This review first appeared, in slightly different form, as:

Rosen, S. (1998) Introduction to Sound: Acoustics for the Hearing and Speech Sciences by Charles E. Speaks. *Journal of Audiological Medicine*, 7(1): 84-86 (book review).

Introduction to Sound: Acoustics for the Hearing and Speech Sciences (second edition) by Charles E. Speaks (1996) Singular Publishing Group: San Diego, 348 pages.

About 10 years ago, a non-technically-minded student of the speech and hearing sciences was in a difficult position. Although clearly needing to understand concepts developed in the physical sciences (such as spectra and linearity), there were no introductory texts which dealt fully with these basic concepts in a simple and straightforward manner. Textbooks which dealt more directly with hearing and speech typically would (and still do) have an introductory chapter which could do nothing more than quickly review such concepts. But for those who had not encountered this material before, such chapters could be not much more than a tease. Clearly, there was a need for a non-mathematical introductory text, aimed at, among others, speech and language therapists, audiologists, phoneticians and psychologists, to prepare students for further study in the speech and hearing sciences.

This book is one attempt to fill that need. But, in the current political spirit of full disclosure of any conflicts of interest, let me first say that I with my colleague Peter Howell, also wrote a book with similar aims which appeared a year or two before the original edition of this one — *Signals and Systems for Speech and Hearing* (1991, Academic Press). Still, I believe I can remain reasonably objective about the merits of this book, and can perhaps provide a nearly unique point of view, as one who has tried to think through *what* needs to be covered in such a book, and *how* best to do it. As it turns out, there are quite a few similarities between the two books, but some significant differences as well.

Starting at the inside of the front cover (a listing of terms and symbols), is not unfortunately, an auspicious start. On this page alone, there are a number of typos (*db* for *dB*, *g* for the prefix giga- instead of *G*) and non-standard usages (*Nt* for newton in place of *N* , and *sec* instead of *s* for second). Typos can just about be forgiven, but I believe a great disservice is done by using non-standard terminology. No other literature will have anything but the symbol *N* for newtons, and it may greatly confuse those who see no other book on acoustics but this one.

Apart from this, the book gets off to a good start with a chapter on *The Nature of Sound Waves* and *Simple Harmonic Motion*. There is rather more emphasis on physical concepts here than in my own book, and I think that is all to the good. I sometimes worried that beginning students would not fully be able to get to grips with concepts like reactance and admittance, but I suppose a passing acquaintance with such concepts is better than none at all.

Following this are two chapters that essentially introduce decibels, a sore point for many beginning students. A chapter on *Logarithms and Antilogarithms* (including a detailed and welcome discussion of scientific notation) precedes one entitled *Sound Intensity and Sound Pressure: The Decibel*. That the author uses about 80 pages to develop this topic must be some sort of record, but one that is mostly justifiable. Some of the presentation could be shortened here by excising the long discussion of log tables (does anyone today use such tables anymore, given the ubiquity of calculators?) and there is an unnecessary discussion of different kinds of measurement scales (which also confuses S S Stevens' notion of a ratio scale with that of a logarithmic one). Apart from these, the strengths of the book are particularly apparent here in that there are many worked examples, and problems for the student to work out. Most chapters also include a *Frequently Misunderstood Concepts* section, in which problems which past students have had difficulty with are explicitly worked through.

The next three chapters are much more problematic, primarily because they move much too quickly for the targeted audience. If someone needs 80 pages to understand decibels, they will need considerably more explanation of the concepts explored in these chapters than is offered here. And some real weaknesses of the book are displayed. There are too few figures for my taste, and there are places where the exposition suffers because of it. For example, in the discussion of constant bandwidth and constant percentage bandwidth filters, it would have been better if both sets of filter shapes had been displayed on both linear and log frequency scales. In general, the figures are rather primitive and clumsy, with spindly plotter-type lettering in which open letters sometimes close up. Their sizes vary in inexplicable ways, with large areas given over to figures with very little information and vice versa. Some of the figures have ‘glitches’ in them (Figures 6-14, 17 and 18) whereas others don’t display what the text says they do (the filter of curve B in Figure 6-10 is not at -14 dB at 500 Hz, as claimed in the text).

There are also some distinct errors throughout these chapters, including a serious inconsistency about the way phase is defined. In Figure 5-9, for example, a true sinusoid (that is to say, one which is 0 at time 0, and increases initially) is shown as having a single component in the phase spectrum with a value of 0°, although it is typical to define 0° as a *cosine*. That this reflects a real misunderstanding (rather than a different convention) is shown in the phase spectrum for the sawtooth, which should have all its components in this same sine phase, but is shown instead as having all components at 90°. The text is even worse, in that it claims that a sawtooth can have *any* phase value for its components, as long as they are all equal. This is patently untrue, as the waveform of a complex periodic tone all in cosine phase will lead to a kind of “bilateral symmetry” in the waveform (properly known as an *even* function) which is completely different from a sawtooth. In fact, it is possible to synthesize a sawtooth with more than one phase spectrum, but certainly not in the infinite number of ways implied here.

Other errors include: the implication that all white noises are Gaussian (that a noise is Gaussian is a statement about its distribution of amplitudes, and it is possible — in fact common in current digital signal processing —to have white noise that is not Gaussian); the statement that an aperiodic wave has to be random (untrue), with an explanation some pages later that a single (non-random) rectangular pulse is aperiodic (true); the implication that frequency responses are typically normalised to the level of the *output* frequency of the greatest amplitude, whereas the more typical case is for them to be referred to the level of the *input*; the implication that the 3-dB bandwidth of a filter is the same as its equivalent rectangular bandwidth; a confusing (and wrong) passage concerning the relation between the frequency response of a system and the maximum levels for a certain amount of harmonic distortion. There is also a completely novel (and certainly misleading) use of the term *transient distortion*, to apply to the spectral splatter that occurs when even pure tones are turned on and off. This usage appears to confuse the distortion produced by a system with a property of the signal.

I was particularly disappointed by these chapters also because they do present some topics not available in any other elementary texts. For example, there is a section on the calculation of spectrum level, and the way to convert between it and overall sound pressure level (although there was a tendency to simply give a result without properly motivating it in this section). At the same time, I was surprised that there was no coverage of the temporal aspects of filtering, and time/bandwidth relationships.

The final chapter, *Sound Transmission*, seems tacked on . It’s not that more “real” acoustics wouldn’t be desirable, simply that the topics do not seem well integrated with the rest of the text.

A video tape to accompany the book is also available, at a fairly substantial price. Don’t bother. The entire tape consists of primitive line animations, only a few of which seemed of any use at all. It reminded me of the worst kind of educational science films made in the 50's, but aesthetically of even lower standard. Given the kinds of visual sophistication we have all become accustomed to, through television, computer-based animation and graphing packages, and surfing the Internet, such a tape has no hope of motivating students.

In summary, for someone who needs to learn about the basic aspects of sinusoids and decibels, I can highly recommend the first half of this book. (But I would hope few readers of this journal would be in that position!) For the basics of signals and systems analysis, from a pictorial and non-mathematical viewpoint, including concepts like spectra and filtering, my own book fits the bill. For the person who wants a straightforward physically-based introduction to the acoustics of speech and hearing for the non-technically-minded ...., well, that book remains to be written!