las humanidades. A pesar de que la arquitectura del texto quede distorsionada por una muy extensa parte final que tiene un desarrollo autónomo e independiente del resto de la obra, sus autores demuestran haber reflexionado a fondo y con conocimiento de causa sobre los problemas que conlleva semejante programa, y ofrecen una tesis original, desacomplejada, razonable y abierta a la comprobación empírica. No es casual que, tras un competente despliegue teórico de raíz evolutiva, adviertan que "ninguna cultura, ninguna forma de organización social, parece reducible por completo a lógicas explicativas evolutivas" (p. 257). Porque el posible rescate, por la vía de su reconceptualización radical, de muchos de los innegables logros de las ciencias sociales y las humanidades pasa necesariamente por entender que la identificación de las restricciones de la evolución histórico-cultural no acaba en la identificación de las restricciones cognitivo-emocionales. Más bien parece ser el principio. Y a esto contribuye inteligentemente una propuesta que integra la idea de una naturaleza común, la dimensión valorativa asimétrica de la psicobiología humana y la interacción del diseño cognitivo con la contingencia espaciotemporal de nuestros vínculos sociales.

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JULIÁN SIMÓN-CALERO, *The Genesis of Fluid Mechanics: 1640-1780*. Dordrecht: Springer, 2008.

This book by J. Simón-Calero has now appeared in its English translation and deserves to be welcomed as a valuable addition to the critical literature on the history of science in fluid mechanics. This branch of science went through its formative years essentially during the period of 1640-1780, on which the book concentrates, and emerged from a stage of spotty, not very systematic knowledge to a modern scientific discipline by the end of this period. There exists a wealth of individual contributions to these developments. But the literature that reviews the genesis of fluid mechanics as a coherent, rationally founded, systematic process of knowledge genesis is scarce. This is where Simón-Calero's book meets an important need.

Fluid mechanics, as the book describes, encompasses the laws of equilibrium in a fluid at rest (hydrostatics) and the governing principles of fluid motions as well as the forces on immersed objects in fluids resulting from such motions (hydrodynamics). The knowledge in fluid mechanics rests on theoretical-deductive reasoning as well as on experimental-observational evidence. Simón-Calero covers all these aspects in their historical interactions, a fascinating case study of knowledge genesis.

The principal aim of the book is to document and explain the early history of fluid mechanics in its chronology, its physical substance and its logical structure. This is achieved by an elaborate account of the key ideas, their chief contributors and the important milestones of insight in the course of this genesis process. Students of fluid mechanics from modern textbooks or academic courses for lack of space and time often remain unaware of the origin and structure of the axiomatic nucleus of this knowledge, which they then take for granted. Thus they lack an element of deeper understanding of the value and coherence of individual contributions. Simón-Calero accurately records who did what, when and why. It can be an enlightening experience for many to view fluid mechanics in this new context.

Simón-Calero's treatment also places much emphasis on the simultaneous developments in mathematical methods such as calculus, differential equations, differential analysis and numerical techniques that were a crucial prerequisite for modeling fluid flow structures and applications. In many cases the fluid mechanicists were excellent mathematicians in their own right and had to invent new mathematical methods and representations to deal with physical reality in their medium. Simón-Calero amply demonstrates this productive synergy.

The main body of the book is divided into two parts dealing with the Problem of Resistance (Part I, five chapters) and the Problem of Discharge of Fluid from Tanks (Part II, five chapters), including flows in ducts and pipes. These problems remained a major preoccupation throughout the genesis of fluid mechanics.

The first chapter on resistance deals with pre-Newtonian precursors, especially Huygens and Mariotte, who in the 17th c. performed first resistance measurements for the Parisian Academy of Sciences. In Chapter 2 Simón-Calero describes Newton's work as forming the first cornerstone of modern fluid mechanics. He presents Newton's achievements in great detail, primarily on the basis of the three editions of Newton's "Principia Mathematica Philosophiae Naturalis" (1687, 1713, 1724), especially in Book II which is devoted to fluids. Among Newton's many contributions Simón-Calero particularly emphasizes the following:

- Newton performed systematic studies of fluid material properties, thereby defining categories of fluid flow. He measured viscous drag in various fluids. He also proposed a qualitative law of viscous stresses in fluid flow.
- Newton also developed an approximate theory of flow resistance on submerged bodies, his "impact theory", on the assumption that the particles of the inflow current would bounce off the front side of the body, being reflected there like rubber balls, but without reaching the rear side. For a "rare" medium, i.e., a thin "gaseous" medium without internal particle interaction, he was able on this basis to determine the resistance of various simple shapes by taking the momentum balance of the particle stream. But his assumptions on the flow pattern in front and on the rear side of the body were in error, which caused poor agreement between impact theory and experiments.

Newton laid the foundations for treating fluid mechanics as a branch of rational mechanics. Newton's immediate followers and contemporaries, e.g., Fatio, De l'Hôpital, Jacob and Johann Bernoulli, tried to exploit Newton's impact theory of resistance as fully as possible. The agreement with practical observations remained disappointing.

In his third chapter Simón-Calero describes the further evolution of the resistance problem. The weaknesses of the impact theory became more widely known. A fresh impetus came from the experimental side. Benjamin Robins, e.g., performed ballistic experiments measuring the path of projectiles ("New Principles of Gunnery", 1742). The results showed major discrepancies from impact theory. Robins disagreed with Newton and found new explanations, favoring streamline models with attached or separated flows on projectiles. Euler soon translated Robins' treatise into German and tended to fully concur with him, providing elaborate comments to substantiate the new claims.

In Chapter 3 and above all in Chapter 7 Simón-Calero deals with the decisive contributions made by two eminent men, Johann Bernoulli (1667-1748) and Daniel Bernoulli (1700-1782), father and son, from Basle, Switzerland. Much of their work on fluid mechanics culminates in their classical publications, the "Hydrodynamica" (1738) by Daniel and the "Hydraulica" (1742) by Johann Bernoulli. The substance of these works and the contributions made to the genesis of fluid mechanics by both scientists are described extensively in these chapters.

Daniel Bernoulli performed discharge experiments (1727), where he directed a jet against a plate to observe the flow pattern and to measure the resistance. He clearly saw that the fluid matter, rather than striking the plate and being reflected, would be deflected laterally before the impact. This led him to reject the impact theory. In his fundamental treatise "Hydrodynamica" (completed in 1732, published in 1738), he introduced the concept of streamlines as flow trajectories and on the basis of the principle of conservation of live forces (mechanical energy conservation) derived an equation of state along flow filaments ("streamlines"), later called the Bernoulli equation, which described the essential relation between velocity and pressure in steady duct flows. He also verified this law by pressure measurements tapping into the side of the discharge pipe with a column water manometer.

Johann Bernoulli, Daniel's father, in his famous treatise "Hydraulica" (1742) went a few steps further: Essentially he regarded the dynamic balance of an infinitesimal volume element of fluid, defined the state variables of pressure and velocity in the interior of the fluid acting upon the element, and applied Newton's Second Law to determine the motion of this element, also for unsteady flows. The introduction of the interior pressure enabled him to study the fluid state variables anywhere in the continuum. Thereby he raised fluid mechanics to a legitimate subject of continuum mechanics, permitting approaches quite equivalent to those used in solid mechanics. His equation for unsteady flows is also usually called the Bernoulli equation.

Thus for the steady flow through ducts the two Bernoullis come to equivalent conclusions from different starting points, the principle of live forces vs. Newton's dynamics. Johann Bernoulli extended the theory to the unsteady flow case. His starting point in Newtonian dynamics was original and seems to have facilitated later generalizations to other types of ideal fluid flows (e.g., by Euler). Simón-Calero also mentions the unfortunate and unnecessary priority dispute between father and son Bernoulli. Both of these men deserve recognition and praise for their brilliant ideas in the genesis of fluid mechanics. This is why Simón-Calero recommends calling their twice invented equation "The Bernoullis' equation" henceforth. A diplomatic compromise.

In their naval treatises Bouguer (1746) and Euler (1749) made no longer any attempt to defend the validity of impact theory. A fresh start was needed and this evolved with field theory, which aimed at predicting the state variables pressure and velocity in a fluid continuum.

In Chapter 4 Simón-Calero describes experiments on resistance, beginning more intensively after 1760 (Borda, Chapman and Bossut et al.). Chapter 5 discusses some semi-empirical methods for the design and operation of fluid driven machines (water mills, water wheels, wind mills and ships). Many of these results were of practical value, though often much debated and disputed.

In Part II of his book Simón-Calero addresses those developments in fluid mechanics which are related to the classical problem of the discharge of a fluid from a containment vessel. Flows through pipes and ducts closely border on the discharge problem. Simón-Calero in his preface to this Part credits Torricelli (1640) as the originator of this scientific issue, but spans the whole era of early knowledge genesis through Newton, the Bernoullis and up to Euler.

In Chapter 6 Calero recounts the early history of the discharge problem. Torricelli (1644) in his discharge experiments established a law for the outflow velocity being proportional to the square root of the water depth in the tank. Torricelli's results were verified and modified by his successors since the results vary somewhat depending on the conditions of the test setup.

By about 1750 it had become well accepted that fluid flows could be represented in continuum mechanics by field equations of state. New research sprang up to develop a general field theory and to contend with more and more applications. In Chapter 8 Simón-Calero describes the new theoretical constructions presented by Clairaut and D'Alembert. D'Alembert (1744, 1749, 1753) studied the motion of fluids in tubes and the solution of streamline flows in ideal fluid continua, derived from his principle of dynamic equilibrium. His zero resistance "paradox" for a closed body in an ideal fluid is also a result of these studies.

In Chapter 9 Simón-Calero deals with Euler's fundamental work in fluid mechanics and here he reaches the apex of the theoretical developments in ideal fluid mechanics in the 18th c. Aside of many smaller, earlier and later contributions Euler in 1755 presented three monographs, closely related and coherent, which until today form the fundamental basis of ideal fluid field theory. In these monographs Euler presents the final version of his general theory, formulated in terms of the momentum balance and continuity equation. He illustrates the usefulness of this general foundation by applications to duct flows, streamline flows, potential and non-potential flows etc. His approach is of great clarity and concise presentation and has remained modern until today. Simón-Calero presents Euler's work in great physical and analytical detail and considers Euler's achievements as the essential final cornerstone in the building of fluid mechanics in the 18th c.

In his final Chapter 10 Simón-Calero reviews the applications of fluid mechanics to pumps and turbines which were feasible in the 18th c. with their contemporary fluid mechanics as background (Pitot, Borda, Daniel Bernoulli, Euler and Segner). Some of these practical achievements precede the maturity of pertinent theories. Simón Calero's book closes with a useful appendix on units of measurement in various countries, a comprehensive bibliography and a helpful index.

This book in summary presents a valuable study on the early history of fluid mechanics as a scientific discipline. The book documents the essential historical milestones and pioneering conceptual contributions to the knowledge genesis in this field. The presentation is chronologically accurate and logically rational on the basis of mechanical insight and logical rigor. The book encompasses theoretical-deductive thought as well as empirical-observational evidence. The reasoning is thorough and systematic. Thus it is helpful to those with historical interest as well as those who seek a deeper physical understanding of the origins of fluid mechanics. It can be read as a self-contained monograph, but also provides a comprehensive list of bibliographical references for further study.

The style is precise and clear, requiring a basic knowledge in calculus and analysis. The English translation of the Spanish original is generally accurate, though not literal everywhere, sometimes missing precise technical terminology, though always aiming at elegance and legibility. A few clarifications were added, regrettably also a few minor sections with useful background material were omitted. But this does not detract from the significant value that this new appearance will have for all those who are interested in the roots of modern fluid mechanics.

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DANIEL STEEL*, Across the Boundaries: Extrapolation in Biology and Social Science.* New York: Oxford University Press, 2009.

La importancia del papel que desempeñan las extrapolaciones en la actividad científica y en significativos aspectos de la vida cotidiana simplemente no puede exagerarse. ¿Cómo es que, para utilizar la bella expresión de Loren Eiseley, las gotas de lluvia en las canaletas pueden, multiplicadas en el tiempo, convertirse en Niágaras que den cuenta de muchos accidentes geológicos que solían explicarse apelando a catástrofes singulares? ¿Cómo es que, para citar ahora a Charles Lyell, es razonable pensar que, así como Newton "vio" que la misma fuerza que alcanzaba a la copa de los árboles y a sus frutos está presente en lugares donde nunca hemos estado —como los planetas distantes—, así también es razonable pensar, *mutatis mutandis*, que estamos justificados en hacer extrapolaciones en el ámbito temporal respecto de la acción uniforme de las mismas leyes y fenómenos que hoy presenciamos? ¿Cómo es que sabemos lo que decimos que sabemos respecto de la toxicidad para los seres humanos de ciertas sustancias si sólo la hemos chequeado en el laboratorio, con roedores, y con exposiciones que, proporcio-