Book Reviews

Science in the Context of Puritan Society

The Great Instauration. Science, Medicine and Reform, 1626–1660. CHARLES WEBSTER. Holmes and Meier, New York, 1976. xvi, 630 pp. $29.50.

Since 1885, when Alphonse de Candolle noted the disproportionate number of Protestants among the foreign members of the French Académie des Sciences, generations of historians of science have been intrigued by the possibility of a relation between two pivotal sets of events in the history of early modern Europe: the transformations that go under the names of the "Protestant Reformation" and the "Scientific Revolution." The setting within which this relationship has most often been discussed is 17th-century England. Little wonder, since England in that era had both a highly successful local variant of radical Protestantism—Puritanism—and an even more successful scientific movement culminating in Newton. Was the one's succeeding the other merely a chronological accident? Or was there a causal relationship between the two?

Robert K. Merton began a historiographic tradition by asserting that there was. His seminal study *Science, Technology and Society in Seventeenth Century England* (1938) argued, among other points, that a significant shift of interest toward science occurred during the Puritan decades of the 1640's and 1650's, that many elements of the radical Protestant ethic were congenial to scientific activity, and that important scientific groups during the latter part of the century were dominated by men of Puritan leanings. Since then the so-called "Merton thesis" has been discussed in scores of books and articles by dozens of historians, including Joseph Ben-David, Mark Curtis, Lewis Feuer, A. Rupert Hall, Christopher Hill, Hugh Kearney, and Theodore Rabb. Although written from diverse standpoints and motivations, most of the discussions of the "Puritanism and Science" question have followed a common investigative procedure. The historian identifies, from standard sources in the history of science, a body either of scientific practitioners or of scientific ideas, which is then examined to discern either the presence or the absence of Puritan motivations. Was the Royal Society, in spite of its name, really a cabal of secret and not so secret Puritans? Were there Puritan and utilitarian motivations to the kinematics and dynamics of the Newtonian era? Did Harvey change his metaphor for the heart and circulation in response to Parliamentarian victories? Were innovations in mathematics linked to Puritan mercantilist interests in London? Find the science, then look for the Puritanism.

Webster's book turns this tradition on its head. He asks not what Puritanism we can find in science, but what science we can find in Puritanism. His analysis proceeds not from science to culture, but from culture to science.

What kind of science are we to look for? Historians have erred, Webster argues at the outset, in their orthodox assumption that science is to be defined in terms of contributions pertaining to a relatively small number of crucial questions, predominantly in the physical sciences. Rather, he believes, the "scientific outlook" of a culture is very different from the "science" the historian chooses in retrospect to isolate. Webster aims to survey the years from 1626 to 1660 "in terms of priorities which were uppermost at that time." Viewed in this way, the more famous discoveries in mathematics, mechanics, astronomy, anatomy, and physiology that have won the acclaim of later historians of science are seen as concerns of only a relatively narrow section of the community of natural philosophers. The majority of Puritan "scientists" were concerned with clusters of "scientific" subjects that had much greater social and political implications.

The key to Puritan science is Puritan eschatology. The social crises of the 1630's and the Civil War of the 1640's convinced Puritans that Christian civilization was approaching the Millennium, the final age in which the prophecy of Daniel 12 : 4 would be realized and man would be restored both to the spiritual purity and to the dominion over nature lost in the fall of Adam. The reformation of the church would be accompanied by a Great Instauration of learning. Baconian philosophy and Comenian educational methods offered the best path to this goal.

Organization came first. Historians have long been concerned with the London meetings of the "1645 group," led by John Wilkins and John Wallis, from which later emerged the Royal Society. Webster argues in great detail that this was only one of many organizational formats, real and projected, by which Puritans hoped to promote investigation of the material world. Boyle's "Invisible College," the Comenian "Universal College," and Samuel Hartlib's "Office of Address" were cut from the same cloth.

Such schemes put the Puritans into the business of education. Webster details how Puritan intellectuals attempted to direct pedagogy away from classical studies and toward science and technology. In doing so, they were led during the 1650's to attack what some Puritans saw as the bastions of conservatism, Oxford and Cambridge—ironically, since the universities were at that very time developing informal scientific groups within the colleges, largely under the leadership of moderate Puritans preferred there by Parliament. Webster examines these groups and their science in great detail, especially those at Oxford in the 1650's.

But Webster realizes full well that tracing out Puritan ideas of scientific organizations and education will not justify a causal link between Puritanism and science. Therefore, in the latter half of the book he examines in massive detail how programmatic intentions translated into substantive science. One set of concerns was focused on medicine and its handmaiden science, chemistry. Webster traces the Puritan attempts to break up the learned medical monopolies, to make medical information available in the vernacular, and to organize hospitals and health care for the poor.

A second set of concerns centered on technology and husbandry. The Puritan intellectuals believed passionately in the Baconian dictum that theory must be tested by its utilitarian applications. Webster shows how they attempted to encourage projects that linked "scientific" analysis with practical innovation: in practical mathematics and surveying, patent policies, histories of trades, economics and monetary theory, coinage reforms, the regional natural history of Ireland, forestry reform and planting of fruit trees, and industrial applications of chemistry. In project after project he shows how "scientific" and technical activity had its origins in Puritan ideals acting through Baconian methodology.

Such a bald summary reflects very palely the richness and detail of Webster's argument. His mastery of the printed and manuscript sources is un-

matched. So is his organizational skill. A work of over 200,000 words, giving thousands of new facts about scores of projects and hundreds of "projectors," could all too easily degenerate into anecdotage. Instead, in Webster's treatment detail is always subordinated to his general argument: the predominant forms of scientific activity during England's Puritan decades can be shown to be a direct outgrowth of a Puritan ideology. The argument is a stunningly convincing one.

Yet I must register not disagreement, but some disappointment. Webster has sought out the science he sees as flowing from Puritan programmatics; to my mind, some of it turns out to be less-than-interesting science. The decades from 1625 to 1660 were exciting times for English science, even if not as productive in "accomplishments" as the post-Restoration era. Harvey announced his discovery of the circulation of the blood; Ent defended it; Wharton and Glisson wrote on the anatomy of glands and of the liver. In mathematics, Briggs worked on logarithms; Oughtred clarified mathematical notation; Wren and Brouncker wrote on the theory of equations; Wallis's *Arithmetica infinitorum* laid the conceptual foundations of the calculus. Gascoigne, Horrocks, Wren, and Ward developed both observational and mathematical astronomy. Atomism was introduced into England by Charleton during the 1650's, and the same decade saw Boyle work out the experimental bases of his corpuscular philosophy. Hooke and Boyle collaborated in carrying out their famous air-pump experiments on the properties of gases.

Little of this finds a place in Webster's narrative. He argues (correctly, in my view) that such lines of inquiry were pursued by a relatively small and socially isolated elite. The sciences of broader appeal and concern were practical mathematics, the technology of trades, chemistry, and husbandry. These were the kinds of subjects that were linked organically to Puritan-dominated culture.

One must be careful not to misinterpret Webster. He would certainly not say that the "elite" sciences were, or are, unimportant. Indeed, he has himself written influential articles on topics in the history of chemistry, physiology, and medicine. But in this, his most recent and certainly his most ambitious work, he is both pleading for and exemplifying an approach to the understanding of the world view of a particular society in terms of its own inner logic, rather than according to its contribution to the "progress towards our present intellectual condition." He even goes so far as to assert that "the worldview of any cultural group merits attention in its own terms."

Many historians of science, I would venture to guess, would not follow Webster that far. Context, yes; total relativity, no. The particular interest western European science holds derives from the way in which it has increasingly focused upon a relatively few problem areas and submitted them to progressively more rigorous and experimental treatment. If a historian of science does not confine himself to the relatively broad historical path delimited by such criteria, his work wanders perilously close to the realm of a cultural anthropology in which the scholar does not even have the advantage of interviewing his subjects. An extreme contextualist position renders moot all the criteria by which a historian of science chooses his objects of investigation.

Such "positivist" criteria even provide the justification for the importance Webster's book will doubtless assume in the historiography of science. Seventeenth-century England is an important historical laboratory for exploring the relationships between social values and scientific concepts, precisely because it recorded some significant "progress." Webster has solved this important historical problem by showing that the set of dominant social values that we label Puritanism gave rise to *certain kinds* of scientific activity, only a few of which were central to the main lines of scientific ideas which were the raison d'être for examining 17th-century England in the first place. But without this index of "progress," Webster could have with equal justification studied the world views of 15th-century Catalonia or 18th-century Turkey.

But I suspect that Webster would not push his historiographic principles to such a point of caricature. He aims to hold up a model of the history of science which places science in the context of the larger society. He would reform history of science by having its practitioners exercise their craft with much greater respect for the intellectual environment from which the sciences emerge. But unlike that of many reformers—including the 17th-century ones whose ideals he chronicles—his practice is as good as his principles. He has written a definitive work whose breadth and substance are commensurate with its aspirations.

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Meeting a Pollution Challenge

Biological Control of Water Pollution. Papers from a conference, Philadelphia, Pa. JOACHIM TOURBIER and ROBERT W. PIERSON, JR., Eds. University of Pennsylvania Press, Philadelphia, 1976. x, 340 pp., illus. Paper, $20.

Not many years ago water pollution control measures were confined to the construction of conventional sewage treatment plants. Today our natural waters are being bombarded with a bewildering assortment of stresses. Each day our cities produce enormous quantities of nutrients, toxic chemicals, and waste heat. Conventional sewage treatment facilities are totally inadequate to neutralize these contaminants, and they continue to pollute rivers, lakes, and estuaries. There is an urgent need for new and economical processes to control water pollution. Biological control holds the dual promise of an efficient and inexpensive means of detoxifying water combined with the utilization of the nutrients in the water for food production.

Biological Control of Water Pollution is a collection of 39 papers presented at an international conference with the title "Biological Water Quality Improvement Alternatives" held at the University of Pennsylvania in 1974. The book describes biological approaches to waste treatment. Emphasis is placed on methods for reclamation of drinking water as well as effective utilization of nutrients in the wastes.

The first part is devoted to general overviews. It includes discussions of legislative problems by Senator Muskie and former Environmental Protection Agency administrator Ruckelshaus. Limnological problems are perceptively analyzed by Ruth Patrick. A subsequent section addresses the problem of chemical pollution of drinking water. Excellent chapters by Robert Harris and Samuel Epstein describe the dangers of contamination of drinking water with carcinogens.

The major portion of the book is devoted to biological treatment methods. Treatment is discussed from a variety of viewpoints. There are chapters on the use of algae, macrophytes, vascular plants, mollusks, brine shrimp, *Daphnia*, and fish. De Jong's description of a Dutch project in which sewage is treated in ponds containing rushes and reeds is of particular interest. A paper from Romania describes the use of sawgrass for the manufacture of paper products and suggests the possibility of harvesting sawgrass from the nutrient-rich waters of Florida. The organizers have not ignored