Much Ado About Numbers:
Shakespeare's Mathematical Life and Times
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This lecture is about the links between Shakespeare and the mathematical times that he lived in. It discusses both the maths to be found *in* Shakespeare's work, and some of the mathematics and mathematicians that might have influenced Shakespeare. This is a summary of some of the main points in the lecture, but more detailed sources are listed in the References.

Shakespeare's Maths

Shakespeare's formal education was at grammar school in Stratford, where his instruction would almost certainly have been limited to Latin grammar and texts (all taught orally). If he had any maths instruction it would have been basic arithmetic. His was pretty much the first generation in England to learn Indo-Arabic numerals, which had only become established in the country in the late 1540s thanks to the popularity of Robert Recorde's book *The Ground of Arts*. Shakespeare's use of the word 'cipher' (the formal word for the digit that we now call 'zero') in his play *Henry V* and elsewhere suggests he was intrigued by this new symbol that represented nothing and yet had the power to make other numbers huge.

Mathematics itself was studied at university as the 'quadrivium', Arithmetic, Geometry, Astronomy and Music. Shakespeare did not go to university, so never formally studied these subjects, but he makes extensive mentions of astronomy and music throughout his works – knowledge that he presumably acquired through reading books and through the popular culture of his time.

Shakespeare mentions numbers throughout his plays, often in playful ways that suggest he was confident with them, and delighted in using them when he could. As a simple example, instead of 'fifty' he might say 'half a hundred' or 'twice five and twenty'.

The 'maths' that Shakespeare mentions in his plays is almost exclusively arithmetic and general numeracy. The latter would have been essential for functioning in everyday life, particular dealing with money, weights, and measures (for buying food etc), and telling the time.

Almost every Shakespeare play mentions money, often with details of coinage – such as 'seven groats and tuppence' in *The Merry Wives of Windsor*. Meanwhile his sonnets contain numerous accounting terms, such as profit, expense and audit – so many, in fact, that some wonder whether he was an 'accountant'. As a shareholder in the Globe Theatre and a property owner, he would certainly have needed to be well versed in managing money. His extensive use of accounting metaphors is in stark contrast with his minimal use of terminology from sailing or navigation, which suggests his life experiences were more involved with money than with international travel.

Shakespeare's plays also inform us about how time was measured in his era. In *Macbeth*, Fleance says he has not 'heard' the clock – because clocks were something you heard (in the form of a church bell) rather than saw. One of the few clocks faces to be seen in Shakespeare's time was the 24-hour clock that is still to be found at Hampton Court. That clock has only one hand (it was rare to record minutes in the

16th century), and on that single hour hand is a symbol of the sun, which orbits the earth at the centre once per day.

Mathematics in Shakespeare's World

Shakespeare lived through a period of great innovation in mathematics, across Europe. There were two particular drivers of this: The growth of international travel and trade, and to a lesser extent, the huge growth in dice and card-based gambling games that revolved around chance.

Long distance travel was dependent on accurate navigation, which depended largely on knowledge of the position of the sun and the stars. This created a demand for much greater accuracy in astronomical measurements. Among the astronomers leading the way in Shakespeare's time was Tycho Brahe, who was able to pursue astronomical research in Denmark without interference from the church. His huge mural quadrant – effectively a giant protractor – enabled him, and his many helpers, to measure the position of stars to within a fraction of a degree. His calculations also involved much harder arithmetic, in particular multiplication to several significant figures. To speed up the calculation process, he made use of 'prosthaphaeresis', a novel method of turning multiplication into addition. This technique was popular for about thirty years until it was made redundant by logarithms, which achieved the same result with less effort. The Shakespeare link? Two of Tycho Brahe's relatives were Rosencrantz and Guildenstern – both of them named on the popular portrait of him, copies of which were known to exist in London. Did Shakespeare get the idea for his characters in Hamlet from viewing that portrait?

Galileo Galilei – born the same year as Shakespeare – took astronomy a step further with his invention of a powerful telescope, which enabled him to see the four moons of Jupiter around 1610. It is believed that Shakespeare obliquely references this discovery in his play Cymbeline, first performed later that year, in which four ghosts' 'orbit' a sleeping Posthumus while Jupiter descends from above.

Incidentally (and not discussed in my lecture) Galileo was later to make a significant breakthrough in understanding the field of probability. One of the most popular games in England in Shakespeare's time was Hazard, a dice game to which Shakespeare refers at leasttwice. The game involved betting on what the total would be if you cast two – or sometimes three – dice. For the three dice version of the game, the popular view was that since there are six ways to roll 9 and six to roll 10, the two outcomes are equally likely. In a private letter to his patron around 1620, Galileo explained that one had to consider all the possible permutations, and when this was done, a score of 10 was more likely. Galileo rarely gets the credit for this insight because his findings were not published until decades after his death. No doubt his patron wanted to keep this valuable knowledge to himself.

Meanwhile, in West London, another contemporary mathematician of Shakespeare was making great mathematical advances while getting little credit for them. Thomas Harriot is believed to have been the first European to understand the mathematical laws of optics, and with it the science behind rainbows, and he set out what we today call Snell's Law (credited to Snell many years later). Harriot is not well known because he never published his work, so Shakespeare is unlikely to have met him. There is, however, a tantalizing suggestion that Harriot knew of Shakespeare's work, because in a letter, Harriot described the debate about the atomic nature of materials as being 'much ado about nothing'.

Why linking maths and Shakespeare matters

It's easy to dismiss the Shakespeare-mathematics connections as being nothing more than a whimsical diversion. I would argue the opposite. Across the world, millions of teenagers are required to study Shakespeare and mathematics without any suggestion that the two might have any connection. Education has a tendency to keep different subjects in distinct silos, but I would argue that those subjects can be deeply enriched by finding ways that they overlap and influence each other. Take any two school subjects and pair them up. 'The history of maths' and 'the mathematics of history' are both fascinating routes of enquiry. 'The maths of Shakespeare' has been discussed in this lecture. But how about 'The Shakespeare of maths'? Now that is an intriguing notion.

References and Further Reading

Eastaway, Rob. "Much Ado About Numbers" *Atlantic Books (UK), The Experiment (USA), 2024 (passim)*

Also:

Arianrhod, Robyn, "Thomas Harriot: A Life in Science", Oxford University Press, 2019.

Chappell, D.Havens, "Shakespeare's Astronomy", Astronomical Society of the Pacific 1945

Chrisomalis, Stephen "Numbering by the books: the transition from Roman to Arabic numerals" Academia, 2009, downloadable pdf

Howson, AG, "A History of Mathematics Education in England", CUP 1982

Recorde, Robert. "The Ground of Arts". A pdf can be found on Internet Archive