
La via delle acque (1500–1700). Appropriazione delle arti e trasformazione delle matematiche by Cesare S. Maffioli

Florence: Leo S. Olschki, 2010. Pp. xxii + 394. ISBN 978–88–222–6008–6. Paper € 43.00

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Cesare Maffioli has written a compelling book on the intellectual appropriation of the mechanical arts and the parallel transformation of mathematics in 16th- and 17th-century northern Italian society. The historical-documentary basis of Maffioli's research is a wealth of printed and manuscript literature relating to the so-called science of waters, a professional activity and a branch of mathematics which came of age in the Renaissance. The protagonists of this hydraulic revolution were Leonardo da Vinci, Gerolamo Cardanus, Galileo Galilei, Benedetto Castelli, Domenico Guglielmini, as well as many lesser scientists, engineers, and practical mathematicians.

While the profession of the architect-engineer was already in the 16th century much more structured (both socially and intellectually) than that of the mathematician, Maffioli reports that the traits that sanctioned the professional status of the mathematicians studied in his book were either the activity of teaching mathematics in some institutionalized form or of writing mathematical works. (A caveat, however, is added at the end of the book, where he states that it is also very hard to delineate the contour of the mathematical field at the turn of the 16th and beginning of the 17th century.) Maffioli notes that an epoch-making transformation occurred at that time in the mathematical field, a change to which, he argues, philosophers responded little. In essence, Maffioli maintains, when mathematics started to busy itself with philosophical and mechanical issues, Aristotelian philosophers were unwilling to recognize the same demonstrative value in mathematical proofs as they found in physical demonstrations. Maffioli sees an example of this tension in the difficulties

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ISSN 1549–4497 (online)

ISSN 1549–4470 (print)

ISSN 1549–4489 (CD-ROM)

Aestimatio 8 (2011) 233–236

that philosophers had when trying to categorize Galileo's new mathematical physics of motion, a type of science which could not easily be interpreted as a form of mixed mathematics or as a mixed science.

The intellectuals' appropriation of the mechanical arts was a vast social and disciplinary movement. For example, Maffioli shows that for Galileo, Castelli, and Guglielmini, this appropriation meant not only the integration of fragments of practical knowledge into a mathematical framework but also the elevation of items of practical knowledge to the status of principles and fundamental concepts. There was also a normative dimension to the effect that they tended to direct engineers towards new ideas and solutions to practical problems.

The book's focus is on the social dynamics and tensions between the intellectuals and the practical experts. According to Maffioli, this aspect has generally been neglected in the historiography of the scientific revolution. The history of hydraulics allows the historian to cast a glance at fascinating controversies regarding the best way to regulate the flow of waters in rivers. Those controversies hint at epistemological discussions between engineers and architects on the one hand, and mathematical philosophers on the other, which center on the practical adequacy of the new theories espoused by mathematical philosophers such as Galileo and Castelli.

Another important finding that Maffioli brings to light is the so-called experimentation in the field. Mathematicians and technicians in the 16th and 17th centuries tended to regard machines, building sites, and the whole terrestrial globe as giant natural laboratories. According to Maffioli, this suggests that it is inappropriate to consider early modern experimentation as a phenomenon happening exclusively in specially dedicated spaces such as the purpose-built private laboratory, the learned academy, or the princely court.

The latter point relates to another interesting development in 16th- and 17th-century Italian hydraulics, namely, its analogy with the medical-naturalistic tradition. Hydraulics practitioners considered both landscape and the whole terrestrial globe as a complex system of interconnected parts which have to be studied not separately but synthetically. Maffioli also sees in the emergence of hydraulics the shaping of an embryonic form of ecological thinking. This ecological thinking figured prominently in the mathematical physicist and physician Guglielmini, for example. It aimed at recovering a harmonious

relationship between art and nature, so that the force of rivers was not to be opposed but instead regulated for the benefit of mankind.

Maffioli thinks that the history of Italian hydraulics raises two fundamental questions. Was the scientific revolution of the 17th century the result of the early Renaissance emphasis on art and technology, or did the scientific revolution become an intellectual movement that subverted the early Renaissance emphasis on art and technology by subordinating artists and practical men to the new mathematical natural philosophers? The central chapters of the book expound interesting details that go some way towards answering these questions. However, Maffioli wisely shies away from drawing a definitive conclusion. He contents himself with pointing out numerous current historiographic indeterminacies. An element of this puzzle to which Maffioli draws the attention of the reader is the role played by critics of the philosophical tradition such as Galileo. Yet Maffioli claims that no interpretation of the scientific revolution has been put forward so far, according to which the scientific revolution is cast as an intellectual appropriation of the mechanical and practical arts on the part of the philosophical tradition, an appropriation accompanied at the same time by a transformation of the social role of mathematicians. This line of interpretation of the emergence of the scientific revolution seems to be what Maffioli would favor, even though he does not develop this line of inquiry much further.

Maffioli's approach is thematic. He discusses the works and the activities of three key figures, namely, Cardanus, Galileo and Castelli, as well as other more or less well known people. He is keen to point out, though, that his account should not be construed as a linear progression but rather as an attempt to read the documents in a sort of neutral way which does not presuppose established historiographic categories.

One particular strength of Maffioli's book is the wide documentary basis on which his work is based. He has identified numerous manuscript sources in libraries and archives which have hitherto not been accurately studied or otherwise published. These manuscript sources demonstrate how much still remains to be done, as Maffioli comments in the conclusion. This strength is evident particularly in chapter 5 where he sets the historical-political scene of his inquiry. Maffioli describes the intriguing behind-the-scene wheeling and dealing of a failed attempt at a hydraulic policy on the part of pope Urban

VIII. Here we can catch a glimpse of how physics and mathematics competed for political legitimation in the heated debate between the Galilean Castelli and the Jesuit Nicolò Cabeo.

Finally, one might wonder how Maffioli's achievement might be regarded, especially from a methodological viewpoint, in relation to the broader field of the history, philosophy, and sociology of early modern science. Maffioli's work is an excellent example of the type of positivist historiography which affirms the primacy of documentary evidence as the basis for historic reconstruction. Still, this type of historiography starts from *a priori* assumptions about interpretive categories such as that of a 'scientific revolution' which have been questioned by historians and especially sociologists of science in recent decades. Perhaps even more radically, one might wonder whether positivist historiography is an adequate tool for approaching the advent of the hydraulic revolution, given all the engineering and practical intricacies, the blurred disciplinary contours, and obscure matters of politics that Maffioli's book masterfully portrays—all the more so, when one considers that ultimately the hydraulic revolution cannot be detached easily from the interpretive horizon of Maffioli himself as a historian of science. For many questions of method and interpretation arise. What is the role of the interpreter in selecting and evaluating the relevance of a set of documents? How can a set of written documents, be they printed books or manuscript notes, be related to events and people who acted and thought in a distant past? How can experiments be understood on the sole basis of a lacunose written historical record?

Perhaps Maffioli's lasting achievement will consist in raising our awareness of the conundrums that positivist historiography doggedly pursued in the history of science at the beginning of the 21st century.