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BOOK REVIEW

The Genesis of Fluid Mechanics 1640–1780 (Studies in History and Philosophy of Science, vol. 220.) By JULIÁN SIMÓN CALERO. Springer, 2008. 517 pp. ISBN 978-1-4020-6413-5. £110.50 (hardback)

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This is an English translation and revision of *La Génesis de la Mécanica de los Fluidos (1640–1780)*, first published in Madrid in 1996. After a 41-page introductory survey, the book is divided into two parts, devoted respectively to 'The Problem of Resistance' and 'The Problem of Discharge'. Each part has its own introduction, followed by five chapters.

The first two chapters of Part 1 concern 'impact theory' and related experiments, mainly in works of Huyghens, Mariotte, Newton and Jakob Bernoulli. Here, resistance is regarded as due to the impact of quasi-solid fluid particles on the parts of bodies exposed to the oncoming flow. Chapter 3 follows the evolution of this approach under Johann and Daniel Bernoulli, Bouguer, Euler, Robins, d'Alembert, Jorge Juan and others. Chapter 4 reviews experiments on resistance, principally by Borda, Bossut and the little-known Swede, Frederik Henrik af Chapman. Chapter 5 concerns 'Fluid-driven machines and naval theories'. The part on machines is devoted to water wheels and windmills, reviewing work of Parent, Pitot, Bossut, Smeaton, Euler and others. The remainder of this chapter treats ship design and operation, the subjects of many eighteenth-century treatises including those of Bouguer, Juan and Euler.

In Part 2, Chapter 6 is on the subject of discharge of water from vessels and tanks, primarily in the studies of Torricelli, Guglielmini, Mariotte, Newton and Poleni. Attempts to discover a unique formula relating the rate of outflow to the diameter of a circular aperture and its depth below the free surface proved inconclusive: despite a reluctance to dispense with Torricelli's law, the precise nature of the efflux turned out to be important. Chapter 7 at last confronts the origins of theoretical hydrodynamics, with the *Hydrodynamica* of Daniel Bernoulli and the *Hydraulica* of his father Johann. Daniel's approach, based on the 'conservation of live forces' (conservation of energy) and the assumption that the flow velocity is constant at each cross-section of a non-uniform tube, yielded many new results concerning steady and unsteady discharge, and oscillations, in angled and non-uniform tubes. The relationship between pressure and flow velocity now known as 'Bernoulli's theorem' here makes its first appearance, as does a rudimentary kinetic theory of gases. Johann Bernoulli's *Hydraulica*, though mainly revisiting problems already solved by Daniel, presents an important new viewpoint: he considers infinitesimal sections within the fluid, subject to their own accelerations under local pressure gradients. Thereby, he set the path to be taken by d'Alembert and Euler in establishing the partial differential equations of inviscid fluid dynamics. The chapter ends with a brief account of the later work of Borda on efflux from vessels.

Chapter 8 continues with the hydrostatical work of Clairaut on the 'figure of the Earth' and the fluid-dynamical treatises of d'Alembert, the most important being his *Essai d'une Nouvelle Théorie de la Resistance des Fluides*. In the latter, there first appear governing partial differential equations for plane and for axisymmetric

irrotational flows, though derived in a rather obscure manner. Chapter 9 then reviews Euler's masterly derivations of the governing equations, now named after him, for general three-dimensional incompressible and compressible flows. The final Chapter 10 returns to the theory of machines, mainly pumps and turbines, in works of Pitot, Daniel Bernoulli, Segner, Euler and Borda.

This book covers most of the main texts in the evolution of fluid mechanics. Simón has clearly laboured hard to read and understand these works, presenting translated quotations and summaries of many salient passages, often reworked in modern notation. He has incorporated many helpful illustrations, both new and old; he has provided many graphs of results first given in tabular form; and he helpfully gives conversions to modern units of the various pouces, pieds, once, feet, fot, etc. of the originals. Yet his book is profoundly disappointing for several reasons.

First, presumably not the direct fault of the author, the English translation is poor, and there is little sign of any copy-editing or proof-reading. Almost every page contains several errors. Prepositions and definite articles are particular weaknesses, erratically absent or wrongly present. Mistranslations abound: e.g. 'barrow' for 'barrel' (p. 10), 'recipient' for 'receptacle' (pp. 27, 346), 'fundaments' for 'fundamentals' (p. 30), 'dumping' for 'damping' (p. 82) and, repeatedly, 'experience' for 'experiment'. The footnotes are particularly error-prone and some are simply incomprehensible, such as 'The meaning of this coefficient, as the times sense, was equivalent to the number of kinetic height the cylinder of equal weight that the resistance force would have' (p. 13). Even proper names are sometimes wrong: e.g. in quick succession, 'Dominico Guglielmini' and 'Domenico Guglielmin' (p. 275), and the baffling 'Frederik Treatise Chapman' (p. 197). How a normally reputable publisher, and the editorial advisory board of the series, could have passed for publication such an error-strewn manuscript defies comprehension.

Secondly, there are many other defects, large and small, that are presumably the author's responsibility. As instances: on p. 64, Mariotte is said to have died in 1689, some years after a 'posthumous work' was published; on p. 48, the angle of incidence of flow against a plate is incorrectly defined in Figure P-2 as the complement of the angle; incorrect equations are given on pp. 83, 346, 375, 404, 405. Though some of Simón's summaries may serve as guides to those who wish to read portions of the original works, others are themselves obscure and seemingly aimless, and the notation is not always explained. Some general assessments seem naïve. For instance, classifying Johann Bernoulli, d'Alembert and Euler as mathematicians (or 'geometers'), but Daniel Bernoulli, Galileo and Newton as physicists (or 'natural philosophers'), he avers that: 'The tension between these points of view is a constant in science, and perhaps they are two intrinsic poles of science' (p. 293). But there was no such clear division at this early date. Other assessments seem contorted. Thus, in assessing d'Alembert's contributions to fluid mechanics, Simón cites: 'The reduction of the phenomenon of motion to two equations in partial derivatives that do not solve the problem, but serve only to define or contain it. The simple fact, on the other hand not so simple, of the intellectual assumption of these equations supposes a remarkable advance, as he makes a very profound abstraction of physical reality' (p. 399). Though for the most part he avoids general historical remarks, Simón's claim that 'French presence in [the American continent] had almost disappeared by the beginning of the eighteenth century' (p. 244) would surely raise eyebrows in Quebec and Louisiana.

Simón's division of material into two parts, on resistance and discharge, is itself problematical, for several important aspects of fluid mechanics do not naturally fit. Vortex motion appears only on p. 81 (Newton's solution) and on pp. 329–330 (Johann

Bernoulli's *gurges*); there is the briefest mention of water waves on p. 450, and nothing on tides or winds. The two-part approach also disrupts the chronology, with many of the same works appearing in both. The extended Introduction seems an afterthought, summarising what is to follow and showing several figures that reappear later.

One must ask whether this book meets any real need. Certainly, its high cost must limit it to library sales. Had it been well written and well produced, it could have been a useful addition to the existing literature on the history of fluid mechanics. But, in the circumstances, readers would do better to stick with the following: on history of hydraulics, Rouse & Ince (1957), Garbrecht (1987) and the scholarly Maffioli (1994) – the last apparently unknown to Simón; on theoretical fluid mechanics up to Lagrange, Truesdell (1954, 1955, 1968), and on later developments Darrigol (2005).

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