

# Preface

In 1800 (An VIII of the First French Republic), the civil engineer Gaspard-Clair-François-Marie RICHE, Baron de PRONY (1755–1839), published a book entitled “*Mécanique philosophique*” (“Philosophical Mechanics”). This title bears the whole spirit of the approach to science and more generally knowledge that was expanded during the Enlightenment and its acceptance by contemporaries of the French Revolution and early nineteenth century. I very much like this title which in fact is explained by the subtitle (in translation) “Analysis of various parts of the Science of Equilibrium and Motion.” It is in this state of mind that I have expanded some aspects of the historical developments of continuum mechanics in the immediate post-Newtonian era till the second half of the twentieth century in two previous volumes. The first one<sup>1</sup> published in 2013 was neatly characterized by my own experience in the field with several national institutions that I visited and/or worked with from time to time (e.g., in the USA, UK, Germany, Italy, Poland, Japan—and obviously France), and by my friendly relationship with research leaders of various nationalities whom I practically all knew personally, being aware of both their strength and pettiness, but always emphasizing the former. The choice of studied groups and schools as also a selection of particular fields was strictly personal since I had decided to speak only about what I knew best, although sometimes superficially and not without some unavoidable misinterpretations and factual errors. This personal and nonobjective vision was naturally criticized by some readers. Most of the time, these people complained that I had not treated at all, or not developed enough, their own field of research—this was the case of finite-strain elasto-plasticity and phase-transformations in deformable solids, although this was touched upon but cursorily—for which I thought that some other scientists would be much more competent than me. Obviously, with a more than

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<sup>1</sup>Continuum mechanics through the twentieth century: A concise historical perspective, SMIA Volume 196, Springer, Dordrecht, 2013.

natural humane bias, some complained about not being cited. To these last people I sincerely apologize. A well-balanced exercise in citation is not easy and is a dangerous exercise when one deals with his own contemporaries. I did not take any chance with the second volume<sup>2</sup> devoted to the eighteenth and nineteenth centuries where all contributors could not complain to me orally or via e-mail, save perhaps in some of my nightmares. Still my choice of subjects and main actors was strictly personal, although greatly influenced by some famous predecessors such as J.L. Lagrange, A. Barré de Saint-Venant, P. Duhem, I. Todhunter and K. Pearsons, R.T. Whittaker, M. Jouguet, and more recently, R. Dugas,<sup>3</sup> I. Szabó,<sup>4</sup> G.A. Tokaty,<sup>5</sup> S.P. Timoshenko,<sup>6</sup> and naturally C.A. Truesdell.<sup>7</sup>

The reader will have noticed that with growing age I am going back in the past. But this has a technical limit due to my lack of knowledge of some “dead” languages. Of course, I could deal with ancient Greek having at home all necessary help for the reading and interpretation of the primary sources. My improved reading of Latin would require the help of a priest but I am not a religious person. Furthermore, the reader must realize that I am not concerned with a total history of mechanics—for which Dugas (see Footnote 3) and Szabó (see Footnote 4) provided beautiful but not completely satisfactory attempts—but only with that part called *continuum* mechanics. This poses the fundamental question of the never-ending debate between the molecular-particular discrete vision and the continuum one. This matter touches upon both history and philosophy and a return to the ancient Greeks may be needed at this very point. But the subject remained of actuality during all centuries in particular with the early developments of continuum mechanics with Poisson, Navier, Cauchy, Piola, etc. In this volume, I consider that continuum mechanics starts with hydrostatics, the notion of *pressure*, and applications to *hydraulics* while *modern* continuum mechanics starts with hydrodynamics, three-dimensional elasticity, and the notion of stress tensor. Hydraulics brings to the foreground the important role of some experimentalists, starting with the Renaissance but also especially in the eighteenth century. Although a theoretician, I have made all efforts to deal with this aspect with sympathy.

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<sup>2</sup>Continuum mechanics through the eighteenth and nineteenth centuries: Historical perspective from John Bernoulli (1727) to Ernst Hellinger (1914), SMIA Volume 214, Springer, Dordrecht, 2014.

<sup>3</sup>Dugas R. (1950). History of Mechanics, Editions du Griffon, Neuchatel, Switzerland [Dover reprint, New York, 1988] (This exists in both French and English editions).

<sup>4</sup>Szabo I., (1977). Geschichte der mechanischen Prinzipien, Birkhauser, Basel.

<sup>5</sup>Tokaty G.A., (1971). A history and philosophy of fluid mechanics. Foulis, Henley-on-Thames [Dover reprint, New York, 1994].

<sup>6</sup>Timoshenko S.P., (1953). History of the Strength of Materials, McGraw Hill, New York [Dover reprint, New York, 1983].

<sup>7</sup>Truesdell C.A., (1968). Essay in the history of mechanics, Springer, New York.

The main purpose of the present volume is to fill in the gaps left in the previous two volumes by completing some details of the genesis and birth period and introducing some important and original fields that I previously neglected. The same format of interrelated essays has been kept. These essays may be read separately although many authors, including me, prefer a global orderly reading of their books. Subject matters that were previously neglected include: a deeper attention to hydraulics, the question raised by porosity in solids, the theory of mixtures and reacting media, and the influence of fast flows and of the birth of aeronautics in fluid mechanics (with Reynolds, Prandtl, von Kármán). This brings me closer to my initial interest as alumnus of the school of Aeronautics in France. Also, in my historical approach, I always try to avoid any “precursoritis” and duly examine the (at the time) contemporary reaction to the then most recent advances. This can be achieved by carefully perusing the lecture notes and treatises published by famous scientists—albeit not necessarily the most creative ones in the field of continuum mechanics—because such works reflect both the state of the art at the time of their writing and what the author tries to input from his own viewpoint with, usually, a deeply thought appraisal. I already applied this strategy with the treatise of Paul Appell in France and the encyclopedic article by Ernst Hellinger in Germany in my second volume. Here, this is applied to the lecture notes and some collected technical works of Pierre Duhem on hydrodynamics and elasticity, and the lecture notes of a course given by Henri Poincaré on elasticity and an introduction course on continuum mechanics delivered by David Hilbert. To some readers, this may seem to grant too much importance to the “Belle époque.” Not only is the viewpoint of two such giants of mathematics as Poincaré and Hilbert of intrinsic interest, but the period at which the lectures were given was a critical one for the whole of physics. It is salient to see whether the burgeoning new physics had any influence on a mature science then thought to have stabilized with magisterial treatises by H. Lamb and A.E.H. Love, respectively, in fluid mechanics and elasticity. Furthermore, the synthetic works of Appell, Hellinger, Duhem, Poincaré, and Hilbert in fact provide the most valuable documentary basis on which a revival of continuum mechanics and its formalization by Truesdell et al. was built in the second half of the twentieth century. We are dutifully following the advice of Rabbi Rashi (Eleventh century) of Troyes in Burgundy: “Ask your master his sources.” This is already what Duhem did when examining Leonardo and his possible sources of inspiration in pre-Renaissance times. This is complemented by essays on the special behaviors of viscoelasticity of solids and plasticity—only superficially mentioned in the previous volumes—on fracture—so important in continuum dynamics—the role of geometry as a cornerstone of the field, and a kind of sociohistorical appraisal of the seminal contributions by our direct masters in the second half of the twentieth century.

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