18[5.10.3].—BRUCE IRONS & SOHRAB AHMAD, *Techniques of Finite Elements*, Ellis Harwood Ltd., Chichester & Halsted Press, a division of John Wiley & Sons, New York, 1981, 529 pp., 23cm. Price $30.95.

Let it be said at the outset that this reviewer holds Bruce Irons in great respect for his many original contributions to the understanding of finite element technology as engineers understand it. Bruce Irons stands out as the most prolific contributor to the art of finite element analysis during the 1960's and early 1970's. Several techniques Irons developed or suggested have since become standard procedures in finite element analysis or motivated significant theoretical work. Examples are: isoparametric elements, use of rational basis functions in conjunction with exactly and minimally conforming C^1 elements, hierarchic basis functions, the frontal solution technique and, of course, the patch test. These impressive accomplishments are based on Irons' almost unique ability to combine strong engineering intuition with mathematical know-how at the level of traditional engineering training.

This book was written with the approach that served Irons so well in that exciting and productive period of the 60's: intuitive reasoning, supported by sketches and analogies whenever possible, with minimal mathematical development. This approach is the source of both the strength and weakness of the book: while the intuitive treatment may provide fresh insight for the mathematically trained and untrained alike, it can lead to misinterpretations and erroneous conclusions when important conditions and qualifications are neglected. There has been very substantial progress in the theoretical understanding of the finite element method in the last ten years. By ignoring these developments the authors accepted the limitations common to all engineer-oriented books written on the subject.

Looking to the future, the authors present interesting observations concerning the users of finite element technology and their requirements: There will be "vast numbers of unsophisticated users" who will be "interested in meshes that give about $\pm 2\%$ accuracy [presumably in stresses]—not much more and certainly not much less". They will have access to "uncosted computers" in their offices and will employ finite element technology in design, submitting small ten-element jobs almost daily. Without actually saying so, the authors make a very good case for adaptive finite element technology. Clearly, unsophisticated users, who are viewing finite element technology as a modeling tool and state their requirements in terms of desired levels of precision of some computed function, will require sophisticated, foolproof software systems. On the subject of error estimation, the authors express a view which has not yet been generally accepted by engineer analysts but is likely to become conventional wisdom within a few years: "We feel that the time is past when we should confirm our answers by experiments, or compare them with other people's answers. Experiments are generally less trustworthy than calculations using an established technique. Rather, we should attempt to keep computing self-contained, to make the computer assess its own results". These requirements present an important challenge to the finite element research community.

The book deals with a wide range of topics. Its 29 chapters are divided into seven parts: 1. Introduction (basic techniques, shape functions); 2. Organization (miscellaneous topics ranging over problems of management, structural concepts, the patch test and development of elements); 3. Solution techniques; 4. Trends in element formulation (the authors predict a bright future for the hybrid and SEMILOOF type elements); 5. Trends in solution techniques; 6. Speculations (miscellaneous non-structural applications and the patch test are discussed); 7. Theoretical details (numerical integration, matrices, differential geometry).

Fracture mechanics and the computational problems assôciated with applications of the finite element method in fracture mechanics receive little attention. This is surprising especially because the authors make the point that they are looking to the future, which undoubtedly will bring ever increasing reliance on fracture mechanics at the expense of the traditional approach based on maximum stress design.

An interesting and unique aspect of the book is its informal style. It is replete with irrelevant and often irreverent comments, which provide welcome diversions in the otherwise demanding pursuit of the idiosyncratic processes of bright engineering minds wrestling with the finer points of finite element analysis.

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19[3.35].—ALAN GEORGE & JOSEPH W. LIU, *Computer Solution of Large Sparse Positive Definite Systems*, Prentice-Hall, Englewood Cliffs, N. J., 1981, xii + 324 pp., $23\frac{1}{2}$ cm. Price $24.95.

This book is about efficient implementation of the Cholesky factorization method for the solution of sparse positive definite systems. The two main concerns of the book are the development of the various reordering schemes and the corresponding efficient algorithms. The basic tools for direct sparse matrix solution are described which include the fundamentals of Cholesky factorization and solution as well as graph theoretic ideas for reordering algorithms. Algorithmic efficiency is achieved by careful consideration of operation counts and storage requirements. Fortran programs implementing the algorithms are included and discussed in great detail.

The authors discuss a collection of methods which from their experience they prefer for solving sparse matrix problems. Band and envelope methods are described and the Reverse Cuthill-McKee Algorithm is proposed for the reordering problem. The minimal degree algorithm is considered for low fill reordering for general sparse matrices. Quotient tree methods for finite element and finite difference problems are also studied. The last of the methods studied are one-way and nested dissection methods for finite element problems.

This book should be of interest to numerical analysts, engineers, and anyone involved in the solution of positive definite sparse matrix systems. As a text, the book could be used along with a good text on iterative matrix techniques for a one semester course on sparse matrix solution. Exercises dealing with program modification as well as more theoretical considerations are included at the end of the