democracy are likely to be more fruitful when they proceed on the assumption that it is a work in progress rather than a finished product (or even an exportable product). This volume reminds us that, amongst the critics of 'American democracy's' infamous complacency, John Dewey still has much to say to us.

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The arts of industry in the age of enlightenment by Celina Fox, Yale University Press, New Haven, 2010, viii+576 pp., $US95.00, ISBN 978–0-300–16042–0

Although this large and handsomely presented volume—it has 260 illustrations, of which 60 are in colour—was published for the Paul Mellon Centre for Studies in British Art, it would be unfortunate if it were read only by those whose interests lie in the history of art. *The Arts of Industry in the Age of Enlightenment*, centred as it is on the beginnings and early development of the Industrial Revolution, has a great deal to say of relevance to innovation and technological change. It is about the development of technical skills and their diffusion.

Celina Fox writes from her perspective as an art and cultural historian and her book has its central focus on the 1700s. In common usage at that time, 'art' referred more to technical skill and had weaker aesthetic associations than at present. As she puts it: 'the arts of industry had much richer connotations than they do today … [they] were taken to refer principally to the skills involved in the processes of industry itself' (p.1). That period, characterised by the intense and wide-ranging intellectual ferment labelled as the Enlightenment, also saw the beginnings of the Industrial Revolution.

Within the past decade there have been several books that relate directly or indirectly to the Industrial Revolution. For example, the economic historian Joel Mokyr (2009) has contributed a substantial study, while many other historians have emphasised the social history of the period (Crump, 2010). However, the catalytic effects on industry of what eighteenth century spin-doctors dubbed the 'Glorious Revolution' have been unduly neglected. Recently, some historians have re-interpreted the events of 1688 as a successful invasion from the Netherlands (Dillon, 2006; Vallance, 2006; Jardine, 2008). One effect of the victorious William of Orange's reliance on Dutch

advisers was to stimulate a raft of institutional changes that, *inter alia*, greatly strengthened the British financial system (Dickson, 1967), surely a crucial prerequisite for the industrial transformation that followed.

The state and evolution of skills, trades and professions over this period of rapid technological change are other issues that historians have tended to neglect, but Fox's work goes a long way towards filling this gap. Her emphasis on tracing changes in the relationship between British art and science from the eighteenth century leads her to outline much of the technical and cultural context associated with diffusion of the innovations and theoretical knowledge of the day.

Chapters in the book deal with trades and technical skills and attempts at their codification (arguably mislabelled 'the history of trades'); drawing and its importance in the development of professions such as surveying and engineering; models and their use as educational aids; the role of organisations and publications (particularly encyclopaedias and technical manuals) in the broad diffusion of skills and theoretical understanding; portraits, technical sketches, industrial images and landscapes.

While most of the book deals in some detail with developments up to 1800, focusing primarily on the eighteenth century, Fox's final chapter updates the same subject matter to the nineteenth century. Post-1800, 'art' gradually came to adopt the strongly aesthetic connotations it possesses today and became more clearly distinguished from the technical and scientific meanings that had been embedded in its earlier and broader usage. The use of the term 'prior art' in modern patent legislation is, perhaps, one of the few surviving instances of eighteenth century usage.

In the course of her book, Fox discusses the activities and interactions of many individuals who made particular contributions. The names and contributions of figures such as Boyle, Hooke and Watt are well known. Others, such as Edmund Dummer (1651–1713) and Samuel Bentham (1757–1813), are not. In different periods, both made substantial technical contributions to British naval strength, not only through ship design, but also in the improvement of naval dockyards and the techniques of ship construction. Their careers illustrate that naval or military needs were a key driver in the evolution and social construction of certain disciplines and professions, particularly surveying, engineering and naval architecture. These are all professions for which, in the absence of photography and blueprints, technical skills in drawing would have been an essential prerequisite. Indeed, Fox notes that from the 1690s there were calls for drawing to be included as an essential part of the education of all British males. (We might also note that even as late as the early 1900s technical drawing remained an important part of school curricula in some Australian schools.)

Skills in drawing, of course, are closely related to the skills necessary for portrait and landscape painting. Prior to the age of photography, hiring a highly skilled portrait artist provided the only means of recording likenesses for family or public purposes. Although not noted by Fox, perhaps it is no coincidence that 'art' began to take on a narrower meaning at around the time that photographs became commonplace. While she certainly explores the social and cultural context in which new technology develops, she does not discuss the reciprocal effect, where the introduction of new technology in turn influences social and cultural change.

The construction of working models required different skills from drawing and provided another means of description and communication. Practical examples included steam engines, pumps, cranes and waterwheels. Some models were used

as proof of an invention or as a means of promotion. Others were favoured by travelling lecturers and were a significant means of diffusion for both theory and practice. In eighteenth-century lecture-demonstrations, models presumably filled a function similar to such modern educational aids as slides and films.

Organisations of various kinds served as focal points for discussion and communication. Clubs and societies also enabled broader scale initiatives than were possible for individuals acting alone. Fox notes that it was the Royal Society that put the arts of industry onto the intellectual agenda. The Royal Society was an early advocate for greater diffusion of trade knowledge and a pioneer in seeking to codify trade skills, but its efforts largely foundered. This was partly through the fellows' difficulties in accurately observing the practices of artisans, with practical men, such as Robert Hooke, being exceptions. More fundamentally, many fellows underestimated the difficulties involved in codifying tacit knowledge. Later, however, more acute and practical observers did achieve success in producing a range of useful technical manuals. For example, among several others listed by the author, technical manuals were produced on clock- and watch-making, carpentry, cabinet making, furniture building, tailoring, the manufacture of kitchenware and the production of salt.

Over the same period as the compilation of specialist treatises, the idea of producing a compendium of all knowledge was born. The first to be widely read was Chambers' *Cyclopedia*, in 1728. In 1745, Chambers' success stimulated one French publisher to commission a translation — but those who took on this task (Diderot and d'Alembert) insisted on producing a completely original work. With its first volume appearing in 1751 and the final volume of plates appearing in 1772, the French *Encyclopedie* was unsurpassed in the high quality of its entries and the excellence of its almost 2900 illustrations. This led many plagiarising translators to produce imitations. Fox observes that a new five-volume edition of the *Cyclopedia*, produced over the decade from 1778, proved no competitor. Its relative failure, however, led its editor (Rees) to begin work on a far more ambitious *Cyclopedia and Universal Dictionary.* With 45 volumes appearing between 1802 and 1819, this incorporated 849 technical plates and was the first English publication to match the *Encyclopedie*.

The availability of technical treatises and knowledge compendiums (including the first edition of the *Encyclopaedia Britannica*, appearing in three volumes in 1771) did much to diffuse skills and knowledge and thus to stimulate new ideas, but organisations were established that stimulated innovation more directly. In particular, the Society for the Encouragement of Arts, Manufactures and Commerce (known simply as the Society of Arts) played a pivotal role. The Society not only laid foundations that led to the establishment of the Royal Academy of Arts in 1768, but also encouraged innovation more directly. Working through a number of committees, it gave grants ('premiums') for improvements of many specialised products. Fox observes that the Society also did much to break down class barriers and substitute guidance by practical experts for that of 'gentleman amateurs'.

From Fox's account, it would seem that the Society of Arts epitomised the infusion of Enlightenment values and attitudes that clearly permeated many aspects of eighteenth century society. With the goal of 'shared knowledge for the common good', she notes that: 'fine and applied artists met on equal terms, not distinguished by an academic hierarchy of ascending value, but working alongside each other for the encouragement of the arts as a whole' (p. 229). Fox's work shows that a similar

mindset established the mood that had led to the Royal Society's early attempts to produce treatises on trade skills, and subsequently to the production of knowledge compendiums, and was common both to intellectual and practical endeavour of many kinds. This is a finding that is implicit in the work of a number of other recent authors — for example, in Uglow's (2002) study of Birmingham's Lunar Society — while Mokyr argues explicitly that the Enlightenment was a key driver of the Industrial Revolution.

How well do these historical analyses reconcile with the ideas developed in modern research on innovation? Notably, much modern research (for summaries, see Dodgson and Rothwell, 1994; Fagerberg et al. 2005) points to technological change as depending on effective systems of social interactions within favourable social, institutional and cultural conditions. It is inadequate to focus solely on economic or financial motivations as driving the interactions leading to technological change and innovation. We need to consider a broader range of motives.

Mostly, social interactions consist of exchanges that individuals perceive as beneficial. Often, such exchanges occur within a formal or informal organisation that operates as a system or sub-system within society as a whole. As an economic example, a commercial enterprise holds onto its employees by providing financial reward in exchange for their services and it is their interactions that produce the external effects of the enterprise. Similarly, organisations such as the Society of Arts, the Lunar Society and the Royal Society — social sub-systems within the broader society of the time — could be seen as bound together by exchanges of ideas and information, with the added benefit of intellectual stimulation. Sometimes, outside the bounds of the organisation, knowledge gained would stimulate members to make further useful contacts, or to develop ideas to gain some benefit. At other times, the organisations would take collective decisions to produce outputs, such as publications or awards, which would similarly stimulate individuals outside their membership.

In the intense intellectual climate of the Enlightenment, with the optimism about change and the possibilities for improving the human condition that it produced, it is little wonder that many were powerfully motivated and that better understanding, enhanced skills and technological advancement resulted. Fox's impressive and comprehensively documented work adds significantly to the mosaic of historical information available around the Industrial Revolution.

The book concludes by discussing the Great Exhibition of 1851. Seen by one commentator as a 'cultural battlefield', the Exhibition was an attempt to reconcile the artistic with the technological. In this respect, it did not wholly succeed. For the most part, technology dominated the exhibits. Although we might infer from Fox's work that the change in usage had begun as early as the establishment of the Royal Academy of Arts in 1768, it was from around the time of the Great Exhibition that 'art' was mostly taken to refer to the fine arts.

Using 'science' in its broadest sense — not merely encompassing science as the development of understanding, but also technology as the development of useful products and processes and the practical skills required for their development — Fox's aim in this book was to provide 'a missing link, even the linchpin, for our understanding of the relationship between eighteenth century British art and science' (p.8). Viewed from the perspective of innovation studies, she has succeeded.

This scholarly and well-written book is a valuable work that has much to teach us, but it would be unfortunate if its inevitable classification as a book on art led to its neglect by students of science, technology and innovation.

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