Acoustics Sound Fields and Transducers
Leo L. Beranek and Tim J. Mellow
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In 1954 Vern O. Knudsen wrote in his review of the 1954 edition of Beranek's book *Acoustics*, "Those who learned their acoustics from textbooks dated before about 1915 will gasp when they compare this up-to-date-text with those of yesteryear... Beranek and Mellow's book begins where the classical books ended; "Acoustics Sound Fields..." is primarily a treatise on modern acoustics... Acoustical engineers, as well as students and others interested in acoustics, will be greatly indebted to the authors for this useful and well written book."

In the almost 60 years since *Acoustics* was published, it has been one of the most cited references in scholarly papers, and has found a place not only on the book shelf, but also open on the desks, of practitioners, educators, and students. This reviewer remembers his introduction to *Acoustics* in the 1970s and a conversation with Beranek in the 1990s about updating the book.

Beranek and Mellow have updated the classic text with additional focus on transducers while retaining many chapters from the 1954 edition. It also introduces techniques that were not even a dream in 1954 and so updates the text to the early 21st century. One major change is in the time since the original edition the CGS units of measurement has largely been supplanted by MKS units; the current edition has been updated to reflect this usage.

Another change is in Chapter 3, on modeling electro-mechanical-acoustical circuits, or dynamical analogies. When using strictly electrical analogy for mechanical elements, where a velocity difference is represented by a voltage, the authors now call this the admittance-type analogy instead of the mobility-type analogy.

The first chapters of the new edition follow the 1954 book and deal with fundamental issues – terminology, the wave equation and solution, dynamical analogies, and acoustic components – with the chapter on radiation of sound deleted here but covered in a more contemporary manner in later chapters. The original text has been mostly retained, but new comments and text are added — for example, in Chapter 3, where reference to the map of the London Underground is added to explain that a schematic shows how circuit elements are connected, not their physical location — a point sometimes missed.

The next section of the book includes a chapter on microphones, a chapter on electrodynamic loudspeakers (called direct-radiators in the 1954 edition), and a chapter on loudspeaker systems. The chapter on loudspeaker systems describes simple, bass-reflex, 2-port networks, transmission line, and multiple drive units (crossover filters and coaxial units) and retains "Beranek's Law" that describes how selection of an enclosure includes psycho-acoustic factors, some of which are still not fully understood and "It has been remarked that if one selects his own components, builds his own enclosure, and is convinced he has made a wise choice of design, then his own loudspeaker sounds better to him than anyone else's."

A new, short, chapter on cell phone acoustics presents some of the design challenges inherent in these and similar devices. An expanded chapter on horn loudspeakers, including separate sub-sections for parabolic, conical, exponential, and hyperbolic profiles, closes out the section.

The next chapter is called Sound in Enclosures (as in the 1954 edition). While the section on sound fields in small, regularly shaped enclosures follows the form from the earlier edition, the next section on sound in large enclosures was rewritten and condensed. The derivation of the reverberation equations has been shortened considerably while the sections related to the energy in a room have been deleted (including equation 10.64 and its derivation in the 1954 edition), but some matters relevant to actual room design have been added — early and late reverberation, and the sound strength metric, G.

A very short chapter, "Room Design for Loudspeaker Listening," a scant 4 + pages, has been added.

The final three chapters return to theoretical analysis for practical design. In Chapter 12 the boundary value method, previously used in Chapter 4, is reviewed in more detail for the analysis of the radiation and scattering of acoustic sources — including the infinite line and cylinder, the rigid sphere, point source, and point source on a sphere, but more to the point some practical electrodynamic loudspeaker design topologies and geometries – including the spherical cap on a sphere, a piston in a sphere, and oscillating concave and convex domes in an infinite baffle – are discussed.

The boundary integral method (also called the boundary element method) is given a thorough introduction in the next chapter with a review of some of the physical and mathematical principles for the method. In addition to mathematical concepts such as the Huygens–Fresnel principle (too easily misinterpreted by many wishful wizards), Rayleigh integrals, Green's functions and the Kirchhoff–Helmholtz boundary integral, the authors present useful examples in both cylindrical and rectangular-spherical geometries — including a rigid circular piston in an infinite and finite

baffle, resilient disks (a.k.a. real world diaphragms), and a long oscillating strip.

The final chapter describes the state variable analysis and applies this method to the equivalent circuit of several loudspeaker designs. State variable analysis develops a set of frequency-dependent transfer function from which the frequency domain and time domain responses are obtained. Three appendices (frequency-responseshapes for loudspeakers, mathematical formulas, and conversion factors) and an index close out the text.

The table of contents includes a list of design summaries and selected tables and references follow each chapter.

One small complaint is that the book's binding is not that robust; in the course of the review several folios began to disassociate themselves from the spine.

The text is aimed towards electro-acousticians, both students and practitioners, and provides a comprehensive introduction and review to electro-dynamic system concepts and design and is a most welcome update to the classic text. *Acoustics Sound Fields and Transducers* will also find its place open on the desk of many who deal with the radiation of sound from vibrating surfaces, including loudspeaker component and mechanical system designers.

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