Available online at www.sciencedirect.com
ScienceDirect
Journal of Sound and Vibration 317 (2008) 1057–1058
JOURNAL OF SOUND AND VIBRATION
www.elsevier.com/locate/jsvi

Book Review

Review of "Friction-Induced Vibrations and Sound", Gang Sheng. CRC Press, USA (2007). 424pp., price £85, US$149.95, ISBN: 1420051784

The literature relating to friction-excited vibration is extraordinarily diverse. At one extreme, the intrinsic nonlinearity of friction has led to many studies of idealised frictional oscillators by the mathematical community interested in nonlinear dynamics. At another extreme are those in the vehicle industry who have to deal with customer complaints about squealing brakes, by extensive testing and the application of "black arts" involving brake compound recipes, shims and the precise tightness of bolts. A third community with different perspectives, priorities and language are those designing controllers for systems such as robots which have frictional interactions as a key ingredient of their dynamics.

This book makes a brave attempt to give a synoptic view over a large part of this landscape. Perhaps the most striking feature is the coverage of background material. In Chapter 2, the author gives a terse but very wide-ranging overview of vibration and acoustics. First, there are the usual topics of a first course in vibration: discrete and continuous systems, free and forced vibration, modal and wave approaches. Then comes an overview of nonlinear vibration, and of random vibration theory—all this in 60 pages. Turn the page, and the chapter continues with airborne acoustics, sound radiation by structures and elastic stress wave propagation. The author manages to say something on every topic, not ducking mathematical details. The result is a very dense read, but an excellent resource for a postgraduate student or an industrial researcher. Some topics are perhaps *too* terse to be effective, except as a revision guide. If one did not already know about the critical frequency for sound radiation from plates, I wonder whether the brief account given here would convey very much.

The reader now needs to take a deep breath, before Chapter 3 launches into a similarly dense and detailed exposition of contact mechanics and friction: Hertzian theory, rough surface adhesion and friction, both lubricated and dry, and a wide range of frictional modelling approaches from data-driven to atomistic computations. This chapter seems quite full and up to date, and when combined with the extensive bibliography it gives a very valuable overview of this subject area, an area which is often not well understood by vibration theorists. Those many authors who have written papers on friction-driven vibration while assuming that all they need to know about friction is Coulomb's law would do well to study this.

Chapter 4 is the core of the book, a 100-page exposition of friction-induced vibration and sound in a wide range of systems. Closed-form solutions and computational methods, phase plane diagrams, bifurcation diagrams and chaos, a variety of friction models and types of instability, all are discussed. Again, the author shows a wish to say something about every topic: stridulation in insects, "singing sands", MEMS devices, the atomic force microscope, rock mechanics and earthquakes all get a mention, alongside more familiar engineering problems such as clutches and brakes.

Where he treats a topic I know well, the vibration of a bowed violin string, the author gives a slightly odd account, concentrating on an example problem which really has very little to do with string vibration. One would not guess from this account that the violin string is the frictional oscillator which has arguably been studied in more scientific depth than any other. I have a suspicion that some other readers may find their own pet subject given a less-than-perfect account. But then, what can one reasonably expect of an author who takes on such a challenge? One lifetime is probably too short to become a real expert on every topic covered in this remarkable book.

doi:10.1016/j.jsv.2008.03.054

The remainder of the book is given over to three chapters which discuss in some detail three particular application areas of frictional vibration and its control: hard disc drive systems, power transmission belt systems and vehicle braking systems. This material is more ''mainstream'', and probably sees the author on his home territory to a greater extent. Each of these chapters is a good, thorough overview of its material, and would make excellent reading for specialists in these areas, especially for new researchers in either an academic or an industrial setting.

Overall this book is impressive, and something which ought to find its way to the bookshelves of research groups in relevant subjects. It is not easy reading, and it has some parts which are less successful, but this is an inevitable consequence of the ambitious challenge the author has set himself, to cover the entire rambling subject and impose some structure and organisation on it. I salute the author for the amount of effort which has gone into the project, and for the unique qualities of the end product.

J. Woodhouse
Cambridge University Engineering Department, Trumpington St, Cambridge CB2 1PZ, UK
E-mail address: jw12@cam.ac.uk