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Margaret Jacob. *Scientific Culture and the Making of the Industrial West*. Oxford University Press, 1997. 269 pp. Paperback \$21.95.

Margaret Jacob's new book, *Scientific Culture and the Making of the Industrial West*, is a revision of her nine-year-old classic text, *The Cultural Meaning of the Scientific Revolution*. The material has been reorganized, the central question of the research redirected, and new sections have been added, most significantly a new chapter on the Watt family based on material only recently available in the Birmingham City Library. Both books provide general, readable introductions to the Scientific and Industrial Revolutions which could be assigned to undergraduate classes, while also posing questions about the relationship between scientific and social changes that will be of interest to historians in many fields.

In *Cultural Meaning*, Jacob sought, "to explain the historical process by which in the seventeenth and eighteenth centuries scientific knowledge became an integral part of Western culture" (3). It focused on the "assimilation" of science into culture, beginning with a discussion of Copernicus' publication of *De revolutionibus orbium coelestium* in 1543 as marking the beginning of the Scientific Revolution, and proceeding through the spread of the Industrial Revolution in Western European countries. Although *The Industrial West* also begins with Copernicus and ends with the Industrial Revolution, it reorients its inquiry significantly by asking a more comparative question: how was scientific knowledge integrated into culture in different ways and to varying degrees in the Western European countries? Why was Britain the first nation to industrialize, and how did this feature of British culture set it apart from Continental Europe?

To approach this question, Jacob divides the book into two major sections, the first entitled "Intellectual Foundations," and the second, "Cultural and Social Foundations." "Intellectual Foundations" deals with the creation of a new science and its audience, the "cultural meaning" of Cartesianism, the challenge of Newtonian mechanics to Cartesian philosophy, and the cultural significance of Newtonianism. According to Jacob, the Cartesianism prevailing on the Continent appealed to "disciplined elites in the service of a strong central government" (41). In England, after the Civil War and parliamentary reforms of the 1640s-1680s, a belief in

Newtonian mechanics came to stand for a comprehensible world ruled by natural law, not by a capricious absolute power. This vision of the world appealed to moderate British reformers such as Christopher Wren and Robert Boyle, two of the founders of the Royal Society, who wanted to preserve social order and property rights while repudiating absolute monarchy. As Jacob argues, the Newtonian forces describing the natural world became the metaphors and models for the social order in Britain. In the first half of the book, the two philosophical systems are juxtaposed against each other in terms of their cultural significance. In the second half, Jacob uses this opposition to explain differences in the rates of industrialization between Britain and Continental Europe.

The second section, "Cultural and Social Foundations," discusses the diffusion of the Newtonian Enlightenment and the application of science to industry, that is, the development of what Jacob terms a "scientific culture." Here, she uses the Watt family to illustrate how the diffusion of scientific education and thinking passed through the generations. John Watt, James' uncle, was a small-scale entrepreneur and mathematics teacher who was also interested in astrology. His nephew, who probably studied some of John's mathematics texts, went on to become arguably the most central figure in British industrialization with the introduction of his steam engine. His son, Gregory, received a classical education at the University of Glasgow where his father heard Joseph Black's lectures on the principle of latent heat. In three generations, the family status rose significantly through their adoption of the scientific culture. The sections in which Jacob discusses the example of the union between scientific education and technical innovation in a scientific culture provided by this family are among the most interesting and well-written parts. The new primary research on the Watts is a valuable addition to *The Industrial West*.

The following chapters in this section deal with the development of scientific culture in the Continental European countries, differentiating the way that science was learned in France, the Dutch Republic, the Austrian Netherlands, the German states, and Italy. These sections are expanded versions of the ones in *Cultural Meaning*; the conclusion that Britain had several advantages on the path towards industrialization—relative freedom from state control, access to public education, a scientific culture—is

essentially reconfirmed. In the chapter, "How Science Worked in Industrial Moments," the example of the construction of a port in the city of Bristol is analyzed to show the conflicting voices of professional interests and appeals to scientific authority. As Jacob points out, the mercantile interests who opposed the construction of the harbor were not content to accept the authority of engineers, but engaged in debates armed with their mechanical knowledge from standard eighteenth-century Newtonian textbooks. That British engineers, gentlemen merchants, and members of Parliament all possessed a certain level of mechanical expertise was, as Jacob convincingly argues, a decisive factor in British scientific culture supporting industrialization.

Overall, *The Industrial West* has been streamlined and is more sharply written than the earlier version of this book. Other small changes have been made that are unfortunately not as advantageous: a pedagogically useful glossary of terms has been removed, the epilogue deleted, and the notes have been moved from the end of each chapter to the end of the book. On the whole, however, the revisions and additions strengthen the text. As in *Cultural Meaning*, Jacob argues in *The Industrial West* for an understanding of the close relationship between science and technology in the early modern period. In the first book, she held that, "the road from the Scientific Revolution to the Industrial Revolution. . . is more straightforward than we have imagined" (7). In this revision, she invokes the image of science and technology as "fraternal twins, born into a family particularly eager for profits and improvement: they have different *personae*, different looks, but are still profoundly related" (9). Although the metaphor of technology as the twin of science reflects a more current and balanced understanding of this relationship than the "road" image, the structure of *The Industrial West* maintains Jacob's original conception. She begins with the "intellectual" and proceeds to the "cultural and social," and the causality seems to be unidirectional: science influences technology, and not the reverse. Jacob's notion of "scientific culture" might have been enriched by a better sense of the interplay and dynamic exchange between the two siblings. Not only can Newtonian conceptions of force be applied to problems in hydraulic engineering, the building of steam engines can re-conceptualize notions of

heat. More attention to these possibilities might have helped to enlarge the concept of "scientific culture."

However, these are minor criticisms about what is, on the whole, a very thought-provoking and solid revision of a classic text. *The Industrial West* will engage students of early-modern Europe, labor and industrialization, as well as historians of science and technology. Margaret Jacob has done an excellent job of drawing together the large themes of the scientific and industrial revolutions with interesting and lively detail in an important new book.

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