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Cesare S. Maffioli. ***La via delle acque (1500–1700): Appropriazione delle arti e trasformazione delle matematiche.*** (Hyperchen: Testi e Studi per la Storia della Cultura del Rinascimento, 4.) xxii + 394 pp., bibl., indexes. Florence: Leo S. Olschki, 2010. €43 (paper).

The Scientific Revolution of the seventeenth century was characterized by an increasing use

of mathematics to explain a greater variety of natural phenomena and by an increasing recourse to direct observation and experiment. From Edgar Zilsel's pioneering article on "The Sociological Roots of Science" (1942), there has grown a tradition of attributing at least the latter of these to craftsmen and artisans. More recently, in *The Body of the Artisan* (Chicago, 2004), Pamela Smith has argued that artisans, through bodily manipulation of objects observed through bodily senses, developed a new experiential and practical way of knowing, an "artisanal epistemology," that transformed science and resulted in the Scientific Revolution.

Cesare Maffioli, in *La via delle acque* ("The Way of the Waters"), offers a remarkable insight into one of the new mathematical and experimental sciences that arose in the course of the seventeenth century. The science of waters—or hydraulics—came out of the urgent practical need to prevent flooding, ensure navigation, and distribute water for mills and irrigation, thus providing a test case for the roles of philosophers, mathematicians, and practical experts (*periti*) in the emergence of a new science. In an earlier book, *Out of Galileo: The Science of Waters 1628–1718* (Erasmus, 1994), Maffioli had traced the development of hydraulics in seventeenth- and early eighteenth-century Italy, from Benedetto Castelli to Giovanni Poleni. In *La via delle acque* he has extended this account back into the sixteenth century, delineating the changing relations between philosophers and mathematicians, on the one hand, and engineers, architects, and practical experts, on the other, and teasing out their philosophical, scientific, and historical implications.

Several of the main trends Maffioli seeks to trace began with Leonardo da Vinci and Girolamo Cardano in the sixteenth century. In Leonardo's explanation for the origins of springs, for example, Maffioli sees the first evidence of the analogy between the terraqueous globe and the human body. In his compendious and unsystematic way, Maffioli argues, Cardano appropriated various discoveries and inventions of artisans (including Leonardo's observations of flowing water) and tried to quantify them and discover their philosophical principles. In the Platonic philosopher Francesco Patrizi, Maffioli sees an attempt to use philosophical ideas such as Hero's atomism to give a rational and philosophical account of flowing water. But in Giambattista Aleotti, who served Ferrara as engineer and architect and who also gave natural philosophical explanations for such things as the origin of springs, Maffioli sees neither a representative of the new science nor a mere artisan, but a new sort of professional, more an architect in the Vitruvian tradition, but one still relying on traditional maxims and rules.

From extensive archival sources and printed works, Maffioli then reconstructs in great detail the events, circumstances, and controversies surrounding some of the main hydrological projects of seventeenth-century Italy and their contributions to the new science of waters. The founder of this new science, Benedetto Castelli, came to the study of waters in a purely practical way: he was appointed hydraulic consultant by Urban VIII and sent to settle the dispute between Ferrara and Bologna over the diversion of the Reno into the Po River. Castelli, a pupil and protégé of Galileo, applied his master's mathematical techniques to the flow of water, adopting as a philosophical principle the incompressibility of water and developing the law of continuity of flow. His resulting recommendations, however, brought him into conflict with the local practical experts. Later Castelli advised the diversion of rivers from the Venetian lagoon, again against the opposition of the water experts. Galileo himself became involved in a similar dispute near Florence, when asked to assess the proposal of the engineer Bartolotti on the straightening of the channel of the Bisenzio to relieve flooding. In his report, Galileo applied his theory of motion on inclined planes to show (supposedly) that Bartolotti's plan would have no effect on the rate of flow. Finally, in Domenico Guglielmini's *Della natura de' fiumi* (1697), Maffioli sees the culmination of the Galilean approach to the science of waters and the full realization of tendencies begun with Leonardo and Cardano. For Guglielmini, who was physician, superintendent of waters, and professor in the new chair of hydrometry at Bologna, art must be guided by science and must imitate, not oppose or dominate, nature. The terraqueous globe is analogous to the human body, he averred, and hydraulics is analogous to medicine—and so should work with nature to restore the body of the world to its natural health. And science consists in the discovery of the mathematical truths at the core of nature: mathematics and physics, according to Guglielmini, treat the same object.

The genesis of the science of waters in the course of these controversies, Maffioli concludes, reveals a twofold process: the appropriation by philosopher-mathematicians of the problems and (sometimes) the techniques of practitioners, and the transformation of mathematics from an abstract science into an integral constituent of nature itself, spawning new mathematical sciences as a result. This process in

turn had two consequences: mathematicians, by virtue of their newly found insight into nature itself, became the true philosophers of nature, and art, including engineering and the other mechanical arts, came to be seen not as opposed to nature but in harmony with it. If the science of waters is any indication, then, the new experimental and mathematical sciences of the Scientific Revolution arose not from artisans and practitioners themselves, but from the appropriation and mathematization by mathematicians and philosophers of a natural world dramatically enlarged by their arts.

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