

## HISTORY OF SCIENCE

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**BY THE NUMBERS: Numeracy, Religion, and the Quantitative Transformation of Early Modern England** by Jessica Marie Otis. Oxford University Press, 2024. xi + 264 pages, including notes, bibliography, and index. Paperback; \$28.99. ISBN: 9780197608784.

Picture the historical development of mathematics as a grand building project. The bottom floor houses basic arithmetic and elementary geometry with numerous openings to the surroundings of ordinary life. It also forms the foundation for higher stories in the superstructure—algebra, calculus, probability, statistics, and much more—all of which are linked to other structures in the neighborhood—the various physical sciences, economics, technology, and others. Under this metaphor, *By the Numbers* portrays the rudimentary furnishings in the room of arithmetic on the ground floor and their role in 16th- and 17th-century England.

Otis has an educational background in both mathematics and history. This monograph, which is a revision of her 2013 history dissertation, combines these two interests but leans toward the humanities, paying close attention to the social setting. Based on meticulous research, Otis shows in granular detail how early modern English men and women came to embrace a new technology of knowledge, learning to read and write, and eventually to reckon with (Hindu-)Arabic numerals in the context of their everyday life. The religious environment here was a widely shared Christian worldview holding that God had created and ordered the universe, as the apocryphal *Book of Wisdom* claimed, by “number, weight, and measure.” Thus, Robert Recorde could assert in his influential 1543 *The Ground of Arts* that number and arithmetic provide the foundation for all human affairs. Given mathematics’ limited reach at the time, *By the Numbers* terms the attendant societal transformation *quantitative*, though this was soon to become a broader and deeper movement of *mathematization*, as algebra, analytic geometry, and calculus became central to scientific theories.

The book is divided into two main parts. The first part (chapters 1–3) tells how Arabic numerals became more widely used in English education and accounting practices and how they came to be the basis for symbolic computational procedures, joining together recording and reckoning. The second part (chapters 4–6) explores three case studies in which the new arithmetic pervaded and transformed daily life and work: people’s sense of time and calendar reform, events of chance and God’s

providence, and the rise of political arithmetic—data collection and the increased use of governmental statistics. These parts are bookended by an “Introduction” and a brief “Epilogue” that look at innate human capabilities with respect to number and arithmetic, that summarize the topics under consideration, and that connect them to the religious outlook of the time period. The book concludes with a few observations about further developments in which number and mathematics became more deeply entrenched in English society.

The story begins by describing how earlier English cultures recorded quantities using tally sticks or Roman numerals, and it explains how addition and subtraction were done concretely on one’s fingers or on a counting board. Here, recording and calculating were performed separately, operations that changed for good once Arabic numerals became more widely adopted by the mid-17th century. Otis exhaustively examines the status and character of vernacular arithmetic texts composed for teaching and learning the new literate way of computing with symbols (over 150 texts are listed in her 39-page bibliography, counting reprints—32 by Recorde alone). She notes that written calculations have the advantage of speed and of recording intermediate results that can be checked to verify the final answer, though she fails to exhibit any of the computational procedures themselves. She also observes that as time went on arithmetic texts began to include more advanced topics, such as fraction arithmetic (common and decimal), proportionality, elementary algebra, logarithms, and trigonometry. She draws no conclusions, however, on what influence these new mathematical developments had on the increased acceptance of Arabic arithmetic, even though some of these (decimal fractions, logarithms) provided simplifying extensions of the system itself during the time period considered.

Religion fits into the story by supplying the medium in which work with numbers and computations could flourish. But it was also responsible for some points of tension. The calendar was important to the practice of religion especially because of its use in calculating a date for Easter. Partly because Protestant royalty was wary of moving closer toward Catholicism, England maintained its traditional Julian calendar until 1752, instead of completely switching over to the more accurate Gregorian calendar nearly 75 years after much of Europe had converted their date-keeping.

Differences of opinion involving quantified chance and luck (odds in games and gambling, insuring belongings and life against risk of loss, astrological predictions)

seemed to challenge God's providence and the natural order, but in the end, chance occurrences, which included miraculous divine interventions, were seen as being under God's sovereign control. While a more probabilistic view of events was beginning to come to the fore, the science of probability wasn't founded until the late 17th century.

The same was true of statistics. Taking a national census of the population for fiscal purposes was thought by some to be akin to King David's disobedient numbering of military-aged men, but by the 17th century the government increasingly used demographic statistics for taxation and policy purposes. Collecting data became more widespread in the 18th century, providing a statistical way of understanding and dealing with a range of social and economic issues.

Time, chance, and numerical data provided arenas in which the new field of Arabic numerals and arithmetic could show its worth. Otis doesn't move into areas of science or relate English developments to those on the continent but notes that mathematics was becoming more indispensable during this period. *By the Numbers* is constrained as indicated by its subtitle, both in time and place, but as such it is an important resource for understanding how Hindu-Arabic numeration and arithmetic became entrenched in one culture in the early modern era. It will be of interest to anyone wishing to explore this aspect of culture and elementary mathematics more deeply.

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**PROTESTANT MODERNIST PAMPHLETS: Science and Religion in the Scopes Era** by Edward B. Davis. Johns Hopkins University Press, 2024. xvi + 316 pages. Hardcover/Ebook; \$64.95. ISBN: 978142144982/ISBN: 9781421449838.

How did liberal Christian intellectuals and scientists understand the relationship between religion and science during the fundamentalist-modernist conflicts of the 1920s? Given the amount of scholarly ink spilled in consideration of the 1925 Scopes Trial, one might reasonably expect that question to have been satisfyingly answered long ago. However, as Edward (Ted) Davis, professor emeritus of the history of science at Messiah University, argues, we "still know very little" (p. 5) about the actual ideas of Christians who embraced evolution. Davis has done much to address that shortcoming in this thorough, incisive study of ten pamphlets on

religion and science published by the American Institute of Sacred Literature (AISL) during the 1920s and 1930s.

Though virtually unknown now, the pamphlet series was hugely significant at the time. Authors included some of the nation's most prominent scientists as well as eminent ministers and theologians. With significant funding from John D. Rockefeller Jr. and "hundreds of individuals, churches, and other organizations," all meticulously catalogued by Davis, "perhaps as many as one million copies" (p. 57) were published and sent to "tens of thousands of prominent Americans and a comparable number of ordinary folk, especially college students and church members" (p. 64).

The book begins with three original chapters by Davis, each of which addresses an important element of the history of these publications. The first chapter explores their origins in the emerging debate between fundamentalists and modernists about the nature of science. As exemplified by their most prominent public figure, William Jennings Bryan, the fundamentalists held to a Baconian definition that distinguished between established fact and theory. By the 1920s, this "allowed them to reject evolution without seeing themselves as rejecting science" (p. 15). In response, Davis notes, a cohort of religious scientists increasingly "sensed danger in letting Bryan be the only religious voice" speaking on evolution. This perception dovetailed with a concern that the popular conception of evolution as "irreligious" (p. 20) constituted "the most serious obstacle to teaching it" (p. 22). In the popular framing, people had to choose to maintain their Christian commitments or accept modern science. Modernists wanted to make it possible to do both.

Chapter 2 considers the production and reception of the pamphlets themselves. As liberal Christians concluded that they needed their own response to Bryan, they devised the series as a vehicle for addressing not only evolution but other issues of religion and science as well. It is here that Davis offers some of his most significant contributions. He notes that the decision to solicit contributions primarily from eminent scientists at elite institutions "reveals wonderfully the degree to which the modernists accepted the hegemony of science and its definition of knowledge" (p. 57). Davis also does an admirable job of reconstructing how the pamphlets were received; his efforts reveal important limits of their effectiveness. He notes that the "gap between" the "elite scientists" who wrote them and "the wide audience that the AISL hoped to reach" was "not always easy to cross, on both scientific and theological avenues" (p. 73).