Beyond Analog Circuit Modeling of Electroacoustic Transducers: Including nonlinearities and thermoviscous losses

By Stephen Thompson, PhD Penn State University

Linear analysis based on analog circuit models of loudspeaker systems can be done either with analytical matrix computation methods or with a code based on SPICE or another electrical circuit analysis code. There are several good codes based on these methods that provide reasonably accurate models of small signal performance of speakers in sealed and ported enclosures. However, we must move beyond these linear models to predict large signal behavior and frequency dependent losses in enclosures and ports. Such models can be implemented with multidomain modeling codes that use the Modelica language, or with Simscape. These methods use a combination of ordinary differential equations and algebraic equations to calculate the performance in each physical domain (e.g. mechanical, electrical, magnetic, etc.) and provide the necessary physical coupling between the domains. They provide reasonable fidelity with less computational intensity than full FEA, so they can be used as components in a larger modeling system that includes programmable controls to reduce distortion or energy losses. This seminar will demonstrate the use of Simscape to model a moving coil speaker including multiple nonlinearities. It will demonstrate the ability to model a control system around the speaker for improved far field performance.

Steve Thompson received a PhD in Physics with a dissertation on the sound production mechanism in wind musical instruments. He then worked for over 25 years in industrial R&D developing acoustic transducers, first for naval sonar systems, then for hearing aids and headsets. In 2005 he returned to the academic environment at Penn State University, where he is now a Research Professor in the Graduate Program in Acoustics. He does research on devices and systems using acoustic transducers and occasionally teaches courses on basic and advanced electroacoustic transducer design and analysis.