Barbara Hahn, *Technology in the Industrial Revolution*, CUP

In *Technology in the Industrial Revolution*, Barbara Hahn directs the methodologies and questions of the historian of technology to the big question in economic history – why did the industrial revolution begin in England during the eighteenth century, heralding with it the advent of modern economic growth? As her case study Hahn takes the archetypal example of a transformed industry: textiles in North-west England between *c.*1760-1840. At the start of this period, cotton constituted less than 1 percent of British industrial output by value, by 1840 it constituted 10 percent. Impressive enough, but this occurred over a period when overall industrial output almost quintupled. However, although we are well served by internalist guides explaining how the new industrial machinery worked from a strictly mechanical perspective, there is surprisingly little in the way of a contextual analysis – detailing how this new machinery was made to work in reference to government regulation, consumer demand, social norms concerning labour practices, gender and so on. It is "a universe too vast to sketch" but in only a short book, Hahn does a superlative job in doing precisely this. In particular, the book is packed with detail, evocatively presented. For instance, to illustrate the sophistication of the pre-industrial marketplace, we are witness to the cloth market in Leeds. Initially held in the open air, deals were struck in whispers so that both sides could keep the details a secret. When the market moved indoors to Leeds Cloth Hall, the windows were built especially large so that vendees could still judge the quality of the goods. Conversely, factories were built without windows when the owner wanted to keep some method or device a secret.

This is not, though, to imply that the material is unyoked from any narrative. For instance, the advantages of factory manufacturing are illustrated by the career of the Nottingham cloth merchant, Samuel Oldknow. Early in his career, his business was established on the traditional putting out system, where every stage in the conversion of the cotton fibre into finished cloth occurred in the houses of subcontractors paid on a piece rate. One advantage of this system was that it required less capital from the merchant who owned the cotton but not the machinery which belonged to his subcontractors. However, such a workforce was inherently difficult to supervise and theft of his cotton was difficult to prevent. If, for example, more waste "trett" and less "neat" fibre was being produced than expected, was this the subcontractor's fault, or because of the quality of the raw cotton Oldknow had provided? Similarly, he was responsible for moving the cotton through each stage of the conversion process; as we travel from house to house with Oldknow (even his account books were arranged according to the street where his subcontractor lived) we can readily imagine how the appeal of a centralised manufactory would have formed, even despite the far greater capital requirements.

This account of Oldknow might also imply that the transition from domestic handicraft to large-scale, steam powered factories was a smooth one, but it is a central tent of Hahn's book that the industrial revolution rarely affords easy description. Instead, facets of both could and did co-exist together, and indeed profitably so. For instance, the wool merchant Benjamin Gott's Bean Ing Mill employed more than a thousand workers in 1819 and he had used steam power at the mill since when it was first constructed. Nonetheless, more than three-quarters of Gott's workforce were engaged in hand processes no different from those used in putting-out (p.130). Also, as great as the financial rewards might be (Gott was an extremely wealthy man when he died), industrialisation was not a simple matter of the swapping labour for capital; for every merchant who profitably adopted the new factory system, four would be bankrupted.

Hahn also describes how technology and the wider world have a synchronous relationship, each constantly changing and adapting to accommodate the other. Here, the heroes of the industrial revolution are not those responsible for the invention in and of itself, but those who were able to adopt and adapt technology so that they became commercially viable propositions. For instance, Richard Arkwright is conventionally presented as the inventor of the spinning frame, which mechanised the spinning of cotton thread. The frame worked by drawing the fibre through successive pairs of rollers, each moving faster than the last until it passed through a flyer that twisted it onto the spindle to collect the fresh-spun yarn. Some internalist analysis have cast doubt on Arkwright's inventive achievement: this method of spinning had been used by the Italians for throwing silk since the 1300s and there had been previous efforts to apply it to cotton (most notably, one patented by Lewis Paul in 1738). Similarly, Arkwright's Cromford mill, the world's first water powered cotton spinning mill, incorporating centralised large-scale production yoked to inanimate power sources and new working practices (swapping semi-independent and skilled home workers for unskilled paid labour) had its own antecedents, especially Lombe's silk mill in Derby.

Arkwright's achievement, though was in negotiating the incorporation of his proprietary technology and factory organisation into social and political structures, ensuring his mill would be a commercial success. In

particular, Arkwright could now spin cotton into yarn strong enough to make all British-made cotton cloth. However, At the beginning of the eighteenth-century, Parliament had banned the sale of printed all-cotton cloth, in an effort to protect producers of domestic fustians (a woollen and cotton mixture) from Indian competition. By securing the repeal of the Calico Act from Parliament in 1774, Arkwright secured a large enough market for his goods, that matched the potential scale of output from his factories. By combining scale of production with scale of market, Arkwright made his fortune, a route that others also copied.

By emphasising the complexity and contingency of the industrial revolution, Hahn's book reminds us that the industrial revolution may never be susceptible to the sort of mono-causal account that are now increasingly advanced in the economic history literature.