research is centered on vector and parallel computation, a field which is still in its infancy. The practitioner would do well to use this monograph as a springboard from which to launch on new methods for the incredible variety of emerging parallel and vector architectures. A summary of the nine chapters follows.

Chapter 1. "Typical Elliptic Problems," in which a description of a variety of physical problems which lead to elliptic systems motivates this treatise.

Chapter 2. "Classical Analysis," wherein a concise overview of the most essential and commonly used classical results are given which serve as a guide to formulation and solution of discrete approximations.

Chapter 3. "Difference Approximations" is a thorough treatment of several differencing techniques with analysis of approximation error and interrelationship of associated properties with solution techniques.

Chapter 4. "Direct and Iterative Methods" and

Chapter 5. "Accelerating Convergence" contain in-depth reviews of many of the most prevalent numerical techniques for solving large elliptic systems. Relative advantages of direct and iterative methods as a function of type of problem are discussed along with methods which utilize a combination of both approaches.

Chapter 6. "Direct Variational Methods" and

Chapter 7. "Finite Element Approximations" deal with variational principles characterizing solution of boundary-value problems, application via patchwork finite element approximation, and error estimation with the aid of classical polynomial approximation theory.

Chapter 8. "Integral Equation Methods," in which there is a concise description of Green's functions, boundary element methods, conformal mapping, capacitance matrix methods and other techniques for solving elliptic equations. Methods discussed here are "quasi-analytic" in that numerical approximations are made in conjunction with extensive analytic reduction.

Chapter 9. "ELLPACK" describes some of the capabilities of the Purdue ELLPACK software package for solving elliptic problems.

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9[65N99, 68-04].—JOHN R. RICE & RONALD F. BOISVERT, *Solving Elliptic Problems Using ELLPACK*, Springer-Verlag, New York, 1985, x + 497 pp., 24 cm. Price $46.50.

While I suspect most readers interested in this book will have some knowledge of the ELLPACK project and its origins, it seems advisable to sketch them because to some such background is necessary to understand this software. The solution of elliptic boundary value problems requires a sequence of operations, i.e., discretization of the domain, discretization of the equations and their boundary conditions, solution of the resulting linear equations, preparation of output. From the early 1970's, researchers in mathematical software have produced many high-quality program packages for individual steps in this sequence. One of the major motivations of the ELLPACK project was to standardize the large-scale testing of such

program 'parts' of the PDE solving process, e.g., so that three linear equation solvers could be easily compared using the same discretization, output stages. The problems confronting the designers of ELLPACK then were not ones of how to design software for PDE's, but how to design a testing framework into which modules could be plugged that were prepared and contributed by others. The result has been a successful software system, now distributed by IMSL Ltd., with capabilities:

(i) for use as a test bed;

(ii) for instructional use (as has been done by the reviewer);

(iii) for 'production' solution of PDE problems (although to the reviewer's knowledge, it has had limited acceptance for this purpose).

The ELLPACK system contains a large library of state-of-the-art mathematical software contributed from many sources to the project. It is used by preparing a 'program' in the ELLPACK language which is then translated by the ELLPACK processor into FORTRAN code with references to routines in the ELLPACK library. One of the features that distinguishes ELLPACK from a software system for solving PDE's is the flexibility to evolve that is built into its design. Software maintenance tools are provided for modifying the preprocessor so that new modules can be added to the library, or even modification of the grammar of the preprocessor can be made.

The book is an aggregate of documentation and literature for the project that has appeared previously in various levels of formality. To have this material edited into one volume provides a very useful reference for the ELLPACK user. The first roughly two thirds of the book deals with the use of ELLPACK to solve boundary value problems and the last third documents it as a language translator. The first two thirds provide an excellent tutorial introduction which moves from elementary to sophisticated uses, a description of the software parts in the library (i.e., a brief, standard format summary of each), and a description of the performance of these parts on a test suite of problems provided in an appendix. The latter third of the book describes how a 'user' can extend ELLPACK by adding code to the existing library or by modifying the ELLPACK language through generating a new preprocessor using a preprocessor generator distributed as part of ELLPACK. The ultimate test of software documentation is, of course, the experiences of a reader using it to accomplish some goals with the software. The reviewer has had happy experiences with the documentation in the first two thirds of the book, but has never tried modifying the ELLPACK as per the last third. Nevertheless, he found the material interesting and confidence-inspiring, although one would have to be a real enthusiast to try to regenerate a new ELLPACK preprocessor.

Two comments: The organization of the book leaves something to be desired in places, particularly in the systems documentation; be prepared for some page flipping and rereading due to repetition and inadequate cross-referencing. Secondly, the book requires a background in numerical methods and software for elliptic boundary value problems for the user documentation and a background in applications software systems and language translation for the systems documentation.

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