ALGEBRA AND THE ART OF WAR: MARLOWE'S MILITARY MATHEMATICS IN *TAMBURLAINE 1* AND *2*

The tenor of Marlowe's mighty line perhaps owed something to John Dee. In his impassioned preface to Henry Billingsley's translation of Euclid's *Elements* (1570), Dee expressed his notion that mathematical endeavours evidenced the tremendous potential of the human intellect:

> Consider: the infinite desire of knowledge, and incredible power of mans Search and Capacitye: how, they, ioyntly haue waded farder (by mixtyng of speculation and practise) and haue found out, and atteyned to the very chief perfection (almost) of *Numbers* Practicall vse.[1]

Despite the specificity of its subject, and the awkwardness of its pedantic, parenthetical qualifications, Dee's sentence displays the kind of humanistic idealism and rhetorical fervour for which Marlowe's protagonists are primarily known. *Dr Faustus* (c.1592) is usually considered the paradigm for early modern depictions of intellectual overreaching, and Frances Yates and Andrew Duxfield have found persuasive resonances between Marlowe's version of John Faust and Elizabethan London's most notorious devourer of learning, John Dee.[2] And yet, there is a subtler sympathy to be found between Dee and Marlowe's earlier creation, Tamburlaine. Here is the potent warlord in the second act of Marlowe's first great play (c.1588), at the very moment his ambitions begin to crystallise:

> Our souls, whose faculties can comprehend
> The wondrous architecture of the world
> And measure every wand'ring planet's course,
> Still climbing after knowledge infinite
> And always moving as the restless spheres,
> Wills us to wear ourselves and never rest…
> (*T1*, 2.6.61-66)[3]

Just as Dee paints a picture of a constantly searching human intellect, almost omnipotent in its 'Capacitye', so too does Tamburlaine articulate human 'souls' as insuppressible in their potential to 'comprehend', and unable to 'rest' until their aspirations are fulfilled. Such rigorous academic labour is articulated by both figures through distinctly physical metaphors: for Dee, 'the infinite desire of knowledge' has to be 'waded' through, just as, for Tamburlaine, the acquisition of 'knowledge infinite' requires a kind of 'climbing'. Tamburlaine's espousal here, then, of the quadrivial arts of geometry and astronomy tenders some surprising intersections with Dee's account of *'Numbers* Practicall vse'.

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[1] John Dee, in Henry Billingsley's *Elements of Geometry* (London, 1570), *2^{v}.
[2] See Frances Yates, *The Occult Philosophy in the Elizabethan Age* (London, 1979), p.120, and Andrew Duxfield, *Christopher Marlowe and the Failure to Unify* (London and New York, 2016), p.78.
[3] All quotations from *Tamburlaine* are cited from *Christopher Marlowe: The Complete Plays*, ed. Frank Romany and Robert Lindsey (London, 2003). Line numbers are inserted parenthetically within the text. *T1* and *T2* are used as abbreviations for parts one and two of *Tamburlaine* respectively.

It is by no means impossible that Marlowe had read Dee's preface: Billingsley's *Elements* was a fashionable book for gentlemen in Elizabethan England to own, and there were almost certainly copies of it in Cambridge in the 1580s, when Marlowe was a student there. But the correspondence that emanates from placing these two passages side by side is admittedly a strange one, for as Dee's and Tamburlaine's sentences press onwards, the two figures seem to apply their similarly 'aspiring minds' (*T1*, 2.6.60) to startlingly different subject matters: Tamburlaine turns immediately to his familiar theme of conquest, and to his newfound intention to obtain 'The sweet fruition of an earthly crown' (*T1*, 2.6,69), whilst Dee's topic reveals itself to be 'that great Arithmeticall Arte of *Æquation*: commonly called the *Rule of Coss.* or *Algebra*', a discipline he considered 'so profound' that there was 'nothyng…more mete for the diuine force of the Soule…to be tryed in.'[4] What possible congruity could be found between Tamburlaine's military exploits and the complex mathematical field of algebra?

The purpose of this article is to show that there are, in fact, important points of intersection between these two phenomena, and that an algebraic mathematics is carefully infused into the language, logic and dramaturgy of *Tamburlaine*. It may have struck Marlowe that the Islamic world he conjured in *Tamburlaine*, in which 'Mahomet' is praised and the 'Alcoran' is evoked, was the same world which exported almost every aspect of the modern mathematics of his age to the West[5], but *Tamburlaine* is much more than an exercise in historical realism, and the mathematics submerged into the play, I want to argue, was transmitted to Marlowe through an array of English sources. Whilst there is a noticeable turn in recent scholarship toward considerations of the indebtedness of early modern literary texts to mathematical topics, Shankar Raman is the only critic to have considered the impact of algebra on the period's drama.[6] Raman has argued in an essay on *The Merchant of Venice* that 'the changing conception of algebraic things in the early modern period was correlated with the shifting construction of legal personhood'[7], but by far the most important practical utility of algebra in the age of Marlowe and Shakespeare was not in the legal, but military sphere. Tamburlaine's driving conquests, I will suggest, afforded Marlowe the opportunity to utilise the algebraic notions he could have gleaned from personal acquaintance with the pioneering mathematician Thomas Harriot and his circle, as well as from an increasing printed literature available in London which combined mathematical and military subjects. I will turn my attention first to the plays' most overt usage of mathematics, in the numbers utilised there to enumerate the battlefield, before considering the more subtle algebraic functions these numbers are imbued with. It will be my contention that the algebra lying beneath *Tamburlaine*'s formal

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[4] Dee (London, 1570), *2^{v}.

[5] On the Arabian and Islamic associations of mathematics, see Patricia Parker, 'Cassio, Cash, and the "Infidel 0": Arithmetic, Double-entry Bookkeeping, and *Othello's* Unfaithful Accounts', in *A Companion to the Global Renaissance: English Literature and Culture in the Era of Expansion* (Oxford, 2009), pp.223-241.

[6] Three influential examples are Henry S. Turner, *The English Renaissance Stage: Geometry, Poetics, and the Practical Spatial Arts 1680-1630* (Oxford, 2006), Mary Thomas Crane, *Losing Touch With Nature: Literature and the New Science in 16th-Century England* (Maryland, 2014), and

[7] Shankar Raman, 'Specifying Things Unknown: The Algebra of the *Merchant of Venice*', in *Making Publics in Early Modern Europe*, ed. Bronwen Wilson and Paul Yachnin (New York and Abingdon, 2010), p.213.

construction acts as a crucial tool with which Marlowe effected an aesthetic based upon exponential increase, and with which he created a truly unique spectacle of war within the limited mimetic capabilities of the theatrical space.

1. ENUMERATING BATTLE

Critics have labelled Marlowe's *Tamburlaine* plays his most 'scientific', and have commented on the advanced nature of their geographical, meteorological and astronomical, as well as military, language.[8] Very few, however, have mentioned the plays' considerable interest in mathematics, the intellectual discipline which, in late sixteenth-century England, increasingly underpinned all of those other arts. The most noticeable instances of mathematics in *Tamburlaine* are utilised for far simpler purposes than mapping the earth or measuring the heavens. At the very opening of Marlowe's play, Meander enumerates the Persian opposition to Tamburlaine's 'lawless train' (*T1*, 1.1.39): 'Your grace hath taken order by Theridimas, / Charged with a thousand horse, to apprehend / And bring him captive to your highness' throne' (*T1*, 1.1.46-8). That particular quantity, a perfectly round one 'thousand', is then permitted to reverberate throughout the rest of the first scene—'send my thousand horse incontinent / To apprehend that paltry Scythian' (*T1*, 1.1.52-3); 'Thou shalt be leader of this thousand horse' (*T1*, 1.1.62)—and is taken up again in the second scene by Tamburlaine himself: 'A thousand horsemen!', he cries in disbelief, 'We, five hundred foot! / An odds too great for us to stand against' (1.2.121-22). Numbers such as these, so crammed full of zeros, must have intuitively conjured the spectre of the East for Marlowe's audiences, for as Patricia Parker has argued, arithmetic was 'bound up with the "infidel symbols" identified with Arabs, Saracens, and Moors', and particularly with the 'infidel 0', or 'cipher', from Arabic *sifr.* But whereas Parker suggests, in relation to *Othello*, that the arabic numerals presented a source of contemporary anxiety for Europeans, military leaders in particular seemed to have embraced their capability to depersonalise large groups of men.

Shakespeare, for instance, represented just such an process in the lengthy portion of *Henry V*'s penultimate act in which a reckoning of the dead stuns its auditors. Having been given a 'just notice of the numbers dead' (*HV*, 4.7.116), King Henry orates the contents of a document detailing 'the number of the slaughtered French' (*HV*, 4.8.75). 'This note doth tell me of ten thousand French / That in the field lie slain', he declares. 'Of princes', he specifies, 'One hundred twenty-six…Of knights, esquires and gallant gentlemen, / Eight thousand and four hundred' (*HV*, 4.8.82-6). Shakespeare projected this morbid mathematical activity onto the fifteenth-century subjects of his historical drama, but troop-tallying was in actual fact a distinctive and integral part of Elizabethan military culture, especially after the creation in 1573 of the 'trained bands', a new national militia

[8] See, for example, John Gillies, 'Tamburlaine and Renaissance Geography', in *Early Modern English Drama: A Critical Companion*, ed. Garrett Sullivan, Patrick Cheney, and Andrew Hadfield (New York, 2006), and Mary Thomas Crane, 'Marlowe and the New Science', in *Christopher Marlowe in Context*, ed. Emily C. Bartels and Emma Smith (Cambridge, 2013).

whose ever-increasing size and stature required rigorous standards of data collection and recordation.[9] Some one hundred and fifty years before the proper birth of statistics, and almost a century before Sir William Petty's coinage 'political arithmetic' appeared in print, Elizabethan militarists meticulously recorded troop numbers in official documents and muster books. A collection of miscellaneous Elizabethan military papers in Cambridge University library evidences such a practise, for amongst its leaves is 'An Abstracte of the Certificates returned from the Lieutennants of the Able men furnished and trayned in the seueral Countyes vppon letters from the Lords in Aprill Ano. Dom. 1588'.[10] Each English county is treated in turn, and the numbers of 'Shott', 'Bowes', 'Bills', and other kinds of troop are listed, with running totals provided. Sussex, for example, contained a sum of '2004 trayned men'. The manuscript also contains sections on the 'Nombers of men appoynted to be drawne together to make an Armie to in Counter the Enimie', and the number of troops required 'to be at London' between the sixth and twelfth of August, dated respectively June and July 1588.[11] A total of twenty-seven thousand 'Footemen' and two thousand four hundred and eighteen 'Horsemen' from ten different counties are recorded in the former section, of which twenty-two thousand four hundred 'Footemen' and one thousand nine hundred and twelve 'Horsemen' were summoned to the capital.

Given that these figures pertained to the very year that *Tamburlaine* was being performed on London's public stages, they can act as a fascinating critical reference point for comprehending the numbers in Marlowe's play. Compared to those quantities of men levied in August 1588, *Tamburlaine*'s 'thousand horsemen' and 'five hundred foot' seem not only entirely plausible but in fact rather humble. The play's numbers, however, swiftly escalate: Theridimas' 'thousand horse' is soon outdone by the 'Ten thousand horse' (*T1*, 1.1.185) promised to Cosroe for the political overthrow of his brother; by the time Cosroe prepares for war with Tamburlaine, his army has grown to 'forty thousand strong' (*T1*, 2.1.61); Bajazeth, a far more formidable opponent than Cosroe, battles Tamburlaine with 'ten thousand janizaries' (*T1*, 3.3.15) plus 'Two hundred thousand footmen' (*T1*, 3.3.18); and Tamburlaine, in the war which never comes to fruition in the final act of the play's first part, prepares to fight a united Egyptian and Arabian force of 'A hundred and fifty thousand horse' plus 'Two hundred thousand foot' (*T1*, 4.3.53-4) with his own 'Three hundred thousand men in armour clad, / Upon their prancing steeds' (*T1*, 4.1.21-2) plus 'Five hundred thousand footmen threatening shot, / Shaking their swords, their spears and iron bills' (*T1*, 4.1.23-4). These numbers are, of course, drastically larger than those that enumerate the national army of Marlowe's England, so much so that they must have been difficult for their audiences to comprehend, especially when, as Andrew Gurr has made clear, *Tamburlaine* was performed by an acting company made up of approximately fifteen players only.[12]

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[9] See Lindsay Boynton, *The Elizabethan Militia, 1558-1638* (London, 1967), pp.90-125.
[10] Cambridge University Library MS Add.54, fol.1^{v}-10^{r}.
[11] Cambridge University Library MS Add.54, fol.10^{v}-14^{v}.
[12] Andrew Gurr, *Playgoing in Shakespeare's London* (Cambridge, 1996), p.122.

What aesthetic function, then, could Marlowe have desired such enormous numbers to fulfil? Emily Bartels linked *Tamburlaine*'s numbers to what she labelled 'the homogenising blur of imperialism', arguing that 'instead of measuring power…their commonality, the variability of how they are perceived, and their arbitrary relation to triumphs and defeats' makes them nothing more than 'a *rhetoric* of power, full of sound and fury, signifying nothing.'[13] But the actual magnitude of *Tamburlaine*'s numbers owes more to historicity than rhetoricity, for many of them fall either exactly or very nearly in line with those Marlowe could have found in contemporary chronicle sources. Both Thomas Fortescue's *The Foreste, or Collection of Histories* (1571) and George Whetstone's *English Myrror* (1586) specified the Persian King's 'thousande horses'.[14] Fortescue testified to Tamburlaine's initial 'five hundred', and Whetstone to the 'two hundred thousand' Turks that 'were slain' in the battle between Tamburlaine and Bajazeth. Perondinus' *Magni Tamerlanis* (1553) even dedicated an entire short chapter to 'the numbers of the dead on either side', pertaining to that same battle between the Tartars and Turks, and provided very similar numbers to Whetstone: 'It is said that two hundred thousand Tartars were killed in that battle; of the Turks, more than one hundred and forty thousand'.[15] Even as Marlowe's numbers grow, they cannot be accused of any dishonesty in their arithmetical grandiosity, for they never become hyperbolical in comparison to those in the historical texts. John Foxe's *Ecclesiastical History* (1570), for example, performing its own act of historical source-work, made the astonishing claim that 'Seb Munsterus writyng of this Tamerlanes, recordeth that…with 600 thousand footemen, and 400000 horsemen, he inuaded all Asia Minor'.[16]

If the actual magnitude of the numbers in *Tamburlaine* sheds little light on Marlowe's poetic craft, a careful consideration of Marlowe's particular deployment of such magnitudes, and the way in which numbers are so carefully plotted throughout a play whose structure is rigorously ordered, may help to do so. Patricia Cahill, seeking to reclaim Marlowe's numerical rhetoric from Bartels's somewhat nihilistic reading, provided the more satisfying suggestion that 'the play, in enumerating the troops brought to the field by Tamburlaine and his foes, foregrounds its investment in a modern, "scientific" discourse.'[17] Certainly, the heady summation executed by Orcanes, Jerusalem, Trebizond, and Soria, as they attempt to express to Emperor Callapine the extent of their massive allied army, resembles the punctiliousness of the muster-book's formalised counting. Each leader provides a quantity—'From Palestina and Jerusalem…three score thousand fighting men are come' (*T2*, 3.5.32-3); 'from Arabia desert…forty thousand' (*T2*, 3.5.35-8); 'From Trebizond fifty

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[13] Emily Bartels, *Spectacles of Strangeness: Imperialism, Alienation and Marlowe* (Pennsylvania, 1993), p.73.
[14] See Pedro Mexía, *The Foreste or Collection of Histories*, trans. Thomas Fortescue (London, 1571), 83^{v} and George Whetstone, *The English Myrror* (London, 1586), p.79.
[15] Petrus Perondinus, *Magni Tamerlanis Scytharum Imperatoris Vita* (Florence, 1553), translated in *Christopher Marlowe: The Plays and their Sources*, ed. Vivien Thomas and William Tydeman (London and New York, 1994), p.109.
[16] John Foxe, *The First Volume of the Ecclesiasticall History* (London, 1570), p.876.
[17] Patricia Cahill, *Unto the Breach: Martial Formations, Historical Trauma, and the Early Modern Stage* (Oxford, 2008), p.58-9.

thousand more' (*T2*, 3.5.40-2); 'from Halla…Ten thousand horse and thirty thousand foot' (*T2*, 3.5.46-8)—until a total is reached: 'the army royal is esteemed / Six hundred thousand valiant men' (*T2*, 3.5.50-1). The repetitive nature of this scene, underscored by the refrain which suffixes each partakers declaration ('Since we last numbered to your majesty' [*T2,* 3.5.39, 45, 49]) links the iterative nature of arithmetic with the play's cyclical narrative structure. Part one of *Tamburlaine*, for example, follows an unusually compartmentalised five-act format, each act (except the concluding fifth) depicting Tamburlaine and a different primary foe. All apart from the transitionary fourth act culminate in either a military allegiance or battle. Linda McJanet has argued that the first printed quarto of *Tamburlaine*'s first part (1590) used massed entries because 'Marlowe was imitating…the classical convention'[18], but perhaps this method of organising stage directions also helped to emphasise textually the cogency of the play's patterning.

Cahill associates the repetitious nature of Marlowe's dramatic world with Bobadil's comic vision of mechanised murder in Jonson's *Every Man In His Humour* (1598), a play, which, as Cahill points out, 'is, at every level, obsessed with disciplinary notions of the normative, the typical, and the regulated' and whose 'use of generic character types' and 'rigorous adherence to the classical unities of place and time' is linked to its 'evocations of arithmetic'.[19] Here is Bobadil:

> say the enemy were forty thousand strong, we twenty would come into the field, the tenth of March, or thereabouts; and we would challenge twenty of the enemy; they could not, in their honour, refuse us, well, we would kill them: challenge twenty more, kill them; twenty more, kill them; twenty more, kill them too; and thus, would we kill, every man, his twenty a day, that's twenty score, that's two hundred; two hundred a day, five days, a thousand; forty thousand; forty times five, five times forty, two hundred days kills them all up, by computation.
> (*Every Man In*, 4.7.69-78)[20]

Bobadil's sums combine accuracy and inaccuracy to a curious degree, but the special kind of mathematical iteration he utilises here, reinforced rhetorically by his steady bombardment of paratactic clauses, attempts to delineate an equational scheme of slaughter. Cahill links it simultaneously to *Tamburlaine*'s aesthetic of quantified violence, and to the military manuals which flooded onto the Elizabethan book market in the final decades of the sixteenth century. Books such as Thomas Digges' *An Arithmeticall Militare Treatise, Named Stratioticos* (1579), Roger Williams' *A Briefe Discourse of Warre* (1590), and Robert Barrett's *The Theorike and Practike of Modern Warres* (1598), attempted to regulate and make programmatic tactical warfare. Often underpinned by mathematics, they 'generated visions of the social realm as an abstraction'.[21] Cahill argues that, collectively, Bobadil, *Tamburlaine*, and the military manuals conjure a Renaissance world far removed from the 'individuated subjectivity' which Stephen Greenblatt's study of 'self-fashioning'

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[18] Linda McJanet, *The Voice of Elizabethan Stage Directions: The Evolution of a Theatrical Code* (New Jersey and London, 1999), p.164.
[19] Cahill (Oxford, 2008), p.30.
[20] *The Complete Plays of Ben Jonson*, ed. G. A. Wilkes, 4 vols. (Oxford, 1981), vol. i. Line numbers are inserted parenthetically within the text.
[21] Cahill (Oxford, 2008), p.36.

so influentially asserted.[22] Instead, Cahill claims, they evidence the production of 'an abstract social body' so that in *Tamburlaine* spectators find human identities that revolve not around '(anti)heroic individualism' but which are 'purely functional, no more than disembodied markers of collective military might.'[23]

There is much validity to this argument, but there is a distinct and important progressional differential between Bobadil's notion of routinised slaughter and Tamburlaine's relentless method of conquest that is left unnoticed in Cahill's work, and that points towards a particularly Marlovian aesthetic effect that has little to do with the evaluation of social identities. For whereas Bobadil's quantities are characterised by a repetition which remains perfectly static, Tamburlaine's quantities are characterised by a roughly exponential escalation: Bobadil foresees his own army of twenty men killing exactly two hundred men a day, every day, with ruthless precision; Tamburlaine's army, contrastingly, quickly and continually multiplies in size, and so, naturally, does the number of enemies it vanquishes. Spectators and readers of *Tamburlaine* must have perceived this growth in Tamburlaine's army from five hundred to eight-hundred thousand as the quantifiable evidence of his swift (and typically Marlovian) trajectory from a humble 'Scythian shepherd' (*T1*, 1.2.155) to the omnipotent 'scourge of God' (*T2*, 5.3.248). In numerical terms, such a rise is carefully plotted by Marlowe, so that if we return to the progression of numbers in the play's first part, we notice that magnitudinous increases occur roughly once in each act. Despite the fixity of the Admiral's Men's small numbers, then, Marlowe attempted nevertheless to take his audiences on a journey of exponential expansion. No such trick is effected in the narratives expounded in the chronicle history texts, and Marlowe's aesthetic intentions and mimetic processes in this respect owe more, I would now like to argue, to a mathematical aspect of military affairs that literary critics have as yet left entirely neglected: algebra. First, some background and the primary concepts must be elucidated.

2. COSSIC NUMBERS AND SPECIOUS LOGISTIC

As Jacqueline Stedall has made clear, algebra, 'as a discipline, a tool and a language evolved gradually over many centuries and in different mathematical cultures, but emerged in forms we recognise and use today in western Europe in the sixteenth and seventeenth centuries.'[24] Owing to innovative figures such as Gerolamo Cardano (1501-1576) and Francois Viète (1540-1603), Italy and France were responsible for many of the subject's new developments. In Marlowe's England, by contrast, algebra remained a relatively quiescent area of mathematical study, and its few practitioners lagged well behind their continental counterparts, especially in their attempts to disseminate the subject's concepts to a wider audience. Astonishingly, seventy-four years were permitted to elapse between the publications of the first and second English books devoted entirely

[22] See Cahill (Oxford, 2008), p.42, and Stephen Greenblatt, *Renaissance Self-Fashioning* (Chicago and London, 1980).
[23] Cahill (Oxford, 2008), p.41.
[24] Jacqueline A. Stedall, *A Discourse Concerning Algebra: English Algebra to 1685* (Oxford, 2003), p.1.

to algebra. The first of these was Recorde's *Whetstone of Witte* (1557). Intended for readers who had mastered the contents of *The Ground of Artes* (1543), *Whetstone* continued its predecessor's dialogue format to introduce lay readers to advanced number theory, 'The Arte of Cossike nombers',[25] and their succeeding application in 'The rule of equation, commonly called Algebers Rule'.[26] The second was Thomas Harriot's *Artis Analyticae Praxis* (1631), a text much denser and more complex than Recorde's, dealing in Latin with both the theory of equations and the solution of polynomial equations with numerical coefficients.

Recorde's 'Cossike nombers' had their intellectual roots in Luca Pacioli's *Summa de Arithmetica, Geometrica, Proportioni et Proportionalita* (1494), and took their name from Italian 'cosa', or 'thing'. They comprised of combinations of abstract numbers (numbers without a denomination) and an attached sign denoting both a variable and that variable's power. A '℥' attached to a 2, for example, would denote our modern 2□; a '℥' attached to a four, 4□^{2}; a '℥' attached a six, 6□^{3}, and so on. A '℥' attached to any number denoted 'nomber absolute: as if it had no signe'.[27] These individual units could then be used to build and solve equations, with the end goal of finding the unknown quantity. As one of the poems prefixing Recorde's main text made clear, this process (the 'rule of Cose') was psychologised as an accumulative one:

> Soche knowledge doeth from one roote spryng,
> That one thyng maie with right good skille,
> Compare with al thyng: And you will
> The practise learne, you shall sone see,
> What thyges by one thyng knowen maie bee.[28]

Algebra is associated here with the epistemological model of deductive logic, in which knowledge quickly escalates from a single known entity. But the 'practise' had its limitations, for, in an age before the existence of calculation machines which could handle multiple decimals, only certain numbers could be easily computed. When Recorde provides his readers with example questions, then, he is careful to use combinations of numbers which are factors and multiples of each other, and which divide neatly down into whole numbers. This is partially for pedagogical purposes, but also because certain combinations of numbers would have been barely possible for the unaided human brain to calculate. Steven Connor has remarked on how 'picking out certain numbers for special attention is the traditional way of redeeming numbers for human life, because it skews and bunches a system of absolute equivalence into one of differential values, creating a lumpy, striated landscape out of one that is otherwise smoothly uniform.'[29] But in the particular world inhabited by the 'rule of Cose', numbers are not picked out for special attention for any numerological

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[25] Recorde, (London, 1557), S2^r.
[26] Recorde, (London, 1557), Ee4^v.
[27] Recorde, (London, 1557), S2^r.
[28] Recorde, (London, 1557), b4^r.
[29] Steven Connor, '"What's one and one and one and one and one and one and one and one and one and one and one?" Literature, Number and Death', a talk given at the 20th-21st Literature Seminar, University of Oxford, 4th December, 2013. Accessed online at http://stevenconnor.com/oneandone.html.

significance they might contain; rather, they are picked out purely for their relational qualities towards other numbers.

In the number theory with which *Whetstone* begins, Recorde explains how numbers are either ‘absolute’ (such as 10, 25, 100), ‘relative’ (such as 6 = half of 12, or 15 = 5 tripled), or ‘figuralle’ (as in $16 = 4^2$, or $27 = 3^3$). Renaissance practitioners of algebra most likely felt far more compelled than modern ones to learn the relative and figural relationships between numbers by heart, and to attach special precedent to those numbers which permitted the most interactions. This was a practise perhaps evidenced by the mathematical board-game Arithmomachia. Taking its name from the Greek word meaning ‘battle of numbers’, Arithmomachia was similar to chess, but relied on players’ abilities to capture their opponent’s pieces using purely arithmetical calculations. Played on a rectangular checkered board, one player used white pieces with even numbers inscribed onto them, whilst another player used black pieces with odd numbers inscribed onto them. The precise numbers used were extremely carefully thought out. White’s even numbers start with 2, 4, 6 and 8, black’s odds with 3, 5, 7 and 9. If we refer to each of these base numbers as □, the rest of the board’s numbers are derived by putting each base number through the following operations: $□^2$, □(□+1), $(□+1)^2$, (□+1)(2□+1), $(2□+1)^2$. The resulting, very precise set of numbers permitted a player’s pieces to be captured through a variety of mathematical transactions. For example, if the number of squares needed to move towards an opponent’s piece multiplied by the value on the piece moving equalled the value on the piece moved towards, the latter piece could be taken and removed from the board. Sixteenth-century players of Rithmomachy could have learned the rules from Ralph Lever’s 1563 instructional manual, which advocated the game’s utility for ‘the honest recreation of students, and other sober persons’,[30] and which specified two versions of the game. The second version was identical to that just outlined, but the pieces were to ‘be marked besyde, with cossicall signes…betokening rootes, quadrats, cubes, fouresquared quadrats, sursolides, and quadrates of cubes.’[31]

One concept to emerge from algebra, then, was a numerical identity based on pure relationality. Another was exponentiality. If cossic signs were deemed the defining components of algebraic syntax in sixteenth-century England, a conceptual link was made also between algebra and the signification of mathematical escalation through what would eventually come to be termed exponents, or indices. The algebraic notation of Harriot’s *Praxis* made a considerable departure from the cossic signs explicated by Recorde, but it was in part designed to make the visual logic of exponents significantly clearer than the cossic system was able to. The first English text to adopt Viète’s *logistice speciosa*, or ‘Specious Logistic’, the *Praxis* utilised a form of representation much more familiar to modern eyes, in which letters of the alphabet stood for both known and unknown

[30] Ralph Lever, *The Most Noble Auncient and Learned Playe, Called the Philisophers Game* (London, 1563), a1^r.
[31] Lever (London, 1563), D1^v.

quantities.[32] Whereas Viète's notation had included linguistic elements, Harriot's was completely symbolic, allowing for a pure and closed representational system that was entirely homogenous. Powers were signified in Harriot's notation by repeating a given letter the number of times it was to be multiplied: our a^2, for example, was denoted *aa* by Harriot; our b^4, *bbbb*, our c^8, *cccccccc*. Exponential increase thus manifested itself textually in a fittingly visual manner: expansion could be seen concisely but immediately on the page.

The pure mathematical realm created by the pedagogical format of the *Praxis* stubbornly emphasised the mechanics and logic of algebraic procedures without ever stating those procedures' potential practical utilities. This was, of course, partly inherent to the subject matter, but also conceivably associated to the fact that the text was published posthumously by two of Harriot's former colleagues, Nathaniel Torporley and Walter Warner. Acting upon Harriot's dying request, and working with a vast quantity of his often oblique manuscript papers, the two men were intensively selective as to what ended up in the *Praxis.*[33] They attempted to create, as much as possible, a treatise that taught cleanly and rigorously the grammar and vocabulary of a new mathematical language. Utility, in this context, was extraneous. But one fascinating page of Harriot's manuscript papers does act as a pertinent example of how Harriot applied his algebraic innovations to practical use.

Fol.51^r of British Library MS 6788 appears amongst a collection of leaves dedicated to military tactics, and contains: on the top half of the page, a diagrammatic representation of a battle formation; on the bottom half of the page, a sequence of lines of algebraic notation. The battle formation is not unlike ones on succeeding pages of the manuscript headed 'Of precedence of soldiers', in which an army of one hundred men is represented diagrammatically in a ten by ten square. In all of these diagrams, each man is given a unique number between one and one hundred, and their exact ordering into certain 'files' and 'rankes' is governed by careful kinds of symmetrical patterning. Groups of four emerge in correspondence with the square's geometry, so that, in the diagram on fol.51^r, men numbered 1, 2, 3 and 4 make up the square's corners, whilst men numbered 13, 14, 15 and 16 make up the square's centre. It seems likely that these two groups would have carried out different kinds of roles with different types of weaponry. Immediately underneath the diagram Harriot writes five separate algebraic expressions, each one demarcated by a roman numeral: I. *m-2d*, II. *m-d*, III. *m*, IIII. *m+d*, IIIII. *m+2d*. The collection of lines that follow show his workings out in multiplying each of these five expressions together: after simplifying *mm-md-2md+2dd* to *mm-3md+2dd* (which is *m-2d* multiplied by *m-d*), Harriot continues to multiply *mm-3md+2dd* by *m* (resulting in *mmm-3mmd+2mdd*), then by *m+d* (resulting in *mmmm-2mmmd-mmdd+2mddd*) and, lastly, by *m+2d*, giving the final result of *mmmmm-5mmmdd+4mdddd*.

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[32] See Francois Viète, *In Artem Analyticen Isagoge,* trans. T, Richard Witmer (Ohio, 1983), p.13 and Thomas Harriot, *Artis Analyticae Praxis*, trans. Muriel Seltman and Robert Goulding (New York, 2007), p.23.
[33] See Jacqueline A. Stedall, *The Greate Invention of Algebra: Thomas Harriot's Treatise on Equations* (Oxford, 2003).

Admittedly, the exact function of this algebraic process is, at least to modern eyes, elusive. There is no obvious link between it and the numerical patterning found within the battle square, nor is there any hint of what the initial five algebraic expressions might denote. That the algebra is directly relevant to the organisation of the battlefield, however, seems indisputable, for reasons beyond proximity on the page. The first reason is one of notation: the letter *m* is not used anywhere by Harriot in the pure algebra of the *Praxis*, making its presence here strongly suggestive of the idea that it is signifying a certain unit ('men', perhaps?), and that it is thus being applied to some specific military purpose. The second reason is that the exponential nature of the algebraic procedure undertaken ties in with other mathematical jottings both on fol.51^{r} and directly overleaf. Placed inconspicuously between the battle diagram and the algebra are two lines of numbers: '1 2 3 4 5 6' is written immediately above '1 2 6 24 120 720'. This same progression is then repeated twice on fol.51^{v}, where it is underscored, in the first instance, by short lists of powers, and, in the second instance, by a triangular arrangement of numbers in which each value is the difference between the two values written directly above it. All of these numbers evidence Harriot's experimentation with factorials (1 x 2 x 3 x 4 x 5 x 6 etc) and other progressions founded upon mounting escalation. Within this context, Harriot's battle algebra can be understood as a method for representing constant increase in new terms, for the process of linear multiplication that takes place there is much the same as tracing the products of the factorial sequence. Although Harriot's notation would not prove as concise as Descartes' (whose technique of using superscripted numbers to denote powers is still commonplace today), it enabled a powerful form of abstract condensation in which the exponential mathematics of warfare could be delineated by a few letters capable of encapsulating unthinkably huge sums.

3. THE ALGEBRAIC STAGE

Having traversed the important algebraic principles emanating from the work of Recorde and Harriot, we can now consider the relevancy of those principles to *Tamburlaine*. Marlowe was curiously well placed to receive notions from algebra, in large part due to his social proximity to Harriot himself. Kyd's letter to Sir John Puckering testified to the two men's friendship, noting both Harriot and Warner amongst those with whom Marlowe had 'conversed withal'.[34] Although John J. Roche has argued that 'the evidence is slight'[35] as regards the link between Harriot and Marlowe, the veracity of Kyd's claims are galvanised by the pair's shared acquaintances in both Sir Walter Raleigh and the Earl of Northumberland. Harriot had been employed by Raleigh since the early 1580s, and accompanied him as chief scientific advisor on his 1585-6 voyage to America. Perhaps he was therefore meant to be implicated in the spy Richard Cholmeley's assertion that Marlowe 'hath read the Atheist lecture to Sr Walter Raliegh & others.'[36] It was Raleigh who then introduced

[34] British Library, Harley MS 6849, fol.218.
[35] John J. Roche, 'Harriot, Oxford and 20th Century Historiography', in *Thomas Harriot*, ed. Robert Fox (Aldershot, 2000), p.236.
[36] British Library, Harley MS 6848, fol.191.

Harriot to Northumberland in 1590/1. Northumberland's passionate devotion to scientific affairs earned him the sobriquet 'the Wizard Earl', and undoubtedly motivated him to offer Harriot eventual lifelong patronage. Marlowe too, it seems, had become close to Northumberland by the early 1590s, if not before. In a letter dated 26 January 1591/2, Sir Robert Sidney sent an account of Marlowe's arrest and trial at Flushing to Lord Burghley, in which he reported Marlowe's claims to aristocratic connections: 'the scholer sais himself to be very wel known both to the Earle of Northumberland and my Lord Strang'.[37] Moving amongst the members of this vanguard social network, Marlowe was likely to have been exposed to many of the cutting-edge mathematical and scientific ideas that circulated between Harriot, Warner, Raleigh and Northumberland. Does it seem too farfetched to imagine Harriot speaking directly with Marlowe about his algebraic innovations, or perhaps even showing him his papers and mathematical workings out? Marlowe would undoubtedly have cherished such an opportunity: Robert Sidney's Flushing letter evinces Marlowe's stubbornness in his self-definition as a 'scholer', just as Marlowe's own relationship with the Ive manuscript exemplifies the opportunistic tenacity with which the playwright sought out the scholarship of his immediate contemporaries.

Marlowe would not have needed an advanced knowledge of mathematics to understand the implications of Harriot's work, and although Harriot's battle algebra was entirely singular, the case for the military efficacy of algebra had been made before. Recorde's *Whetstone* had included example questions on military subjects which Digges' *An Arithmeticall Militare Treatise, Named Stratioticos* (1579) greatly expanded upon. Digges' book functioned as a unique hybrid of mathematical textbook and military manual, teaching its readers arithmetic in its first section, algebra in its second, and information on military 'Offices, Lawes, Stratagemes &c' in its third, and covering topics such as 'Fractions Cossical', the 'Rule of Cosse', 'Equations' and the 'Inuention of Quadrate or Second Rootes'. Like Recorde, Digges provided his readers with practical example questions such as this one:

> There is deliuered to the Serieant Maior 60 Ensignes, in euerie Ensigne 160 Pikes, and short weapon. The Generals pleasure, is that he shall put them into one mayne Squadrone, and to arme it rounde with seauen ranckes of Pikes, I demaund how many Pikes, how many Halbers, he shall vse to mak the greatest Squadrone, and howe manye Ranckes shall be in the Battayle.[38]

Digges proceeds to find the solution to this problem (and the many others like it) by transforming the known and unknown numerical values into algebraic ones using the 'Rule of Cosse', and by creating an 'Equation' from which each unknown numerical value can be derived. In this respect, he owed much to Recorde's method, but Digges' was the only significant printed exegesis on algebra to appear in between *Whetstone* and the *Praxis*, and that it should appear in a book whose

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[37] S.P. 84/44 fol.60, transcribed by R. B. Wernham in 'Christopher Marlowe at Flushing in 1592', *English Historical Review* (April, 1976), 344-5.
[38] Thomas Digges, *An Arithmeticall Militare Treatise, named Stratioticos* (London, 1579), H2^{v}.

focus was on military tactics surely bolstered the perceived concordance between the two disciplines.

All of these sources—Recorde, Digges, Harriot—would have been readily available to Marlowe either through the London book market, or through personal acquaintances, and the conceptual overlap between algebra and the art of war evidently had a powerful effect on Marlowe's thought and *Tamburlaine*'s artistry, in respect to the two algebraic principles previously explained: relationality and exponentiality. When considered in terms of algebraic relationality, the image of human identities that emanates from *Tamburlaine* looks somewhat different from those painted by either Greenblatt or Cahill. Cahill's account of *Tamburlaine*'s 'fascination with aggregate—as opposed to individual—bodies'[39] may successfully extend Greenblatt's focus on the over-reaching individualism of the play's protagonist, but it does little to express what relationship Tamburlaine's (anti)heroism actually has with 'the man who may be no different from an indeterminate number of others'.[40] Certainly men are abstracted in *Tamburlaine*, but they are not necessarily homogenised, so that we find the protagonist's reassurance that each of his troops provides a certain value—'Not all the gold in India's wealthy arms / Shall buy the meanest soldier in my train' (*T1*, 1.2.85-6)—immediately alongside his admission that the outward appearance of certain men single them out for special authority: 'Art thou but captain of a thousand horse', Tamburlaine asks Theridimas, 'That by characters graven in thy brows / And by thy martial face and stout aspect / Deserv'st to have the leading of an host?' (*T1*, 1.2.168-71).

This emphasis on the rank and quality of men asks for caution in the regarding of mere numbers. We perhaps recall Henry V's particular interest in counting those deceased who were once 'princes, barons, lords, knights, squires / And gentlemen of blood and quality' (*Henry V*, 4.8.90). Although *Tamburlaine* refrains from invoking such titles of feudal hierarchy, it implies instead a social order based upon military competency. Meander asserts that even should Tamburlaine's men 'be in number infinite', he will be sure to 'triumph in their overthrow' so long as they are 'void of martial discipline' (*T1*, 2.2.43-50); Tamburlaine's anxiety that the size of Theridimas' army makes it an 'odds too great for us to stand against' is quickly modified by other concerns, such as 'are they rich? And is their armour good?' (*T1*, 1.2.122-3). In the characters' weighing up of the potential of individual armies, then, and in their calculations of the probabilities of those armies' success in battle, the rank and quality of men qualify magnitudes just as algebraic variables and their powers qualify their numerical coefficients. Cahill argues that *Tamburlaine*'s depiction of a social body is linked to the Elizabethan military manuals, in which 'the individual is scarcely visible',[41] but the manuals were themselves, of course, aimed at an elite readership of individuals exactly like Tamburlaine who, through force or privilege, took charge of other human beings. What manifests from both the pedagogical style of the military manuals and *Tamburlaine*'s

[39] Cahill (Oxford, 2008), p.28.
[40] Cahill (Oxford, 2008), p.68.
[41] Cahill (Oxford, 2008), p.27.

depiction of martial relationships is a fundamental bestowment of power upon certain individuals: power to command and control large groups of others as if they were pure mathematical entities like algebraic expressions in an equation, ready in their passivity to be ordered and re-ordered according to abstract principles.

But Marlowe makes this special method of organising human value *Tamburlaine*'s prerogative for reasons other than sociological concerns, and Cahill's emphasis on the play's 'social body' somewhat obscures the more important relationship to be found in *Tamburlaine* between its mathematical interests and its larger aesthetic objectives. If the commanding and controlling manoeuvres performed by the play's military leaders come to resemble the task of the algebraist, so too do Marlowe's dramaturgical techniques, for algebraic procedures enable the playwright to effect a performance of exponentiality within the limited confines of the theatrical space. In the *Defence of Poesy*, Sidney had mocked the absurdity of attempts to stage large battle scenes in the simplistic playing spaces of his age, decrying that 'two armies fly in, represented with four swords and bucklers'.[42] Clearly, this was not a mimetic difficulty that could be easily overcome, for almost twenty years after Sidney sat down to write the *Defence*, *Henry V*'s penultimate chorus ashamedly declared: 'oh for pity! — we shall much disgrace / With four or five most vile and ragged foils / Right ill-disposed in brawl ridiculous / The name of Agincourt' (*Henry V*, 4.0.49-52). It is, of course, extremely difficult to recover the details of *Tamburlaine*'s original staging, but the directions found in the play's first printed quarto (1590) collectively imply that its battle scenes took place away from the audience's view. Take, for example, 'Enter to the Battel, & after the battell, enter Cosroe wounded', or 'Baiazeth flies, and he pursues him. The battell short, and they enter, Baiazeth is ouercome'. In both cases, there is confusion over the word 'enter', but, logically, and given the directions' specific dramatic contexts (in which the characters mentioned are already on stage), the 'enter' in 'Enter to the Battel' must not ask for battle to be brought on stage, but rather for it to be removed from it. Certainly, one of the largest and most lengthily foregrounded battles in the play, between Tamburlaine's forces and the Emperor Callapine's, occurs whilst the audience watch Calyphas play cards amongst alarums and battle noises backstage.

Frank Romany and Robert Linsey were most likely correct, then, when they argued that 'we *see* few battles' in *Tamburlaine,* but their assertion that 'instead the play feels like a triumphal pageant'[43] is not entirely warranted, for having the battles take place offstage certainly did not render Marlowe incapable of successfully creating a powerful impression of both their scope and duration. Conversely, having them out of view may have facilitated their aesthetic force, for, in *Tamburlaine*, Marlowe seized the artistic opportunity to conjure enormous vistas and huge numbers of men without them ever actually being fully visually present. If Turner alerted critical

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[42] Philip Sidney, 'The Defence of Poesy', in *Sidney's 'The Defence of Poesy' and Selected Renaissance Literary Criticism*, ed. Gavin Alexander (London, 2004), p.45.
[43] Frank Romany and Robert Linsey, in their 'Introduction' to *Christopher Marlowe: The Complete Plays* (London, 2003), p.xvii.

attention to the concept of a geometric stage, in which 'a fundamental congruence between stage and map' permitted the dramatist complete spatial control, Marlowe conceived also of an algebraic stage, in which volume and magnitude could be creatively manipulated.[44] Marlowe must have been aware that much of the force of algebra came from its density, and its ability to reduce unwieldy magnitudes and their complex relationships down to small and efficient symbolisms. He must also have recognised the analogy between algebra and dramatic composition, with Mycetes' offhand remark that ''tis a pretty toy to be a poet' (*T1,* 2.2.54) perhaps a self-referential joke regarding the condensational mimetic procedures undertaken by *Tamburlaine* itself. For although the number of players in the Admiral's Men had, of course, to remain fixedly small throughout the duration of the play, audiences were nevertheless carefully guided by the verbal fabric of Marlowe's play in their efforts to imaginatively multiply them.

Shakespeare was explicit about this kind of representational logic in *Henry* V, and the grounds on which he pleaded with his audience to redeem him from charges of mimetic incompetency had more than the ring of algebra to them: 'Into a thousand parts divide one man / And make imaginary puissance' (*Henry V*, Prologue, 24-5), the chorus exhorts, for 'true things' may be minded 'by what their mockeries be' (*Henry V*, 4.0.53). In this respect, Shakespeare was undoubtedly influenced by *Tamburlaine*, and it was surely no coincidence that both Marlowe's play and *Henry V* utilised the massive battles of chronicle history in order to experiment with the possibilities and limitations of Elizabethan theatrical representation. The important mathematical distinction between the two plays, however, helps to clarify *Tamburlaine*'s singularity. Whereas *Henry V* required its audiences to imagine each of the King's Men's members as one thousand men in their performance of Agincourt, the numerical values represented by the actors performing *Tamburlaine* were subject to continual change as the play's numbers grow exponentially. To put it another, more mathematically appropriate way: if a man, *m*, is equal to 1000 in *Henry V*, in *Tamburlaine*, *m* is equal to 100, then 1000, then 10,000, and so on. Simple actor/character boundaries are effaced, and players become re-psychologised as algebraic indeterminates whose values must be calculated by their spectators.

In this complex mathematical negotiation between the play and its audience, spectators are encouraged to constantly recalibrate the numerical scale of the events unfolding in front of them, and the numbers expressed by characters, in both the preparations for battle and its aftermath, act simultaneously as coefficients and imaginative aids. This is not to say that Marlowe required excessive cognitive labour from his spectators, for although they are compelled to calculate, the manner in which the play's numerical process unfolds works not simply to specify the exact values of war, but also to create an almost subliminal image of mathematical grandiosity and culminating enormity within the theatre itself. These special kinds of algebraic tricks facilitated Marlowe's creative desire to exercise total control over the mimetic process, and to represent the seemingly unrepresentable, unhindered by either the architectural and technological primitiveness of the

[44] Turner (Oxford, 2006), p.6.

available theatrical spaces, or the stifling Aristotelian dogma which Sidney had used to criticise the drama of his contemporaries. What Stephen Greenblatt infamously labelled Marlowe's 'will to absolute play'[45] was also a will to absolute power, and his vision of dramatising the relational and exponential aspects of cutting-edge conquest were enabled by the conceptual overlap between algebra and the artistic medium of the theatre. Marlowe's desire was to encapsulate in his own artistry, and in the humble confines of the theatre, the artistry of warfare, in all its enormity.

4. THE ART OF WAR

What kind of *affect* was this particular *effect* supposed to have? Marlowe's conception of an algebraic stage was no doubt linked to a broader fascination with representations of vastness. Emrys Jones has argued that 'vastness is a quality that enters the European imagination in the sixteenth century', and that 'it is important to recognise that Marlowe shares this European sensibility.'[46] He goes on to link a 'peculiar appetite for huge numbers and immense vistas' with the development of 'Weltbilder', or world-pictures—'works that occupy an intermediary place between paintings and maps'—and with 'a new kind of landscape painting', exemplified by artists such as Albrecht Altdorfer, Joachim Patinir and Pieter Bruegel the Elder, in which 'a high viewpoint is often adopted' and 'thousands of fighting soldiers' cover 'an immense plain' in the image's foreground.[47] Jones qualifies that he is 'not suggesting that Marlowe actually saw any of Altdorfer's (or Patinir's or Bruegel's) work', but argues that 'we should not assume…his interest in gigantic battle scenes can be explained simply with reference to classical literary sources such as Lucan's *Pharsalia*.'[48] There is certainly much affinity between Altdorfer's achievements in painting and Marlowe's in *Tamburlaine*: both attempt to create an image of warfare which showcases its sheer power, its scope, and the strange beauty incurred by its kinetic brutality. Hans Holbein the Younger, too, made heavily geometrical drawings of battle scenes, which, although smaller in their topographical scale to those by Altdorfer, represented confused conglomerations of a multitude of bodies, muscles tensed and twisted in the heat of action, carrying pikes and swords that are either raised in the air or pointed toward a foe. They are as mesmerising as they are horrendous, and they were, like those by Altdorfer, intended to aestheticise warfare, and to recognise it as an art in itself as well as an appropriate subject of art.

What bypasses Jones' attention, however, is that Marlowe could have seen images very similar in their effect to 'Weltbilder' or Altdorfer's landscapes much closer to home, in the battle formations printed in the Elizabethan military manuals. In this respect, Peter Whitehorne's influential translation of Machiavelli, *The Arte of Warre* (1562), was the most important precursor. It

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[45] Greenblatt (Chicago, 1980, repr. 2005), pp.193-221.
[46] Emrys Jones, '"A World of Ground": Terrestrial Space in Marlowe's *Tamburlaine* Plays', in *The Yearbook of English Studies* Vol.38, No.1 (2008), 181.
[47] Jones (2008), 182.
[48] Jones (2008), 182.

included the 'figure[s]' of seven different orders of battle, in which 'the footmen, the horsemen, and euerie other particuler membre' were represented on the page by an array of 'poinctes & letters',[49] such as punctuation marks for target and pike men, and majuscule 'C's and 'G's for captains and generals. After the reader had perused them, they could follow directly on to another short and highly visual treatise appended to the back of Machiavelli's text, 'gathered and set foorthe' by Whitehorne himself, and called *Certain Waies for Orderyng of Souldiers in Battelray*. Here, again, representations of battle arrays were composed of majuscule letters and minuscule 'o's. By 1579, when Digges' *Stratioticos* was published, printed representations of the battlefield had become increasingly complex, in terms of both their scale and intricacy. *Stratioticos* featured a large, pull-out 'Battaile in Portraiture'[50] followed by a comprehensive prose description of the picture's contents: the 'Armie', Digges explains, is separated 'into two *fronts*', the first front 'separated into *8 Battalions*, euery of them hauing 30 in a ranke, and 33 ranckes', the second front 'deuided into 5 greater *Battallions*, euery one of them being of 2000 men'; these battalions are in turn 'impaled on either side with an hundred Ranke of Pikes' and two '*Winges* of *Horsemen'*, so that in total 30,000 footmen and 6,000 horsemen are condensed onto a single leaf.[51] `Finally, by 1591, when William Garrard's *The Arte of Warre* was printed, authors and engravers were able to utilise a varied assemblage of models to depict battle arrays. Garrard's book contained the simpler style diagrams like those found in Whitehorne's text, but added woodcut representations of more complicated formations such as the 'ring' or 'Limasson', the 'S', and the 'D' or 'Snaile', all of which required their symbols to spiral and curve around the page.[52] Most impressive amongst the book's illustrations are its pictorially ambitious, meticulously detailed woodcuts depicting entire battlefields, one of which declares to 'show euerie Weapon [that] should be placed to fight'.[53]

Printed battle formations, then, often provided Elizabethan military manuals with much of their distinctive visual quality, and although Nina Taunton, Nick de Somogyi and Patricia Cahill have all written skilfully on them, none quite registers the degree of awe early modern readers must have felt upon encountering these unique diagrams. Specially designed, and usually newly commissioned, they encapsulated both a geometrical and an algebraical artistic beauty: geometrical because perspectival (Digges' 'Battaile in Portraiture' even came with its own 'scale of Pages'), algebraical because vast amounts of space and enormous numbers of human bodies could be compressed into small and simple symbolisms, able to be represented in their entirety on a single piece of paper. The letters used to signify different kinds of infantry in Whitehorne's and Garrard's texts, in which men and their military statuses are reduced to the concision of letters and points, would even come to resemble the notational systems used by Viète, Harriot and Descartes, a parallel which not many readers would have had the means to notice, but which Marlowe, in his

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[49] Peter Whitehorne, *The Arte of Warre, Written first in Italian by Nicholas Machiauell* (London, 1562), fol.109^{v}.
[50] Digges (London, 1579), between pp.176 and 177.
[51] Digges (London, 1579), p.178.
[52] Garrard (London, 1591), p.86-88.
[53] Garrard (London, 1591), between pp.192 and 193.

singular position, may indeed have contemplated. At any rate, such powerful representations must have conjured vivid pictures in many of the imaginations of their viewers, providing them with a kind of birds-eye view of the enormity of the battlefield, all framed neatly within the rectangular boundaries of the book's pages.

When Marlowe references specific, technical battle formations in *Tamburlaine*, it is to evoke precisely this effect of beauty in grandeur, kinesis and concision. As Orcanes, Jerusalem, Trebizond and Soria gather their massive allied army to combat Tamburlaine's, Orcanes plans their method of attack:

> Our battle, then, in martial manner pitched,
> According to our ancient use, shall bear
> The figure of the semicircled moon,
> Whose horns shall sprinkle through the tainted air
> The poisoned brains of this proud Scythian.
> (*T2*, 3.1.64-68)

The lines are evocative of streamlined violence. In *Tamburlaine 1*, the Sultan of Egypt had imagined Tamburlaine's army as 'A monster of five thousand heads, / Compact of rapine, piracy, and spoil' (*T1*, 4.3.7-8), and it is a similar kind of compactness which provides the 'figure of the semicircled moon' its potential force here. Multitudes of men are conceived as one massive, unified body, made possible only by a co-operation which might remind us of algebraical interaction and relationality, but which also homogenises the troops into one single entity, one nexus of organised brutality, whose formulaic structure (as delineated in the manuals) makes it easy to multiply. Its movement is imbued with an almost grace-like beauty, mirrored in Orcanes' grammar: his short, jerky clauses in the lines on 'martial manner' and 'ancient use' are in concordance with militaristic precision, but once the 'figure' itself is mentioned, those clauses smooth out into a more fluid (if grotesque) poetry, envisioning Tamburlaine's 'poisoned brains' being 'sprinkle[d] through the tainted air' by the sharp points of the figure's 'horns'.

Interestingly, this is not the only mention of a semi-circled moon in *Tamburlaine.* Audiences listening to Orcanes words cited above may have recalled Bajazeth, in the play's first instalment, declaring the size of his army in these terms:

> As many circumcisèd Turks we have,
> As hath the ocean or the Terrene Sea
> Small drops of water when the moon begins
> To join in one her semi-circled horns.
> (*T1*, 3.1.8-12)

Raman has located an early modern 'shift from representing things—be they commodities, people, or algebraic unknowns—as determinate-but-unknown to representing them in their merely potential determinateness, leaving their ontological specification to different locations (the courtroom and the concrete equation) within which such valuation or determination dynamically occurs.'[54] In

[54] Raman (New York and Abingdon, 2010), p.213.

Bajazeth's turn of phrase, numerals are effaced to make space for poetic conceit: the unknown is left unspecified, and the location at which valuation or determination takes place is not the courtroom or the concrete equation but the individual imagination. It might seem like Marlowe recklessly recycled the image, but the semicircular, horned moon fulfils a similar function on both occasions. Poetry in both instances acts to aid the algebraic stage: it amplifies the enormity of the battles that will take place out of view, but it also conjures more specific images of that battle's quality, beauty and artistry. When considered collectively, the play's evocations of the horned moon superimpose a complex set of images and referents on top of each other: the actual moon's role in a conceit attempting to communicate an inexpressible quantity is combined with the reference to the technical battle formation, and also potentially to its material representations in the military manuals, for, as it happened, one of the largest and most lavish illustrations in Garrard's *The Arte of Warre* depicted 'The Battell in forme of a Moone'. The visual specificity of *Tamburlaine*'s poetry, combined with the play's more concrete numerical declarations, prepare the audience for those moments when the stage in front of them is empty, and help to regulate their imaginative processes. In this respect, Marlowe attempted to create the ultimate illusion: he wanted his spectators to see the utmost grandeur, enormity, and beauty, even when the theatrical space was at its most sparse.

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I hope to have shown, then, that algebra is subtly incorporated into the formal composition of *Tamburlaine*, and that it was intended by Marlowe to perform a very specific aesthetic role. I do not propose, however, that *Tamburlaine*'s algebra would have been easily (if at all) visible to its audiences. Rather, algebra functions as a fundamental technology at the core of *Tamburlaine*'s artistic structure, quietly enabling the play's intended affects to find their fruition. This mode of *submersion* is apposite to *Tamburlaine* for two reasons.

Firstly, because this is the method by which Marlowe dealt with many of the play's intellectual sources and resources. Ever since F. C. Danchin noticed, for example, as early as 1912,[55] that one of Tamburlaine's most prolonged speeches subsumes large sections of Paul Ive's *The Practise of Fortification* (1589), critics have remained perplexed as to why such parochially prosaic material should be so delicately woven into the fabric of Marlowe's highly wrought poetry, especially given that Ive's treatise was published after *Tamburlaine*'s first performances, and that Marlowe, therefore, must have consulted it in manuscript. Despite critics' constant attempts to characterise the pervasive intertextual habits of Renaissance literary compositional processes, none of their terms—'plagiarism', 'aggregation', 'patchwork', 'compilation'[56]—adequately sums up

[55] F. C. Danchin, 'En marge de la seconde partie de Tamburlaine', *Revue Germanique* (Jan-Fév, 1912).
[56] See Stephen Orgel, 'The Renaissance Artist as Plagiarist', in *ELH*, Vol.48, No.3 (Autumn, 1981), 476-495, Linda Woodbridge, 'Patchwork: Piecing the Early Modern Mind In England's First Century of Print Culture', in

what occurs in *Tamburlaine*, because all suggest a form of plagiarism that, by being culturally legitimised and out in the open, is not really plagiarism at all. Many of Marlowe's intertextual navigations and much of his source-work, on the contrary, is aimed at the creation of effects and affects other than 'the pleasures of recognition',[57] and, for Marlowe, cutting-edge technologies like Ive's and like algebra were not meant to be acknowledged, but rather felt.

The second reason is that *submersion* was fundamental to the entire ontological status of mathematics in the Renaissance. The influential philosopher Michael Dummett has written that 'Platonism…is founded on a simile: the comparison between the apprehension of mathematical truth to the perception of physical objects, and thus of mathematical reality to the physical universe'.[58] This particular philosophy of mathematics was widespread in Marlowe's age, and it had no better advocate than the figure with whom this article began: John Dee. For Dee, the power of mathematics, and the reason algebra was pertinent to 'the diuine force of the Soule', was its ability to bring the human closer to God by understanding the invisible but very present aspects of His creation. Dee saw the discovery of mathematical phenomena as unlocking knowledge of the physical world, whilst Marlowe thought to use mathematics as a way of creating his very own world, within the little space of the theatre. Perhaps, in this way, we can detect further evidence of Marlowe's dangerous intellectual and artistic pretensions: perhaps he, like Tamburlaine, wished to become a 'scourge of God', and to create, aided by the newly emerging mathematical technologies of his age, beauty and wondrousness from such ungodly materials as violence and warfare.

English Literary Renaissance, Vol.23, No.1 (Winter, 1993), 5-45, and Jeffrey Todd Knight, *Bound to Read: Compilations, Collections, and the Making of Renaissance Literature* (Pennsylvania, 2013).

[57] Orgel (1981), 480.

[58] Michael Dummett, *Truth and Other Enigmas* (London, 1978), p.202.