

Civilization and the culture of science: Science and the shaping of modernity, 1795–1935

By Stephen Gaukroger

Oxford, UK: Oxford University Press, 2020, 544 pp., ISBN: 978-0-19-884907-0, \$50.00

On 24 March 1877, in a lecture recognized as “the first and indeed the most decisive attack on established historical scholarship,” the German physiologist Emil du Bois-Reymond addressed the topic of “Civilization and Science” (du Bois-Reymond, 1912; Fuchs, 1994). Passing over “the unedifying details of politics,” du Bois-Reymond pointed to a comparable absence of moral or aesthetic improvement among “the heroes of literature and art” (du Bois-Reymond, 1912, pp. 608–620). As he saw it the true basis of historical development was to be found in the study of the natural world. “Science is the chief instrument of civilization,” he announced, “and the history of science the essential history of humanity” (du Bois-Reymond, 1912, p. 596).

Du Bois-Reymond's proclamation could serve as the charter of my field. Indeed, George Sarton repeated its argument six decades later in an address inaugurating a “seminary on the history of science” at Harvard University:

Definition. Science is systematized positive knowledge, or what has been taken as such at different ages and in different places.

Theorem. The acquisition and systematization of positive knowledge are the only human activities that are truly cumulative and progressive.

Corollary. The history of science is the only history that can illustrate the progress of mankind. In fact, progress has no definite and unquestionable meaning in other fields than the field of science (Sarton, 1936, p. 5).

The last volume of Stephen Gaukroger's four-part history, *Civilization and the Culture of Science*, takes aim at this familiar story of triumph.

Gaukroger's book is divided into four parts. First, it recounts how champions of science presented the investigation of the natural world as the basis of Western superiority. Then, it describes how claims for the unity of science came to substitute for the dogma of Christian universality. Next, it shows how scientists grounded those claims in an Epicurean doctrine that reduced nature to matter and energy. Finally, it recalls how economics, philosophy, technology, eugenics, and popular culture endorsed this secular characterization of the world.

Such a presentation has its merits. It is not hard to find a line of continuity between Christian missionaries who strove to enlighten the world and 19th-century boosters who spread the gospel of science. Improvements in knowledge lent Condorcet, Comte, and Spencer the same conviction that Ricci, Bossuet, and Intorcetta drew from teachings of the Church. Similarly, Virchow, du Bois-Reymond, and Büchner's calls to unite biology with chemistry and physics helped to compensate for the disappointments of the Revolution of 1848. Haeckel, Dobzhansky, Simpson, and Mayr saw evolution as the key to progress in nature; Mill attempted to unify “ethics, politics, economics, and logic” (p. 251); Cohen, Windelbrand, and Cassirer employed Kantian reasoning to defend science “as the motor of civilization and culture” (p. 287); touts hawked science in children's books,

magazines, novels, exhibitions, museums, and zoos; and even if scientists no longer endorse eugenics, people remain vulnerable to a host of other statistical abuses, such as arbitrary norms, standardized tests, and predictive algorithms.

Unfortunately, the foundations of Gaukroger's polemic are shakier than he suggests. Gaukroger equates reduction in science with a materialism that he disparages as "empty, fruitless, and counterproductive" (p. 154). Very few scientists, however, shared Büchner, Moleschott, and Vogt's confidence that the universe consisted solely of matter in motion: Bernard was unwilling to abandon his belief in vital forces, Tyndall had a penchant for pantheism, Huxley remained agnostic on metaphysical issues, and both Helmholtz and du Bois-Reymond endorsed Kirchhoff's "commitment to a methodological programme" of scientific description (p. 265). Gaukroger mistakes his subjects' working assumptions for philosophical allegiances.

Moreover, since Gaukroger treats the history of science as a branch of intellectual history, he devotes most of his attention to extracting ideas from secondary accounts. This approach leads him into error. It is one thing to ignore social history: patrons and patronage, institutions and underwriting, and all the other details of employment matter only as much as they affect knowledge, and over the long run it is hard to demonstrate that they really do. (Scholars have shown, e.g., that astronomy prospered as well under the Church as it did under the State) (Heilbron, 2001). It is another thing to ignore practice: scientists spend most of their time investigating problems, and the constraints they face—whether in their materials, apparatus, experiments, observations, teaching, publications, and lectures—guide the course of their ideas. Nevertheless, Gaukroger maintains an Aristotelian distinction between thinking and doing, even to the point of dividing natural philosophy from mathematics, describing his actors as "fitting physics into a mathematical mould," as if physics were the content and mathematics the vessel (p. 92).

Gaukroger carries this distinction over to his account of technology, highlighting the inadequacy of any "linear model" of epistemological hierarchy among scientists and engineers in the field of aeronautics (Wengenroth, 2003). His example is telling. Fluid dynamics remains the most complex branch of classical physics (in fact, anyone who provides a general solution to the Navier–Stokes equation can win a million dollar prize). It is not surprising that scientists played little role in the development of aircraft: even today no one really understands how they fly (Regis, 2020). By contrast, science was central to the development of telegraphy, electrical power, vaccines, transfusions, pharmaceuticals, plastics, dyes, and refrigeration. No mention is made of these successes; instead, Gaukroger links scientific invention to the horrors of the First World War.

If Gaukroger is right to draw attention to the increasing diversity of research, he is wrong to attribute this pluralism to the nature of the world. Convergence has been of equal importance to modern science, and his attempts to brush aside the conservation of energy as a "matter of intertranslatability" (p. 120) or to discount the evolutionary synthesis for failing to incorporate embryology (p. 217) miss the significance of those theoretical innovations. Variational principles account for more phenomena than Newtonian forces, just as natural selection accounts for more phenomena than supernatural design. The fact that theories do not account for everything is no mark against their cogency. Science is neither one nor many: it displays as many tendencies to lump as to split, the choice of which mainly reveals the temperament of the historian. Gaukroger favours splits, but at a certain point his predilection is hard to distinguish from bias. *Civilization and the Culture of Science* skips over nearly every breakthrough in the last third of the 19th century, including those in mathematics, astronomy, physics (spectroscopy, statistical mechanics, electron theory, and analytical dynamics), earth sciences (geophysics, meteorology, and oceanography), chemistry (dyes, plastics, bonds, and thermodynamics), physiology (neuroscience, metabolism, and homeostasis), biology (cytology, immunology, and genetics), environmental sciences (botany, zoology, and marine biology), embryology, archaeology, anthropology, and psychology. Many of these advances synthesized earlier findings.

Gaukroger's final theme of secularization leans on Jean Delumeau's studies of Christian piety (p. 392). In the same way that early modern clerics encouraged congregations to adopt monastic practices of contemplation, 19th-century scientists encouraged the public to adopt rational modes of thought and action. This is an intriguing thesis. Gaukroger instances Norbert Elias's *Civilizing Process* (1939) as support, but he might as easily have cited Carl Lotus Becker's *The Heavenly City of the Eighteenth-Century Philosophers* (1932) or Karl Löwith's *Meaning in History*

(1949), both of which joined philosophy to history in narratives of intellectual continuity. For me, the operative question is not so much whether science broke with theology, as Peter Gay or Hans Blumenberg would have it, but whether science was the main driver of changes in religious outlook (Jewett, 2020). As good as a case can be made for the secular impetus of the humanities, from the demonstration of papal forgery by Lorenzo Valla to the critical analysis of biblical sources by Johann Salomo Semler and Hermann Samuel Reimarus to the historiographical meditations of Johan Gustav Droysen and Wilhelm Dilthey. There is no reason to privilege science in this regard. What Anthony Pagden refers to as the “autoptic imagination”—that is to say, the authority lent by seeing for oneself—can arise equally from encounters with new places, new things, or new texts (Pagden, 1993).

Gaukroger is wrong to associate science with a providential view of history. Just as many *lumi re* lacked faith in the future, many 19th-century scientists had misgivings about their prospects (Vyverberg, 1958). George Sarton’s paraphrase of Emil du Bois-Reymond’s lecture omits this crucial passage:

Pursued one-sidedly, science confines our glance to the immediate, tangible, certain result. It turns the mind away from more general considerations and disaccustoms it to move in the realm of the quantitatively indeterminate. In one respect, this is the invaluable advantage that we prize, but where science reigns exclusive, the mind grows poor in ideas, the imagination in images, the soul in sensitivity, and the result is a narrow, dry, and hard mode of thought, forsaken by the muses and the graces (du Bois-Reymond, 1912, p. 604).

This is hardly an expression of optimism.

Owen Chadwick agrees. *The Secularization of the European Mind in the Nineteenth Century* asserted that science did not kill faith; rather, agnosticism resulted more from changes in experience and education than from any sustained campaign against religion (Chadwick, 1993, p. 187). (“The forties was the time of doubts, in the plural and with a small d... In the sixties Britain and France and Germany entered the age of Doubt, in the singular and with a capital D.”) Chadwick characterized this change as a loss of a “sense of providence” (Chadwick, 1993, pp. 184, 258). Even so, Gaukroger insists that scientists replaced priests (p. 394). That may well have been August Comte’s ambition, but it was one that did not survive the challenges of modernity. Science continues to be questioned by politicians, clerics, academics, journalists, and the public.

Gaukroger admits that he lost track of whether he is “writing as a historian or philosopher” (p. 426). He dismisses as Whiggish John Theodore Merz’s survey of nineteenth-century science, but he offers no better alternative to the national and topical approaches of that pioneering work (Merz, 1904, p. 113). Instead, his polemic repeats familiar charges: that science is a cult, that truths are not universal, that objectivity is a myth, that theory disregards invention, and that the investigation of the natural world merely replaces one dogma with another. None of this is particularly illuminating. Readers of this journal will find in *Civilization and the Culture of Science* neither a convincing portrait of the endeavour nor a prescription of how to balance its claims against competing values and interests.

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