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## Book Review

Jessica Maris Otis, 2024. *By the Numbers, Numeracy, Religion, and the Quantitative Transformation of Early Modern England*. Oxford University Press, 280 p., ISBN: 9780197608784.

In 1987, Keith Thomas published in the *Transactions of the Royal Historical Society* a paper titled “Numeracy in Early Modern England”.<sup>1</sup> Thomas argued that, between the 16<sup>th</sup> and the 17<sup>th</sup> centuries, the English population experienced a transformation in its levels of numeracy. Jessica Otis’ *By the Numbers: Numeracy, Religion, and the Quantitative Transformation of Early Modern England* offers a new and detailed synthesis of this phenomenon. Nicely printed and complemented with a detailed bibliography, this fascinating study contributes to a line of enquiry on everyday mathematical practices that is attracting increasing attention among scholars from a variety of historical fields.<sup>2</sup>

Essentially a study of popular numeracy in early modern England, the book has the merit of de-naturalizing contemporary understandings of numbers and mathematics as key tools to understand, describe, and govern the world. It reconstructs a social world in which our assumptions on the roles of mathematics were far from granted, but out of which such assumptions eventually emerged. The focus of the book is not on any individual actor, but on the ordinary men and women of early modern England. The book can be divided into two parts: in the first, (Introduction and Chapter 1), Otis reconstructs the variety of numerical practices that her protagonists had at their disposal. Chapters 2 through 6 offer a series of case studies, which exemplify “the quantitative transformation” at the core of the book.

The Introduction and Chapter 1 provide an effective introduction to the rather unfamiliar land of late medieval and early modern mathematical practices. Appropriately, the author stresses the importance of recognising the materiality and plurality of early modern techniques to represent and manipulate numbers, arguing that we would better describe these as a multiplicity of techniques (the author uses the term “numeracies” in the plural form), which early modern actors could choose and combine. Critiquing the anachronistic tendency to regard our numerical techniques as ‘natural’ or ‘superior’, Otis argues that the transition to “Arabic numerals” (more accurately referred to as “Indo-Arabic numerals”) was “neither immediately nor universally believed to be a significant improvement over other early modern symbolic systems, despite being the only system with the potential to unite recording and calculation” (p. 12). Through this framework, she can make sense of the slow and contradictory patterns of adoption of Indo-Arabic numerals in early modern England that have baffled previous scholars. Her argument is that such seemingly contradictory patterns are “in fact consistent with a culture where multiple forms of numeracy coexisted without a single dominant system” (p. 11).

Chapter 1 outlines the plurality of means through which people in early modern England represented and manipulated numbers, which the author describes as “multiplistic numeracy” (p. 41). Otis classifies numerical systems in three categories: performative, object-based, and written numerical systems. This classification allows the author to foreground the material aspects of early modern English numerical techniques. The chapter places at the foundation of early modern numeracy the oral use of number-words and of bodily gestures to represent numbers (what is often referred to as “finger reckoning” or “finger counting”). Otis argues that, unlike today, there was no social stigma associated to adults using fingers to represent numbers and count (p. 18). The chapter then discusses “object-based” numerical systems, and, while recognising the wide-ranging set of objects that were used to represent numbers (from beans to spoons), it mainly deals with tallies and counters. Tallies are mainly presented through their canonical example of English tally sticks. Their common association with illiteracy is criticised, and the variety of their uses is presented. The discussion then moves to counters, and the techniques related to their use on counting boards, mainly relying on a close reading of Recorde’s *The Ground of*

<sup>1</sup> Keith Thomas, ‘Numeracy in Early Modern England: The Prothero Lecture’, *Transactions of the Royal Historical Society* 37 (1987): 103–32, <https://doi.org/10.2307/3679153>.

<sup>2</sup> See for instance William Deringer, *Calculated Values: Finance, Politics, and the Quantitative Age* (Cambridge, Massachusetts ; London: Harvard University Press, 2018); Sebastian Felten, *Money in the Dutch Republic: Everyday Practice and Circuits of Exchange* (Cambridge: Cambridge University Press, 2022); Thomas Morel, *Underground Mathematics: Craft Culture and Knowledge Production in Early Modern Europe* (Cambridge: Cambridge University Press, 2023); Morgan Kelly and Cormac Ó Gráda, ‘Connecting the Scientific and Industrial Revolutions: The Role of Practical Mathematics’, *The Journal of Economic History* 82, no. 3 (2022): 841–73.

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*Artes* in its original 1543 edition. As this edition of Recorde's text does not discuss multiplication and division, neither does the chapter, only recognising that "multiplication and division were more difficult" as they required intermediate stages (p. 31). The reader is left wondering how such techniques worked in detail. Written numeral systems are then outlined: Roman numerals – appropriately presented as a recording rather than a reckoning system – and Indo-Arabic numerals, which combined the two functions. Appropriately, the chapter not only presents the multiplicity of means through which people represented, recorded, and manipulated numbers, but it also stresses the hybridity of these practices, for example noting how in the early modern period written numbers were often the result of calculations carried out elsewhere, or how different written systems often coexisted in written sources, which often had low levels of standardisation.

The book then presents a series of chapters that investigate changing uses and attitudes towards numbers in several fields. Chapter 2 discusses the uses of different numeral systems in relation to trust. Foregrounding the varying degrees of permanence of the available systems, Otis argues that the highest degree of encryption of quantitative information was provided by tally sticks, followed (in order of declining permanence) by written number-words, Roman numerals, and Indo-Arabic numerals. Otis describes a variety of strategies used by early modern writers to prevent tampering of numbers in written records, and uses the relative proneness of Indo-Arabic numerals to forgery as an explanation for the persistent use of tallies, word-numbers, and Roman numerals. The eventual widespread use of Indo-Arabic numerals from the seventeenth century is explained in terms of the greater versatility of the system.

While the first two chapters rightly make clear that numeracy was not necessarily linked to literacy in England at the beginning of the early modern period, Chapter 3 shows how the transition to Indo-Arabic numerals made the association of the two necessary, because of the inherently written character of calculation with the ten figures. The emergence of the largely successful genre of the vernacular arithmetic textbook is presented as direct evidence of this transition, and the chapter discusses the evolution of these documents in time, together with their readers and reading practices, also thanks to analysis of marginalia. The chapter closes with a discussion of how the teaching of reading, writing, and arithmetic became increasingly institutionalized in petty and charity schools, which provided foundational training for a broad subset of the English population.

Chapter 4 deals with the calculation related to time. As early modern England had a multiplicity of chronological systems (e.g., Julian, Gregorian, regnal, liturgical, etc.), calculations were necessary to move between different temporal systems. The advent of the Gregorian reform of the calendar in 1582 made these matters even more pressing. Otis turns her attention to calendars/almanacs to show how people increasingly relied on mathematical calculations to navigate the plurality of temporal systems of early modern England. Chapter 5 examines the increasing diffusion of games of chance, of insurance, and of the first mortality statistics during epidemics. The author presents the increasing quantification of chance as the convergence of two separate "worldviews": a divine/providential one and a calculative one. Bills of mortality feature again in Chapter 6, which discusses the increasing use of quantitative tools to describe, study, and govern English society, from the tension between self-interested and religious resistances to tax censuses, to the ubiquity of parish registers, to the emergence of political arithmetic, first as an explicit tool of governance, and then as a self-proclaimed neutral field. The epilogue wraps up the book, noting that early modern England was characterised by the emergence of a socially widespread attitude to describe and understand the world quantitatively. This transformation, hence, was not limited to the realm of scholarly practices, but characterised English society at large.

In the span of just 160 pages, Otis manages successfully to give a picture of the process of deep transformation in the uses of numbers and numerical thinking that characterised early modern England by documenting in detail the historical situatedness of multiple forms of numeracy, their material aspects, and social pervasiveness. This is a welcome contribution that shows the importance of the quantitative transformation of early modern England, and in so doing opens several important questions for further research. For instance: what forces made different mathematical techniques emerge, change, and in some cases disappear? Otis gestures in more than one place to possible explanations, but does not provide an overarching argument. Similarly, while the book is very detailed in discussing techniques to record numbers and elementary calculations (mainly addition and subtraction), it does not delve into the processes related to the more complex calculations that early modern actors increasingly needed to face, such as practices of exchange, calculation of simple and compound interest, the quantification of risk and annuities, the handling of rational numbers. More broadly, while this quantitative transformation was clearly a consequential phenomenon, we need to know more about how it related to other transformations in English society. To what extent should we understand it as a reflection of socio-economic change, and to what extent, instead, did this transformation act as an agent of change in early modern England? How was this widespread use of mathematical practices related to the development of new techniques and forms of knowledge? Finally, recent research has started to show that similar processes of increasing social spread of mathematical practices also characterised other European areas, as Morel has recently summarised.<sup>3</sup> To what extent did the quantitative transformation of early modern England relate to these broader processes?

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<sup>3</sup> Thomas Morel, 'Mathematics and Technological Change: The Silent Rise of Practical Mathematics', in *A Cultural History of Mathematics in the Early Modern Period*, ed. Jeanne Peiffer and Volker R. Remmert, vol. 3, 6 vols (London: Bloomsbury Publishing, 2024), 179–206.