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Book Reviews

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The Genesis of Fluid Mechanics, 1640–1780

Julián Simón Calero, Springer, New York, 2008, 517 pp., $199.00

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FLUID mechanics is one of those rare disciplines that both science and engineering can claim as their own. It has a rich history and can trace its genesis to archaic Homo sapiens, who, quite empirically, unceremoniously, and without a hint of what either a fluid or mechanics is, discovered around 400,000 years ago that a streamlined object travels farther than a blunt one. As a result of that enduring and endearing past, numerous books have been written on the subject and its history. The present author chose to detail a very specific period, 1640–1780, which he anoints as the "genesis" of fluid mechanics. I recently reviewed another book (*AIAA Journal*, Vol. 45, No. 4, 2007, pp. 959–960), *The Dawn of Fluid Dynamics: A Discipline Between Science and Technology*, by Michael Eckert, who chronicled the development of fluid mechanics during the early decades of the twentieth century. So, who is right? Neither and both. If we speak of the science of fluid mechanics, then the period of 1640–1780 richly deserves the honor of being the cradle of that science, a period when differential calculus was perfected, Isaac Newton's *Philosophiae Naturalis Principia Mathematica* was first published, and *Leonhardi Euleri Opera Omnia* resonated. In short, rational fluid mechanics was born. Eckert, on the other hand, writes about the boundary-layer theory that for the first time enabled first-principles solutions of certain technologically important viscous flow problems. Ludwig Prandtl's impact on the discipline may not qualify as the dawn of fluid dynamics, but is certainly a very important milestone. Fluid mechanics as a technology goes back to antiquity, and an author may one day write about the true genesis of that aspect of the discipline.

The present book is a translation from the original Spanish, *La Génesis de la Mecánica de los Fluidos (1640–1780)*, published in 1996 by Universidad Nacional de Educación a Distancia. Verónica H. A. Watson has done a superb job translating the monograph and the English is quite readable, down to the subtleties of scientific writing. The author even acknowledges that Ms. Watson has improved his own difficult, sometimes baroque, and sometimes highly condensed original text into clearer and occasionally "sweet" English.

It is a pity that Calero's affiliation or bio is not to be found anywhere in the English edition. It would have been useful to find out if the author has a background in fluid mechanics and interest in the history of science or technology or if he is a genuine historian with an interest in mechanics or, more broadly, physics. The reader may wish to know about other significant work by the same author. I gathered from independent sources that Julián Simón Calero has recently been the President of the Council of European Aerospace Societies and has affiliation with Universidad Nacional de Educación a Distancia in Madrid, Spain. But that could be a different Julián Calero.

The book is divided into two parts, the problem of resistance and the problem of discharge, an unusual categorization by today's standards, but that perfectly fits the essence of the period, when fluid mechanics boiled down to the prediction of discharge rates from different orifices and the drag experienced by a body in relative motion with a fluid. There are five chapters in the first part covering the following topics: forerunners of impact theory, impact theory, evolution of the resistance problem, experiments, and machines and naval theories. The second part also contains five chapters: discharge from vessels and tanks, hydrodynamica and hydraulica, theoretical constructions I (Clairaut and d'Alembert), theoretical constructions II (Euler), and applications to pumps and turbines. The two parts are preceded by a prolegomenon, which, more than a mere introduction, does exactly what the word means, providing a nice summary and overview of the entire treatise.

The author has done a splendid job of detailing the intense period of discovery, warts and all. Now abandoned theories such as the impact theory are developed in all their gory and erroneous details. Even the mathematics is thorough and impeccable, which is unusual for a history book. An occasional typo, such as 4 instead of 2 in Equation [2.3], does not distract from the meticulousness of the author's research. The analysis is exactly what existed during the period 1640–1780, and modern ways of looking at the same problem are occasionally described. I say that not because I read the original manuscripts, especially the ones written in Latin, but rather because Julián Calero establishes an aura of trust, and his treatment, even when he discusses theories that we now deem subpar, is logical, self-consistent, and void of pitfalls. It is utterly fascinating to read how the greatest of all geniuses can occasionally develop a less-than-perfect theory. Even the line drawings, though not credited, appear to have been copied from the original manuscripts, which makes the history more authentic. It comes alive.

Leonhard Euler is a very important figure in the development of rational fluid mechanics, and the present author spares no details about his many contributions. Julián Calero is undoubtedly influenced by the magnificent introductions written by Clifford A. Truesdell for the two volumes of *Leonhardi Euleri Opera Omnia*, which covered the periods 1687–1765 and 1765–1788. Isaac Newton is, of course, properly credited for creating the science of mechanics, and his dabbling in fluid mechanics is elaborated.

Here is an indication of the author's general views as outlined in the first two pages of the book. Fluid dynamics and fluid statics gave rise to subsonic, transonic, and supersonic subspecialties. "The basic hypotheses that mathematically regulate fluid mechanics, the structure and formulation of its fundamental equations, and the problems of its applications were all forged in the second half of the 17th and first half of the 18th centuries." "Key concepts in fluid mechanics—such as turbulence, boundary layer, discontinuity surfaces, viscosity and thermodynamics processes—were introduced in the course of the 19th and twentieth centuries."

The period covered by the book is sandwiched between two poles, Isaac Newton's *Principia* in 1687 and Euler's continuum approach in 1755, each looking at fluids from a different point of view. Newton considered a fluid to be an aggregate of particles that respond individually to the laws of mechanics, thus the impact theory, which considers the force generated by the impact of a current against an object as consisting of the sum of the effects of each individual impact. Euler, in contrast, asserted that the fluid is a continuum for which the space–time evolution is governed by the laws of dynamics in the form of a partial differential equation. Euler's is the prevailing view today. Pre-Newtonian contributions such as Torricelli and his namesake law are detailed. Post-Newtonian nuggets are included as well. We learn of the three members of the Bernoulli family, brothers Jakob and Johann and the latter's son Daniel, and the infamous feud between the father and son. P re Johann published *Hydraulica* in 1742, but claimed he had written it in 1732, before fils Daniel presented his *Hydrodynamica*. According to Calero, we know today that the father plagiarized his son's theory. Nevertheless, Johann's work is of higher quality because it tackles the problem in a more general manner and is more solidly based on Newtonian mechanics. Finally, we also learn of the sudden falling out of two greats, Leonhard Euler and Jean le Rond d'Alembert.

In closing, the history of the development of rational fluid mechanics is a fascinating one. For all lovers and aficionados of fluid dynamics, professionals as well as amateurs, *The Genesis of Fluid Mechanics, 1640–1780*, is recommended reading. Classroom teachers in particular should seriously consider sprinkling their lectures on Bernoulli equations, Euler equations, Torricelli's law, pitot tube, d'Alembert paradox, and many of the other topics covered in the present book with the lively history provided therein.

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