J. Fluid Mech. (1999), *vol.* 400, *pp.* 375–378. Printed in the United Kingdom

BOOK REVIEWS

Atmospheric Dynamics. By J. Green. Cambridge University Press, 1999. 324 pp. ISBN 0 521 24975 9. £40.00

As the blurb truly states, 'this is a remarkable piece of work – a personal vision – that is unmatched anywhere else in the literature … dominated by Green's physical insights presented in a colloquial manner …'. Again, the book 'is an introduction to fluid mechanics in the atmosphere for students and researchers that are already familiar with the subject, but who wish to extend their knowledge and philosophy beyond the currently popular development of conventional undergraduate instruction'. The book breaks the conventions of modern scientific publication that we write formally and compactly, reaching our conclusions by use of polished arguments, with little indication of the thought processes that led to those arguments. The reader is shown more of the scaffolding than the cathedral. The book is almost as if it were a record of the oral comments of a lecturer at a course on dynamical meteorology, sometimes lacking the formal notes written on the blackboard or overheard projector. Certainly the author assumes that the reader already knows a lot of meteorology, geophysical fluid dynamics, and applied mathematics (notably Fourier integration, theory of a function of a complex variable, and asymptotic analysis), so this is not a self-contained textbook for a senior or a graduate course. Indeed, it is better suited to the instructor, who has the knowledge and maturity to assimilate the ideas, than to a student of such a course.

The author takes each of a succession of the standard topics of dynamical meteorology, and typically muses about its meteorological significance, examines its physical mechanisms, tests their orders of magnitude, suggests a simple fluid mechanical model, solves it, explores the results for appropriate values of the parameters, comments on the relation of the results to the phenomenon being modelled, and notes the merits and demerits of the model. He asks the reader many questions, and answers some. He is not afraid to admit that he does not know something, for example writing 'I do not know what the first of these [terms] is, and it worries me.' All this is an admirable way of encouraging students, and their teachers, to think about the meaning of the work they are being taught, to test the theories, and to challenge the assumptions they are told to make. Good teachers talk about their intuitive thoughts, but are usually too inhibited to commit the thoughts to writing. Also, let us admit it, we who claim to be good teachers share, in practice, too few of our intuitive thoughts with our pupils. Advisers of PhD students and course instructors who read this book will be inspired to teach better.

The book seems rather out of date, with little use of recent observations and discoveries. It might almost have been written 20 years ago, and indeed it is based on lecture courses given by the author at Imperial College, London and the University of East Anglia over more than 20 years. This is a strength as well as a weakness, because the fundamentals of the subject have changed little in that time, and I feel that the author wishes to use the fundamental ideas and contemplative attitude of a bygone age in order to understand and interpret better the torrent of data produced by modern meteorologists.

A few of John Green's comments seem to me carelessly phrased, a few are obvious, some are well known to many as well as useful, but his comments as a whole provoke his readers to think for themselves about the fundamentals of dynamical meteorology. This is his major achievement.

Now the conventions of modern scientific publication are based on accumulated experience, as well as technological development in publication and commercial need, and we break them at our peril. Originality in science is to be welcomed in general, but originality in spelling, punctuation and grammar is not. The author's writing resembles less the lucid text of a contemplative scholar than the oral comments of a lecturer. We all make the equivalents of misprints in speech. These errors are inevitable and forgivable, but they do confuse our students and so even one error is regrettable. Such errors in print are more easily avoided, although many do seem to occur in every book on fluid mechanics. Yet here their profusion will make many points hard for students to follow. The index could be more helpful. Unfortunately the publisher, falling from its usual high editorial standards, has not corrected these matters before they reached the public. Further, the author lists essentially no references, and so none on the major work by Helmholtz, Kelvin, Richardson, Rossby, Charney and so on, yet refers often to the views of named former colleagues. Of course, few students today care about who discovered any idea of fluid mechanics, but references do help a student or an instructor to follow up a point as well as to attribute the discovery, and so they seem to me to be more useful than acknowledgements of former colleagues who are unknown to the present generation of students. There are no exercises for students to work through.

However, these technical criticisms should not eclipse recognition of the outstanding achievement of the book in which '... the classic principles are derived ... in a novel, distinctive, and at times even idiosyncratic, way' and the physical principles are examined '... in order to resist *blindly* [my italics] following the ever more complex computer simulations of atmospheric dynamics'. I enjoyed reading the book.

P. G. DRAZIN

Hydrodynamics of Pumps. By C. E. BRENNEN. Oxford University Press/Concepts EDI, 1995. 317 pp. ISBN 091 8564422. £60.

When compared to rotating machines handling gases, liquid turbomachines present special problems associated with two characteristics of liquids: their ability to cavitate and their higher density which increases the possibility of damage to the machine, especially for unsteady flows. In this book, attention is focused on both cavitation, and unsteady flows and forces in pumps.

One of the merits of this book is that it relates flow phenomena in pumps to physical principles, rather than trying to relate quantities via empirical expressions. The latter is common practice in the pump community and can be found in many textbooks. Often quantities are related for which there is no fundamental reason to believe that a causal relationship exists. Brennen openly expresses his criticism for this practice and other areas, for example the widespread and misleading use of inconsistent units in the turbomachinery industry, and the common use and misunderstanding of a design constraint for cavitation put forward by the Hydraulic Institute.

The book is divided into three parts. Part I is an introduction to pump design based on two-dimensional fluid mechanics. It starts with an introduction to nomenclature, and the definition of common quantities like head and flow coefficients and specific speed. This is followed by methods to quantify the performance of simple two-dimensional cascades, and it ends with a review of three-dimensional effects and secondary flows. A clear aim of this part is to establish that no previous knowledge of pumps is required for those readers who are unfamiliar with the subject. However, the elaborate and sometimes even confusing presentation of the theory of inviscid performance analysis may prevent them from reading any further. The knowledgeable, on the other hand, should not skip this part because it introduces the notation that is used through much of the book. The second part discusses cavitation in pumps. It gives a complete overview of all types of impeller cavitation as well as the coefficients and dimensionless numbers used to describe its influence on pump performance. This is followed by a discussion of cavitation inception and its assessment, which is complicated by the influence of liquid quality, residence time, turbulence intensity and surface roughness. A chapter is devoted to a concise theory of bubble dynamics, cavitation damage, and noise. Part II concludes with a chapter on the degrading influence of cavitation on performance, including performance measurements of pumps, inducers, and partially and supercavitating cascades, as well as several theoretical models to quantify the effect on performance.

Part III deals with unsteady flows, vibrations and forces in pumps. It begins with an overview of unsteady phenomena and their associated frequencies. A large section is devoted to the theory of dynamic response of hydraulic systems. Time domain methods are briefly addressed. An excellent introduction is given to frequency domain methods, which are extensively used in assessing the unsteady behaviour of pumps, both analytically and experimentally. The section ends with an interesting account of an analysis of a cavitating inducer. The final chapter concerns radial and rotordynamic forces. A concise but clear introduction to rotordynamics is followed by a survey of unsteady radial forces that can result from fluid flows through hydrodynamic bearings and seals, and from the main flow and leakage flow through and around impellers.

The book is well-written and well-balanced between theoretical and experimental work. Given its relatively small size, the book covers a remarkably wide range of topics, without becoming too superficial. It provides a large number of references to both textbooks and articles in scientific journals, which makes the work an excellent desk reference. There are, however, some shortcomings. Careful reading is necessary since quotations from the literature, especially those involving equations, are in a few cases inaccurate or incomplete, e.g. references to Balje (pp. 18–19), Hirs (p. 277), and equations (4.18), (10.46) and (10.47). Moreover, the sequence in which information is presented is not always optimal; there are many forward references and the notation relies in many cases on explanations given in the introductory chapters. Further, while most previous investigations are merely touched upon, some are discussed at great length, and the reason for this distinction is not always clear. Some readers may be disappointed that no account has been given of experimental techniques, nor of recent advances achieved by CFD.

As stated in the preface, the book is intended as a reference for both pump experts and advanced students. One could argue that pump engineers are primarily concerned with design issues, whereas students, and indeed Brennen himself, are interested above all in the different physical phenomena occurring in pumps. Combining these objectives would mean integrating the physics of turbomachinery flow behaviour with design methods, but at the moment this can only be done to a very limited extent due to the complexity of the flow phenomena involved. This is why current design practice relies so heavily on empirical methods. Although pump engineers will not find any improvements to existing design methods in this book, there is still reason enough for them to read it for it provides a physical background to many problems which are encountered in pump design, since many of these find their origin in cavitation and unsteadiness. The classification of different types of cavitation and unsteadiness may shed some light on the cause of problems in actual pump designs and this may assist in the design of more effective liquid turbomachines.

B. P. M. van Esch