

open and cooperative but with a firm sense of direction.”

Our Own Devices is even more insightful and provocative than Tenner's earlier book in illuminating how contemporary technology changes us as much as we change it. Tenner has become a worthy successor to such luminaries as business philosopher Peter Drucker, social critic Lewis Mumford and historian Lynn White in connecting technology's past, present and future. ■

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The spark of Enlightenment

Volta: Science and Culture in the Age of Enlightenment

by Giuliano Pancaldi

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Lucio Fregonese

Alessandro Volta (1745–1827) was a leading natural philosopher who made significant contributions to fields as diverse as electricity, chemistry and pneumatics. His famous electrical battery contributed decisively to the rise of modernity.

Pancaldi's book is a scientific biography of Volta within the context of Enlightenment culture. The author examines central aspects of Volta's biography, including his education and religious attitudes, and traces a lively picture of the social and scientific networks, both local and international, in which he operated. The sources used include Volta's correspondence, the main Italian scientific journals and the surviving information on the many journeys he made to meet and talk with other scholars.

The focus is mainly on Volta's work on static electricity (1765–1787) and the advanced stages (1796–1799) of the long path that took him to the invention of the battery. Ideally, these two achievements should be considered alongside his work in other scientific fields, but the partial state of our knowledge justifies this selective approach.

Pancaldi's interpretation of Volta's static electricity rests on a sharp polarization, which gives prominence to “experiment and apparatus over theory, instrumentalism over deep philosophical commitment, efficacy and public recognition over private achievement”. Not all historians or philosophers of science will agree with such radical epistemological and historiographic assumptions.

In discussing the portrait of Volta in old age shown here, Pancaldi singles out three of the elements — theory, experiment and apparatus, and public recognition — that

appear in his pairs of polar opposites. The book in Volta's hand represents theory; the battery and the *condensatore* (the first version of the modern capacitance electroscope) in the foreground represent his electrical instruments; and the ribbon of the *Legion d'Honneur* on his jacket collar represents public recognition.

Pancaldi interprets Volta's invention in 1775 of the electrophorus (a new electrostatic generator that uses what we now call electrostatic induction instead of friction) as having been inspired not by theory but by the desire for an improved and effective apparatus, aimed at gaining social and scientific recognition. He claims that Volta simply imitated and improved on a similar device described years earlier by the German physicist Franz Aepinus. In about 1778, Volta is presented as having finally managed to define a sound theoretical framework, which was however “midrange”, because it built on concepts (capacity, tension and actuation) that, according to Pancaldi, “stemmed directly from laboratory practice”. Aepinus and two other important physicists working with electricity, Henry Cavendish and Giambattista Beccaria, are indicated as likely sources of inspiration. Volta's invention (1780) and conceptualization (1782) of the *condensatore* are rooted in his newly defined handling of electricity. Volta's later extensive efforts to quantify various electrical quantities, especially tension, are connected to the general “quantifying spirit” of the Enlightenment.

Pancaldi provides important insights into Volta's path to the battery. He shows that Volta's detection of contact electricity emerged in the context of the more general “hunt for weak electricity” pursued at the time. He also argues convincingly that Volta's creation of the battery was probably catalysed by a paper in which the English chemist William Nicholson had described an apparatus suggested to work like the electrical organ of the torpedo fish. The battery is accordingly presented as a largely “unintended consequence” of a process of “competitive imitation” with Nicholson to reproduce the functioning of the animal's organ. The relative merits of theory and practice are evaluated just as for Volta's static electricity. Experiment, laboratory-based conceptualization and instrumentalism are placed at the core of Volta's enterprise. His deep theoretical commitments are correspondingly given less weight.

Pancaldi offers new results on the way in which Volta presented the battery on various occasions and on how it was received in different contexts (the English and French press) and by various scholars (Nicholson, Etienne-Gaspard Robertson, Johann Wilhelm Ritter, Hans Christian Ørsted and Jean-Baptiste Biot). The battery found many heterogeneous uses and interpretations, which Pancaldi sees as further evidence of “unintended



Fulfilling his potential: Alessandro Volta valued theory, experiments and public recognition.

consequences”. Another chapter focuses on the celebration of Volta, including iconography and the centennial commemoration of his death in fascist Italy.

Pancaldi's final image of Volta is of an instrumentalist with manipulative and eclectic tendencies, characteristics that Volta certainly had. But Volta's natural philosophy seems to require further clarification. Volta himself denied that Aepinus' device was the inspiration for his electrophorus, claiming instead that he produced it with the highly theoretical goal of confirming his own conceptualization of a very complex area called “vindicating electricity”. As Pancaldi points out, Volta continued to allude to his deep theoretical views as a prime mover of basically all his electrical achievements, including his controversial hypothesis (1792) of contact electricity. As evidence of this, Volta repeatedly referred to his very first electrical paper (1769), a difficult work that remains the only systematic theoretical exposition he ever produced in this field.

From the portrait reproduced here, Volta seems indeed to reassert a deep theoretical commitment, with his natural philosophy as a whole (the book) indicated as the origin of his electrical instruments. Conversely, he can be seen as claiming that the instruments speak in favour of his own natural philosophy. It seems that further enquiry and reassessment are needed for both Volta's natural philosophy and its links with the instruments he produced. ■

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