most specialists but few nonspecialists will want to own this book. A few of the papers, however, could be quite informative for the general reader; the above-mentioned papers of Lootsma, Fletcher, and McCormick are in this class, as are, to a somewhat lesser extent, the reports of computational experiments by Himmelblau and by Sárgent and Sebastian.

J. W. D.

52 [4, 5].—GUNTER H. MEYER, *Initial Value Methods for Boundary Value Problems*, Academic Press, New York, 1973, x + 220 pp., 24 cm. Price $14.50.

MELVIN R. SCOTT, *Invariant Imbedding and its Applications to Ordinary Differential Equations. An Introduction*, Addison-Wesley, Reading, Mass., 1973, 215 pp. Price $19.50, cloth, $11.50, paperbound.

Although these books deal with the same topic, there is remarkably little overlap. When they are to be distinguished in this review, the author's initials will be used. The books are monographs devoted to the technique of invariant imbedding as applied mainly to two point boundary value problems for ordinary differential equations. There are several ways of viewing invariant imbedding. The original view is to consider a particular problem as imbedded in a family of problems with the length of the interval as a parameter. The invariant imbedding equations are differential equations for the unknown boundary values as a function of this parameter. These equations turn out to have specified initial values, in this respect, they are simpler than the original problem. Moreover, the approach is a natural one to some problems, e.g. when only the missing boundary values are of interest, or for parameter studies varying the interval length, or when a free boundary is to be located. Another view of invariant imbedding is as a kind of shooting method. A third view appropriate to linear problems is based on Riccati equations and is a natural approach to Sturm-Liouville problems.

When the ordinary differential equation is nonlinear, the imbedding equations are partial differential equations. They are the principal object of the theory in GHM and are thoroughly investigated using characteristic theory. Numerical aspects of the solution of the partial differential equations are treated as well. MRS is almost wholly concerned with linear problems, which lead to initial value problems for ordinary differential equations. His analysis is based on the Riccati approach and particular attention is given to the computation of the solution (as opposed to the missing boundary values). GHM is the more demanding of mathematical background, but both books place modest demands on the reader. Both books are clearly written and well structured, though both would have profited by more careful proof reading.

It is frequently the case that the invariant imbedding equations are stable and represent an effective way to solve boundary value problems. The authors do not attempt to evaluate the approach in comparison to alternatives, though MRS explicitly responds to criticisms of the approach. There can be difficulties such as instability, stiffness, cancellation, and critical lengths. Some of these are brought out by example, though the reviewer's experience has been that stiffness is a common and serious difficulty which neither author mentions. There are some nice applications of physical interest which are detailed in examples. The Stefan problems and oil reservoir problem in GHM and the Sturm-Liouville problems in MRS particularly appeal to the reviewer.

It will dishearten those writing codes for initial value problems to learn that nearly all the examples in both books were computed using fixed-step, fourth-order Runge-Kutta codes. The techniques being studied are utterly dependent upon the reliable, efficient solution of initial value problems. Because they were obtained from long obsolete codes, the computations reported cannot be used to assess the reliability and effectiveness of the approach nor its efficiency as compared to methods not based on initial value problems. Since this situation is all too common, the reviewer points out there have been three substantial evaluations of codes for the initial value problem published in recent years. There is a high quality, portable code in the text of C. W. Gear (published 1971, reviewed *Math. Comp.*, v. 27, 1973, p. 673) and there are several other codes as good or better which can be easily obtained. With the ready availability of these codes, workers requiring the solution of an initial value problem no longer have any excuse for using codes of lesser quality.

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53 [5, 13.20].—Patrick J. Roache, *Computational Fluid Dynamics*, Hermosa Publishers, Albuquerque, New Mexico, 1973, vii + 434 pp., 27 cm. Price $12.50.

Chapter headings: 1. Introduction. 2. Incompressible Flow Equation in Rectangular Coordinates. 3. Basic Computational Methods for Incompressible Flow. 4. Compressible Flow Equations in Rectangular Coordinates. 5. Basic Computational Tools for Compressible Flow. 6. Other Mesh Systems, Coordinate Systems, and Equation Systems. 7. Recommendations on Programming, Testing, and Information Processing.

This book is aimed at the person interested in the practical application of its subject. The methods included are described in enormous detail, with emphasis on recipes rather than principles. Practical hints abound, and some of them, in particular in Chapter 7, are quite good.

The book operates, however, within narrow limits. The methods included are simple, with one exception—low order, difference schemes. No substantive discussion is given of spectral methods, finite element or Galerkin methods, higher accuracy methods for compressible flow, or Monte Carlo methods. No proper discussion is given of the effect of boundary conditions on stability. The author suggests that the short-