BOOK REVIEWS

Advances in Turbulence

W. K. George and R. Arndt, Eds.
Hemisphere Publishing Corp. 1989

This book is based on a symposium held in 1986 to honour Stanley Corrsin, one of the best-loved people in fluid dynamics. Papers were contributed by many of his former students and others influenced by his work. By heartbreaking coincidence, Stan died after a long illness the day before the symposium started: anybody aspiring to a career in science, especially as an adviser of research students, should read the affectionate but factual "In Memory" tribute by the editors, which ends "... seeking new knowledge is fun and a truly human experience."

Who, apart from the many members of Stan's spoof "Society for Statistical Geometry", should buy this book? It surveys the whole field of turbulence research as at mid-1986, and, although some of the original research contributions have since been published in fuller form in archive journals, the review papers are still timely and stimulating. Therefore it can be recommended to any graduate student or research worker studying turbulence.

John Lumley's lead paper "The state of turbulence research" is a lively and combative survey: it refers to the passing, in the last few years, of some of the "big guys" of turbulence research—Stan himself, his Caltech contemporary Janos Laufer and his Johns Hopkins colleague Laszlo Kovasznay, and, more recently, that giant of the previous generation A. N. Kolmogorov, whose theory of local isotropy Stan extended to scalar fields.

Parviz Moin and Philippe Spalart discuss the contributions of numerical simulation data bases to the "physics, modeling and measurement of turbulence"—the topics nearest to Stan's heart. Bill George contributes a provocative article on self-preservation, exposing the nakedness of simple arguments (ignoring the necessary equality of mean-flow and turbulence scales in a truly self-preserving flow).

Dale Taulbee contributes an excellent review of "Engineering turbulence models", which, even in the 1990s, should be required reading for any academic or industrial worker at the sharp end of turbulence research. Rene Chevray's review of "Chaos and the onset of turbulence" is a sane and extraordinarily comprehensive survey, including a hilarious discussion of Spanish and Portuguese estimates of the length of the coast of Portugal. Prince Henry of Portugal, called The Navigator, sent his trainees out to explore the world: he must have had much the same talents as Stan Corrsin.

Preben Buchhave's authoratative review of turbulence measurement techniques recalls Stan's involvement in hot-wire anemometry in the days when men were men and amplifiers were not. Tom Mueller's final paper on flow visualization and hot-wire anemometry happily terminates this volume, which celebrates one of the great experimentalists—and characters—of fluid dynamics.

Peter Bradshaw

Computational Fluid Dynamics

G. de Vahl Davis and C. Fletcher,
North-Holland

This hardcover volume contains most of the 16 invited and 58 contributed papers presented at the International Symposium on Computational Fluid Dynamics held in Sydney in August 1987. The absence of eight papers, among them five invited ones, is betrayed by the curious inclusion of related brief summaries, and reflects, presumably, the authors' desire to see their papers appear between more prestigious covers. Of the eleven contributed articles appearing in full, only a small minority combine quality with the degree of breadth and lucidity one hopes to find in lead papers. Two articles, one by G. F. Carey (University of Texas) on supercomputing in CFD and the other by P. E. Rubbert (Boeing Company) on CFD in airplane design, effectively form this minority. Both provide historical perspectives and give useful descriptive expositions of the status in 1987. Fairly broad, though less readable, accounts are provided by V. M. Koveny, A. S. Ledger and G. Cherny (USSR Academy of Sciences) on some operator splitting and fractional-step schemes for the Euler and NS equations, and by Y. I. Shokin summarizing recent Russian work on completely conservative difference schemes applied to conservation laws. Of the remaining, more narrowly focused, invited contributions, that by J. Fromm (IBM) offers a most impressive physical interpretation of numerical results for transition to turbulence in a flow between two discs with relative rotation. An interesting account on time-dependent instabilities and cellular structures in high-aspect-ratio, differentially heated cavities is given by Simkin (AT&T laboratories). Focusing on purely numerical issues, a paper by Cabannes (University of Paris), exposes an unusual approach to flow simulation, based on ideas from kinetic gas theory (e.g., momentum exchange by particle collision), and a contribution by Satofuka (Kyoto University) presents a block *explicit* solution methodology in which groups (blocks) of nodes are treated implicitly, while block-to-block coupling is handled explicitly, permitting an efficient vector–computer solution.

An attempt to classify contributed papers by topic or approach yields Reynolds-averaged NS applications as the largest group. There is the usual crop of k-ε-model applications to complex incompressible flows—around 3-D model buildings, in 3-D gentle bends, in a combustion-chamber model, around a 3-D car body, in a 2-D separated diffuser and in swirling flow—some performed, again as usual, with commercial CFD packages. Two papers report Reynolds-stress/flux-closure calculations, one relating to the challenging problem of describing the interpenetration of two fluids with very different densities, and the other concerned with a buoyancy-driven cavity flow. Other studies apply simpler mixing-length models or focus on laminar conditions in complex 3-D flows in a circular bend, an impinging jet in cross-flow and over wing geometries. A computational study by Lopez on multiple vortex breakdown in a ducted flow swirled by a rotating end-wall shows impressive and detailed agreement with flow-visualization experiments.

An examination of compressible-flow computations indicates an increasing tendency towards a full inclusion of viscous features. A couple of contributions report k-ε-model solutions for supersonic-nozzle flow and transonic-cascade flow. Further viscous-flow solutions are obtained for hypersonic re-entry type bodies and over subsonic, high M-number helicopter-rotor blades. An unusual study considers the interaction between a turbulent mean-flow field, computed with the k-ε-model, and acoustic-wave propagation. Two papers apply LES to transitional or stability-related features in a transonic shear layer and in cumulus convection, while two further studies employ the vortex method for oscillating bodies and mean-flow/acoustic interactions in a duct which is partially blocked by baffles.

Transonic flows with embedded shocks are resolved in a total of five contributions, the most spectacular one, by Baum and Eidelman, presenting a time-dependent simulation of the interaction between a high-M-stream and a circular wall-recess. The renewed interest in hypersonic aerodynamics is reflected by three papers considering reactive flows in the context of very high-M-number shocked flows. One study employs a spectral, multidomain NS solution to identify the possible role of false diffusion in hypersonic flow schemes.

A total of seven papers focus on extensions or the application of FE and BE methods. Topics considered include oscillating bodies near a free surface, viscous non-Newtonian fluid flow with and without separation (three papers), a Petrov–Galerkin approach to highly advective separated flow, and the use of a domain-decomposed, pseudo-spectral (Chebishev) method for elliptic flows.

Numerical issues, related primarily to economy and efficiency of solution, are addressed in eight papers. Consideration is given to gains resulting from marching or repeated-marching approaches to the parabolized NS equations, from the use of the method of characteristics for the 3-D Euler set, from the application of a group-explicit solution to recirculating flow, from multigrid acceleration in cavity and diffuser flows, and from the application of efficient vectorizable formulations to the 3-D Euler equations. Only one contribution considers grid-generation issues within the FE context.

On the whole, this book differs little from many others emerging in the wake of symposia and conferences, in that it offers a diffuse and rather inaccurate snapshot of some CFD work at a particular time (here, 1987). The book is likely to be of some interest to those wishing to "indulge" in general reading, but is unlikely to be of great benefit to those seeking to acquire a significant amount of highly specialized information on any one narrow segment.

M. A. Leschziner

Industrial Energy Management and Utilization

Larry C. Witte, Philip S. Schmidt and David R. Brown

This book grew out of short courses given by the authors at University of Houston and University of Texas at Austin, and is at least partially aimed at senior academic students. Despite this, it is also thoroughly practical in approach and well deserves study by the "practicing engineers" which form its other target.

It seeks to cover the field of industrial energy conservation and auditing, which is a subject that is not well supplied with such reference texts. Many practicing engineers have accumulated knowledge haphazardly over years of experience, but would be hard-pushed to set it down to instruct others. In this book, that knowledge has been put into an accessible form.

After an introductory chapter skimming the world energy scene, the book starts in with a good basic guide to energy audit methods, including those all-too-common situations where available data and installed metering are in scant supply. A comprehensive chapter on economic analysis follows, and sets the pattern for the book, which packs a surprising amount of information into each chapter. An important chapter on dealing with people and getting them to act in favor of energy management is followed by one of thermodynamics, heat transfer, and fluid mechanics—all treated amazingly well in only 42 pages!

Specific areas of industrial equipment —combustion systems; steam and condensate; heat exchangers; heat recovery; insulation; industrial buildings; cogeneration; power circuits and machinery; and electrical energy—are dealt with in successive chapters. The coverage is again very thorough, except that the newer technologies get little or no mention. For example, fluidized bed boilers seem not to exist, and no information is given on other pollution-control items such as low-NO_x burners. The book as a whole is very biased towards *process* industry, rather than industrial premises in general. This shows up most in the disappointing chapter on industrial buildings which has very little on space heating (or cooling), regarding buildings mainly as receptacles for the process equipment. The reader is referred to the ASHRAE guides (for UK, see IHVE guides). Cogeneration is covered mainly in terms of steam turbines, with, for example, gas turbines dismissed as of too low efficiency in comparison. This sounds very much like a rule-of-thumb that is beginning to show its age.

Mention of ASHRAE brings me to the broadest criticism of the book, as addressed to the European reader. US units and reference organizations are used throughout, which at best, will make it harder to use by those brought up on SI units; and at worse make acronyms unfamiliar, not understandable, or just plain inaccessible in Europe. As examples, heat transfer fluids are quoted under their US trade names, while it is not clear whether there are European equivalents. At the other extreme, in the economic analysis chapter, does anybody here actually use the "sum-of-the-year's-digits" depreciation method? (Luckily, several more familiar methods are also described.)

The book concludes with a very dense chapter on the characteristics of particular selected process industries that are highly energy-intensive. Again an amazing amount of information is supplied in a short space, though it is not, in this case, clear whether it would be particularly useful in practice. A good set of appendices give tables and graphs of thermodynamic, heat transfer, and electrical data that will be of constant value.

All in all, this is a book which sets out to cover a vast field, and achieves it remarkably well. It is highly recommended as a reference book for anyone concerned with industrial energy, despite the need for technical translation from US practice.

Pete Lilley

The Mathematical Theory of Turbulence, Second Edition

M. M. Stanisic

Springer-Verlag, 1985, 1988, 501 pp.

It has always been a pleasure to see Professor Stanisic at professional meetings. He is courtly and scholarly, an ambassador from another place and another era, when a professor was educated, a gentleman and a scholar, taking seriously his duty to preserve, transmit, and comment on the work in his field. It was an honorable calling, differing in many subtle ways from being a professor here and now, at least in the sciences.

This book is the lecture notes that Professor Stanisic prepared for his graduate course in turbulence at Purdue. The book has, in many respects, the simplicity, charm and lack of sophistication of something like Prandtl-Tietjens *Fundamentals of Hydro- and Aeromechanics*. This flavor probably represented the best of the books from which Professor Stanisic himself learned, and was, I suspect, what he was aiming for. Unfortunately, it is nearly impossible to achieve also the intellectual distinction of these timeless works.

Internal evidence suggests that the bulk of the manuscript may date from the sixties. I say this because of the inclusion of mixing lengths, Heisenberg, Hopf and magnetohydrodynamics. Not