Book Reviews

Vibration Testing: Theory and Practice

Kenneth G. McConnell, Wiley, New York, 1995, 606 pp., $84.95

McConnell states that this book is dedicated to exploring the principles and subtleties of vibration testing for the benefit of practicing engineers and graduate students. Many parts of the book appear to have been written for advanced graduate courses; however, it is not a conventional textbook, since there are only a few short worked-out examples, and there are no homework exercises. The book is packed with practical information about testing and with gems of wisdom that are obviously born of McConnell's long experience. Considerable attention is paid also to types of real dynamic system behavior that often are neglected in books that focus on theoretical analysis. A short description of each chapter follows.

Chapter 1, An Overview of Vibration Testing, defines some of the common types of practical vibration testing and the major factors involved in planning tests; gives examples from McConnell's experience of inappropriate test specifications and practices; and describes dynamic systems in general, the major subsystems and flow of data in vibration testing, and the types of testing equipment commonly used. Every chapter concludes with a summary, usually lengthy. McConnell presents in this summary his own definition of vibration testing, which has a strong flavor of environmental qualification testing; however, I found very little subsequent discussion of this subject until the concluding chapter, which is devoted entirely to it.

Chapter 2, Dynamic Signal Analysis, reviews the important concepts required for analysis of analog vibration signals, including random and deterministic signals and their statistical properties, Fourier analysis, correlation concepts, and spectral density. Appended to this chapter (and to all subsequent chapters) is a list of "References." However, it really is a bibliography, not a reference list, since most of the entries are not cited in the text of the chapter. References that really are cited are indicated in footnotes. This and most subsequent chapters could use many more specific citations than actually appear, for the benefit of readers who need to relearn basic concepts that are not reviewed in this book.

Chapter 3, Vibration Concepts, reviews free and forced responses of one- and two-degree-of-freedom damped systems, of the popular ideal types of nonlinear vibration, and of modal analysis for discrete and simple continuous systems. There is a strong emphasis on matters most relevant to testing and realistic structural dynamic behavior.

Chapter 4, Transducer Measurement Considerations, gives detailed descriptions of the electromechanical characteristics of modern piezoelectric accelerometers and piezoelectric force transducers, and of the influences on transducer system response due to associated power and signal conditioning circuits; and discusses piezoelectric angular accelerometers, transducer transient response, accelerometer cross-axis sensitivity, corrections accounting for transducer mass, methods of calibration, force transducer sensitivity to bending moments, and environmental effects on transducer systems.

Chapter 5, The Digital Frequency Analyzer, describes the computational processes, based on the discrete Fourier transform, executed by modern single- and dual-channel analyzers. The combination of Chapters 2 and 5 strikes me as a condensation of a book such as D.E. Newland's *An Introduction to Random Vibrations and Spectral Analysis*, 2nd ed., except that McConnell includes less theoretical detail and more down-to-Earth information about the specific numerical processes implemented by commercial digital analyzers, information that vibration testing users of these instruments should know.

The bulk of Chapter 6, Vibration Exciters, is devoted to detailed analysis of electrodynamic exciter systems: unloaded exciter characteristics, voltage and current modes of power amplifier control, armature dynamics, and interactions between exciter and structure leading to practical problems such as force dropout around resonances.

Chapter 7, The Application of Basic Concepts to Vibration Testing, presents several examples of real and realistically simulated vibration testing. These examples illustrate concepts from previous chapters and introduce some new subjects, such as exponential window functions and diverse types of excitation signals. The test articles were simple beams and frames, and the objective of testing was to measure frequency response functions accurately. Chapter 7 includes many illuminating experimental results.

Chapter 8, General Vibration Testing Model: from the Field to the Laboratory, is a detailed presentation of McConnell's perspective on environmental qualification testing, based on linear system analysis in the frequency domain. He states in Chapter 1 that "there is no general theory of vibration testing" and that he developed Chapter 8 to establish a better "framework to guide the processes used in setting up a vibration testing program." I question McConnell's use of "general" and "vibration testing" in the title of Chapter 8 and in the quoted phrases, because his discussion is focused on qualification testing; it has little relevance to other important types of vibration testing, such as modal testing and dynamic aeroelastic testing.

The book is marred by a multitude of editorial deficiencies. Although some chapters and sections have been edited nicely, far too much of the book resembles a typical second draft of a professor's notes distributed to students in an advanced graduate course. The organization is inconsistent, with some passages appearing almost totally out of context. For example, a short discussion of a technique for identification of externally applied forces appears from out of the blue in the introduction to Chapter 7 (accompanied by eight uncited bibliographic sources listed at chapter's end); this material belongs toward the end of Chapter 8, where McConnell repeatedly emphasizes the desirability of knowing these forces. Also, there are notational and logical inconsistencies, and there are many, many typographical errors, some obvious but others deceptive. All of the book should have been proofread more carefully, and its technical content should have been independently edited.

Although the table of contents is quite thorough, there is no author index, and the subject index is mediocre. For example, McConnell refers on p. 369 to the "five and ten rule quoted earlier." Having forgotten the exact details of the "rule," I searched back for it, but received no help from the index. All chapter sections and subsections and all equations are numbered, but cross-referencing within the book is inconsistent. Many equations and assertions appear without any reference to sources within or outside the book. This and the inadequate indexing reduce the value of the book as a source of readily available and useful information.

Because the book covers such a broad range of topics, there is useful and probably new information here for anyone involved in vibration testing. Which parts prove to be most useful will depend on one's own areas of work and interest. For example, I have occasionally been puzzled by the behavior of piezoelectric transducers, and I am very interested in structure–actuator interaction, so Chapters 4 and 6 were most immediately informative. When I next need to delve into the intricacies of digital data analysis relevant to modal testing, I shall certainly consult Chapters 5 and 7.

William L. Hallauer Jr.
U.S. Air Force Academy

Errata

Experimental Study of a Normal Shock/Homogeneous Turbulence Interaction

S. Barre, D. Alem, and J. P. Bonnet
Université de Poitiers, F-86036 Poitiers Cedex, France

[AIAA Journal, 34(5), pp. 968–974 (1996)]

FIGURE 15 was mistakenly used for Fig. 16. Both figures are shown herewith in their correct form.

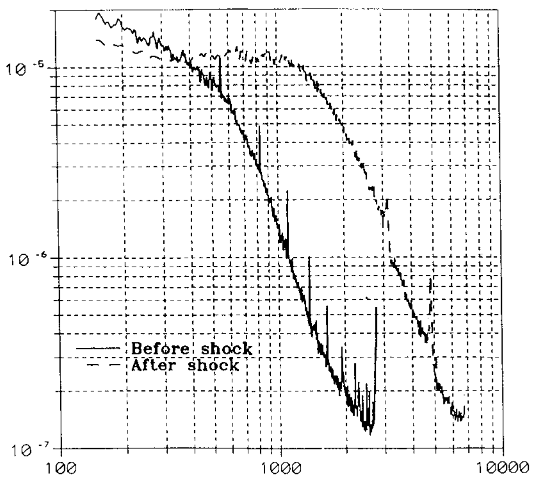

Fig. 15 Normalized hot-wire spectra just before and 11 mm (≈2 mesh grid size) downstream of the shock wave.

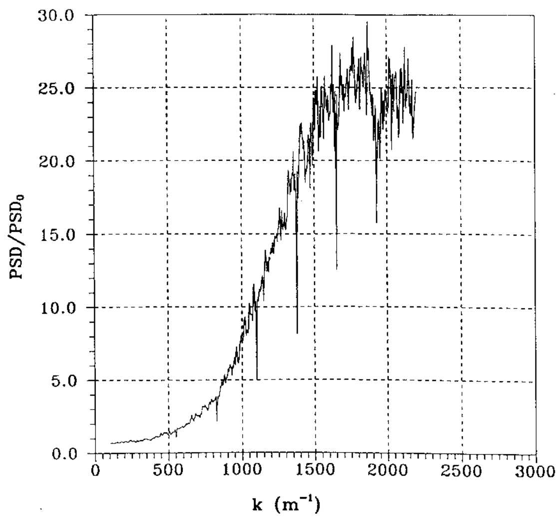

Fig. 16 Ratio of normalized hot-wire spectra just before and 11 mm (≈2 mesh grid size) downstream of the shock wave.

AIAA regrets the error.