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Book Review

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A Shock-Fitting Primer

Manuel D. Salas, CRC Press, Boca Raton, Florida, 2010, 400 pp., $129.95.

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Shock fitting is the art of treating shock waves as true discontinuities for which the motion is controlled by equations derived directly from the physics. Although the procedures enjoyed considerable success in the 1960s and 1970s to predict flows around blunt bodies and are known to provide very accurate solutions with relatively few mesh points, they unfortunately never found widespread use. The reasons are many. Alternative shock-capturing methods can be very easy to apply and require neither detailed knowledge of the shock physics nor complex data structures. Another is the general lack of availability of resources on how to implement fitting.

In the past, one often learned shock fitting by hunting down and reading faint copies of Moretti's famous PIBAL (Polytechnic Institute of Brooklyn Aeronautical Laboratory) reports or, if one was fortunate enough to work in the environs of NASA Langley Research Center, one learned at the direction of one of Moretti's most famous students, the author Manuel D. Salas.

In his book, Salas has gathered the accumulated wisdom about shock fitting into a book that includes the history, the shock physics, and a disk of MATLAB® codes. The first chapter covers a history of the understanding of shock phenomena going back to d'Alembert and Euler. The second is where the basic ideas of characteristics, weak solutions, and finite difference schemes are introduced through a study of the one-dimensional inviscid Burgers equation. Algorithms for the two basic types of shock fitting are presented here: "boundary shock fitting," where two regions are separated by a moving boundary and "floating shock fitting," where the shock is tracked through a mesh and the difference approximations are modified at the shock to avoid differencing across the discontinuity. With the basic ideas out of the way, chapter 3 goes into great detail deriving the physics of shock waves for the Euler gas dynamics equations in general coordinates. The fourth chapter shrinks back down to one-dimensional problems and covers complex shock interactions and quasi-one-dimensional nozzle flows. With one-dimensional problems understood, chapter 5 returns to a variety of complex two-dimensional shock flows, including those in blunt-body and swept-wing problems. Up to this point, the book is classical, gathering the contributions of Moretti and Salas in one place. The final chapter reviews and shows the promise of recent work from Italy using floating shock fitting and finite volume schemes.

What this book does for the reader is present a detailed analysis of multidimensional shock physics and how that physics can be used to understand and derive the shock motion equations. It is neither a numerical analysis book nor a fluid dynamics book. It quickly reviews some basic concepts for both, of course, but the reader should already know finite difference, finite volume methods and compressible fluid dynamics. Much of the study is presented handbook style, so the reader can jump into sections as needed.

Example codes, many of which appear to be direct translations from classical Fortran to MATLAB®, are presented for the topics covered in chapters 2 through 5. They solve problems in both one and two dimensions, including difficult blunt-body and swept-wing configurations. In one way, the supplied disc serves to preserve the classic codes of Moretti and Salas. In another, the examples give the user the opportunity to study shocked flows through numerical simulations. The codes do not, unfortunately, provide examples to study from to learn how to implement shock fitting for one's own codes, and they are lightly commented and without direct references to the text, especially the later chapters. In fact, some comments in the supplied code do not refer to equations in the text but in other sources.

In summary, Salas has preserved the art of shock fitting for the reader with this book. He derives the detailed shock physics needed to understand and implement shock-fitting codes. The included code can study shock motion in a way that is not possible with shock-capturing methods. Much of the material is difficult to find elsewhere and is now collected into a single volume.

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