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REVIEWS

Fish Locomotion. By R. W. BLAKE. Cambridge University Press, 1983. 208 pp. £29.95.

This engaging monograph is concerned with the kinematics, dynamics, and energetics of fish swimming. The book is intended for the researcher in biomechanics with some familiarity with both the mathematics and the biology, and charts a somewhat hazardous course between the fundamental zoological questions and the intricacies of the unsteady-flow theories which are needed in the subject. Building on Lighthill's influential book *Mathematical Biofluiddynamics* (SIAM, 1975) and other reviews, the author wisely chooses to emphasize recent advances in the field; almost a third of the more than 200 references date from 1975 and after. There are nevertheless some helpful features for the newcomer to the field, including brief summaries at the beginning of each chapter and frequent references to the literature, including other syntheses and reviews.

The book begins with a brief but adequate introduction to fluid dynamics, with emphasis on the origins of lift and drag. The theory stops at Bernoulli's equation, so there is no reference to the vortical wake of a finite wing in the discussion of induced drag, and no mention of virtual mass, although both phenomena are key ingredients in the slender-body theory given in chapter 5. The next three chapters are also preparatory, and they are well written and interesting. The topics are: the unusual muscle physiology of fish, a survey of the attempts to reconcile power required as a function of speed, size, and shape, and the possible causes of drag and drag reduction. Emphasis here is on measurement and empirical relationships. In this connection, it is impossible to read through this account without wondering how some of the experiments were done! A brief explanation would have been welcome.

The final chapters deal with the kinematic and dynamical theory of swimming, including Lighthill's work on undulatory propulsion, the roles of the various fins, stability and control, and the intriguing question of swimming strategy. A typical optimization problem is that of burst and glide versus steady swimming, and Weihs' analysis of this question is included. The final chapter is a compendium of miscellaneous topics, including flying fish and terrestrial locomotion.

The style of the treatment is likely to appeal more to the zoologist than the analyst, and at some points one is inclined to go to the original source to clarify a technical question. In the discussion of burst and glide swimming, for example, swimming efficiency is written, without comment, as proportional to swimming speed. This is not an obvious property from the discussion of efficiency given elsewhere in the book, and it is learned from Weihs' paper that this proportionality is supported by data by Webb, given in a paper referenced by Blake. Since the assumed form of efficiency is what gives rise to an interesting optimization problem, the reader deserves a more critical discussion. Minor annoyances are the misprints (of the nine equations in chapter 2, (48) and (49) are misprinted) and the almost undecipherable notation in the analysis of larval swimming. Also, for many readers unfamiliar with the classification of fish, a brief summary of the main properties of the most frequently referenced families (Scombridae, for example) would have been helpful; any such reader will probably want to keep chapter 2 of Lighthill's book handy.

Any attempt to survey a field as diverse as the present one is to be welcomed, and the present volume doubly so since it correctly strives for a proper biological framework for the mechanics, and not the other way around. It is certanly one of the most concise introductions to the subject, and the most up to date. One senses that the field is still young, but maturing rapidly, and the main strength of this book is its focus on some fascinating problems which will be with us for some time.

S. CHILDRESS

Physico–Chemical Elementary Processes in Flotation. By H. J. SCHULZE. Elsevier, 1984. 320 pp. Dfl 175.00.

Froth flotation is the basis for some very successful industrial separations, particularly the recovery of sulphide minerals from very-low-grade ores. It is also used for the recovery of other minerals, and is used in biotechnology, effluent treatment, and in special applications such as the recovery of metal cations from dilute solutions.

The essential structure of a flotation cell involves the suspension of finely divided solids in water by an agitator which simultaneously disperses through the pulp finely divided air bubbles. The hydrophobic component of the solids attaches itself to the air bubbles, which rise up to a froth layer on the top surface, from which it is scraped over a product weir.

The design of industrial flotation systems is based largely on experimental correlations derived from experience and from limited large-scale testing. It is clearly very desirable to provide a scientific basis for the development of a logical framework for the design of flotation circuits.

The microprocesses that are of significance in flotation are primarily concerned with the effective interception of particles by bubbles and the adherence of the intercepted particles to gas bubbles. The author has provided a review of the hydrodynamics associated with the trajectory of particles and bubbles. This analysis is based on the use of stream functions in non-swirling situations, and provides a basis by which the efficiency of interception can be determined. The treatment is clear within the limitations of the formulation, and provides useful information of a quantitative nature which gives orders of magnitude of the energies of interception and the grazing efficiencies of collision.

The probability of attachment of an intercepted particle is treated at length primarily on the basis of an analysis of the factors that influence the stability of a water film between the particle and the bubble surface itself. The author is particularly skilled in the presentation of this material. Included in the treatment is an analysis of the hydrodynamic stability of the film following perturbations, and the development of criteria associated with the steady-state film stability based on the 'disjoining pressure' concept, which incorporates a treatment of the effect of electrical charge and ionic strength of the lamella. This treatment is currently incomplete, as the author acknowledges, in its ability to take into account the effects of tensides on the surface properties of the bubble and the particle.

The treatment of the transport of the bubble/particle aggregates from the pulp to the froth and the transport within the froth is less complete. The author points to the relatively new work of Wollman, in which a convincing mechanism for the flotation of fine particles and their effect on froth stability is proposed. His analysis is based on the transport of fine particles to the pulp from the interface by the macrocirculation of the fluid within the cell. At the interface the probability of interception is much higher than in the pulp volume itself, and in passing through the interface the bubble forms a liquid lamella with the same concentration of fine particles as is present at the top of the pulp surface. This is an interesting concept, and is one which will probably be developed fruitfully in the near future.

The author's treatment of macrocirculation in the flotation cell itself omits reference to the effect of air dispersion on circulation and transport of solids and the effect of recirculation to the impeller on efficiency. This is understandable within the stated framework of the book, but the omission of this topic does not reflect its extreme importance in cell design and operation.

It is inevitable in such a comprehensive survey that the treatment of individual aspects is very concise and sometimes is difficult to follow. However, the inclusion of a well-judged bibliography clearly referenced from the text is valuable. The author also includes worked examples in the form of programs coded for a standard programmable calculator. The logic is easy to follow, and with the data provided is a useful basis for estimating properties such as the disjoining pressure, particle trajectories, critical film thickness, etc.

Despite these features, the monograph is certainly too advanced for undergraduate use, but will be extremely valuable for postgraduate students and full-time research workers. It should also be useful to those engineers and technologists who are concerned with optimum process design and operation. It is stimulating and well written, and the author is to be congratulated.

E. T. WOODBURN

The Measurement of Turbulent Fluctuations: An Introduction to Hot-Wire Anemometry and Related Transducers. By A. V. SMOL'YAKOV and V. M. TKACHENKO (translated by S. CHOMET, edited by P. BRADSHAW). Springer, 1983. 298 pp. DM.98.00.

The authors attempt to deal with the following questions (from the Preface): what to measure, how to measure, and how to interpret the results of measurement with particular attention to the latter. The first part of the book (Chapter 1) lays down the fundamental ideas of the statistical approach to the description of turbulence, while the second (Chapter 2) presents the basic ideas underlying experimental methods for determining the different statistical parameters of turbulent fields. The third, and most comprehensive, part of the book (Chapters 3–5) is devoted to the problem of interpreting experimental results that have been distorted by the averaging introduced by transducers of finite size.

The third part of the book represents a reasonable attempt to summarize in easily readable form the diverse literature that has arisen since the work of Uberoi & Kovasznay (1953). Extensive applications to both hot-wire and pressure transducers are included, along with much of the related material needed to make the theory comprehensible. If the authors primary goal was to write a book on transducer spatial resolution, they have succeeded. Unfortunately they have not been so successful in realizing their remaining objectives.

The account of the statistical background of turbulence is brief and reasonably comprehensive, except for several glaring exceptions. There is no discussion of the relation between the one-dimensional and three-dimensional spectra and the aliasing present in the former which is usually measured. The universality of the small-scale turbulence at high Reynolds numbers, the cornerstone of the spatial-filtering analysis, is scarcely mentioned. Further, the $k^{-\frac{5}{3}}$ law (2.1, p. 56) seems to be dependent on the assumption of isotropic turbulence, one of the few errors. As in-depth analysis of Taylor's frozen-field hypothesis and its limitations (as e.g., in Lumley 1965) would have been warranted, in view of its central position both in practice and in the book, and its absence represents a serious deficiency.

The sections on hot-wire and laser-Doppler anemometry are poorly written, misleading in content, and would have been better left out altogether. For example, the only hot-wire calibration mentioned is King's law, and there is not even a reference to any of the excellent review articles which have been written over the past ten years (the one by Comte-Bellot (1976) comes quickly to mind). The discussion of laser-Doppler anemometry consists almost exclusively of the effects of Brownian motion, which is almost never a problem, with again no reference to any of the excellent books or review articles which are now available on the subject (Buchhave, George & Lumley 1979 is but one of many).

The book does contain a number of insights which contribute to its overall value. For example: "Field measurements are usually subject to minimum distortion because of the complete absence of scale effects, which may arise in laboratory experiments because not all the similarity criteria can be satisfied (2.2, p. 64)." Arguable perhaps from the point of view of the atmospheric scientist, but certainly on-the-mark regarding a principal (but often overlooked) difficulty in laboratory simulations.

The translator and editor have done a commendable job in preparing a text that flows smoothly, free from the complex sentence structures often present in technical translations. All things considered, the book, although seriously flawed in content, represents a contribution to the increasing library of turbulence books, and could prove of value to expert and novice alike.

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