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Kevin Lambert, *Symbols and Things: Material Mathematics in the Eighteenth and Nineteenth Centuries*, Pittsburgh, PA: University of Pittsburgh Press, 2021, x + 318 pp., ISBN: 9780822946830.

The central preoccupation of this book is how the development of British mathematics in the 18th and 19th centuries can be seen better by attending to material objects and context. We get a rich account of Cambridge journals and books, from Cocker's best-selling *Arithmetick* (first edition 1678), as well as other kinds of texts, such as letters and notebooks.

For much of the later 18th century, mathematics in Britain was declining in vigour and mathematics in Continental Europe was growing in strength—mathematicians there were discovering new fields and new ways of writing and distributing mathematics. The full story is more complicated, but by the early 19th century the view of a younger generation of Cambridge mathematicians was that British mathematicians fallen dangerously behind the French, and they set about trying to reform the syllabus from positions inside and outside the university. This has been much studied by historians. Here, Lambert shows, Deighton's bookshop played a crucial role in providing and stocking the new books necessary to promote change. The first of these was an English translation of Lacroix's algebra textbook, which sold an impressive 979 copies when it came out in 1816; at 18 shillings a copy it made a good profit for Deighton. Other translations and original works followed, and soon there was need for a journal. This was the journal of the Cambridge Philosophical Society, which a generation later became the *Cambridge and Dublin Mathematical Journal*. On this topic, Lambert's earlier attention to Cocker and still more to the *Ladies' Diary* pays off, and the reader gets a rich sense of what was involved in the evolution from one sort of journal in one context to a different journal at a later time.

Advanced mathematics began to be done outside Cambridge in the 1830s. The notable figures were George Green in Nottingham and George Boole in Lincoln, and their work and their complicated and inconclusive connections to Cambridge and London are well known. Less well studied but well presented here are the large local libraries they could join and the ways these helped them get their work printed. One of Lambert's positions is that we should not see mathematicians as solitary figures with pen and paper in hand, but consider how they came to hear of advanced mathematics, how they could turn to other people for help, and how they could get into print. This is not a wholly new insight, and it could have become a tedious

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methodological drumbeat, but here it does good work enriching our picture of how mathematical life is possible in various time periods and what forms it might take. There is, for example, a fascinating account of how contemporary class divisions could show up: Nottingham, for example, had an expensive, well-stocked library with links to Cambridge for the new middle class, but much smaller libraries and their attendant societies in the working-class district of town.

Mathematicians did and do, of course, use pen and paper, but only slowly and imperfectly (as every graduate student might be reassured to learn). Whatever they may have kept in their heads, they also wrote their ideas down in notebooks, and exchanged letters with friends and trusted colleagues. One prolific notebook-keeper was William Thomson, later Lord Kelvin. He is known to historians for many things, one of them being that as a young man in 1845 he rescued Green's first and most influential essay from obscurity; Lambert conjectures that Thomson may have been given one of the remainders from Deighton's bookshop. Thomson also wrote extensive, and sometimes hostile, marginalia in books by other authors, such as Maxwell's *Treatise on Electricity and Magnetism*, which he forever failed to grasp because he could not construct a mechanical model of what was presented. These notebooks document the progress of Thomson's thought and reveal how what he read in various journals sometimes enabled him to work out what he had previously been unable to do. The point in the abstract is not very remarkable, but Lambert animates the context and uses it to make precise historical points.

For correspondence, Lambert turns to the letters between William Rowan Hamilton and Tait about quaternions. We learn in passing of Tait's ingenious way of gluing Hamilton's letters, some of which were quite lengthy, into a letter-book so that they could be re-read, and how the practice of dating notes enabled items and ideas to be found. Lambert speaks of how Hamilton and Tait "tuned-in" to each other, and he is right, but it might also be that it took the established Hamilton a few exchanges of letters to realise that the much younger Tait was good enough to be a colleague he could work with—and promptly to see him as a rival.

Lambert also offers a chapter on what he calls Romantic space, in which he describes people imagining space through diagrams. This is not romantic in the sense of the Weimar philosophers of the period, but is Kantian in essence. His idea is that "even the most abstract ideas are thought through and with things and that how we think shapes what we think" (p. 120). Rather like Kantian space, Romantic space is an intuition prior to experience but believed to be absolutely true; strictly, Kantian space is a condition for the possibility of certain ideas. I was not entirely convinced that the account of how people tried to make sense of lines of magnetic and electrical force was thinking about space, rather than what they believed to be in space. But Lambert finds a distinction between Herschel's simple view that space is empty and Whewell's Romantic view that our idea of space confers truth upon our basic mathematical ideas, and grounds this in the two authors' appeals to different publics: Herschel's in London and Whewell's in Cambridge. That is well worth exploring, and fits with Whewell's views about what a Cambridge education ought to consist of, but it also surely reflects the different takes on the world of an observational astronomer and a theoretical physicist.

Every reviewer has quibbles, and I have a few. It is too easy to say Coleridge was not a philosopher (p. 120); he wasn't a professional philosopher but his Kantian writings joined him to Hamilton, as did his poetry. I was intrigued to learn (p. 44) that the Baruya of Papua New Guinea build much larger fences than are needed to demarcate gardens and keep out pigs, and do so to express cultural values and systems of thought. Lambert takes this as a way in to understanding the different values attached to journals, which is fine. But he misses a contemporary shift in cultural values that went right through Western Europe in the early 19th century: the remarkably sudden collapse of the idea of Latin and Greek and the ancient authors as forming the core of a civilised British identity. To be sure, the idea did not immediately and entirely disappear (it has a baleful exponent in British politics today), but it lost status and was replaced by the disciplines of *belles-lettres* and philology. An essay tracing from when Newton's *Principia Mathematica* was so revered in Cambridge partly because it was in Latin to the fracturing of a gentleman's education by the time of Maxwell would have been a fine addition to this book. And that leads me to my penultimate quibble: the book reads as a series of overlapping essays, which gives each chapter a clear focus but has occasioned some unnecessary repetitions (for example, concerning Sir Edward Bromhead). Finally, the book would benefit from a larger index.

I confess I picked up this book wondering if we need another book about mathematics at Cambridge in the 19th century. My answer when I finished reading it is: Yes, we need this one. Its account of the materiality of mathematical practices and so of the role of context in mathematical discovery is informative, lucid, and could serve as a model for what could be done elsewhere.

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