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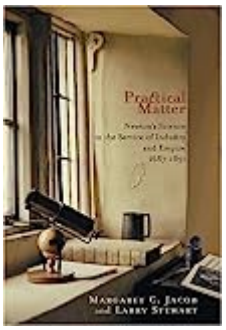

Margaret C. Jacob, Larry Stewart. *Practical Matter: Newton's Science in the Service of Industry and Empire, 1687-1851.* Cambridge: Harvard University Press, 2004. 201 pp. $35.00 (cloth), ISBN 978-0-674-01497-8.

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Published on H-Albion (April, 2006)

The "Knowledge Economy" of the Eighteenth Century

University presidents are fond of proclaiming the importance of the "knowledge economy" in ensuring economic success in the twenty-first century. That is, they argue that the intellectual work of university scholars is really the basis for future prosperity, rather than natural resources, entrepreneurial spirit, or seat-of-the-pants trial and error. Margaret Jacob and Larry Stewart move this argument back two centuries, arguing that it was precisely the existence of a knowledge economy in the century and a half after Isaac Newton that made possible the huge technological and economic explosion that we now call the Industrial Revolution (or the "industrial revolution," for those less comfortable with the heroic label).

Jacob and Stewart set out to explain, as they tell us in their introduction, why science wins, why between 1687 (the publication of Newton's *Principia Mathematica*) and 1851 (the Crystal Palace exhibition) science–and especially mechanics–becomes central to western thought, and economic and technological development. They trace a line from the acceptance of Newton, through the burgeoning of public experimentation, through the development of scientific curricula in schools, to scientific interest on the part of capitalists and entrepreneurs, and state interest in using science to advance understanding. In the process, Britain first, and other European countries and America later became industrialized. In other words, Jacob and Stewart argue, science was a major factor in the burgeoning of enterprise that was the Industrial Revolution.

The authors begin with Newton and ask a very important question: given that his great work, the *Principia Mathematica*, was such a difficult book to understand, why did it become so famous and so important? There were several reasons. First, while we tend to privilege books 1 and 3, since they contain the astronomical work most commonly now associated with Newton, the authors argue that, at the time, book 2, on mechanics, was much more significant. Thus, the practical elements of this important natural philosophical text struck the contemporary readers almost immediately. Equally, Newton's mechanics demonstrated God's rationality and as such proved very attractive to Whig Anglicans in the first generation after Newton, and to virtuosi and Masons thereafter. This section, then, is reminiscent of Jacob's

earlier arguments in *The Newtonians and the English Revolution, 1689-1720* (1976).

Practical Matter next examines the flourishing of mechanical demonstrations, lectures, and popular experimentation, using material first developed in detail by Stewart in his book, *The Rise of Public Science: Rhetoric, Technology, and Natural Philosophy in Newtonian Britain, 1660-1750* (1992). The authors show that at the same time that the Royal Society became increasingly more interested in mechanical questions, more exciting mechanical spectacles took place outside those privileged halls, in more entrepreneurial, radical, and democratic venues. Informal clubs sprang up, scientific education became more sought, and all this flourishing of scientific interest happened at the same time–and often with the same people–as the development of mechanical manufacturing and the growth of factories. While Jacob and Stewart do not demonstrate explicit connections between Newtonianism and the Industrial Revolution here, the inference is clear.

The interplay of science and industry is also evident in the growth the "Lit. and Phil." movement and by the participation of manufacturers in such organizations. Jacob and Stewart discuss the careers of two such manufacturers, who were largely self-educated, but saw the importance of scientific study and themselves delivered papers at their local Literary and Philosophical societies. Unfortunately, it is not clear in this telling whether the science aided the industry–or rather, as seems more likely, that these men saw science as a path to social mobility and gentility.

Likewise, the relationship between scientific education–especially as sponsored by the state–and industrial progress, is not as clear cut as the authors imply. While scientific education expanded greatly in the eighteenth century, especially in the French context, the ends of that education were not the manufacturing of better goods. The authors describe the changing curricula of French *lycÃ©e* and the *Ecole Polytechnique*, which is very interesting, but the *Ecole Polytechnique*'s move to ever greater scientific complexity often seemed to mitigate against practical application, rather than to aid it. The story of the interaction of science and technology in this period, as in others, is a very complex one, without a simple one way influence.

Historians have debated the relationship between science and technology for many years. At times, scholars have argued for a strong cause and effect (either from technology to science, or science to technology), while at other times, they have denied any connection whatsoever. There is now, I would argue, a growing understanding of just how complex a relationship this is. That is, just as we would no longer accept the Hessen thesis (named after Marxist scholar, Boris Hessen) that Newtonian physics owed all to practical technology, neither would we be satisfied by a bald claim that Newtonianism "caused" the Industrial Revolution. While Jacob and Stewart do not make such a claim, they do want to suggest that the creation of a knowledge economy, through the widespread permeation of Newtonians, mechanics, and experimentalism, provided impetus, ideas, and principles for the growing industrial sector. This is intriguing, and I am sympathetic to the enterprise, but I do not think they have proven their case.

The arguments in this book are suggestive rather than rigorously proven. There is little evidence brought forward to demonstrate the links–between Newtonianism and Anglicanism, between this alliance and manufacturing. We see the impressive rise in popular science, but is there a clear link (except coincidence) between this and the Industrial Revolution? Some of these are links the authors have demonstrated elsewhere, but it would still have been useful to provide a more convincing analysis, especially as this book is designed for a wider audience, potentially meeting these issues for the first time. While suggestive, this book would have been more powerful with clearer arguments defended with more explicit data. Otherwise, the knowledge economy of the eighteenth century seems every bit as elusive as that of the twenty-first.