Chapter 3, a special discussion by Phylis Morrison, presents the history of documentary, not necessarily scientific, photography. I was pleased to see such old acquaintances as an ionic-microscope photograph of the tip of a tungsten needle that clearly reveals the atoms. I was astonished not to see Harold Edgerton's now-vintage photograph of the high-velocity impact of a water drop on a solid surface; the crown-like image illustrates loss of symmetry and transition to a periodic structure. It was a historic photograph, and I think the author should include it in the next edition.

It is known that, after a certain crash in his career, Winston Churchill unexpectedly had a lot of spare time, a lot of worries, and an inability to act. By chance he became interested in oil painting, and in the subsequent 50 years, he interspersed oil painting with his diverse and important business. In his book, *Painting as a Pastime* (republished by Levenger Press, 2002), Churchill strongly recommended painting as a remedy for worry and mental overstrain. After reading Felice Frankel's book, I have a feeling that scientists may find the envisioning of science a useful pursuit that could diversify their lives and be a reliable remedy for stress. Perhaps a great scientist in the future will write a book, *Envisioning Science as a Pastime*, and therein acknowledge the author with gratitude.

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Fundamentals and Applications of Ultrasonic Waves

J. David N. Cheeke
CRC Press, Boca Raton, Fla., 2002. $99.95 (462 pp.). ISBN 0-8493-0130-0

Imagine an introduction to ultrasonics that brings a student from basic acoustics to the forefront of current ultrasonics research. Such a textbook could become indispensable, and David Cheeke's *Fundamentals and Applications of Ultrasonic Waves* succeeds in its avowed purpose of becoming such a text. Since Cheeke has made significant contributions in the applied ultrasonics fields he discusses in the latter part of his book, he can present the topics authoritatively.

Throughout the book, Cheeke balances elementary introduction and advanced application; his discussion of advanced application extends to current research in theoretical and experimental ultrasonics. Nonetheless, wherever possible, Cheeke uses qualitative models to elucidate complex concepts he has derived mathematically but whose full physical implications may be opaque to the neophyte. In introducing ultrasonic measurement techniques, he enumerates the steps and methods—and also the pitfalls that await the unsuspecting novice.

After a beautiful introduction to the prevalence of ultrasonics in nature and its emergence in our technological world, Cheeke devotes six chapters to fundamental acoustics. Much of that material could be found in a few undergraduate textbooks, the most familiar being *Fundamentals of Acoustics* by Lawrence Kinsler, Austin Frey, Alan Coppens, and James Sanders (Wiley, 2000). However, even in his first six chapters, Cheeke goes beyond the usual scope of undergraduate textbooks when discussing certain topics to be used in later chapters.

After chapter 6, Cheeke begins to discuss topics more specific to ultrasonic propagation, gradually introducing the reader to Rayleigh waves, Lamb waves, and acoustic waveguides. The propagating waves discussed are the main ones used in the succeeding application chapters. In a transition chapter, he discusses group velocities, velocity surfaces, and slowness surfaces, important concepts for analyzing wave propagation and in designing ultrasonic-measurement systems. An ultrasonic device requires some sort of mechanical transduction to produce sound energy. To introduce transduction, Cheeke first discusses piezoelectricity and then presents the piezoelectric constitutive relations and the piezoelectric coupling factor. Once he acquaints the reader well with these concepts, he qualitatively extends them to other forms of transduction involving electricity and magnetism, optics, and heat.

The final six chapters successfully present modern applications of ultrasonics. Cheeke starts with the most elementary applications, namely piezoelectric transducers, delay lines, and analog signal processing. He ends with one of the most intriguing problems of modern ultrasonics—sonoluminescence, the emission of light by collapsing bubbles in a liquid undergoing cavitation. At its minimum radius, such a bubble is predicted to have a central temperature between 20 000 K and 30 000 K. Poetically, the author describes the phenomenon as " 'a star in a bottle' with a hot optically opaque center and a cooler optically thin outer region." For a discussion of sonoluminescence, see Detlef Lohse's article in PHYSICS TODAY (February 2003, page 36).

A principal focus of the book is the physics and design of ultrasonic sensors. Typically of most texts, the first chapters cover reflection, refraction, and transmission through various media. But then Cheeke launches into detailed discussions of waves in different environments: on surfaces, in the bulk, in media sandwiched between two structures, trapped near surfaces, leaking away from surfaces, in films, in thin plates, and in cylinders. Those environments support such phenomena as surface acoustic waves, longitudinal and transverse bulk waves, trapped acoustic waves, cutoff modes, dispersion modes, and symmetric and antisymmetric modes. For the general case, he derives in detail the pertinent wave equations and dispersion relations. For special cases, he outlines advanced techniques for solving the equations and then presents the principal results. For the most specialized uses, he simply presents results and gives qualitative phenomenological discussions that make them plausible.

Because it relies on the knowledge acquired in the previous chapters, chapter 13 on sensors must have been the most difficult to organize, but Cheeke meets the challenge and continues to balance fundamentals with applications. In that chapter, he first derives general ultrasonic-wave sensitivity relations for such factors as mass loading, fluid viscosity, and temperature. He then uses the equations for reflections at intermediate boundaries to deduce the effectiveness of certain ultrasonic-wave modes as ultrasonic sensors. Through simple models based on sensitivity results derived from reflection and refraction relations, he conveys the physical processes that are important in sensor design. Finally, he discusses ultrasonic sensors used as mass detectors; as level, temperature, density, viscosity, and flow sensors; and in gas chromatography and in biosensing devices.

Each of the first 10 chapters ends with an excellent summary and provocative and instructive questions. Therefore, one is left at a loss when these summaries are absent from the last seven chapters. Perhaps Cheeke had some self-referential intent when he stated in the acknowledgments that authors are sometimes compelled by publishers' deadlines to abandon the full completion of their books. Even so, I think the outlines of the application chapters presented in the table of contents are enough to navigate through the engrossing topics within those chapters.

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Wavelet Transforms and Their Applications

Lokenath Debnath
Birkhäuser, Boston, 2002. $79.95 (565 pp.). ISBN 0-8176-4204-8

Wavelets are everywhere nowadays. Whether in signal or image processing, in astronomy, in fluid dynamics (turbulence), or in condensed matter physics, wavelets have found applications in almost every corner of physics. Furthermore, wavelet methods have become standard fare in applied mathematics, numerical analysis, and approximation theory. As a result, publishers strongly compete with each other to release new books at a sustained pace on the topic.

Some textbooks have a distinctly mathematical flavor, including Ingrid Daubechies's celebrated *Ten Lectures on Wavelets* (Society for Industrial and Applied Mathematics, 1992), the Yves Meyer volume *Wavelets, Algorithms and Applications* (Society for Industrial and Applied Mathematics, 1993), or the more popular *Wavelets: Tools for Science and Technology*, by Stéphane Jaffard, Yves Meyer, and Robert D. Ryan (Society for Industrial and Applied Mathematics, 2001). Among the texts more directly aimed at signal processing, we may cite Stéphane Mallat's *A Wavelet Tour of Signal Processing* (2nd ed., Academic Press, 1999). Finally, there are introductory textbooks suitable for a first contact with wavelets. *Wavelet Transforms and Their Applications*, by Lokenath Debnath, clearly belongs to the last category. Debnath has published several textbooks on turbulence, wavelets, and mathematical methods, and has also lectured extensively in the US and in India on wavelet analysis. The present volume results from his teaching experience.

Despite its title, *Wavelet Transforms and Their Applications* is not a textbook on wavelets. (Wavelets appear only on page 361!) Rather, the book is an overview of a class of integral transforms that generalize the Fourier transform to the time–frequency (or time–scale) domain: the short-time (or windowed) Fourier transform (also improperly called the Gabor transform), the Wigner–Ville transform, and the wavelet transform in both its continuous and discrete realizations. It is commendable to discuss such transforms as a class, because they have marked similarities that arise from their origin in group-representation theory. Debnath's treatment is essentially self-contained. For example, the first two chapters review Hilbert space and the Fourier transform in great detail. Many exercises, with hints and solutions, appear throughout the text. Altogether, this is a textbook suitable for a one-semester course at the senior or graduate level.

Unfortunately, the organization of the book is inexcusably sloppy. There are many typographical errors, some of which are mathematically confusing. Some statements are simply wrong. To give a few examples: on page 96, $\|Tx\|$ should replace $\|T\|$ in the definition of the operator norm; on page 181, "eigenfunctions" should replace "eigenvalues;" and on page 207, the Gaussian window is claimed to be the only minimal uncertainty state, whereas all coherent and squeezed states are also minimally uncertain.

Worse yet, the structure of the book is somewhat random. Ideas are sometimes used before they are properly defined. Frames are described twice—in sections 4.5 and 6.4—without cross-reference. Many mathematical assertions are inaccurate or missing. For instance, unbounded operators are never mentioned, and that omission creates a systematic confusion between Hermitian and self-adjoint operators. The definition of the support of a function on page 37 is not the accepted one. Chapter 2 discusses distributions at length but, curiously, does not describe the much simpler tempered distributions. Chapter 3 does not even mention Fourier transforms of tempered distributions.

Finally, the author propagates the terminology "Heisenberg uncertainty relations" in a classical signal-processing context, although only Fourier's theorem is involved. The term "Fourier uncertainty relations" would be more appropriate. This in no way minimizes Werner Heisenberg's achievement, which was to interpret quantum measurements probabilistically, not to discover the mathematical theorem that relates the width of a bump to that of its Fourier transform.

In conclusion, Debnath's book is certainly on the right track, but we can only hope that a second edition will alleviate its shortcomings.

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