacrificing some flexibility, but in practice the models come very close to those generated by more complex, expensive and time-consuming programs. Dyne's David Hyre presented a second paper, on optimizing magnet-structure design for speakers. In one example, a real driver was compared with a simplified version with the same critical dimensions (voicecoil, gap and pole piece height, magnet dimensions). When modeled in MoTIV and in Ansoft Maxwell, the results were very

close (within 2%), demonstrating that simplified driver modeling offers good accuracy for most applications.

Peter Larsen presented his Fine R+D package (one of several modules in his Loudsoft software suite; www.LoudSoft.com/index.php/en/products/test-measurement-2/fine-r-d-2), which includes Fine Motor (models magnets), Fine Cone (models speaker cones), Fine Box (speaker boxes), Fine X-over and Fine QC. Fine R+D, when combined with Fine hardware, is used for loudspeaker, headphone and microphone development.

Sonos' (www.Sonos.com) Tim Sheen discussed estimating short- and longterm power requirements for powered speakers. Using Spice simulation of an amplifier and speaker playing music, he demonstrated that shorter time averages (such as instantaneous vs 100ms averaging) revealed higher peak power levels.

David Burd (Free Field Technologies — www.FFT.be/index.php?pageID=1; an MSC Software company — www.MSCSoftware.com) described the Arctran finite- and infinite-element acoustical modeling tool. Arctran and similar programs are complex software tools that are powerful and flexible in trained hands. Computer modeling must be compared with experimental measurements, driving the models and reality to converge.

Harman's Director of Business Development and Global Benchmarking Rob Barnicoat discussed the "Quantum Logic Surround 360" signal processor, which generates multichannel sound from mono, stereo or multichannel signal sources. It is said to extract individual voices and instruments as well as reverberation information, then redirect it into a newly defined multichannel soundfield that can include height information.

Equity Sound Investments' (<http://Sites.Google.com/site/equitysndinv>) Steve Hutt talked about "Audio System Variance in Production Vehicles". Hutt measured four identical production vehicles, finding significant variances in spatially averaged measurements, and wide variances in single-point measurements (not spatially averaged). These are caused by component variations, as well as by incorrect or damaged speakers or gaskets. Automotive QC groups focus on quality at the component level (such as speaker frequency response), not at the system level (what the customer hears from the complete in-vehicle system). Loudspeaker drivers have a fairly wide performance tolerance, typically $\pm 2\text{dB}$ and often $\pm 3\text{dB}$, which is audible. For nondefective speakers, equalization can correct much of the problem.

Two half-day seminars were on the design of moving-coil motors by Richard Litvan, and design of miniature speakers and microphones by Osman Isvan:

- Little's "An Overview of Moving-Coil Transducer Motor Design" provided a review of what makes loudspeaker magnetic motors work, how they are designed, and how to measure their performance. Once objectives have been chosen, designing the magnetic motors of moving-coil speakers is a complex series of tradeoffs involving design topologies; magnet material types and grades; the permanent-magnet magnetization process; thermal demagnetization; voicecoil design options; voicecoil inductance; analysis of motor design using physical equations and finite-element analysis; methods for measuring magnetic-motor performance; and the general topic of nonlinear motor behavior. Case studies and examples illustrated each facet of this multidimensional approach.
- Systems engineer and inventor Isvan addressed "Miniature Speakers and Microphones: Design and Application", covering digital and analog topics related to microspeakers and microphones in mobile devices such as laptops, tablets, cellphones and headsets. He emphasized system optimization for the particular application. Physical principles apply at any size, yet some aspects of loudspeaker design don't scale simply. Handheld devices' unique operating conditions, industrial design, assembly and manufacturing constraints lead to design and manufacturing approaches that are distinct from larger-loudspeaker

applications. Headphone drivers must be specially designed and characterized by special test methods, due to their unique acoustic coupling with the ear. In handsets and headsets, beyond optimization of typical audio parameters, the two-way communication environment introduces additional performance metrics such as echo-return loss and doubletalk performance. In addition, the high density of parts in mobile devices makes induced interactions among components a challenge. Microphone miniaturization rules out use of a dynamic microphone, and as the condenser microphone is scaled down, SNR targets become tougher to meet. Isvan explored omni, unidirectional and noise-canceling microphones, ECM and MEMS technologies, and compared digital and analog mikes.

Jim Hunter (Klipsch Program Manager, Historian, and 34-year employee) delivered the keynote: "The Life & Times of Paul Klipsch", including a slide show of archival documents and photos stretching back to the 1920s as he discussed the life of the prolific inventor and engineer. Audio was Klipsch's fifth career, which began in 1946 when he founded one of the first US loudspeaker companies (www.Klipsch.com/Founder), to build and sell the Klipschorn (www.Klipsch.com/klipschorn-floorstanding-speaker). "It is difficult to separate the man from the company; however, we can trace the development of the industry from Edwin Armstrong demoing FM with Klipschorns; to the Audio Fair in New York; to correspondence and visits with Dick Heyser, Arthur Fiedler, Saul Marantz, Avery Fisher, Sherman Fairchild, John Eargle, and more." Klipsch is one of America's best-known audio pioneers because he revolutionized the way the world listens to recorded music, having developed the corner-horn speaker that proved it was possible to reproduce the wide dynamic range of an orchestra in the home using the very-low-power amplifiers available in the 1940s. The Klipschorn is the only speaker that has been in continuous production, relatively unchanged, for over 60 years. Klipsch's audio career continued up through 2000 when the *Journal of the Audio Engineering Society* published one of his last papers. He died on 5 May 2002, at the age of 98.

At the ALMA banquet dinner, Lifetime Achievement awards were awarded to Paul W. Klipsch posthumously, and to Vance Dickason (author of the *Loudspeaker Design Cookbook* and editor of *Voice Coil*). The technical contribution award went to Sean Olive for his research and to Doug Button for his many contributions to transducer design. Awards for contributions to ALMA were given to Michael Oslac (Board Emeritus) and Phil Bunch.