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REVIEWS

Hydraulics in the United States 1776–1976. By HUNTER ROUSE. Institute of Hydraulic Research, University of Iowa, 1976. 238 pp. $10.60.

The book begins with a prologue, which briefly describes the technology that the early settlers brought with them and how far it had developed by 1776. Among the illustrations is a map of London's water supply from the north; this is in fact the New River, opened in 1613 and still in excellent order. In the first 50 years of independence (chapter I), transport by water remained of great importance. Franklin continued to help, river navigation was improved, and canals were built. The most important change was the use of steam power, and here Fulton's ships had a marked influence on progress in Europe. Brunel *père* makes a fleeting appearance at this point.

As the size of cities increased, the need was felt for improved water supply and sewerage (chapters II and III), and the discovery of gold in California led to a new kind of demand for water. As in England, industrialization began in hilly country where water power was available, and names emerge such as Francis, Herschel and Pelton, which are familiar today. The way is lightened by mention of a textbook writer who was so hard pressed for material that he devoted space to methods of reviving the apparently drowned. The demand for knowledge and its dissemination led to the appearance of more laboratories and textbooks (chapter IV). Unhappily, many publications described long and painstaking experiments with the results in dimensional terms and unrelated to other work. As elsewhere, the subject became chaotic, and the word began to acquire a tinge of disparagement and contempt, which even now it has not entirely lost. Numerous careers are described, among them that of Clarence King, the first director of the United States Geological Survey. It may be added that his *Mountaineering in the Sierra Nevada* is well known to historians of exploration, and his vivid account of the first ascent of Mount Tyndall is a classic.

The primary concern of the Corps of Engineers had long been the regulation of such rivers as the Mississippi and the Missouri. Its official policy was to oppose the provision of a laboratory for model tests, urged on it by Freeman, an important figure in the American Society of Civil Engineers (chapter V). As has been found elsewhere, the military mind, trained for war and not for peace, was resistant to new ideas. But eventually, after much waste of time, two laboratories were built, one under Freeman's direction at the Bureau of Standards, and the other for the Corps of Engineers at Vicksburg. The latter prospered, but surprisingly the former did not.

The introduction of scientific ideas (chapter VI) is shown to have transformed the subject, which now became truly international, and the process was hastened by the Second World War. Under the pressure of events, enormous apparatus was constructed, such as the towing tank and the recirculating channel at the David Taylor Model Basin. Pioneer work on cavitation near

torpedo-shaped bodies was carried out at Caltech in a water tunnel fitted with a resorber to destroy the bubbles swept away in the stream. Since the War the supremacy of the United States in the subject has been established beyond doubt (chapters VIII and IX), largely with government aid administered by the Office of Naval Research and the National Science Foundation. The Bureau of Reclamation Laboratories at Denver and the Waterways Experiment Station are without parallel elsewhere. The book closes with a brief epilogue discussing the future.

The author is to be congratulated on the successful conclusion of what must have been a laborious task. As the scope of the work is more restricted in time and space than his *History of Hydraulics* (1957), it goes into more detail. There is little duplication. Evidently catalogues and works of reference have been ransacked, and the tale is brought right up to the present day. The book is more personal than its predecessor, and full accounts are given of hydraulicists (surely a less revolting word than hydraulicians) who are still at the height of their powers. Of the illustrations, no less than 163 are portraits. But the book is no mere catalogue. It reads easily, although the progress of an English reader may be occasionally checked by an unfamiliar idiom, such as 'a self-designed steam engine' or 'he sought to sell Napoleon on the use of a submarine'.

The index is too short and is unworthy of the detail given in the text. For example, under flow measurement there are 13 entries, none of them labelled. There are two entries under Harvard, but they do not include on page 48 the date (1847) of establishment of its engineering faculty or on page 62 an account of a bequest for its hydraulics laboratory. Yale appears in several places in the text, and its corresponding date (1852) is also given, yet in the index it is missing altogether.

A. M. BINNIE

Principles and Practice of Laser-Doppler Anemometry. By F. DURST, A. MELLING and J. H. WHITELAW. Academic Press, 1976. 412 pp. £12.00.

Laser Doppler Measurements. By B. M. WATRASIEWICZ and M. RUDD. Butterworths, 1976. 167 pp. £6.90.

The aims of these two books are allegedly similar; the extent to which those aims are met widely disparate. It might be expected that the shorter book might serve as a more succinct and assimilable introduction to the subject but in the opinion of the reviewer this is far from true.

The first book is a broad-based reference work on the state of the art in laser anemometry in late 1975. Whilst there are conspicuous omissions in the developments of transit time anemometry and signal analysis from single photon detections, it is nevertheless a competent survey of ideas, information and measurements. The book is presented in the unusual format of a figure with detailed explanation on each page. Each point is identified and explained or discussed, with a brave attempt to isolate the many and varied interrelated facets of a subject requiring command of many disciplines. This had been highly successful and the book is both readable and encyclopedic.

The organization of the book is clean and elegant. Chapter 1 introduces concepts and gives an overview of the subject. Chapters 2 and 3 give some background optics and physics of scattering in sufficient depth for most requirements of a potential user. Chapters 4 and 5 continue with optics, with the stress now on real components and their assembly into optical systems appropriate for laser anemometry. Chapters 6–9 lay out the basics of signal processing and go into considerable and necessary depth. The emphasis is again on understanding the physics and giving practical hints. Frequency analysis is covered in some depth, but this may be defended as being revision of information-theory concepts required for later studies of tracking and counting. The implication of reduced data for fluid dynamics could perhaps have merited a little more detail, as could the discussion of photon correlation which is popular where the signal is low, and in a number of difficult engineering situations. Chapters 10 and 11 discuss particles and their production and chapter 12 is a good indication of how each anemometer system may be designed for its specific application. The appraisal of laser anemometry on the basis of recent measurements in chapter 13 is as up to date as possible. There is a very good bibliography and reference list with a definition of notation used throughout.

The last sections are fairly complete but still leave the potential user a lot of work in selecting an optimal system. It is probably impossible to place significant emphasis on specific aspects of system choice without being accused of bias. The authors have been as impartial as possible at this stage in the development of the subject.

This book should be read by those who consider that laser anemometry might be a solution to their problems. Two pitfalls are to be avoided: first, although this topic is fashionable, it is not always the best choice for a given application; and second, however good the book, there will be many additional problems to be solved by those who must use the technique.

The second book, officially with a similar aim and content, is not in the same class and is unworthy of the intellectual ability of its authors. The title appears inappropriate when we see that less than 20 % of the book (pp. 109–126) could be considered to deal with 'measurements'.

The first half of the book comprises historical development, related physical phenomena and principles of operation. There is a surfeit of interesting but irrelevant detail and one can only describe the mathematics of the presentation as obscurantist. In a book whose title implies that it is intended for scientists and engineers who might want to make measurements with the technique its partition of material is inapt. There are a few simple physical ideas in this subject which should be clearly identified; in a book of this length the excess depth of detail in some areas is only matched by its unwarranted absence from others. For example, the two most widely used signal retrieval methods, frequency tracking and correlation, are awarded only five and one-half pages, compared with two pages in the same chapter on elimination of laser noise, usually quite irrelevant for a real fringe system.

The chapter on signal processing falls short of the present-day knowledge and indeed the approach taken appears very dated in this rapidly expanding field.

Chapter 5, on the measurement of turbulence parameters, trivializes the very serious practical and conceptual difficulties. The final section, on applications, apart from its brevity, has no merit. The references to this section are sufficient to show that the authors are aware of many realistic and useful applications of laser anemometry: why have they not attempted a more detailed discussion? This is, after all, what the book purports to be about.

In summary then, the book of Durst, Melling & Whitelaw is a practical and necessary complement to the bookshelf of anyone involved in the application of laser anemometry to the measurement of mean velocities and turbulence. The book of Watrasiewicz & Rudd does not offer comparable coverage of the material but might be read for interest and to obtain different insight into some of the many and various details of laser anemometry. It is by no means complete nor very relevant to the needs of practising engineers or scientists.

A. E. SMART

Asymptotic Wave Theory. By M. ROSEAU. North-Holland, 1976. 349 pp. Dfl. 75.00.

This book, which is in English, has grown out of courses which the author has given to graduate students in the University of Paris as part of the theoretical mechanics course. It is assumed that the reader is familiar with the elements of ordinary differential equations, and with complex-function theory, including analytic continuation. The chapter headings are: 1, The Fourier–Laplace integral; 2, Special functions; 3, The wave equation; 4, Asymptotic methods; 5, Scattering matrix theory; 6, Flow in open channel; asymptotic solution of some linear and nonlinear wave equations; 7, Seismic waves; 8, Some problems in water wave theory. Only a few of the topics can be mentioned here. Chapters 1 and 2 introduce Fourier and Laplace transforms, and the gamma function and Bessel functions respectively. In chapter 3 these are applied to the reflexion and refraction of a plane wave and of a spherical wave at a plane interface, the reflected wave being expressed in the form of an integral. Chapter 4 includes Laplace's method, Watson's lemma and (very briefly) steepest descents, but not Fourier integrals. Two difficult cases, a pole near a saddle point and two nearly coincident saddle points, are both treated. Chapter 5 uses the one-dimensional wave equation $d^2u/dx^2 + (k^2 - f(x))\,u = 0$ to introduce the ideas of scattering-matrix theory; both the direct and the inverse problem are treated. Chapter 6 is the longest chapter; most of it is devoted to the linear theory of the equation

$$\left(\frac{\partial}{\partial t} + c_1 \frac{\partial}{\partial x}\right)\left(\frac{\partial}{\partial t} + c_2 \frac{\partial}{\partial x}\right)\phi + \lambda\left(\frac{\partial}{\partial t} + a\frac{\partial}{\partial x}\right)\phi = 0,$$

which is solved by the method of characteristics and also by integral transforms. The nonlinear equations of motion are treated by the method of characteristics, and also by the method of slowly varying parameters. The last section of this chapter deals with nonlinear dispersive waves and the two-scale expansion procedure. Chapter 7 treats elastic waves in an infinite elastic medium containing a spherical inclusion of a different elastic material. A plane simple harmonic

longitudinal wave is assumed to be incident on the inclusion, and the reflected and diffracted waves outside the inclusion are to be found. These can all be expressed in series involving spherical Bessel functions, or alternatively in the form of contour integrals. For short waves the latter can be treated asymptotically by the method of steepest descents, or (in shadow regions) by Watson's method. Chapter 8 presents two of the author's own original contributions. In both cases the solution is expressed in 'closed form', i.e. in the form of a contour integral where the integrand is the solution of a functional equation which can itself be solved by contour integrals. The first problem is the reflexion of water waves by depth profiles depending on two parameters. The solution is complicated but the bottom profile and the reflexion and transmission coefficients can be found in a more explicit form. The second part is concerned with the diffraction of tidal waves by a solid wedge when the frame of reference is rotating with a constant angular velocity. Here it is the amplitude of the edge wave which can be found explicitly.

Maurice Roseau is well known as a master of analytical techniques. The present volume represents his choice of a number of techniques which he has applied in an elegant manner to a number of problems. It is not a textbook on mathematical methods, nor an encyclopaedia of results; it is perhaps a fault that there are no exercises. Students who take the trouble to work through this book will find themselves well equipped to undertake research on many of the linear problems which still require solution.

F. URSELL