J. Fluid Mech. (2018), *vol.* 855, *pp.* 1238–1241.
doi:10.1017/jfm.2018.658

BOOK REVIEW

Experimental Hydraulics: Methods, Instrumentation, Data Processing and Management. By Marian Muste (Editor in Chief). IAHR Monographs, two volumes, CRC Press, 2017. 906 pp. ISBN: 9781138027534. £190.00.

This monograph deals with experimental techniques and measurements in open channel flows, over 900 pages. Very few books provide a similar coverage of this subject area. A solid but somewhat outdated reference is the handbook by Troskolanski (1960). Tropea, Yarin & Foss (2007) delivered an outstanding reference, although the text emphasised fluid dynamics and lacked detailed coverage of open channel flows. Novak and co-workers developed texts mostly focused on physical modelling (Novak & Cabelka 1981; Novak *et al.* 2010), while a few open channel hydraulics textbooks include introductory sections on physical modelling (Henderson 1966; Chanson 2004). Hughes provided an excellent coverage of physical modelling techniques, although limited in scope to coastal engineering applications (Hughes 1993). This new monograph is a two-volume handbook, prepared and edited by a panel of senior editors, who are well known in the field, with contributions from a large number of experts. This review evaluates the book both for its intended audience (researchers in civil, environmental and hydraulic engineering) as well as an altogether different one, namely that concerned with the interface between fluid physics, engineering and environmental science. This group has an increasingly large audience membership, and practitioners who have not followed a traditional engineering educational pathway may require some basic knowledge in open channel hydraulics and measurements for their work. The present review was conducted by two senior researchers (H.C., B.M.), and three early-career researchers (H.W., X.L., C.W.). The latter researchers 'road-tested' the monograph over a three-month period, using it as a first source of information to solve the day-to-day problems of a varied group of physical hydraulic modellers.

Volume I of the monograph starts with major sections on the fundamentals of open channel hydraulics, basic concepts in dimensional analysis and similitude, physical modelling and experimental design. These three chapters cover a lot of basic material in a concise manner and they should be compulsory reading for every individual who does not have a background in hydraulic engineering and research. These chapters also contain a wealth of references for readers requiring a more detailed treatment of specific topics. The introductory content is followed by a series of more practical sections on the conduct of experiments, data processing and analyses, as well as some valuable discussion on uncertainties. Again this is important reading for non-specialists, who should read the materials in parallel to conducting physical measurements.

In addition to its value to early-career or non-specialist researchers, volume I of the monograph provides an excellent teaching resource at undergraduate level. Significant effort has been made to ensure that the content in this volume is accessible to readers through an abundance of figures and tables. From the educator's perspective, sections discussing similarity requirements for complex flows and how to address similitude shortcomings are worthy additions to the basic dimensional analysis content taught in basic fluid mechanics and hydraulics courses. The sections related to

quality control, record keeping, the statistical treatment of results and the discussion of uncertainties should be required reading for any students who will undertake experiments, irrespective of their chosen discipline.

Volume II provides a detailed treatment of the measurement techniques required for a broad range of hydraulic engineering applications. It covers flow visualisation, velocity measurements, topography and sediment transport. The general principles presented to guide researchers in the selection of experimental techniques are very valuable in this regard, such that all measurement techniques are presented in the context of the overall experiment. The section on velocity measurements is very comprehensive and reflects the development of new techniques over the past three decades such as particle image velocimetry, laser Doppler anemometry/velocimetry, acoustic Doppler velocimetry and acoustic Doppler current profiling (LDA/LDV, ADV, ADCP). Although the treatment of more 'traditional' measurement techniques is perhaps more thorough than newer imaging-based techniques, an appropriate level of detail is included with respect to the latter. Possibly the most useful section is chapter 6, volume II, which brings together a broad range of measurement techniques, encompassing water depth, bed shear stress, pressures and forces. This chapter is followed by valuable content on flow rate measurements in chapter 7. Experienced researchers are likely to find volume II most helpful in practice. It is felt that volume II could have been structured differently, starting from simple techniques and global measurements such as discharge and water depth observations, down to detailed millimetric and sub-millimetric measurement techniques, such as velocity and turbulent stress measurements. However, the ordering of the content does not detract from its quality, and the volumes are well organised so that readers can quickly access the required information.

The book is well targeted at readers who need guidance on designing and conducting hydraulic experiments. Despite its practical nature, it provides a broad yet concise introduction to the basic flow physics and theories underlying most hydraulic and fluid dynamics problems. However, the monograph emphasises the application of such concepts, and the practical meaning of fundamental theories without compromising on details. This is considered very helpful for both early career researchers as well as for senior researchers who view the field from an elevation.

The contribution is most valuable in practice for its coverage of both traditional and advanced flow measuring techniques. With the fast development in experimental methodology and instrumental technology in the past two to three decades, largely thanks to the revolutionary growth in the processing capacity of computers, mastering any of the many branches of instrumentation now requires a large amount of expertise. This is a significant challenge for postgraduate students and researchers who are not experienced in physical modelling or prototype measurement of hydraulic phenomena. For these readers, the first step into the subject of experimental hydraulics could be like entering a lobby with dozens of lifts leading to different parts of the building complex but an unattended reception desk. The publication of this book now provides such an attendant, guiding the readers to the correct lifts. The chapters on signal processing and velocity measurements are extremely valuable for this reason, as they bridge a traditional knowledge gap for an experimentalist in the field of civil and hydraulic engineering, who may lack a thorough understanding of the electrical and electronic aspects of the instruments. However, the data analysis and processing techniques that are covered in the book seem to focus mainly on steady/quasi-steady flows, and very nearly avoid coastal applications and transient flows altogether. The use of data despiking, for example, may change substantially in dealing with transient,

oscillatory or rapidly varying turbulent flows as compared to steady/quasi-steady flows. This provides a challenge for the editorial team to address in future versions of the monograph.

Experienced researchers with sufficient background knowledge of flow measurement techniques should easily find the most useful information in this book about experimental arrangement and selection of suitable instrumentation, including the associated limitations and data-processing requirements for the instruments. These readers are still encouraged to refer to relevant literature cited at the end of each chapter for further information on the application of a particular technique to specific cases, as it is impossible to cover all practical issues in one handbook.

What could be improved? Chapter 8 of volume I lacks the technical depth found in the other chapters of the monograph. It introduces some important issues related to data assimilation and the validation of numerical models. However, the contents fell short of the readers' expectations on several points. There is no mention of the increasing demand for computational fluid dynamics (CFD) modelling, and the associated challenges of verification and validation (Roache 1998, 2009). No discussion is developed on the validation of numerical models for extreme events, including against field observations recorded during major floods (e.g. Kvocka, Falconer & Bray 2015). Hybrid modelling, based upon interlinked physical and CFD modelling, is not covered, despite important recent contributions (Novak *et al.* 2010). It is suggested that future editions could contain a more detailed treatment of very large datasets from multiple sources, and a discussion on the different goals and data requirements associated with numerical modellers and theoreticians. These would provide additional input to the experimental decision-making process outlined at the start of chapter 4.

Overall the contributors, the editorial team as well as the learning society (IAHR) should be applauded for this initiative. This monograph fills a knowledge gap, covering a most relevant topic and including some of the latest developments in this area. One may argue that there is little coverage on field measurements during natural disasters (floods), air–water free-surface flows, hydraulic structures and unsteady rapidly varied open channel flows. This is true and merely reflects the needs for further specialised monographs on these difficult and specialised topics. The treatment of coastal applications lacks the depth of other topics of interest to hydraulic engineers. However, this monograph achieves its purpose of being an excellent book for graduate students, researchers and engineers in civil engineering interested in open channel flow and measurements, and a very useful reference text for those developing, designing and conducting physical hydraulic experiments.

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