than monolingual, and these cases can be seen as monolingual language processing augmented with elements of machine translation. Even the lexicography chapter is for a good deal concerned with monolingual aspects, but what the authors do say about multilingual lexicons is to the point. Their argument that the meta-text of a monolingual dictionary is in another language, and that thus every explanatory dictionary is multilingual, only contributes to a confusion of ideas. The meta-text is a special style, but this text type is of course part of the same language.

A more regrettable shortcoming is the fact that the book is not multilingual in scope. The authors openly admit that they have made efforts not to refer to literature which is not in English. An introductory book should not narrow its readers' horizon in this way. There are already too many (computational) linguists, for whom "natural language" is a synonym for "English". It seems preferable to emphasize that linguistics is not only the science of language but also of languages. Computational linguistics is developing in that direction as well.

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Electronic Synthesis of Speech

R. Linggard

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Speech synthesis has become, in the last ten years or so, a field of substantial commercial as well as intellectual interest. The Compleat Computational Linguist must ultimately include speech synthesis (and recognition) in his purview, just as theoretical linguistics must ultimately explain the regularities in speech. The field has been difficult to cover because important facets of it come from such widely divergent disciplines as electrical engineering and phonetics, and because there have been no general and easy introductory text or reference books. *Electronic Synthesis of Speech* goes a long way toward easing this last difficulty.

Linggard intends this book to be "a comprehensive text and reference source for scientists and technologists working in the field" and also suggests that it should be useful as a "textbook for courses on speech processing" (p. vii). The first two chapters cover history and phonetics, and the other four chapters treat mathematical and computational aspects of synthesis.

I don't think this book would do as a sole reference or course text book, although it would be very useful if augmented with other sources. Because it attempts a broad coverage of speech synthesis in a small volume, it doesn't cover any single subject in depth. It would be difficult to teach from this book because of its lack of exercises and problems for the student. But overall, it's a good book. The references are numerous and useful, and it is especially satisfying to see synthesis set in its historical context.

Linggard's coverage of the engineering aspects of speech synthesis is excellent, although for a thorough understanding you should consult the original technical papers, which he references quite well. (A good collection of these is in Flanagan and Rabiner (1973).) Spot checking several of his numerous equations and their derivations turned up no apparent errors. It is refreshing to see the basic equations for speech production derived from a true mechanical model rather than from an electrical analog.

I would guess from this book that Linggard's home discipline is engineering, because his coverage of phonetics (Chapter 2), in contrast, is errorful and misleading. Don't get your phonetics from this book; buy another, on phonetics alone. (Ladefoged (1975) would be a good selection, and Ruhlen (1976) has an excellent introductory chapter on phonetics.) Linggard can also be faulted on his short discussion of the pre-historic evolution of speech (pp. 2-3), which is speculative, superfluous, and probably wrong.

It is often unclear if Linggard's comments on phonetics are meant to apply just to English or to speech in general. In addition, I think many of his details are mistaken or misleading. Here is a sampler:

On page 23 is Fig. 2.4, Linggard's main presentation of speech sounds. It is a table of IPA (International Phonetic Association) symbols for sounds, illustrated with example words. This table is quite misleading and insufficient, especially for speakers of non-upper-class British dialects. The legend to the figure reads "Some suggested IPA symbols for the phonetic transcription of English"; one must read the text carefully to discover that they are really only symbols for RP (Received Pronunciation) English, a minority upper-class British variety of speech. He gives the word *further* as an example of the sound /ə/ (called "schwa"), and his symbols for the diphthongs in *peer, pair, boar,* and *boor* use /ə/ for the second part, or off-glide, of the vowel; the student might think that /ə/ sounds like *r*, but it doesn't. RP has dropped some /r/s and changed others to /ə/. The peculiarities of RP should have been discussed and the table should have covered more general English.

There are also some discrepancies between vowel symbols in his table and the table for RP presented in Hughes and Trudgill (H&T; 1979: 26):

	Linggard	H&T
bat	a	æ
bet	e	ɛ
load	əʊ	ou

More common usage of these symbols is in line with H&T, not Linggard: if you pronounced *bet* with the sound most people transcribe with /e/, it would sound like *bait*. This table is also incomplete, in that several phonetic symbols used elsewhere in the book – such as /o/ and /ɛ/ further down on the same page – are not defined. A table showing common variations in usage of symbols for sounds, as in Ladefoged (1975: 64), would have been a great help for the beginner.

On page 24, describing lip position and nasality, he writes "Fortunately, these two variables do not seem to be used as continuous variables to any great extent." True but misleading. The same thing could be said about every other nonprosodic linguistic variable!

On page 25, he writes "[In English] the /w/ consists of a rapid transition from a /u/ position to a /ə/ position." Not exactly true. The /w/ consists of a rapid transition from a position slightly more extreme than /u/ to whatever vowel follows.

On page 25, he writes "But in some languages and dialects whispered or unvoiced versions of /w/, /j/, /r/, and /l/ are valid articulatory gestures in their own right." True but misleading. Almost any voiced sound can be found as a regular unvoiced variant in some language, even vowels (cf. Japanese, Shoshone (Ruhlen 1976: 267)), and in English these sounds are regularly devoiced when following an unvoiced stop in the same syllable.

On page 26: "The anomalous position of /h/ as a fricative now becomes clear, since it is obvious that it is impossible for it to have a voiced equivalent." In fact, /h/ is often phonetically voiced.

On page 28: "Pitch is the fundamental frequency of vibration of the vocal cords." This is not correct; pitch is a perception typically corresponding to fundamental frequency, but which may be influenced by other variables, such as loudness.

There is something wrong with the spectrogram on page 33: at the location labeled /r/, the third formant actually rises a little instead of falling, as it must if an /r/ is to be heard.

On page 37 he says: "For all stops the place of closure is mainly characterised by the formant transitions into and out of the stop." This is a controversial position and should be labeled as such. Some researchers think that the noise at the instant of release is more important.

On page 15 he writes: "In general terms, two of these [formants] are required to specify vowel quality, a third is required to establish speaker identity, and the fourth/fifth may be added to give natural voice quality." But on page 33: "For a given speaker three formants are usually enough to characterise the vowel." This is confused and confusing. What's probably true is that two formants are required for normal vowels, three for vowels colored with /r/, as in *hurt*, and no one knows how many are required for speaker identity and natural voice quality.

If this review has seemed to concentrate too much on phonetics, it's because that's where the problems lie.

In summary, this book gets a "B": "D" in prehistory, "A" in history, "C" in phonetics, and "A" in engineering. If you want to set up shop in computational phonetics, get this one plus a good book on phonetics, and start collecting papers from the journals.

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Readings in Knowledge Representation

Ronald J. Brachman and Hector J. Levesque (Editors)

Los Altos, CA: Morgan Kaufmann Publishers, Inc., 1985, xix+571 pp.
ISBN 0-934613-01-X; $26.95

To anyone working in artificial intelligence, this book provides a comprehensive introduction to knowledge representation (KR). By presenting original source papers that have served to define the problems of KR, the book provides a unique overview of the field. The overall organization of the collection of papers includes discussion of what constitutes a knowledge representation language; it presents problems introduced because of the demand for automatic inferencing to provide implicit information; and it addresses the issues of what constitutes an adequate domain knowledge for a specific application.

The book also includes an extensive partially annotated bibliography of many related works that could not be included in the volume. These annotations include pointers to each mentioned article's applicability to KR in general, in networks, in frames, regarding logic formalisms, whether they are procedural or production system approaches, or whether they are specific to domain knowledge representation.

The book has provided an excellent resource for my Introduction to Natural Language Processing class. It makes available many of the relevant papers that are critical to the current focus of research regarding meaning: What is it? How to represent it? What are the constraints introduced because of KR assumptions and their role during implementation, and the general concerns of what should be included in an implementation. Complementary as well as opposing viewpoints are found in close proximity. Even the role of logic in KR, along with the