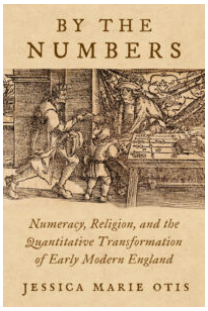
By the Numbers. Numeracy, Religion, and the Quantitative Transformation of Early Modern England, *Jessica Marie Otis*. Oxford University Press, 2024 (xi+280 p.), isbn: 978–0197608784





Jessica M. Otis

This book is a reworked version of Otis' PhD thesis submitted to the University of Virginia in 2013. It describes the spreading of numeracy and the quantitative transformation taking place in early modern England (approximately 15th to 17th century).

It is well known that most animals have some intuitive notion of (small) numbers, while being literate is something that has to be learned. Hence literature was considered to be academic, while arithmetic was something practical, a technical skill used every day or that was needed in certain professions like accounting, or construction, or in the military. There was also a religious aspect to counting and measuring since the Bible said that "all things were made by God in number, weight and measure". Hence measuring and counting the surrounding nature and people was something like doubting God's plans. Nevertheless, by the 17th and 18th century numbers had become an accepted way to understand God's creation. In six chapters Otis explains how early modern England became a period of transition to a numerate society, mainly through the introduction of the Hindu-Arabic number system.

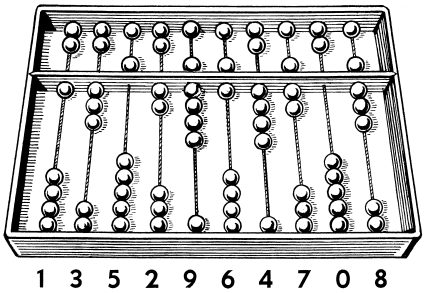
In a first chapter Otis explains the different primitive counting systems that existed since long. There existed complicated ways of finger counting, which was somewhat forgotten in England but it was reintroduced by the books of Robert Recorde. There were also tally-sticks: marks were cut on a stick which was split in half so that debtor and creditor could get half and they can agree as long as the marks on both halves fit. Sticks could also be transferred to another person so that it became a way of payment, a kind of money so to speak. Of course there needed to be a written note who the original creditor and debtor were. When a debt was paid, the sticks were broken or burned. This was easy to understand for everybody from the illiterate to the higher educated members of Parliament. There was however no guarantee that the debt would be paid unless the inscription on the stick identified it as an Exchequer stick. The latter sticks were issued as a form of government bonds. In the 18th century the sticks were gradually replaced by cheques. As an alternative there were also minted metal disks that were called counters, compters or jettons. These were often used as markers on a counting board. These counters were inspired by the Greek pebble abacus that was used for counting (hence the word calculus, which is Latin for pebble or counter and abacus which is derived from the Latin word abax meaning flat surface, referring to the surface on which the pebbles were lined out). Such chequered surfaces for calculation were used already in the 12th century and gave also the name to the English Royal Exchequer, and of course later to the cheque.



Tally sticks



counting board



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This brings us to the use of counting boards. That was a flat surface with horizontal lines corresponding to the Roman numbers I, X, C, M. The space in between correspond to V, L, D.

On each line some tokens were placed that symbolized the number of units. For example 9 had 4 tokens on the line I and one between I and X which represented 5. When adding 1, there would be 5 tokens on the line I which, like in present tallying, is crossed out and replaced by an extra token at the level V. Since between two lines there can be at most one token, the 2 tokens at level V are replaced by one token at level X, giving the result 10. In general when two numbers were laid out on the board separated by a vertical line, adding them consisted in moving the tokens from one side to the other, applying the rules about no more than 4 tokens on a line and no more than 1 in between them. The result can be easily transcribed in Roman notation. Subtracting numbers was obtained by applying these operations in reverse. Variants existed like for example the abacus was "mechanizing" the same idea, with a slightly different layout. It represents numbers in a positional bi-quinary system where the digits 0-9 are represented by tokens on the positional lines with the 5 represented by a token on the same line but separated from the units.

In the second chapter it is explained how the Hindu-Arabic number system was conquering the numerical manipulations and recordings. This happened reluctantly, because this notation was considered prone to modification. This was much less the case with the symbols used in the notation of Roman numbers and there were less possibilities to insert symbols before or after a written Roman number. That is why it became usual to replace the last I in a number by J to prevent extension to the right. For example 8 was written as VIIJ. On the other hand doing the computations was so much easier with the Arabic number system than with the Roman notation. So initially, even if computations were done with the Arabic numbers, the result was still denoted in Roman numbers for the record.

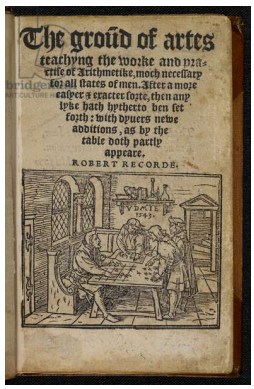
As already mentioned before, all this arithmetic was not considered to be an academic skill, practical manuals were produced that were distributed at large scale for self study, not in Latin, but in the local language. It started in Italy with the *Summa Arithmetica* (1494) by Luca Pacioli who collected the knowledge instructed in the abacci schools where merchants were instructed in the new Hindu-Arabic system. It was quickly spreading over Europe. In England, the booklet *The Ground of Artes* (1543), by Robert Recorde (c.1510 - 1558) became widely spread and widely used. Recorde also promotes the use of the plus and minus sign and inverted the symbol '=' for equality. There were other, similar books, but Recorde's was definitely the most popular. Otis proves this by the number or notes taken in the margins of the copies that are left.



Summa de Arithmetica
L. Pacioli, 2nd ed. (1515)


Allegory of Arithmetic
Gregor Reisch (1504)

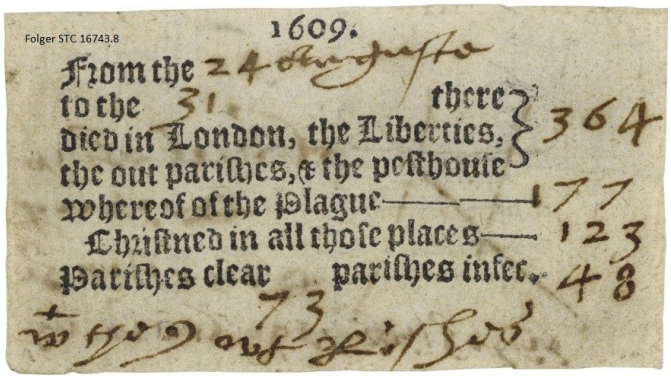

Robert Recorde



Title page (1543)

People also became more and more depending on numbers. There was the computation of the date of the religious holidays, especially the introduction of the Gregorian calendar in October 1582 became a challenge. But counting years according to the reign of the monarch was, for merchants traveling in Europe, a complicated task. Because James I of England and Ireland crowned in 1603 was also James VI of Scotland since 1567 was an extra complication that merchants had to deal with besides the conversion between the different locally valid monetary systems. It was already complicated with the non-metric English system.

There were also the different hours which were calibrated by the church bells ringing at fixed times, but they were not always synchronized between different parishes. The Plague entered England in 1348, but the epidemic returned in different waves in 16th and 17th century. Mortality bills were meticulously collected distinguishing between epidemic and other deaths. Hebdomadal lists were widely distributed and eagerly consulted to follow the evolution of the epidemic and take corresponding measures.



London Mortality bill (24-31 August 1609)

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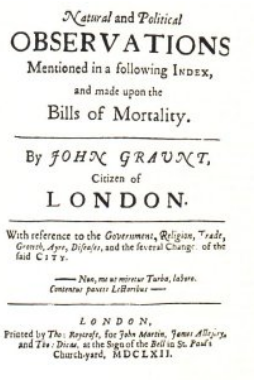
In the 16th century also the first notions of chance and statistics became a common issue. Not only gambling was an incentive. In fact the mortality bills were also tools to evaluate the risk of the Plague. Even in this early stage over- or under-reporting became a tool to force certain outcomes. There was also a religious aspect because things happened by God's Providence, and predicting things based on numbers was like putting yourself in God's place. Nevertheless in the 17th century life and fire insurance became more usual and quantified chance was rather generally adopted.


Natural and *Political*
OBSERVATIONS
Mentioned in a following INDEX,
and made upon the
Bills of Mortality.
By JOHN GRAUNT,
Citizen of
LONDON.
With reference to the *Governments*, *Religion*, *Trade*, *Growth*, *Ayre*, *Diseases*, and the several Change of the said CITY.
LONDON,
Printed by *Tho. Roycroft*, for *John Martin*, *James Allestry*, and *Tho. Dicas*, at the Sign of the *Bell* in St. *Paul's* Church-yard, MDCLXII.

edition MDCLXIJ



William Petty

In the last chapter Otis considers the emergence of counting people for fiscal or military reasons which became in the 18th century known as "political arithmetic". Again there was a religious resistance against counting people. There is the biblical account of king David who ordered a census and was later punished for three reasons: murder, adultery, and organizing the census. The Compton Census (1676), named after the bishop of London, collected parish data to find out the ratio of Catholics and Protestants and those who did conform the Church of England. The reason was not purely demographic but had political and certainly a fiscal undertone. So underreporting became a problem. Mid 17th century, counting the number of hearths rather than people for taxation was considered more just but being too invasive, it was turned in 1696 into a window tax. More and more data were collected. Already in 1662, John Graunt (1620-1674), the founder of demography, took the analysis to the next level with his book *Natural and Political Observations*, inspired by William Petty's (1623-1687) publications who promoted to use the collected data into an instrument for social engineering.

The book is written in a pleasing format for a general readership. As an history book, there are many citations, often in the original (written) English used in that period, but this is easily understood, even for present day readers who are not especially trained. Of course these citations and other justifications require a lot of notes and references. Although the book has 280 pages, the actual text is only some 180 pages since it is completed with 51 pages of notes and 37 pages of primary and secondary references and 9 pages with a useful detailed index. In order not to interrupt the reading too much all these notes are collected at the end of the book instead of adding extensive footnotes. The topics in the different chapters are thematic so that the story over the different chapters is not in its historical sequence. I can recommend this interesting history which highlights how the transition was initiated to a numerate population and a more data driven society, which we know all too well these days.

Adhemar Bultheel