

Sound, Structures, and Their Interaction
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Published in 1993; Originally Published in 1972

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Preface to the Second Edition

Like the 1972 (first) edition, this text is intended for the applied physicist and engineer acquainted with the mathematical tools found in graduate textbooks. A familiarity with elementary theory of vibrations and strength of materials is desirable. No prior acquaintance with acoustics is expected from the reader.

The primary difference between this book and more familiar texts is the space assigned to the effect of radiation loading exerted by the ambient fluid on the vibrations of elastic structures and the resulting modification of radiated and scattered pressures. Unlike the standard modern acoustic texts, this book returns to the tradition of Raleigh's *Theory of Sound* by covering the vibrations of elastic shells. The presentation of plate vibrations includes the Timoshenko-Mindlin correction required to generate meaningful high frequency results. The chapters dealing with acoustics are self-contained. They address primarily sound radiation and scattering, to the exclusion of numerical solutions, statistical techniques, and consequently flow-related phenomena and other broad-band excitations.

Even though the original title has been retained as being still appropriate to the material covered, there are substantial differences from the 1972 edition. To retain the manageable size of the original edition, the theories of plates and shells have been combined into a single chapter and the chapter dealing with acoustic transients has been dropped. There is an increased emphasis on asymptotic solutions. Acoustics in the first edition was limited to rigorously tractable geometries: the plane, the cylinder, and the sphere. Had we wanted to discuss radiation and scattering by slender bodies of revolution, we would have had to use prolate spheroidal wave harmonics where applicable, and for nonspheroidal geometries we would have referred readers to papers using numerical methods. These configurations are covered in this new edition, but in preference to rigorous formulations, the pressure fields are computed asymptotically by means of simple mathematical models that are solvable in terms of familiar cylinder functions. The chapter on sound radiation by submerged plates has been extensively rewritten to incorporate some of the new results in this area developed over the past decade—in particular, a closer examination of the near-field, the effect of stiffeners and compliant layers, and the relation of load distribution to far-field directivity and acoustic power. The more concise analytical treatment of sound radiation by simply supported cylindrical shells has been supplemented with a study of low-frequency radiation by free-floating, not necessarily cylindrical shells of revolution. Other new subjects covered in this second edition are the acoustics of bubble swarms, the propagation of sound waves in elastic pipes, and the insertion loss of finite panels. Both Rayleigh and Kirchhoff scattering receive more extensive treatment. Sound radiation by a source placed in a planar elastic baffle is used to illustrate the reciprocity principle, which is then used to analyze the far-field of sources located on elastic spherical and cylindrical baffles. The introductory chapter has been supplemented with a historical review of the development of structural acoustics.

Except for the extensive bibliography associated with that historical section, references listed at the end of each chapter are intended to supplement the material in this text either by providing the point of departure for the analysis presented here or by extending the analysis to areas not covered. Since, with the exception of the mathematical foundation, the development is relatively self-contained (the required knowledge of acoustics and theory of structures being derived or restated in the text), the references cited at the outset of an analysis are primarily mathematical in nature, thus sparing the reader the task of correlating the notations used in different texts on acoustics and plate and shell theory.

While our main goal is to present the underlying theories, we illustrate their application by means of problems selected for their practical interest. We hope to provide readers with the analytical tools for studying practical problems of interest to them. If an apology is needed for not having included those particular problems, we gladly accept the reproach that Shakespeare has Hamlet address to Horatio: "There are more things on heaven and earth, Horatio, than are dreamt of in your philosophy."

We are happy to acknowledge the moral and financial support of individuals and agencies within the U.S. Navy that enabled us to generate much of the material that is not part of the acoustician's stock in trade. Finally, it is with pleasure that we acknowledge the consistent helpfulness and patience displayed by our respective coworkers: J.M. Garrelick, J.E. Cole, III, and Rudolph Martinez at Cambridge Acoustical Associates, Inc., and numerous staff members at the David W. Taylor Naval Ship Research and Development Center.

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September 1985

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