

A new type, **CARDINAL**, has been added. It is an unsigned integer and is used in place of the **INTEGER**, which is now used only when a **VARIABLE** can be negative. This would appear to allow the compiler to do more checking if the programmer will initially think out the variable possibilities.

The **CASE** and variant **RECORDS** now include an **ELSE** statement, which will catch unspecified case values. This is handy when using a case selector which is of an unallowed type but isn't specified in the **CASE** label list. Other changes, such as putting vertical bars in front of **CASE** label, make the program more readable.

The different types **CARDINAL**, **REAL**, and **INTEGER** are not permitted in the same expression, so it is necessary to decide on the type of the answer and then change all types to explicitly agree with this one type. Fortunately, utilities are included which allow one to change explicitly from one type to another.

There are several other helpful changes. **ELSIF** allows modifications to the **IF THEN** statements, so that the **FOR** statement can have a step value other than 1 (which is still the default value). Procedures can be called before they are declared. File handling seems much more sensible and more specific, with more checking and probably less possibility for error.

The last section contains the utilities. These seem to give much more control over handling errors as well as string handling that is, as noted earlier, very similar to UCSD capabilities. All the input-output procedures for text file or terminal access seem well thought out with more error checking than I'm used to, although in actual use they may not perform as well as expected.

Overall, the book offers many hints and warnings about how to use or not misuse the various aspects of Modula-2. Those who have had previous experience with Pascal should probably be writing simple programs in a few hours with this book. I would recommend beginning by going through the first and third parts very rapidly to gain a general overview. After that, it would be best to concentrate on part two, actually write some simple things, and play with some of the examples. Learning the syntax should occur quickly since it is very similar to Pascal. For the newer concepts I think it would take me a lot more than a few hours and probably more than what is covered in this book to understand them thoroughly.

For those who are thinking of getting involved with Modula-2, I'd recommend reading Gleaves' book before investing in a Modula-2 compiler. The book explains better than anything else I've seen what Modula-2 is all about. Although it takes some work, it is certainly a readable text.

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**THREE DEGREES ABOVE ZERO:  
BELL LABS IN THE INFORMATION AGE**  
by Jeremy Bernstein  
Charles Scribner's Sons, New York, NY  
1984, 241 pages, hardcover, \$17.95

**Reviewed by Brian Pankuch\***

This book is an intriguing mixture of the history of technology and science with personal insights about some of the scientists who have made important discoveries. Bernstein provides extensive background material about many Bell scientists, beginning with their early research interests and continuing to the current work they are doing at Bell Labs. I was struck by the diversity of these individual stories. While some scientists seemed to move directly into their main research, others knew what they wanted to do but found it difficult to pursue their chosen field at the appropriate level until arriving at Bell. A great deal is said about academic freedom in higher education, but one can't help but be impressed by the freedom many of these scientists feel they have. The combination of basic research, technology, development and the freedom to pursue personal interests is not only satisfying to the individual but also a very successful approach. Seven Nobel Prizes in Physics alone have been won by Bell Lab scientists.

The four main parts of the book are mostly concerned with the solid state and fiber optic areas, but considerable chemistry and material science seep in. Many sections of the book offer impressive descriptions of the latest technology. Bell is testing fiber-optics which transmit 420 million bits/sec. Using these techniques, a thirty volume encyclopedia could be transmitted in one second, making a mistake in only a single letter.

Among the computer sagas is the story of Belle, a very capable chess playing computer who beats 99 out of 100 human players and is providing insight into how people think when they play chess. It seems that part of what grandmasters do is to see the entire chess board as a single entity. That strikes me as being a bit like thinking of NaCl as a chemical with many properties, i.e., a whole entity. It isn't just a group of letters that are laboriously put together following a bunch of rules to make a compound. In other words, this research may give us insight into the learning process and how it can be improved.

The stories of some of the major discoveries are especially interesting. Some researchers identified their major interests quickly; others seem to be continually searching for new areas, whether in the area of computer identification of human speech or the photovoltaic effect in silicon. The latter discovery occurred by chance when Russel Ohl placed a cooling fan in front of a bench light, chopping the light. The voltage shown on an oscilloscope followed the chopped light. Instead of just moving the light, he began to study the effect, and fifteen years later the first solar battery resulted from the research begun in this way.

Many other discoveries resulted from the same combination of inspiration and hard work. Shockley and Bardeen were able to work on the transistor because of a technological breakthrough. They combined new physical insights with an improved mathematical theory to produce greater understanding and further technical breakthroughs.

Managers at every level at Bell Labs have very strong backgrounds in science and technology but very different attitudes toward their jobs. Addison White comments on his position at Bell "...the jobs that management people should be doing are fairly dull. So the higher my responsibility became, the duller the work was." Another manager, Arno Penzias, Nobel Prize winner in Physics and Director of Research, has a different slant. "The nice thing about each of the administrative jobs that I have had is that the previous occupant retired, so that I was able to redefine the job. In each case I became convinced that I had the best conceivable job, not just in Bell Laboratories but probably in the world of science ... Each new job turned out to be marvelous."

Some of those interviewed expressed concern that the break-up of AT&T may create more pressure for short term results and less emphasis on basic fundamental research which has a longer term payback. As might be expected, some individuals are mostly concerned with continued funding of personal interests, but others have a general anxiety that the strange magic that makes Bell Labs what it is may not continue. With the freedom at Bell and a Director of Research with an attitude like that expressed by Penzias, one feels that Bell Labs will continue to do very well in the future.

This gives some of the flavor of the book, good science and technology laced with interesting personal anecdotes. In many ways, these scientists and engineers come across like the rest of us. They have a great deal of uncertainty as to the future and are seeking balance and satisfaction in their work. The difference is that much of their work is literally at the frontiers of current science. Bernstein's book not only suggests that this fantastic group of people will continue their balancing act in the future but gives the reader some very positive feelings about what science and technology are creating.

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## **BASIC COMPUTER PROGRAMS IN SCIENCE AND ENGINEERING**

by Jules H. Gilder

Hayden Book Co., Rochelle Park, NJ  
1980, 256 pages, softcover, \$8.95

Reviewed by Harry E. Pence

There are a wide variety of computer books with titles that indicate that they are designed for scientists and engineers, and the purposes of such books vary equally widely. Gilder has written this book to fulfill two major goals; it is intended to be a sourcebook of mathematical, statistical, and electronic engineering programs and to provide examples that may be used