"A most fine figure": Shakespeare's Mathematical Art

by

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Abstract

This thesis explores the role of mathematical elements in three of Shakespeare's plays: *Love's Labour's Lost*, *The Merchant of Venice*, and *King Lear*. It begins with a discussion of the status of mathematics in Renaissance England, which focuses on mathematics' revaluation in the period. In Chapter Two, mathematics is examined as one of *Love's Labour's Lost*'s languages – a source of businesslike precision, entertainment, and uncertainty. In Chapter Three, *The Merchant of Venice*'s computational environment is analyzed as a prelude to a consideration of the use of mathematical elements for containment purposes. Lear's map, in *King Lear*, is analyzed in Chapter Four as a mathematical construct and its significance as an emblem of the cruel mathematical reductionism that pervades the play is traced out. By examining the various practical and creative applications of mathematical elements in these three plays, I demonstrate that Shakespeare saw the value and power of mathematics.

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Chapter One

Introduction

In *Noble Numbers, Subtle Words: The Art of Mathematics in the Science of Storytelling*, Barbara Fisher describes mathematics as "that part of language generally called upon for the precise expression of practical calculations and certain imaginative concepts" and suggests that "when mathematical elements are strongly present in a literary text, they contribute a necessary dimension to its language" (11). Like Fisher's study, my thesis stems largely from these fundamental connections between mathematics, language, the imagination, and meaning. However, where Fisher considers the role of mathematical elements in the works of several authors spanning a period of four hundred years (11), I propose to examine the ways in which they function in three Shakespearean plays particularly rich in mathematical references: *Love's Labour's Lost*, *The Merchant of Venice*, and *King Lear*. In the following pages I will investigate the interplay between various mathematical components such as number, "number word" (Fisher 23), enumeration, calculation, equation, proportion, geometric shape, measurement, mathematical symbol, and mathematical metaphor. I will trace the comic and tragic functions of this "specialized language within language" (Fisher 11) in Shakespeare's drama, illustrating that the playwright was deeply interested in mathematics as a system of inquiry and expression, and that he regarded mathematical elements (as he did words) as "practical *literary* instruments" (Fisher's emphasis 21) and artistic tools.

Before launching into an in-depth examination of the mathematical elements located in these three plays, however, it is useful, first, to gain some understanding of the status of mathematics in Renaissance England.

In *The Measure of Reality*, Alfred W. Crosby discusses "the epochal shift from qualitative to quantitative perception in Western Europe during the late Middle Ages and Renaissance" (n. pag.). John Murdoch refers to this same phenomenon as "the near frenzy to measure everything imaginable" beginning in the fourteenth century (qtd. in Kaye 3), and Joel Kaye calls it a "measuring 'mania'" which "came to dominate speculation in this period" (3). Indeed, the Renaissance was preoccupied with both arithmetical and geometrical forms of measurement, which led to various mathematically rooted inventions such as "mechanical clocks, geometrically precise maps, double-entry bookkeeping, exact algebraic and musical notations, and perspective painting." Undoubtedly, many Western European citizens were "thinking quantitatively" in this period (Crosby n. pag.). They were asking questions about various aspects of their world and seeking quantitative answers to them. While time, space, music, and the visual arts were becoming mathematized, "calculations" were being made "easier, more rapid, and more precise" (Bouwsma 188). "Mathematics," as William J. Bouwsma notes, "rapidly became a part of the general culture of the age" (188).

Also, during the Renaissance mathematics successfully "challenged" Aristotelian natural philosophy (physics), which, as Peter Dear explains, "aimed at understanding qualitative processes" and deemed "[q]uantities . . . at best peripheral . . . because they

failed to speak of the essences of things" (Dear 65).[1] Several Aristotelian physicists "denigrated the mathematical enterprise on precisely these grounds" in the sixteenth century, but mathematicians began to respond – to fight back in defense of mathematics and the mathematical sciences – by the late 1500s (Dear 65-66). Over the course of the sixteenth and seventeenth centuries nature and natural philosophy alike were mathematized, largely because of the influence of such scientists as Galileo and Kepler. Other proponents of the study of mathematics made "strong claims for their discipline that revolved around its practical dimensions" (Dear 79). I will examine some of these claims below.

In his first address as London's Mathematical Lecturer, Thomas Hood[2] lauds "the mathematicks":

> For what soeuer seuerall c[om]mendations there are in other things in this profession: they all concurre and meete togeather. If either antiquitie of any arte may magnifie the same, or the professors therof bring credit therto, or the wonderfull effects and strange deuises extoll the thing, or the subiect matter set foorthe the praise, then shall the mathematicks surpasse

[1] Dear elaborates on this sentiment: "Measurements, whether of dimensions or of numbers, were purely descriptive, while the natural philosopher's job was defined by its attempt to *explain*, not merely describe" (65).

[2] According to E. G. R. Taylor, Hood was "appointed *Mathematical Lecturer* to the City of London under the patronage of Sir Thomas Smith and Lord Lumley" in 1588. On November 4 of that same year, he delivered his first lecture "before a distinguished company" at Smith's house. However, after approximately four years, Hood's mathematical lectures were "discontinued, perhaps because they were too academic for a majority of listeners" (179).

> them all: they were inuented before all other, imbrased by kinges and wisest men, strange in deuises and effects, and for the subiect matter they haue the world. (A4v)[3]

For Hood, all praiseworthy aspects of "other things" come together, in the manner of converging lines, upon mathematics. With reference to its early conception, royal reception, substantial subject matter, and "strange" influence,[4] Hood paints mathematics as the highest of all arts. The lecturer goes on to quote an unnamed authority who "truely saide" that "[t]he Mathematickes are unto the wit, as fire is to the golde" (B3v) and later "capture[s] man's special affinity with [mathematics]" by recounting the story of Aristippus (Zetterberg 12), who

> suffering shipwracke on the coast of *Rhodes* found described in the sande Geometricall figures, wherin he took such singuler comforte, that forgetting his losse, and cause of sorrow: he cryed out thus unto his fellowes, be of good cheere my mates . . . for loe I see the footesteppes of men. (B3v)

Here, the markings of math function as man's imprint upon the world – an obvious sign of his presence. "Of all the sciences and arts," Hood suggests, mathematics "is most

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[3] All quotations from texts published before 1700 are cited by signature. In quoting I modernize long *s*, but otherwise make no changes unless specified.

[4] Of course, mathematics had strong connections to magic in the Renaissance. See Zetterberg for a survey of the different types of "mathematical magic" in England, 1550 – 1650.

distinctly man's own: a unique and wondrous tool which sets him off from the rest of creation" (Zetterberg 13).

In his preface to *The gro[un]d of artes teachyng the worke and practise of Arithmetike, moch necessary for all states of men*,[5] Robert Recorde also links mathematics to man. However, Recorde uses the skill of numbering rather than the figures of geometry as his mathematical point of reference. "[W]ho so setteth small pryse by the wyttie deuyse and knowledge of numbrynge," Recorde declares, "he lyttell consydereth it to be the chyefe poynt (in maner) wherby men dyffer from all brute beastes: for as in all other thynges (all most) beastes are partakers with vs, so in numbrynge they dyffer clene from vs" (*5v). According to Recorde, men are inferior to animals in various respects: "[t]he foxe in crafty wyt excedeth moste men," "[a] dogge in smellyng hath no m[an] his pere," and "[t]he nyghtyngale, the lynet, the thrusshe, the larke / In musical harmony passe many a clarke" (*5v). Yet, when it comes to numerical dealings such as "discern[ing] one thynge from many" (*6), man clearly prevails over beast. Though unwilling to go so far as to cite "nomber" as the solitary difference between man and animal, Recorde determines that it is "thonely thyng (all most) that separateth man from beastes" (*6v). To conclude, the author judges that "he therfore that shall contemne n[om]ber . . . declareth hym selfe as brutysshe as a beaste, and vnworthy to be counted in the felowshyp of men" (*6v) – a pointed call for all men to learn the art of numbering.

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[5] Hereafter, I will refer to this work as simply *The Ground of Artes*.

If man's mathematical abilities distinguish him from animals, they also bring him closer to God. Paula Blank points out that, "[a]lthough we tend to hear more from Renaissance writers about the nominalist God who creates through the Word, many also worshipped Him as a mathematical God" (480). As Blank notes, this is "a Judeo-Christian analogue" to the "philosophical tradition, attributed ultimately to Pythagoras, which identified numbers and numerical relations as the essential and underlying cause of all phenomena, on earth as in heaven" (480). Thus, Recorde refers to the Creator as "that true fountayne of perfect n[om]ber, which wrought the hole world by n[om]ber [and] measur" (*7v), and alludes to the mathematical enigma of God, who is "trinite in vnite, [and] vnite in trinite" (*7v). In a similar vein, John Dee, in his influential "Mathematicall Præface" to Henry Billingsley's 1570 translation of Euclid's *Elements of Geometrie*, translates the words of "the great & godly Philosopher *Anitius Boetius*": "*All thinges (which from the very first originall being of thinges, haue bene framed and made) do appeare to be Formed by the reason of Numbers. For this was the principall example or patterne in the minde of the Creator*" (*1). God's "*Numbryng*, then," Dee later clarifies, "was his Creatyng of all thinges. And his Continuall *Numbryng*, of all thinges, is the Conseruation of them in being: And, where and when he will lacke an *Vnit*: there and then, that particular thyng shalbe *Discreated*" (*1v).

The concept of God as "a supreme mathematician" who "designed the universe mathematically" appealed strongly to Renaissance scientists and mathematicians (Kline 219). First, it suggested that the mathematical sciences were causal because they could reveal the scheme by which God created the cosmos and, thus, could be classed as natural

philosophy. Second, it gave mathematicians' and scientists' work a divine purpose, since the quest for governing principles of the universe could be considered both a mathematical and a spiritual pursuit (Kline 218-20). Because each of God's creations' "distinct partes, properties, natures, and vertues, by order, and most absolute number" are "brought, from *Nothing*, to the *Formalitie* of their being and state" in the mathematical mind of the Creator (Dee *1), the study of mathematics seems to offer man the opportunity to solve, numerically (and, thus, certainly[6]), the mysteries of the universe and, perhaps even more importantly, "approach the mind of God" (Kline 219). Thus, Dee reasons:

> By *Numbers* propertie therefore, of vs, by all possible meanes, . . . we may both winde and draw our selues into the inward and deepe search and vew, of all creatures distinct vertues, natures, properties, and *Formes*: And also, farder, arise, clime, ascend, and mount vp (with Speculatiue winges) in spirit, to behold in the Glas of Creation, the *Forme of Formes*, the *Exemplar of Number* of all thinges *Numerable*: both visible and inuisible: mortall and immortall, Corporall and Spirituall. (*1-*1v)

Pulled inwards and upwards by numbers, the man of mathematics, himself, becomes "almost god-like" (Zetterberg 13).

For many, a sense of the "spiritual and mystical nature of numbers" (Blank 481) led, primarily, to a "contemplative" (Howson 5) kind of mathematics. In this form,

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[6] As Recorde points out in his preface to *The whetstone of witte* (1557): "It is confessed emongeste all men, that knowe what learnyng meaneth, that beside the Mathematicalle artes, there is noe vnfallible knoweledge, excepte it bee borowed of them" (b1v).

mathematics was considered "an abstract science" (Bouwsma 189) which tended to "lea[d] away from the things of life" (qtd. in Howson 5). Indeed, Pythagoras himself had relegated mathematics to the purely philosophical realm by arguing that numbers are "immaterial, eternal and inviolable, not to be applied as measurements of physical objects" (Blank 481). Dee, on the other hand, suggests that "*Thynges Mathematicall*"[7] occupy a middle ground "betwene thinges supernaturall and naturall." They "are not so absolute and excellent, as thinges supernatural: Nor yet so base and grosse, as things naturall." They have a "meruaylous newtralitie . . . and also a straunge participati[on] betwene thinges supernaturall, immortall, intellectual, simple and indiuisible: and thynges naturall, mortall, sensible, compounded and diuisible" (☞4v). In order to grasp the "absolute" significance of numbers and, thus, arrive at an understanding of mathematics' higher, metaphysical meanings, it is, Dee suggests, necessary to understand numbers as they exist in their material state – necessary, in other words, to apply numbers to physical things:

> . . . in Numbryng, we say One, two, Three. But how farre, these visible Ones, do differre from our Indiuisible Vnits (in pure *Arithmetike*, principally considered) no man is ignorant. Yet from these grosse and materiall thynges, may we be led vpward, by degrees, so, informyng our rude Imagination, toward the c[on]ceiuyng of *Numbers*, absolutely . . . that at length, we may be hable, to finde the number of our owne name,

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[7] According to Dee, "*Mathematicall* thinges" are of "two principall kindes: namely, *Number*, and *Magnitude*" (*1).

> gloriously exemplified and registred in the booke of the *Trinitie* most blessed and æternall. (*1v-*2)

In this way, numbers applied in the world – for example, the concept of "[t]hree Lyons" or "[t]hree Egles" (*1v) – serves as an essential starting point for a more mystical understanding of number and its role in the universe.

Later, Dee takes care to distinguish between the pure and "grosse" whole numbers to which he refers in this passage and those numbers (i.e., fractions) used by "the common Logist, Reckenmaster, or Arithmeticien" (*2). He divides the general category of "*Arithmetike*" into various specific classes in order to accommodate the art's numerous uses. He separates "vulgar" arithmetic from speculative arithmetic (*2-*2v). Yet, on every level, regardless of the differences between one "*Arithmetike*" and another which Dee posits, the author's belief in the "sublime value" of mathematics (Debus 22) shines through. "Consider," Dee writes in anticipation of "*Algebra*," a form of vulgar arithmetic, "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" (*2v). Arithmetic, it seems, is marvelous for Dee not only in its philosophical but also in its vulgar, practical form.

The author follows this same pattern with arithmetic's "next Sister . . . the Absolute Science of *Magnitudes*" (a1v) which "commonly, now is, and from the beginnyng, hath of all Philosophers, ben called *Geometrie*" (a2). Dee would rename the science "*Megethologia*" since it "lift[s] the hart aboue the heauens, by inuisible lines, and

immortall beames meteth with the reflexions, of the light incomprehensible: and so procureth Ioye, and perfection vnspeakable" (a2v). Later, he separates "the puritie, absolutenes, and Immaterialitie of Principall *Geometrie*" from various kinds of "*vulgar Geometrie*" (a3v). These are low practical arts[8] dealing with different types of measurement. However, they are notably "deriued" from pure geometry (a3v), and Dee's glowing accounts of them seem to suggest that they participate in some way in the magnificence of the contemplative art from which they spring.

Although Dee pays much attention to mathematical abstractions at the start of his "Mathematicall Præface," the bulk of his work is primarily concerned with the high practical applications of mathematics. "*Perspectiue, Astronomie, Musike, Cosmographie, Astrologie, . . . Architecture,* [and] *Nauigation*" are only some of the many "*Methodicall Artes*" rooted in "the Science of *Geometrie*" (b1) which are praised at length by Dee. In many ways, as I have already suggested, the author works to differentiate between the kinds of mathematics he promotes. He separates God's mathematics from man's, and speculative from low and high forms of practical mathematics, taking care to classify and define throughout. Yet, these seemingly opposing types of math ultimately bleed together, so that one inevitably comes away from Dee's text with a multifaceted view of mathematics – a sense of mathematics as both a useful tool and an imaginative force, and

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[8] This explicit distinction between "low" and "high" practical mathematical arts is my own, although it is implied by Dee. I use the former term to refer to those practical arts which Dee considers types of "vulgar" arithmetic or geometry. I use the latter term to refer to those nineteen practical arts which are not "vulgarly taught" and which "dea[l] with thinges on high" (a3v). These "vse the great ayde, direction, and Method of the sayd principall Science [of Geometry], and haue propre names, and distinct" (b1).

a feeling for the interplay between these two functions. Clearly, "the arts and sciences of his preface are magical, as well as mathematical" for Dee (Zetterberg 70). Because of this the author is able to establish an often subtle but "strange participation" between practical and contemplative math and, in general, cultivate an air of amazement around the mathematical arts and sciences.

In *"Mathematicall Magick" in England: 1550-1650*, J. Peter Zetterberg illustrates the frequency with which "glowing accounts of the power and utility of mathematics" (19) appeared in the period:

> Pick from the shelf at random a mathematical work written in the vernacular for a popular audience during the late sixteenth and early seventeenth centuries, and one thing will invariably be true of it. Regardless of its author or the exact nature of its subject matter, it will be prefaced by a rhetorically extravagant account of the wonderful feats and marvelous utility of mathematics. (14)

Both Dee's "Mathematicall Præface" and Recorde's *Ground of Artes* are prime examples of influential narratives of this kind. As Allen G. Debus points out, the "Mathematicall Præface" "was frequently referred to in the late sixteenth century as a major statement of the value of mathematics" (Debus 24) and, in 1574, only four years after the work's original publication, Dr. Richard Forster "described Dee as a very Atlas bearing upon his

shoulders the sole weight of the revival in England of the mathematical arts" (Taylor 171).[9]

Recorde's *Ground of Artes* was, perhaps, even more successful. Published first in 1543 and finally in 1699, this arithmetic text went through "at least forty-five" issues and editions (Howson 13).[10] In addition to a preface which, as I have already suggested, celebrates number and alludes to its divine origin, Recorde's work contains a "declaration of the profyte of Arithmetyke" (*2) written in the form of "[a] dyaloge betwene the Mayster and the Scoler" (A1). Here, Recorde's Mayster responds to the Scoler's allegation that "n[um]berynge" is "contemptyble [and] vyle" because it is "so c[om]men" (A1v). Man's regular use of numbering, Recorde's teacher argues, is what "proueth" that number is "ryght excellent, and of hygh reputation, syth it is the ground of all m[en]nes affayres" (A1v). Although he admits that "nombre . . . exceade[s] all prayse" (A1v), the Mayster extols the mathematical element's uses and those who make regular use of it. He illustrates that number holds an important place in all occupations. It is essential, he contends, that the musician, physician, lawyer, judge, philosopher, theologian, soldier, lord, and merchant, among others, have knowledge of mathematics in order to perform their duties properly. Moreover, Recorde, like Dee, paints number as the ultimate "key to

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[9] It is important to note that, despite its apparent popularity in the late sixteenth century, the "Mathematicall Præface" appears to have received little attention by writers in the seventeenth century. There are "occasional references to it" by figures such as Thomas Browne and John Webster, but, surprisingly, "among major scientific authors of the seventeenth century we find very few citations" (Debus 24).

[10] Dee, himself, edited the 1561 and 1570 editions of *The Ground of Artes*, and Geoffrey Howson speculates that the "success" of the "Mathematicall Præface" may have "led to the large number of reissues of Dee's editions" of Recorde's text (25).

knowledge" (Debus 13). "Wherfore in all greate workes, are clarkes so moch desyryd? wherfore are audytours so rychely feeyd? What causeth geometrians so hyghly enhauncyd? why are astronomers so greatly aduauncyd?" Recorde's teacher asks, rhetorically. "[B]ycause that by nombre suche thynges they do fynde, whiche elles shuld farre excelle mans mynde" (A1v-A2). Thus, the Mayster later resolves: "Wherfore as without nomberynge a man can do almost nothynge, so with the helpe of it, you maye attayne to *all* thing" (emphasis added A2v).

Dee, Recorde, and Hood tried to arouse the public's interest in and respect for mathematics. Undoubtedly, each of these apologists believed in the power, utility, and marvelousness of the art they promoted. Moreover, each sought to make a case for "mathematics' place in education" (Howson 25).

In his essay "Of Studies," Francis Bacon claims that, just as "*Histories* make Men Wise; *Poets* Witty; . . . *Naturall Philosophy* deepe; *Morall* Graue;" and "*Logick* and *Rhetorick* Able to Contend," so "The *Mathematicks*" make men "Subtill"[11] (Pp3v). Furthermore, he prescribes the study of mathematics for those plagued with concentration troubles: "if a Mans Wit be Wandring," Bacon writes, "let him *Study* the *Mathematicks*, For in Demonstrations, if his Wit be called away neuer so little, he must begin again" (Pp3v). Here, the author isolates mathematics as a subject which requires one's full, uninterrupted attention. Since one must put forth a prolonged effort in order to find the solution to a mathematical problem or to understand a mathematical proof, mathematics functions as a useful mind-training tool. The subject, according to Bacon, "provide[s]

[11] "Clever, dexterous, skilful" ("Subtile," *a.* Def. 7).

discipline" (Howson 5). It trains the mind to focus. Furthermore, in the *Basilikon Doron*,[12] King James advises Prince Henry of the importance of studying mathematics:

> I graunt it is meete ye haue some entrance, speciallie in the Mathematickes; for the knowledge of the arte militarie, in situati[on] of Campes, ordering of battels, making Fortificati[on]s, placing of batteries, or suche like. And let not this your knowledge be deade without fruites, as S. *Iames* speaketh of Faith: but let it appeare in your daylie conuersation, & in all the actions of your life. (H7v-H8)

Clearly, as Rick Bowers notes, "[t]he efficacy of a critical mathematical approach to problem-solving was not lost on King James" (372).[13] However, although both Bacon and his King (in addition to Recorde, Dee, and Hood) seem to regard mathematics as an imperative educational tool and subject, it is important to remember that mathematics was generally considered of little importance and was looked down upon (presumably, for the philosophical reasons cited above) by many in Renaissance England. Thus, mathematics education was not easily acquired.

In the first century, the Roman Boethius had "adjoined the mathematical quadrivium of arithmetic, geometry, music and astronomy" to "the trivium of grammar, logic and rhetoric," in this way "spelling out the place that mathematics should hold in a liberal education" (Howson 1). Yet, for the most part, as Howson points out,

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[12] This title originally appeared in Greek letters.

[13] For a brief discussion of King James' "interest in the new mathematics," see Bowers p. 381*n*4.

mathematics appears to have held "little appeal for the humanists" (9). By 1500, "a network of 'petty schools'" had been set up in England which provided students with an "elementary education" (Howson 9-12). These schools were sometimes separate from the grammar schools, but grammar schools "[f]requently . . . provided for a 'class of petties' taught by an usher or an older pupil" (Howson 12). Here, boys were taught "the alphabet and syllables, . . . reading, writing, and perhaps arithmetic" (Thompson 9). When arithmetic was taught at this level, it was "in the form of 'casting accounts,'" which was regarded as a useful tool for those who would later become apprentices (Howson 12).

In the average Elizabethan grammar school, arithmetic was typically taught to "the junior classes" by an usher for less than four hours per week.[14] It likely shared a time-slot with "[w]riting out the Catechism in English" on Saturdays from one o'clock in the

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[14] If Recorde's *Ground of Artes* can serve as a guide, students would have been taught "[n]umerati[on]," or "the arte to expresse and rede all sommes proposed" (A7v), addition, subtraction, multiplication, and division. An example of elementary early modern mathematics teaching might prove useful. Recorde's "Mayster" teaches his "Scoler" how to multiply digits "aboue 5" (G5v-G6). The two digits are to be written down, with one above the other. To the right of each digit, one is to note "howe many eche of them lacketh of 10" (G5v). A line is drawn beneath. Thus, in multiplying 7 and 8, one would write:

8 2
7 3

Next, one multiplies the two digits in the right-hand vertical column (e.g., 2 and 3) and places the product (e.g., 6) beneath them. One then chooses either pair of diagonally placed numbers (e.g., 7 and 2, or 8 and 3) and subtracts the lesser from the greater. This answer (e.g., 5) is placed below the left-hand vertical column of numbers. The finished product reveals the problem's solution (e.g., 56):

8 2
7 3
---
5 6

afternoon until five o'clock in the evening (Howson 10-12). As S. J. Curtis notes, "since the teaching was either at the end of the day or on a half-holiday, it [arithmetic] was not popular with the pupils nor with the usher who had to teach it" (90). Similarly, Craig R. Thompson observes that the study of mathematics occasionally "reached geometry" but, for the most part, "[a] grammar master simply could not be bothered with this sort of thing [mathematics] when the real business of school, languages, had first call on his time" (27-28).

At the university level, as in the grammar schools, "little stress" was put upon the learning of mathematics (Howson 12). There were "signs of change" (Howson 12) at Cambridge in 1549, when "new statutes" were put into place which dictated that the Bachelor of Arts degree begin with "a year's study of mathematics; that is, cosmography, arithmetic, geometry, [and] astronomy" (Simon 252-53). However, these statutes were overturned by Elizabeth in 1570. At this point, mathematics was "excluded" from the university curriculum for being too "practical" a study, and more suited to a "technical education" (Howson 12). According to Bowers, the situation at Oxford was slightly different. At this institution "'New Statutes'" were put in place in 1564-65 which "de-emphasized science to favour the subjects of the trivium." As a result, the "quadrivial subjects" were transferred from the Bachelor to the Master of Arts Degree (370).

In *The Scholemaster*, first published in 1570, Roger Ascham puts forth his case against mathematics:

> Some wittes, moderate enough by nature, be many tymes marde by ouer moch studie and vse of some sciences, namelie, Musicke, Arithmetick,

> and Geometrie. Thies sciences, as they sharpen mens wittes ouer moch, so they change mens maners ouer sore, if they be not moderatlie mingled, [and] wiselie applied to som good vse of life. Marke all Mathematicall heades, which be onely and wholy bent to those sciences, how solitarie they be th[em]selues, how vnfit to liue with others, [and] how vnapte to serue in the world. (D1v)

For Ascham, mathematics (primarily, it seems, in its abstract form) is a dangerous study. It affects men's minds and, as a result, their ability to function as responsible, contributing members of society. Yet, the most common and the most potent charge against mathematics in Renaissance England was that it was "a tool of the trades" (Blank 479). Indeed, mathematics battled "the taint of 'usefulness'" as an "insidious enemy" (Taylor 4).

Presumably, Shakespeare attended Stratford-upon-Avon's local grammar school, the King's New School, from 1571 until 1579 (Honan 43-59). Here, he likely learned mathematics according to the custom described above. As Blank points out, Shakespeare "seems to know the basic operations of addition, multiplication, and division, as taught to schoolchildren from the 1540's" (477). Moreover, he seems to have had some "'textbook' knowledge of arithmetic," since he displays a mathematical understanding of words such as "place," "parcel," and "article" – words which were "first attested" in an arithmetical sense by Recorde in his *Ground of Artes* (Blank 477-79).[15] Indeed, one can

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[15] Although there is no clear-cut proof that Shakespeare read Recorde, I find this "textual evidence" of Blank's "that Shakespeare knew Robert Recorde's work" highly convincing (477*n*9).

be sure that the playwright was not one of the "ordinary" grammar-school students complained of in John Brinsley's *Lvdvs Literarivs: or, The Grammar Schoole* (1612), whose knowledge of "the ordinary numbers or numbring" is described as so deficient that they "can hardly tell you the number of pages, sections, chapters, or other diuisions in their books" (E1).

Shakespeare's plays are peppered with numbers and "the general terms for computing with numbers" (Blank 477). His characters repeatedly "sum," "cipher," "reckon," "number," "account," "cast," "count," and "figure."[16] In Shakespeare's kings, clowns, soldiers, businessmen, fathers, daughters, and lovers, the spirit of quantification is very much alive. Human and material value are measured and calculated, feelings are contained and expressed, characters manipulate others and are, themselves, manipulated, and, ultimately, comedy and tragedy are enhanced via mathematics in Shakespeare's plays.

In "From Shakespeare to Rabelais: What Would Life Be without Arithmetic?" John McClelland attempts to answer, for Shakespeare, the question posed in his title. The playwright, McClelland contends at his essay's end, thought that life without arithmetic "would be a lot richer, a lot more poetic, and a lot more fun" (33). On the contrary, in the following pages I will show that, like Dee, Recorde, and Hood, Shakespeare saw mathematics as both a practical tool and an imaginative power. I will not suggest that Shakespeare meant to promote the spiritual, philosophical, or scientific value of

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[16] Blank notes that the last four verbs in this list "occur with special frequency" in Shakespeare's works (477).

mathematics, as these three apologists do, or even that his vision of mathematics' usefulness and powerfulness was the same as theirs. But I will suggest that (whether purposely or not) Shakespeare weighed in on the debate over the value of mathematics which was in the air in early modern England by consciously using mathematical elements to make his plays – *Love's Labour's Lost*, *The Merchant of Venice*, and *King Lear*, especially – more poetic, more amusing, and, overall, dramatically richer.

Chapter Two

Love's Labour's Lost and the Language of Mathematics

Near the end of Shakespeare's *Love's Labour's Lost*, Mote[1] pokes fun at the linguistic exhibitions of Nathaniel, Holofernes, and Armado. "They have been at a great feast of languages and stolen the scraps," the page remarks to the clown, Costard (5.1.34-35). Notably, Mote's phrase falls naturally back onto the drama, which, as many have pointed out, is, itself, "a great feast of languages." In "*Love's Labour's Lost* and the Critical Legacy," Felicia Hardison Londré observes that "Euphuism" – the "effort to explore and expand the possibilities of the English language through rhyming, antithesis, alliteration, . . . and lexical borrowing from classical Greek, Latin, and contemporary foreign languages" – was a "courtly fad" which "peaked in 1578." She notes that "[w]ith its numerous examples of the movement's characteristic verbal conceits (including the most rhymed lines in any Shakespeare play), *Love's Labour's Lost* is a textbook example of Euphuism" (6). Of course, many critics have commented on "the play's concern with language and how to do things with words" (Woudhuysen 19). Walter Pater, for example, suggests that the play's plot is strikingly subordinate to its word power, writing that "[t]he merely dramatic interest of the piece is slight enough – only just sufficient, indeed, to be the vehicle of its wit and poetry" (66). Thomas R. Price remarks that "there is not perhaps in literature any other work of a great poet that contains within so small a

[1] For the sake of consistency, I have adopted the Norton edition's name-spellings. For a concise account of variants, pronunciations, and spellings of all of this play's characters' names, see Woudhuysen, pp. 109-10. For a helpful summary of "[t]he two main arguments about the spelling and pronunciation of Armado's Page's name" (Woudhuysen 342), in particular, see Woudhuysen's "Appendix 3," pp. 342-45.

compass so vast a variety of tricks with words." Sixteen of the play's eighteen characters "may fairly be called punsters," he points out, "and the dialogue at all stages of the action is sparkling and flashing from all sides with puns" (71).[2] William C. Carroll argues that "*Love's Labour's Lost* is not just a play filled with languages," but "a play radically concerned with the very nature of language – with its history, its potential, its proper use by the imagination" (11).

Despite critics' apparent fascination with Shakespeare's treatment of language in this early comedy, however, little attention has been paid, specifically, to one of the languages with which the playwright is clearly preoccupied in *Love's Labour's Lost* – the language of mathematics. How, one might ask, does this language function in the drama? In what ways is it similar to and in what ways different from the play's other languages? What comic effects stem from Shakespeare's characters' usage of mathematical terms and elements? In answering these questions, I will inspect several examples of businesslike precision, numerical fluidity, and "numerical dubiety" (Booth 66) in this play. I will position this comedy's mathematical entertainments within an emerging cultural interest in arithmetical and other "mathematical amusements" (Zetterberg 73), and then examine riddles and witticisms which play on and link numbers and words. Finally, I will consider number's effect on what Stephen Booth calls "that ultimate violation of norms" (76): the inconclusive status of *Love's Labour's Lost*'s ending.

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[2] Price counts almost two hundred and fifty "noteworthy" word-plays in *Love's Labour's Lost*, which he distributes among the play's sixteen "punsters." Price points out that "[t]he only characters that do not play with words are the Forester and Lord [Mercadé]. To them the poet gives the chance to say but a word, and they manage to say that word, simply and gravely, without a pun" (71-72).

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Love's Labour's Lost is full of what Fisher refers to as "'hard' number and 'soft' word," as well as words which "contain both (hard) numerical and (soft) narrative senses" (23). Fisher takes care to clarify the differences between the former two of these three categories. Words she describes as "hav[ing] a certain plasticity, the ability to project multiple meanings and to express subjective conditions" (24). "Unlike numbers," Fisher asserts, "words are eminently flexible, multidimensional, and capable of ironic twists and ambiguities; they have an uncanny ability to *sustain paradox*" (Fisher's emphasis 25). Numbers, on the other hand, are essentially words' opposite:

> The most elementary use of number in language is to express measure and quantity with precision. By convention, number signifies absolute values. It is the most concrete, most abstract, most constant, most inflexible, most rigidly invariable component of language. . . . We can count on it. Absolutely. (24)

Although *Love's Labour's Lost* serves as a testament to the ultimate malleability of words, the play begins with precision in the form of the King of Navarre's exact and exacting "statutes" (1.1.17). Of prime importance to the comedy's plot is the fact that three of the King's lords – Biron, Dumaine, and Longueville – have agreed "to live and study" (1.1.35) with him at his court, transformed into "a little academe, / Still and contemplative in living art" (1.1.13-14), for a period of three years. There are, however, "other strict observances" (1.1.36) which, the King insists, must be met: "As not to see a woman in that [three year] term" (1.1.37); "one day in a week to touch no food, / And but

one meal on every day beside" (1.1.39-40); "And then to sleep but three hours in the night, / And not be seen to wink of all the day" (1.1.42-43).

Longueville highlights the difficulty of the second rule in this list as he attempts to downplay it: "I am resolved" (1.1.24), he states before signing Ferdinand's "schedule" (1.1.18) and, thus, fully committing to the precepts. "'Tis but a three years' fast. / The mind shall banquet, though the body pine" (1.1.24-25). Biron clearly objects to all three of these regulations, but specifically points out that, heretofore, he "was wont to think no harm [to sleep] all night / And make a dark night too of half the day" (1.1.44-45). In each of these two commentaries, number is emphasized. Longueville works to make three years seem a short length of time. Later, he continues this effort, remarking: "Costard the swain and he [Armado] shall be our sport, / And so to study three years is but short" (1.1.177-78). Biron, on the other hand, underscores the unreasonable nature of the measures proposed by the King. "O, these are barren tasks, too hard to keep," he declares. "Not to see ladies, study, fast, not sleep" (1.1.47-48). Afterwards, he accentuates the length of three years by breaking the original unit of time into smaller parts as he pledges to "bide the penance of each three years' day" (1.1.115). The implied quantity, here, breaches a thousand, and Biron's mental reckoning of the large number of days' penance he must endure in Navarre's academe is a sign of his pained anticipation of the time to come.[3]

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[3] I disagree with H. R. Woudhuysen's argument that, although Biron "means he will endure every day in the three years, . . . it is possible to understand him as also saying that the three years will seem like a day" (29-30). Woudhuysen suggests that this "feeling is strengthened" by Longueville's comment on the study period's shortness (30), but it seems to me that the two characters are meant to have opposing visions of the coming

On the heels of this remark, Biron discovers that the King has not only forbidden his studying partners from conversing with or wooing women, but has also taken pains to limit their opportunities to (literally) see any member of the opposite sex. Only four days earlier (as Longueville explicitly notes), the King "proclaimed" that "no woman shall come within a mile of [his] court . . . [o]n pain of losing her tongue" (1.1.119-22). Moreover, Biron learns that "if any man be seen to talk with a woman within the term of three years, he shall endure such public shame as the rest of the court can possible devise" (1.1.128-30). Notably, the King's penchant for absolutes lands him into some trouble on these two points. Biron is forced to remind the apparently absentminded Navarre of the coming of "[t]he French King's daughter . . . About surrender-up of Aquitaine / To her decrepit, sick, and bedrid father" (1.1.133-36). The King, in return, admits that he is obligated to see and speak with the Princess and to lodge her, at the very least, near his court.[4] The King's fickle behaviour prompts Biron's subsequent prediction – "Necessity

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study term.

[4] The matter of the King's final attitude towards these two oaths concerning women is somewhat confusing. After Biron brings the Princess's visit to the King's attention, the King concludes, "We must of force dispense with this decree. / She must lie here, on mere necessity" (1.1.145-46). The King seems determined to do away with both statutes. Shortly after the Princess arrives "[o]utside the gates of the King's court," however, Boyet informs her:

> He [Navarre] rather means to lodge you in the field,
> Like one that comes here to besiege his court,
> Than seek a dispensation for his oath
> To let you enter his unpeopled house. (2.1.86-89)

This sentiment is echoed by the King himself when he comes face to face with the Princess. Although he welcomes her "to the court of Navarre" (2.1.90) he refuses her request, "Conduct me thither" (2.1.95), with the response, cut short by the Princess, "Hear me, dear lady. I have sworn an oath–" (2.1.96). The King sums up his position on the matter later in the scene:

will make us all forsworn / Three thousand times within this three years' space" (1.1.147-48). In one sense this projection is hyperbolic, as Woudhuysen suggests (27), but in another sense it seems more than possible, given the rate at which oaths are already being broken in this play.

Money matters involving Aquitaine, discussed at length by the Princess and the King of Navarre near the play's beginning, serve as a second example of businesslike precision and quantification in *Love's Labour's Lost*.[5] There are two key numerical values in the France-Navarre debate. The first (though never explicitly stated) is *two* hundred thousand crowns – the "entire sum / Disbursèd by [the King of Navarre's father] in [the King of France's] wars" (2.1.129-30). The second, and frequently mentioned, figure is *one* hundred thousand crowns.[6] According to my reading, the King of France claims to have paid his total debt to Navarre in two separate installments of one hundred

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> You may not come, fair princess, within my gates,
> But here without you shall be so received
> As you shall deem yourself lodged in my heart,
> Though so denied fair harbour in my house. (2.1.170-73).

It seems, then, that the King dispenses with the edict that he and his lords not see or speak to a woman for a three year term, but holds fast to his other rule, that no woman come within a mile of his court, by devising a plan to lodge the Princess and her ladies outside of the court's gates in tents set up in his park. Given the fact that the King has decided to disregard one oath, his fixation on not being forsworn with respect to the Princess's lodgings seems rather hypocritical.

[5] "*Businesslike*," as Crosby notes, "means careful and meticulous and, in practice, is a matter of numbers. It was one of the trails that led to science and technology insofar as its practitioners were quantitative in their perception and manipulation of as much of experience as could be described in terms of quanta" (200).

[6] Woudhuysen notes that "the hundred thousand crowns are mentioned four times in the course of the King's speech (2.1.128-52) and they are but half of the principal sum involved" (28).

thousand crowns. Along with the alleged first hundred thousand crown payment (which Navarre, in passing, claims that neither he nor his father actually received [2.1.131-32]), France offered "[o]ne part of Aquitaine" as "surety" for the payment of the second hundred thousand crowns (2.1.133-34).[7] The King of France maintains that the second installment of one hundred thousand crowns was paid to Navarre, but Aquitaine was not returned as expected. According to the King of Navarre, however, the second hundred thousand crowns was never repaid by France.

Kristian Smidt argues that the Princess is sent by the King of France to "pres[s] Navarre to buy Aquitaine for money which was originally loaned to [her] father" (qtd. in Londré 6), and John Turner suggests that the Princess and her ladies aim "to take back again the half that has already been once repaid of a debt owed by France to Navarre and to forfeit instead the possibly overvalued territories in Aquitaine that had been laid in surety against that debt" (qtd. in Londré 6). I would argue, however, that the Princess is sent by her father to Navarre with a choice for the King: he must either yield up Aquitaine or return the King of France's second payment of one hundred thousand crowns.[8] Navarre declares that, if the Princess is able to prove that France has "faithfully . . . paid" (2.1.155) the second hundred thousand crown installment, he'll "repay it back / Or yield

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[7] The King of Navarre makes it a point to note that Aquitaine is not actually "valued to the money's worth" (2.1.135). He later informs the Princess that he "much rather had depart" with the land "[a]nd have the money by our father lent, / Than Aquitaine, so gelded as it is" (2.1.145-46).

[8] Given Biron's earlier account of the reason for the Princess's visit to Navarre, quoted above, and Boyet's statement that France's "plea" (i.e., his claim) is "of no less weight / Than Aquitaine, a dowry for a queen" (2.1.7-8), it seems that the Princess's father would rather have Navarre return his land than refund his hundred thousand crowns.

up Aquitaine" (2.1.157-58). The Princess readily accepts this challenge, and orders Boyet to "produce acquittances / For such a sum from special officers / Of Charles, his [Navarre's] father" (2.1.159-61).[9]

Londré claims that "[b]ecause the text offers so few references to the business aspect of the Princess's visit, and because there is no historical basis for a transaction between France and Navarre involving Aquitaine, it is difficult to see what this is about" (6). In the most general of senses, this money and land dispute is "about" consequential quantification and computation. During their business discussion the Princess's and Navarre's attentions are focused on issues of worth, debt, and payment. Woudhuysen asserts that "*Love's Labour's Lost* dwells on the question of how much things amount to, both in the sense of how much they add up to and to what they are equivalent in value or significance" (27). Indeed, the Princess and Navarre are preoccupied with such topics, here. How much money has been lent to France? How many crowns are owed to the Princess's father? How many to Navarre? What is the value of Aquitaine? These and other such questions are raised in the Princess-Navarre debate. Some are answered right away and without disagreement. As for the others, one must assume that the Princess, with her "packet" of receipts "and other specialties" (2.1.162-63), proves right in the end.[10]

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[9] Boyet is unable to produce these receipts upon the Princess's command, but promises the King of Navarre: "Tomorrow you shall have a sight of them" (2.1.164). It is, of course, this delay which, at least initially, keeps the Princess in Navarre.

[10] As many have pointed out, the matter is presumably resolved offstage, for near the play's end the Princess thanks the King "[f]or my great suit so easily obtained" (5.2.721).

Both Navarre's statute-making and oath-taking concerns and the business with Aquitaine are relatively serious matters in which mathematics (via number, measure, and/or calculation) is involved. In each instance, characters aim for precision, and, in each, mistakes are made, and misunderstandings occur. In the first of these cases number is mainly stable. In the second, however, mathematical wrangling results in at least an initial semi-confusion. Here, number seems more fluid. Values seem more unstable and, thus, open to negotiation and change.

This is a sentiment with which *Love's Labour's Lost* plays. Costard's sentencing after being discovered by Armado "'Sorted and consorted, contrary to [Navarre's] established proclaimed edict and continent canon" (1.1.246-47) with "the weaker vessel" (1.1.255), Jaquenetta, serves as an interesting example of measure's inconstancy in this play. Costard's "obscene and most preposterous" (1.1.232-33) encounter with the "base wench" (1.2.54) – which, humorously, takes place in a mock precise location: "north-north-east and by east from the west corner of [the King's] curious-knotted garden" (1.1.235-36) – calls for some form of punishment. "It was proclaimed a year's imprisonment to be taken with a wench" (1.1.270-71), Navarre informs the offender. Yet Costard's sentence, when the King "pronounce[s]" it, is not so bad as that. "You shall fast a week with bran and water," Navarre declares (1.1.279-80), and appoints Don Armado to be his "keeper" (1.1.282). However, when the constable, Dull, turns Costard over to Armado with what he claims are instructions from Navarre, the clown's sentence is different: "Sir, the Duke's pleasure is that you keep Costard safe, and you must suffer

him to take no delight, nor no penance,[11] but a must fast three days a week" (1.2.113-15). Dull's inattention to the numerical element of the King's punishment contributes to a sense of number's fluidity in *Love's Labour's Lost*.

On various occasions number leads to confusion in this play, for characters often have trouble performing simple arithmetical operations. Armado is admittedly "ill at reckoning" (1.2.38). His excuse – "it fitteth the spirit of a tapster" (1.2.38) – is arguably an affected dig at a skill in which he is so clearly deficient.[12] When the braggart is unable to provide the solution to the elementary mathematical problem "How many is one, thrice told?" (1.2.37) – or, in other words, What is 1+1+1? – Mote designs an impromptu arithmetic lesson for him. Using gaming terms with which, as he suspects, the "refinèd traveller of Spain" (1.1.161) is familiar, he draws the correct answer – three – out of his student:

> MOTE. . . . I am sure you know how much the gross sum of deuce-ace amounts to.
>
> ARMADO. It doth amount to one more than two.
>
> MOTE. Which the base vulgar do call three.
>
> ARMADO. True. (1.2.42-46)

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[11] Dull's use of the word "penance," here, is (as the Norton editors point out) a comical slip, possibly for the word "pleasance" (1.2.115*n*).

[12] Booth writes: "[W]e scorn Armado for pretending – and bothering to pretend – general class-based superiority to arithmetic: to know and use the multiplication tables is not therefore to resemble a publican figuring up a bill" (67).

In this roundabout way, Armado learns that three ones are three. He later makes use of this lesson in a love letter to Jaquenetta, in which he proudly counts King Cophetua's triumphs in the matter of wooing "the penurious and indubitate beggar Zenelophon" (4.1.64-65): "[H]e it was that might rightly say '*Veni, vidi, vici*', which to annothanize in the vulgar . . . *videlicet* 'He came, see, and overcame.' He came, one; see, two; overcame, three" (4.1.65-69).

In like manner, Costard demonstrates his ability to count to three in an "enumerative speech" (Hasler 176) in which he answers Biron's query as to how his meeting with Jaquenetta was brought to light: "In manner and form following, sir – all those three," the clown declares. "I was seen with her in the manor house, sitting with her upon the form, and taken following her into the park; which put together is 'in manner and form following'" (1.1.200-03). Here, Costard combines the three words "manner," "form," and "following" into a single phrase as easily as he separates and numbers them as three distinct actions. Yet, his mathematical expertise ends here. Halfway through *Love's Labour's Lost*'s final scene, in a discussion with Biron over the number of Worthies taking part in the pageant of the Nine Worthies prepared for the Princess by Holofernes et al., Costard challenges his superior's claim that "three times thrice is nine" (5.2.488):

COSTARD. Not so, sir, under correction, sir, I hope it is not so.

You cannot beg us, sir. I can assure you, sir, we know what we know.

I hope, sir, three times thrice, sir –

BIRON. Is not nine?

COSTARD. Under correction, sir, we know whereuntil it doth amount.

BIRON. By Jove, I always took three threes for nine.

COSTARD. O Lord, sir, it were pity you should get your living by reck'ning, sir.

BIRON. How much is it?

COSTARD. O Lord, sir, the parties themselves, the actors, sir, will show whereuntil it doth amount. (5.2.489-99)

Costard's personal solution to this multiplication problem is never revealed to Shakespeare's audience, and the pageant's actors never succeed in representing three times three Worthies. This is in part because of what happens during the performance – the audience's mocking, the quarrel which occurs between Costard and Armado, and the entrance of the messenger Mercadé with news of the King of France's death for the Princess – and in part because, as Sir Arthur Quiller-Couch and John Dover Wilson point out, "Holofernes shares with the other 'worthies' a curious incompetence in arithmetic: they cannot tell their own number when they get together" (xxxi*n*).

Indeed, the clown informs Biron that there are only "three Worthies" (5.2.486) and "everyone pursents three" (5.2.488) – the fuel for their above debate – although there are, and have been from the entertainment's inception, five pageant actors in total. Moreover, when Holofernes doles out the pageant's roles near the end of the final act's first scene, he never accounts for nine Worthies.[13] Nathaniel is assigned to play

[13] Woudhuysen notes that "Holofernes' initial casting of the pageant is clearly unsatisfactory in Q: '*Iosua*, your selfe, my selfe, and this gallant Gentleman *Iudas Machabeus*;'" (5.1.118-19*n*). I have adopted the emendation of this passage first

Joshua,[14] Armado Hector, Costard Pompey, and Mote Hercules. The schoolmaster, himself, takes on the role of Judas Maccabeus, and when Armado inquires as to who will represent "the rest of the Worthies" (5.1.119) – his arithmetical abilities are apparently advanced enough for him to notice that the number of total pageant parts exceeds the number so far distributed – Holofernes promptly volunteers: "I will play three myself" (5.1.120). (For this Holofernes becomes, to Mote, a "[t]hrice-worthy gentleman!" [5.1.121]. The page "can do the sum," as Woudhuysen observes [28]). If one takes this statement as the pedant's bid to play three Worthies in addition to the one he has already signed up for, eight Worthies have been established. If, however, one reads this as Holofernes' offer to play three Worthies in total, only seven Worthies have been accounted for.[15]

Like Holofernes and Costard, the King himself has obvious trouble getting the relationship between five actors and nine Worthies straight. After listing the five cast

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suggested in the Oxford edition of the play (and accepted by the Norton editors): "Joshua, yourself; myself, Judas Maccabeus; and this gallant gentleman, Hector" (5.1.107-8). This reading "is based on Proudfoot's suggestion that either 'and this gallant Gentleman' or '*Iudas Machabeus*' was misplaced by the compositor and that '*Hector*' was omitted – the error arising from interlineation or through its being a marginal addition" (Woudhuysen 5.1.118-19*n*).

[14] In the show, Nathaniel actually plays Alexander.

[15] If, rather than the Oxford emendation, one accepts the emendation of Q supported by Woudhuysen – which necessitates "the omission of 'my selfe, and'" (5.1.118-19*n*) so that the text reads: "Joshua, yourself; this gallant gentleman, Judas Maccabeus" – the designation of pageant parts varies, but the fact that Holofernes fails to hand out all nine roles does not. In this reading, the role of Joshua is assigned to Nathaniel, Judas Maccabeus to Armado, Pompey to Costard, and Hercules to Mote. When Holofernes' promise to represent three Worthies is taken into account, only seven Worthies have been cast.

members and their parts for his fellow audience-members, Navarre announces: "And if these four Worthies in their first show thrive, / These four will change habits and present the other five" (5.2.528-33). The King's emphasis on the number four in these two lines renders his mistaken count hard to miss, and Biron loses no time before confronting his ruler with the error. Only the briefest battle of wits ensues, since the lord is so clearly in the right:

> BIRON. There is five in the first show.
>
> KING. You are deceived, 'tis not so.
>
> BIRON. The pedant, the braggart, the hedge-priest, the fool, and the boy,
>
> Abate throw at novum and the whole world again
>
> Cannot pick out five such, take each one in his vein. (5.2.534-38)

Unlike Navarre, Biron emphasizes the proper number of actors, five, and even connotes the numbers five and nine through a reference to novum, a "dice game . . . in which the main throws were five and nine – like the five actors playing the Nine Worthies" (5.2.537*n*).

Dramatically, characters' mathematical failures – such as the counting mishaps of the King, Costard, Holofernes, and Armado – are comic affairs. In fact, during these scenes the playwright is likely to pull able-witted audience-members into participating in the play's flurry of calculations. For example, during Costard's tirade on three threes, members of the audience are liable to tally the answer in their own heads to be sure that Biron is, indeed, correct, and as Biron recounts the five Worthies for the King (perhaps

reckoning the number on his fingers) audience-members are likely to cipher the sum along with him.

Woudhuysen argues that numbers' "reality is insisted on by their being beyond the wit of some of the people in the play to calculate," and, more specifically, that "[t]he simple reality of numbers in relation to words is represented by how hard sums are" (27). These statements are accurate with respect to number in its abstracted or ideal state (i.e., the reality of the number nine is insisted on despite, or perhaps even because of, Costard's inability to believe that it is the product of three threes). However, it is important to note that, in the reality of the *play*, numbers often take on a decidedly "unreal" quality because various characters are unable to use them properly. Since numbers periodically prove inconstant and are often applied incorrectly – in other words, since one cannot "count on" numbers as they are used in this comedy – they must be continually questioned rather than blindly accepted as precise measurements throughout *Love's Labour's Lost*.

Critics of *Love's Labour's Lost* have generally read its mathematical elements in conjunction with a number of topical allusions, to which I will now turn my attention. In *A Study of* Love's Labour's Lost, Frances A. Yates writes:

> Everyone is agreed that *Love's Labour's Lost* is one of the most topical of all Shakespeare's plays, that it bristles throughout with allusions to contemporary events and to living persons, and innumerable are the efforts which have been made to explain its meaning in terms of the dramatist's environment. (2)

Among the drama's "most discussed" allusions are (in no particular order) "the Gray's Inn revels . . . during which appeared a masque of Muscovites similar to that in Shakespeare's play; anti-Spanish sentiments in the figure of Don Armado; . . . the pamphlet war between Gabriel Harvey and Thomas Nashe" (Brown 37*n*6); and the play's "attack on the 'School of Night'" (Woudhuysen 70).[16] The last of these is to a "supposed . . . secret atheistical, philosophical and scientific academy, the chief source for English Copernicanism and a precursor of Baconian scientific investigation." It was presumably headed by Sir Walter Raleigh and comprised of "writers like Christopher Marlowe, George Chapman and Matthew Roydon as well as the mathematician and astronomer Thomas Harriot, the translator John Florio, the Spanish educationalist Juan Luis Vives and the Italian intellectual Giordano Bruno" (Woudhuysen 70).[17]

When critics have commented on *Love's Labour's Lost*'s wealth of mathematical references, it has been primarily in connection with theories about Shakespeare's satire of this rival group.[18] Quiller-Couch and Wilson note that the School of Night's "members

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[16] The phrase "Schoole of night" appears in a remark made by the King of Navarre in the play's fourth Act. It has, however, been suggested that the expression may be "no more than a misprint in quarto and Folio" (Woudhuysen 72) and should be emended. See Strathmann for details.

[17] Strathmann argues that "there is no independent evidence – no evidence stronger than 'a critic's own proclivities of belief' – to establish the Q reading 'Schoole of night' as an allusion to Ralegh and his associates" (186). However, Eric C. Brown observes that "it has become a critical commonplace that *Love's Labour's Lost* to some extent satirizes Sir Walter Raleigh's coterie of intellectuals" (21).

[18] Shakespeare was apparently affiliated with "an opposing group allied to the Earls of Essex and Southampton; it included the writers John Eliot and Thomas Nashe" (Woudhuysen 70).

affected astronomy and mathematical calculations" (xxxi). They then draw attention to the fact that "[n]one of the fantastics in this play can count, even upon their fingers" and that "this particular inability is more than once matter of burlesque" (xxxi*n*). After supporting this claim with the examples discussed above, these editors assert: "That these passages play insistently on *somebody's* mathematical pretensions (well known to the audience) is surely evident" (xxxi*n*). Yates is much more explicit: "The allusions to heaven's lights, to mathematical calculations, to a 'School of Night' – indeed the whole pretentious plan with which Navarre sets out of making his court a 'little academe'" are all "to be explained, according to this [the 'School of Night'] theory, as a mocking attack on the pretensions of the learned Releigh group" (7).

I do not seek to disprove these arguments. However, I would suggest that there is a larger mathematical atmosphere surrounding *Love's Labour's Lost*, and that observations about mathematics in this play need not be inextricably bound to theories about the "School of Night." I would point out that *Love's Labour's Lost* is the product of a society in the midst of a revaluation of mathematics, and that the play dramatizes the Renaissance's preoccupation with measurement. Moreover, I would draw readers' attentions towards the emerging cultural interest in arithmetical and other "mathematical amusements" in sixteenth- and seventeenth-century England.

According to Zetterberg, "As mathematics was defended for its utilitarian power, so too was it proclaimed for its recreative value" (93). Zetterberg writes of "mirrors which distort the image in a variety of comical ways" (45), "knives poised delicately on the lips of cups, and conceited drinking glasses, as well as displays of fireworks and

waterworks" (47). These are samples of what Hendrik van Etten "characterize[s] as 'mathematicall recreations'" (Zetterberg 47) in his text of the same name.[19] However, despite the sensational nature of each of these examples, not all of van Etten's mathematical amusements are quite so marvelous. In fact, "[t]o the gadgets and devices of these mathematical arts, geometry and arithmetic themselves added a variety of puzzles and tricks" (Zetterberg 47). Listed under the seventy-sixth "problem" in the table of contents of van Etten's work are eleven "pleasant questions by way of Arithmetike," including "*Of the number of souldiers that fought before old Troy*," "*Of the number of Crownes that two men had*," "*About the houre of the day*," "*Of Pythagoras Schollers*," "*Of the number of Apples given amongst the Graces and the Muses*," and "*Of a Mans Age*" (*5). These are all mathematical "story problems" (Zetterberg 97), and the first is a fairly straightforward multiplication exercise:

> *Homer* being asked by *Hesiodus* how many *Grecian* Souldiers came against *Troy*, who answered him thus; the *Grecians*, said *Homer*, made 7 *fires* or had 7 *Kitchin*s, and before every *fire*, or in every *Kitchin* there was 50 *broaches* turning to rost a great quantitie of *flesh*, and each *broach* had meate enough to satisfie 900 men: now judge how many *men* there might

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[19] *Récréations mathématiques* was published in French in 1624. The fifth edition was translated into the English tongue and published in England in 1633 as *Mathematicall Recreations* (Zetterberg 71-73). "It was very popular with English readers," Zetterberg observes, and "a second edition appeared in 1653, a third in 1674" (73). It is important to note that van Etten considered his work "a Collection of sundrie *Problemes*, extracted out of the Ancient and Moderne *Philosophers*" (A2[?]). He cites "Socrates, Plato, Aristotle, . . . Pythagoras, . . . [and] Euclides," among others, as his sources (A5v). In doing this, he draws attention to the fact that societies, from ancient to modern times, have participated in mathematical recreations.

> be. Answere, 315,000. that is, *three hundred and fifteene thousand men*, which is cleare by multiplying 7 by 50, and the product by 900 makes the said 315000. (K4)

The arithmetical questions included in van Etten's volume are of varying degrees of difficulty, and this is, surely, one of the simpler ones. Problem number forty-six is much more difficult: "*To finde a number which being divided by 2 there will remaine 1, being divided by 3, there will remaine 1; and so likewise being divided by 4, 5, or 6. there would still remaine 1: but being divided by 7, there will remaine nothing*" (F3). The smallest answer is 301, "to which continually adde [4]20, and you have other *numbers* which will doe the same" (F3v).[20] Thus, 721 and 1141 work as well.[21] In addition to these two types of problems, there are also "[m]ind-reading feats" – "a popular kind of arithmetic recreation" (Zetterberg 96) also included in Humfrey Baker's *The VVellspryng of sciences* (1568), which devotes its "fiueth" and final chapter to "sportes, and pastime, done by number" (X6v).

Calculating and solving mathematical problems, then, was a popular form of recreation for some Renaissance citizens. Zetterberg observes that "science" in general (which, of course, includes mathematics), "quite simply, was fun – fun for those beset with Jacobean melancholy or the boredom of the upper classes, who found it to be a refreshing activity, fun for those otherwise troubled by religious rancor and civil war, who

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[20] The text states that the number to be added is 220, not 420, which is clearly an error.

[21] 721 is the first riddle-solution offered in the text, at which the author arrives by multiplying 2, 3, 4, 5, and 6 and adding the remainder one.

found it to be a pleasing diversion" (121). Thus, it does not seem at all unreasonable to suggest that, in *Love's Labour's Lost*, Shakespeare was having his own kind of fun with mathematics – that he was dealing with mathematics in a dramatic forum where he could play with it.

Although Shakespeare does not include, in *Love's Labour's Lost*, mathematical riddles of the exact kind highlighted above from van Etten's and Baker's works, critics have noted the presence of riddles rooted in number in this comedy. First, following Armado's, Mote's, and Costard's conversation about "[s]ome enigma, some riddle" and its "*l'envoi*" (3.1.62) is a demonstration of these two concepts centered on mathematics. Armado begins with the riddle, which he later refers to as "the moral" (3.1.76): "The fox, the ape, and the humble-bee / Were still at odds, being but three" (3.1.74-75). Next, Mote literally "add[s] the *l'envoi*" (3.1.77): "Until the goose came out of door / And stayed the odds by adding four" (3.1.80-81).[22] The illustration is supposed to be for Mote, who thinks *l'envoi* is "a salve" (3.1.70) although it is, according to Armado, "an epilogue or discourse to make plain / Some obscure precedence that hath tofore been sain" (3.1.70-71) – in other words, the answer to a riddle. However, the riddle morphs into a second arithmetic lesson for the braggart – "a counting rhyme . . . meant to teach Armado what three plus one comes to" (Woudhuysen 27). Like a true teacher Mote, after the first run-through of the riddle and *l'envoi*, instructs Armado, "Now will I begin your moral, and do you follow with my *l'envoi*" (3.1.82-83). The rhyme is rehearsed again, with each

[22] In this context, "four" clearly means "a fourth" (3.1.81*n*).

character taking the other's original part so that, this time, Armado performs the arithmetical operation.[23]

Three of the play's riddles provide a crucial link between word and number in this play. First, the dialogue between Mote and Armado which surrounds the latter's first arithmetic lesson accentuates number as part of a riddle/word-play. In response to Armado's declaration, "I have promised to study three years with the Duke" (1.2.34), Mote asserts, "You may do it in an hour, sir" (1.2.35) – a mathematically puzzling mission. When the braggart maintains that such a task is "[i]mpossible" (1.2.36), the page sets out to prove him wrong. After helping Armado study the number "three" as a concept in and of itself – the product of one counted three times – Mote reveals the verbal trick which lies at the riddle's heart. "Why, sir, is this such a piece of study?" he asks his student, rhetorically. "Now here is 'three' studied ere ye'll thrice wink, and how easy it is

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[23] Yates proclaims that "[t]here is probably a memory of some jargon familiar to the 'School of Night' in this and other passages hinting at 'number'" (99). Yet, it seems to me at least as likely that arithmetic rhymes functioned as teaching tools/games in the period. Thomas Hylles' *The Arte of vulgar arithmeticke*, published in 1600, includes (as the text's title page notes) arithmetical "Rules, Precepts, and Maxims . . . *composed in meeter for the better retaining of them in memorie*" (A1). The author writes that "it is well known, that the same arte, or the most part therof, is already extant in Latin verses long agon, by a learned Mathematician our own countrim[an] *D. Buckle*" (B2). The connection between mathematics and verse, Hylles suggests here, is not a new one. Moreover, he notes that, "as there is no one arte more generally necessarie for all degrees, nor more commonly vsed among men, so is there none more slippery or apter to be forgotten, where it is not either c[on]tinually practised, or the rules fixed in a very firme and retentiue memorie" (B2). Although Hylles versifies mathematical rules and methods and not colorful examples of elementary computation, his insistence on the usefulness of what one might call "mathematics in meter" is significant and, in my opinion, lends support to the possibility that rhymes such as that involving the "humble-bee" in *Love's Labour's Lost* were a playful and more popular version of educational/recreational metrical math.

to put 'years' to the word 'three' and study 'three years' in two words, the dancing horse[24] will tell you" (1.2.47-50).[25] The number three is a fixed mathematical element in this witty illustration, and its status as the "hard" one of the two words ("three years") which Mote "jokingly takes . . . as the object of 'study'" (1.2.50*n*) rather than the period of study is significant. Yet, "three" is also a mere word with which Mote can play as he does with the measure "years." Moreover, Armado's response – "A most fine figure" (1.2.51) – is a word-play with mathematical overtones. In one sense it functions as a comment upon the mathematical figure, or number three, which he has just been taught (and for which he has seemingly developed a certain amount of respect). In another, it serves as a compliment on the page's impressive "verbal turn" (1.2.51*n*).

Second, Dull poses a riddle to Holofernes and Nathaniel in the play's fourth Act: "What was a month old at Cain's birth that's not five weeks old as yet?" (4.2.32). Like Mote's riddle, the puzzle presented here by the constable is mathematically confounding. The numbers simply do not add up. What, one must ask, does not age a single week in hundreds of years? Holofernes' immediate answer – "*Dictynna*, Goodman Dull, *Dictynna*, Goodman Dull" (4.2.33-34) – is later rephrased: "The moon was a month old when Adam was no more, / And raught not to five weeks when he came to five score"

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[24] According to the Norton editors this is a reference to "Morocco, a performing horse trained to 'count' with its hooves" which "was a London sensation in 1591" (5.1.50*n*). Notably, the existence of such a horse serves as a foil to the common notion that the ability to number distinguishes man from beast.

[25] Woudhuysen notes that "the play puns on the two senses of telling, as in telling a story or a lie and as in counting" (30). See Fisher, pp. 25-26, for an exposition of the similarities between the "narrative and quantitative senses" (Fisher 25) of the word.

(4.2.37-38).[26] For those unfamiliar with the trick, Dull reveals the riddle's key soon after: "the moon is never but a month old" (4.2.43-44). This is, of course, because of the moon's cycles and the monthly birth of a new moon. Although number is the most essential ingredient in making this puzzle particularly puzzling, a purely practical, mathematical approach would prevent one from discovering its solution. As Woudhuysen puts it, "Dull's riddle . . . shows how numbers, language and time can be duplicitous" (29), especially when they work together.

Third, in his "extemporal epitaph on the death of the deer" (4.2.46-47), Holofernes plays with a series of words (and one letter) that have numerical meanings:

> The preyful Princess pierced and pricked a pretty pleasing pricket.
>
> Some say a sore, but not a sore till now made sore with shooting.
>
> The dogs did yell; put 'l' to 'sore', then 'sorel' jumps from thicket –
>
> Or pricket sore, or else sorel. The people fall a-hooting.
>
> If sore be sore, then 'l' to 'sore' makes fifty sores – O sore 'l'!
>
> Of one sore I an hundred make by adding but one more 'l'. (4.2.53-58)

Here, Holofernes refers to three different deer: a pricket, a sore, and a sorel. Each deer connotes a different number based on his or her age – a pricket is a "[b]uck in its second year" (4.2.11*n*), a sore a "[d]eer in its fourth year" (4.2.54*n*), and a sorel a "buck in its third year" (4.2.55*n*). Yet, although the schoolmaster's poem emerges from a discussion between himself, Nathaniel, and Dull on the wounded deer's age, these numbers now

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[26] Holofernes substitutes his own "Adam" for Dull's original "Cain." This does not affect the riddle's meaning, as Holofernes, himself, points out when he notes, "Th'allusion holds in the exchange" (4.2.39).

become secondary to the number of deer Holofernes is able to "make" out of the original "one." The pricket is transformed into a sore on account of being in pain after it is shot. By adding the letter "l" to the word "sore," Holofernes ends up with a sorel – which is either a deer of a different age or fifty sores (because the letter "l" also functions as the Roman numeral for fifty). By adding yet another "l" – another fifty – Holofernes finishes with one hundred sores. His is a "rare talent" (4.2.59), as Nathaniel points out, to draw one hundred from one. The pedant agrees, and credits the epitaph to "a gift that I have, simple, simple – a foolish extravagant spirit full of forms, figures,[27] shapes, objects, ideas, apprehensions, motions, revolutions" (4.2.61-63).

Woudhuysen calls Holofernes' poem the play's "most elaborate joke about numbers" and suggests that "the point of it is that numbers can be as arbitrary or symbolic as words and are open to being played with in just the same way" (28). I agree with this analysis, but believe that Woudhuysen understates the link between number and word established by Holofernes, here. In fact, the connection between mathematics and language is particularly pointed in this instance because Holofernes alludes to number's origin in the alphabet.[28] He reminds his audience that letters are the foundation for both numbers and words – that the former need not be treated differently from the latter. Both, as he proves, are open to manipulation.

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[27] By "figures" Holofernes probably means both numbers and figures of speech.

[28] For both the Greeks and Romans numbers were letters. Although Hindu-Arabic numerals (the numbers 0-9) had gained widespread acceptance by Shakespeare's time, Roman numerals were, of course, still in use.

All of the play's references to verses as "numbers" occur after (and strengthen) this linkage between number and language. First, the schoolmaster, himself, criticizes Biron's sonnet as "only numbers ratified" lacking in "the elegancy, facility, and golden cadence of poesy" (4.2.114). "I fear these stubborn lines lack power to move" (4.3.50) Longueville says, next, of the sonnet he has written for Maria, and threatens, "These numbers will I tear, and write in prose" (4.3.52). Biron refers to the sonnets of the King, Longueville, and Dumaine as "fiery numbers" which "the prompting eyes / Of beauty's tutors have enriched [them] with" (4.3.296-97), and, in a slightly different vein, Rosaline makes reference to the numbers within the numbers (i.e., meters) of the "verses" (5.2.34) she has received from Biron. She judges "[t]he numbers true" but declares: "were the numb'ring, too, / I were the fairest goddess on the ground. / I am compared to twenty thousand fairs" (5.2.35-37). Poetry, then, is numbers (i.e., verses), is made of numbers (i.e. "metrical numbers and feet" [Woudhuysen 30]), and can include numbers (i.e., numerals) for added effect.

Like words, as Rosaline shows in this last example, numbers can be used for the purpose of exaggerating. Further examples of this application in the play include Catherine's claim that she has received, from her admirer Dumaine, "[s]ome thousand verses of a faithful lover. / A huge translation of hypocrisy" (5.2.50-51) and Maria's assertion that her letter from Longueville is "too long by half a mile" (5.2.54). Numbers are also used in a figurative sense when Biron declares that Rosaline's beauty is such that "[a] withered hermit fivescore winters worn / Might shake off fifty, looking in her eye" (4.3.238-39). Moreover, when Mote insults Armado, aside, for not knowing what three

ones amount to by calling him "a cipher" (1.2.52) he supplies *Love's Labour's Lost* with a potent mathematical metaphor. Here, the braggart is deemed a zero, a nothing, a no-wit for his arithmetical inabilities. Later, Mote repeats this critique after demonstrating that Armado loves Jaquenetta "'by' heart," "'in' heart," and "'out' of heart" (3.1.34-36). "I am all these three" (3.1.38), Armado admits, before Mote mumbles in another aside: "And three times as much more, and yet nothing at all" (3.1.39-40).

Indeed, worth is reckoned by various characters throughout this comedy. Costard's preoccupation with the value of his "remuneration" (3.1.120) from Armado is a prime example of this. The word "remuneration" is a general term synonymous with payment or compensation which takes on a specific numerical value when the clown recalls that it is "the Latin word for three-farthings" (3.1.126). Costard immediately turns his attention towards what he might buy with the money: "Three-farthings – remuneration. 'What's the price of this inkle?' 'One penny.' 'No, I'll give you a remuneration.' Why, it carries it! Remuneration! Why, it is a fairer name than French crown" (3.1.126-28). Soon after, he inquires of Biron, "Pray you, sir, how much carnation ribbon may a man buy for a remuneration?" (3.1.132-33), and thanks the lord for his clear-cut answer – "three-farthing-worth of silk" (3.1.136). When Biron gives Costard a "guerdon" (3.1.155) the clown's level of excitement increases significantly. He compares its worth to his remuneration right away: "Guerdon! O sweet guerdon! – better than remuneration, elevenpence-farthing better[29] – most sweet guerdon! . . . Guerdon – remuneration" (3.1.156-58).

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[29] If Costard has computed correctly, Biron has given him one shilling (3.1.157*n*).

The Princess's worth, however, is a much trickier subject. When Boyet attempts to compliment her by pointing out that "nature . . . did starve the general world beside" by presenting her with every "grac[e]" (2.1.9-12), the Princess expresses her dissatisfaction: "I am less proud to hear you tell my worth," she informs him, "Than you much willing to be counted wise / In spending your wit in the praise of mine" (2.1.17-19). The mathematical senses of telling and counting are central to understanding the Princess's unfavourable reaction, here. Clearly, she considers Boyet's assumption that her worth can be reckoned an insult. The King, on the other hand, has the right idea in implying that the Princess's worth is infinite. "O Queen of queens," he writes to her, in verse, "how far dost thou excel, / No thought can think nor tongue of mortal tell'" (4.3.36-37).

Near the play's end, in the scene in which the masked Princess and her ladies "mock" (5.2.139) the disguised King and his lords, mathematics is the source of much wit and word-play. Each exchange between wooed and wooers involves some witty reference to quantity. The discussion between Rosaline (disguised as the Princess), the King, and Biron revolves around the word "measure." When the King instructs Boyet, "Say to her we have measured many miles / To tread a measure with her on this grass" (5.2.183-84), he is speaking figuratively. Rosaline, however, picks up on the word's mathematical meaning, and refutes his claim: "It is not so," she retorts, and charges Boyet to "[a]sk them how many inches / Is in one mile. If they have measured many," she contends, "The measure then of one is easily told" (5.2.87-89).[30] Biron chimes in with a

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[30] Rosaline purposely plays on the word "told," here. She pretends to expect the men to have "counted" (or be able to count in their heads, on the spot) the number of inches in one mile, and also to "express" that number (which, in fact, is 63,360) to her. This task

practical excuse: the Muscovites cannot "tell" (5.2.191) how many inches make up one mile because they measured their miles not by inches but, rather, "by weary steps" (5.2.193). Rosaline, however, "refuses to be put off by this inexactitude" (Woudhuysen 29), and demands that they tell her "[h]ow many weary steps . . . [a]re numbered in the travel of one mile" (5.2.194-96). In the face of this second perplexing order, Biron delivers an ingenious answer: "We number nothing that we spend for you. / Our duty is so rich, so infinite, / That we may do it still without account" (5.2.197-99). The suitors, he claims, need not keep track of the deeds they do for their ladies since the service they offer is unlimited. Later, Rosaline closes the discussion with number, as she bids "adieu" to the King – "Twice to your visor and half once to you" (5.2.226-27). As the Norton editors suggest, the King's "masked . . . (double) face deserves two farewells" whereas the King, himself, merits "less than one (for behaving so foolishly)" (5.2.227*n*).

The dialogue between the Princess and Biron is quite short, but almost entirely consumed by mathematical bandying:

> BIRON. White-handed mistress, one sweet word with thee.
>
> PRINCESS. Honey and milk and sugar – there is three.
>
> BIRON. Nay then, two treys, an if you grow so nice –
> Metheglin, wort, and malmsey – well run, dice!
> There's half-a-dozen sweets.

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is, as Rosaline surely knows, virtually impossible.

PRINCESS. Seventh sweet, adieu. (5.2.230-34)[31]

Clearly, the Princess sets the discussion's tone when she takes both the words "sweet" and "one" literally.[32] After she provides the first set of three sugary words, Biron catches on. He changes his mind and requests a second set of three sweets, bringing the total to six. The seventh, and last, word (the Princess keeps an accurate account) is, of course, the lady's good-bye. The Princess resolves to "play no more" with Biron (5.2.235), but when he requests "[o]ne word in secret" (5.2.236) she consents. Interestingly, in his use of the quantity "one" again, the lord obviously repeats his original mistake. The Princess's response – "Let it not be sweet" (5.2.236) – suggests that another exchange immersed in number is impending. Dumaine's and Maria's dialogue is the shortest of the four, but it begins along the same lines as the Princess's and Biron's discussion. Arguably, it develops to the side in a similar manner.[33]

Finally, Longueville is as concerned with doubles and halves as Rosaline. He tells Catherine, "You have a double tongue within your mask, / And would afford my

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[31] This numerically-concerned banter takes up five of Biron's and the Princess's eight-line-long conversation.

[32] Similarly, earlier in the play Boyet pays particular attention to the number one when he turns Longueville's "desire" for Maria's name into a mathematically troubling affair. "She hath but one for herself," he replies, and "to desire that were a shame" (since, if obtained, the lady would be left with none, herself) (2.1.199-200).

[33] As in the Princess's and Biron's conversation, the number of words uttered is highlighted here. Dumaine opens with, "Will you vouchsafe with me to change a word?" (5.2.238). Maria directs him to "[n]ame it," and then stops him after "[f]air lady" (5.2.239-40). This is in part because he has spoken more than the one word he was given permission to speak, and in part because she wants to stay true to her promise and give him back his words' equivalent – "[f]air lord" (5.2.239).

speechless visor half" (5.2.245-46) in an effort to keep her from talking overmuch and to convince her to remove her mask (5.2.246*n*). Later, after a short discussion of the meaning of the word "'Veal'" (5.2.247) during which the two disagree, Longueville suggests "part[ing] the word" (5.2.249) or reaching a "compromise" (5.2.246*n*). This Catherine interprets as a reference to division (5.2.249*n*), and informs him, "No, I'll not be your half" (5.2.249).

The playful literalness of the Princess and her ladies in these instances is transformed, at the play's end, into a more serious precision reminiscent of the King of Navarre's statute-making at the opening of *Love's Labour's Lost*'s. The Princess (now turned Queen) orders the King "[t]o some forlorn and naked hermitage / Remote from all the pleasure of the world," where he must "stay until the twelve celestial signs / Have brought about the annual reckoning" (5.2.777-80) if he wishes to win her hand in marriage. Catherine promises to "mark no words that smooth-faced wooers say" for "[a] twelvemonth and a day" (5.2.804-05). If, she claims, Dumaine comes to France with the King after such a period, she will give him the indefinite "some" of her "much love" (5.2.806-07). Maria pledges to Longueville: "At the twelvemonth's end / I'll change my black gown for a faithful friend" (5.2.810-11) and, lastly, Rosaline insists that Biron "jest a twelvemonth in an hospital" (5.2.848) for her love, emphasizing the "day to day" (5.2.827) commitment he must make to this cause.

I would suggest that number effects the play's final inconclusiveness in two, somewhat opposing, ways. On the one hand, this comedy's often playful approach to number (for example, its instances of numerical fluidity and its staging of situations in

which simple arithmetical operations are performed incorrectly or lead to elaborate debate) contributes to what Booth calls the "*Love's Labor's Lost*-like failure to arrive at a rationally predictable conclusion" (69) which is epitomized in the play's ending. In other words, when one cannot depend upon a comedy's characters to count to five or multiply three times three and come up with the correct and logical solution, the notion of "predictable conclusions" begins to unravel. In this sense, the play's numerical dealings anticipate and prepare the audience for Biron's disappointed statement, "Our wooing doth not end like an old play / Jack hath not Jill" (5.2.851). Yet, on the other hand, the prescribed "year and a day of the lords' separation from their ladies" (Woudhuysen 29) tempers *Love's Labour's Lost*'s indeterminacy, for these precise measures offer a strict timeline for future resolution.[34] Hence, the King's response to Biron's discomfort: "Come, sir, it wants a twelvemonth an' a day, / And then 'twill end" (5.2.854-55).

Yates cites Aristophanes' *Birds*, in which the playwright "laughs at the sudden passion for science amongst the Athenians of his day," as a "Greek precedent for mocking at scientists, and all their 'measuring' and 'numbering', in a satirical comedy" (99). She argues that Shakespeare exhibits "a similar attitude to scientists" in *Love's Labour's Lost*, and concludes that "these two great comic geniuses thought independently along the same lines when confronted by similar situations" (100). I would agree that, at times, Shakespeare treats his characters' mathematical tendencies – their preoccupations with

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[34] Woudhuysen argues that the waiting period imposed on the lords by the ladies "is both a precise legal formulation and a romance length of time signifying for ever" (29). I disagree with his latter implication that, through the ladies' decision to put off the Jacks' having of their Jills, the play defers resolution entirely.

numbers, enumeration, and simple arithmetical operations, for example – with a certain amount of "mockery-merriment" (5.2.138). However, it seems to me that Shakespeare deals with this "science" in much more than a merely satirical manner. Blank suggests that "[i]n Shakespeare's poems and plays, the terms and elements of mathematics rival language itself as an expressive system" (476). In *Love's Labour's Lost*, mathematics is its own language. At times, its terms and elements are "hard" and dominate the drama. Yet, in many instances, these terms and elements are more word-like, more pliable, and they intersect with the other languages of the play. Mathematics is the source of businesslike computation and precision, but also presents itself in riddles, rhymes, puns, and metaphors. Ultimately, it is treated by Shakespeare as a "signifying system" (Blank 476) open to being played with, and a creative force to be reckoned with.

Chapter Three

The Merchant of Venice and the Mathematics of Containment

"Containment," as D. Jerry White notes, "is a theme that has received some attention from Shakespearean critics in the last three decades" (9). For example, there are "sociological studies of containment and class structure, new historical studies of subversion and containment through the festive elements of the plays," and "gender criticism on the containment of female erotic power" (White 9). Each of these studies, as White points out, "explore[s] the repressive cultural implications" of Shakespeare's plays via the "metaphor" of containment (9). In another vein there is White's own research, which deals with "a much smaller topic" (9): the "wordplay on contentment and containment" (12) in *The Merchant of Venice* and *Measure for Measure*. Here, the author suggests that being "conTENT" (i.e., satisfied) in these two plays is linked to being "CONtent" (i.e., "that which is contained") (White 9).

I propose to consider the motif of containment in *The Merchant of Venice* from a very different perspective. In the following pages, I will examine the play's mathematical elements – calculation, equation, numerical quantities (for example, "three thousand ducats" and "one pound"), non-numerical quantities ("all" and "nothing"), non-specific and relational amounts ("more," "less," and "something"), and geometrical shape (circularity). In large part, I will adapt Fisher's paradigm for looking at *King Lear*'s mathematical elements for my consideration of *The Merchant*. I will, to apply Fisher's words on *King Lear* to this play, explore the "entire calculus" of *The Merchant of Venice* – "its choice of sign and symbol, its emotional economy, its computation of identity, its

balance of proportion and disproportion, in a word, its *reckoning*" (Fisher's emphasis 35). I will suggest that many of these elements are used for the purpose of "containing" on two separate levels in this comedy: first, they are employed by various characters within the play to contain such things as risk and revenge in addition to other characters; and, second, they structure the play, itself, and, in effect, contain its "affective content" (Fisher 35).[1]

Before delving into these two applications of *The Merchant of Venice*'s mathematical elements, however, it would, perhaps, be useful, first, to comment briefly upon the relationship between containment and measurement, and, second, consider instances of precision and measurement in this play which are not directly related to characters' containment efforts.

I will illustrate below that, in many instances, the very attempt to measure or evaluate a "thing" in *The Merchant of Venice* is, essentially, an attempt to contain either the measured thing, itself, or a related thing or character. In such instances, quantitative specification is, undeniably, an effort (or part of an effort) to set limits, or place bounds, on an "other."[2] Granted, however, this is not always the case, for the comedy is peppered with measurements and other mathematical elements that contribute, in a more sweeping sense, to the play's atmosphere of quantification and computation. It is this broad

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[1] This idea of a mathematical structuring which serves to contain a drama's emotion is also taken from Fisher's study of *King Lear*.

[2] For the sake of clarity, I use this term to represent the various things and characters which are contained in *The Merchant of Venice*.

numerical and computational environment that I want to examine in considerable detail first, in preparation for considering mathematical containment in *The Merchant*.

I will begin with the occupations of two of this comedy's major characters and the play's setting. The fact that the merchant, Antonio, and the moneylender/usurer, Shylock are employed in trades which require that they spend a significant amount of time and energy quantifying and calculating is an important detail when it comes to considering *The Merchant*'s mathematical climate.[3] So is the related fact that the play is set primarily in Venice. In general, "Europe's mercantile development from the thirteenth century onward placed increased importance on an understanding of, and proficiency in, commercial arithmetic" (Swetz 15). However, Venice in particular was held as the

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[3] Much criticism of *The Merchant of Venice* has dealt with sixteenth-century English attitudes towards mercantilism and usury, with frequent attention being given to anti-usury sentiments in the Renaissance. According to Kiernan Ryan, "[f]or [Christian] Enzensberger the text cunningly dramatises and solves a subordinate conflict of the period – mercantilism versus usury – as if it were the main conflict of society" (37). Walter Cohen, in "*The Merchant of Venice* and the Possibilities of Historical Criticism," pinpoints the chief difference between merchants and usurers when he notes that "[t]he distinction between" the two figures "could be drawn on the grounds that only the former operated for mutual benefit, as opposed to self-interest" (48). Moreover, the merchant's affairs involved considerable risk, whereas the usurer's "return on his money" was "guaranteed" (Cohen 48). With these differences in mind, critics have studied the merchant and usurer as opposing figures. Enzensberger, for instance, ultimately "diagnose[s]" *The Merchant* "as an allegory of the triumph of merchant capitalism over the reactionary practice of usury" (Ryan 37). Yet, Cohen points out that "[w]riters of the period register both the medieval ambivalence about merchants and the indisputable contemporary fact that merchants were the leading usurers" (49). He, therefore, observes: "It may be that Shakespeare intends a covert parallel between Shylock and Antonio" (49). Karen Newman also argues for a connection between merchant and usurer in *The Merchant of Venice* when she suggests that "[t]he merchant of Shakespeare's title is ambiguous; it applies literally to Antonio, but also characterizes Shylock, and indeed all the play's action" (117). Of course, from a purely mathematical standpoint, Antonio and Shylock are very much alike since each, as I have suggested above, earns his living by computing with numbers.

mathematical nucleus of Europe. In *Capitalism and Arithmetic: The New Math of the 15th Century*, Frank J. Swetz points out that "[b]y the fifteenth century, Venice's commercial ventures had made it the trade capital of Europe, and one of the richest cities of the known world" (7). This was, in large part, due to Italian advancements in commercial mathematics. As Swetz notes, "Early, during their rise to commercial supremacy, the Italians, and particularly the Venetians, realized the importance of the use of arithmetic in their daily business transactions" (11). Italians "adapted new mathematical techniques for their commercial interests" and even "became innovators" in the business field, to boot (Swetz 12). In fact, Italy was the birthplace of "what we call double-entry bookkeeping" (Crosby 206). The technique was devised around the beginning of the fourteenth century by Italian accountants, and introduced to the world in print in 1494 in Luca Pacioli's seminal work, *Summa de arithmetica, geometria, proportioni et proportionalita* (Crosby 210-16).[4] Unsurprisingly, Venice became well-

[4] Crosby suggests that "[t]he immediate significance of double-entry bookkeeping was that it enabled European merchants, by means of precise and clearly arranged records kept in terms of quantity, to achieve comprehension and, thereby, control of the moiling multitude of details of their economic lives" (208). This strikes me as an excellent example of mathematical containment although, unlike David Bady, I see no specific references to the technique in *The Merchant*. In "The Sum of Something: Arithmetic in *The Merchant of Venice*," Bady suggests that Portia "enact[s] a financial ritual" in the play – "the statement of audit" (23). He argues that Portia evaluates herself, Bassanio, and their marriage by "debit" and "credit" – the familiar terms of double-entry bookkeeping. It is important to note that these terms do not actually appear in *The Merchant of Venice*, although they can be found in *Othello*. Rather, Bady locates narrative forms of these principles in the comedy – for example, he points out that "Bassanio's value is a *debitum*" when he offers "worse than nothing" to Portia (25). For Bady, the fact that Portia "submit[s] to the account book" is a fundamental part of her "acceptance of Venetian calculation" in Belmont (30). I find Bady's claim that Portia practices a kind of identity and relationship accounting in Shakespeare's play intriguing, but am ultimately skeptical of his assertion that *The Merchant* contains an intricate

known as "one of the best places in the world to study mathematics" (Crosby 211).[5] *The Merchant*'s Italian setting, then, represents an "advanced" commercial, computational culture (Cohen 50). It points to practical businessmen, and especially to merchants, who, by the late 1590s (when Shakespeare was writing this play), had been "teaching humanity how to be businesslike" for a number of centuries (Crosby 200). It represents the daily site of a "torrent of transactions" (Crosby 200) – a world of number-crunching and money-matters which was even more commercially developed than the London Shakespeare's audience-members knew firsthand (Cohen 50).

These mathematically-concerned impressions of Italy are fleshed out in the text of *The Merchant of Venice*, which (as I have already suggested) is saturated with mathematical elements. In particular (to borrow Lisa Hopkins' characterization of *King Lear*), *The Merchant* "is a play obsessed with numbers" (32). Fisher suggests that an author's use of number "to designate quantity and measure . . . or to lend an actual or stylistic precision to a description" is "unexceptional" (12). It is, as she points out, merely part of a "mode" that "is both informative and methodical: it supplies direct information of a quantitative nature and is received by the reader as such" (12). In *The*

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double-entry bookkeeping plot. I am equally doubtful of the critic's contention that Shakespeare's audience-members – even "gentlemen preparing at the Inns of Court, shopkeepers and their journeymen, courtiers involved in the operations of the Exchequer, [and] merchants" (Bady 26) – would identify Portia's evaluations of self and other with an attempt to "balance" the proverbial "books" (25).

[5] According to Swetz, "[t]he climate of mathematics and mathematics education in Italy was of such excellence that it attracted students from all over Europe" (13). In fact, "[f]rom the fourteenth century on, merchants from the north travelled to Italy, particularly to Venice, to learn the *arte dela mercadanta*, the mercantile art, of the Italians" (Swetz 10).

Merchant of Venice there are certainly standard numerical applications. A handful of examples should suffice: Graziano cautions Lorenzo (who has just complained that he must be a "dumb wise" man since "Graziano never lets [him] speak" [1.1.106-7]), "Well, keep me company but two years more / Thou shalt not know the sound of thine own tongue" (1.1.108-9); Morocco refers to "a Persian prince / That won three fields of Sultan Suleiman" (2.2.25-26); Lancelot alludes to "the sisters three" (2.2.54); Portia is "half afeard" that a Messenger "spend'st such high-day wit in praising" the newly arrived "ambassador of love," Graziano, only because they are related (2.9.91-97); Portia notifies Lorenzo that she and her waiting woman, Nerissa, intend to "abide" at "a monastery two miles off" until Bassanio and Graziano return from Venice (3.4.31-32); and the Duke sends "some three or four" to "give [Balthasar] courteous conduct" to the Venetian court (4.1.146). Some number or other is employed in each of these instances, but these amounts are basically unremarkable. In each of these cases number blends in, attracting (and deserving) little or no attention. In other words, these statements simply contain common, informative, and ultimately perfunctory "number words."

Yet, in most cases, number is more notable and central to the play's mathematical tone. For example, Shakespeare makes use of number for characterizational purposes. Early in the play's first Belmontian scene, for instance, Portia defines one of her personal shortcomings in numerical terms. After pointing out that "to do" is not "as easy as to know what were good to do" (1.2.11), she openly admits to Nerissa, "I can easier teach twenty what were good to be done than to be one of the twenty to follow mine own teaching" (1.2.13-15). This is a personalized mathematical translation of the notion that

"[t]he brain may devise laws for the blood, but a hot temper leaps o'er a cold decree" (1.2.15-16). Earlier, following a rather meaningless remark of Graziano's ("silence is only commendable / In a neat's tongue dried and a maid not vendible" [1.1.111-12]) and Antonio's confused response, "Yet is that anything now?" (1.1.113), Bassanio describes and passes judgment on his friend with the help of number: "Graziano speaks an infinite deal of nothing, more than any man in all Venice. His reasons are as two grains of wheat hid in two bushels of chaff" (1.1.114-16). Here, Bassanio illustrates that Graziano's "sensible remarks" (1.1.115*n*) exist, but are remarkably few in number (especially when compared to his "infinite" foolish utterances). As an extension of this, he notes that "you shall seek all day ere you find them [Graziano's reasons], and when you have them they are not worth the search" (1.1.116-18).

Number is also key in establishing a sense of demand for Portia. Her suitors, it seems, are as numerous as Graziano's silly comments. Bassanio informs Antonio that "[t]he four winds blow in from every coast / Renownèd suitors . . . And many Jasons come in quest of her" (1.1.168-72), while the heiress, herself, complains, "Whiles we shut the gate upon one wooer / Another knocks at the door" (1.2.112-13). Nerissa "overname[s]" (1.2.31) six "princely suitors that are already come" (1.2.30) to win her lady, before informing Portia that she "need not fear . . . the having any of these lords" since they have decided not to partake in her father's casket test (1.2.84-88). Portia responds favourably to this news, expressing her delight that "this parcel of wooers are so reasonable" (1.2.91). In this statement, the word "parcel" could be read simply as "group" ("Parcel," *n.* Def. 6a). Its "depreciative" meaning – "A bunch, a load, a pack"

("Parcel," *n.* Def. 6b) – could even be key in this instance.[6] However, "parcel" might hold a special arithmetical meaning, here. Blank points out that Shakespeare uses the word in *Antony and Cleopatra* and *A Lover's Complaint* "in reference to a number as part of a series of numbers, a usage also found in Recorde" (479*n*). Given the play's emphasis on the string of suitors which Portia has encountered (and which she feels she will, in the future, be obliged to meet with), she is likely tagging this particular group, mathematically, as a certain number of wooers which constitutes only a part of the larger sequence of suitors come to Belmont.

Moreover, direct ties are created between number and identity in this play. For example, shortly after this dialogue between Nerissa and Portia, a servingman enters with word of five other admirers, four departing and one approaching. "The four strangers seek for you, madam, to take their leave," he informs the heiress, "and there is a forerunner come from a fifth, the Prince of Morocco, who brings word the Prince his master will be here tonight" (1.2.103-4). Noticeably, four of these five are presented as nameless, their identity represented wholly by number. In her reply to the servingman, Portia completes the mathematical takeover – the displacement of name by number – by repeating the two figures her servingman has mentioned, virtually ignoring the Prince of Morocco as an individual suitor. She focuses on count over character, insisting, "If I could bid the fifth welcome with so good heart as I can bid the other four farewell, I should be glad of his approach" (1.2.107-9).

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[6] The *OED* cites Thomas Middleton as the first to use the term in this manner in 1607, although *The Merchant* might contain an earlier example of such an application.

When dealing with Bassanio, on the other hand, Portia represents herself numerically. Immediately before the favoured suitor tries his hand at the casket test, the heiress portions herself out to him, for the prodigal has (as she informs him in the following passage) performed a simple arithmetical operation on her with his eyes – he has "divided" her single self into two halves, conquering them both:

> Beshrew your eyes,
> They have o'erlooked me and divided me.
> One half of me is yours, the other half yours –
> Mine own, I would say, but if mine, then yours,
> And so all yours. (3.2.14-18)

In these mathematical terms, Portia articulates her feelings for Bassanio. This is a deed which she has had some trouble accomplishing, as her earlier attempt to convey her affections ("There's something tells me – but it is not love – I would not lose you; and you know yourself / Hate counsels not in such a quality" [3.2.4-6]) suggests.

Number also helps Graziano express himself. In the play's fourth Act, after Shylock is sentenced to "presently become a Christian" (4.1.381), Graziano taunts the Jew: "In christening shalt thou have two godfathers. / Had I been judge thou shouldst have had ten more, / To bring thee to the gallows, not the font" (4.1.394-96). The sum of ten and two, as Graziano knows, is twelve – the number of men required to make up a jury (4.1.395*n*). Here, then, Graziano uses number to express his hatred of Shylock, his wish to see the moneylender hanged for the attempted murder of Antonio, and what would have been his own mercilessness had he been in the Duke's powerful position.

Finally, and in a much lighter vein, numbers are employed for comic relief. Lancelot delivers his own palm reading, paying particular attention to exaggerated numbers in the process: "Go to, here's a simple line of life, here's a small trifle of wives – alas fifteen wives is nothing. Eleven widows and nine maids is a simple coming-in for one man, and then to scape drowning thrice, and to be in peril of my life with the edge of a featherbed – here are simple scapes" (2.2.145-49). The clown also objects to the fact that his father, Gobbo, has purchased a present for Shylock, in part because he claims that he has been "famished" in the Jew's "service" (2.2.93). "You may tell every finger I have with my ribs" (2.2.94-95), he points out, as proof. The declaration is comical, for instead of proposing a reckoning of his bare ribs on his fingers, Lancelot suggests tallying his ten fingers on his protruding bones.

Numbers are not, however, *The Merchant*'s only mathematical element. In the play's second act Bassanio assesses Graziano as "too wild, too rude and bold of voice" (2.3.102), and proposes that, if Graziano expects to accompany him to Belmont, he "take pain / To allay with some cold drops of modesty" his "skipping spirit" (2.3.166-68). Graziano promises to behave appropriately when the two have reached their destination, but protests: "I bar tonight. You shall not gauge me / By what we do tonight" (2.3.180-81). Here, Graziano uses the verb "gauge" in its figurative sense, as in "judge," but the term has clearer mathematical connotations: it signifies measurement.[7] In these lines, then, Graziano alludes to another of the play's mathematical preoccupations: measuring

[7] The term is defined, in part, in the *OED* as: "To ascertain by exact measurement the dimensions, proportions, or amount of" ("Gauge," v^1. Def. 2a).

men and women – their characters and, more frequently, their value (both monetary and human). As Bady notes, "On the Rialto, mercantile arithmetic even presumes to the Pythagorean privilege of defining virtue" (17).[8]

Indeed, the topic of "worth" is introduced only thirty-five lines into *The Merchant of Venice* when, summarizing the common worries of merchants, Salerio remarks upon "merchandise" (1.1.40) instantaneously ruined – "in a word, but even now worth this, / And now worth nothing" (1.1.35-36). Shortly after, upon the arrival of Bassanio, Lorenzo, and Graziano (i.e, "better company" [1.1.59]), Salerio turns his leaving Antonio's presence into a matter of relative worth: he notifies the "so sad" (1.1.1) trader, "I would have stayed till I had made you merry / If worthier friends had not prevented me" (1.1.60-61). Politely, Antonio refuses to accept such an explanation for Salerio's sudden departure. He offers a loose valuation of his modest friend's worth – "Your worth is very dear in my regard" (1.1.62) – and puts forth an alternate reason for Salerio's exit: "I take it your own business calls on you, / And you embrace th'occasion to depart" (1.1.63-64).

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[8] Bady observes that *The Merchant* "has often been credited with one important mathematical locus, Lorenzo's discourse on harmony" (14). The critic quotes from John M. Robinson's *An Introduction to Early Greek Philosophy* when claiming that Lorenzo's speech in *The Merchant*'s fifth act is "acknowledged even by classicists to be the 'purest' expression of 'the distinctly Pythagorean . . . identification of . . . ratios with the musical intervals'" (14). However, as Bady suggests, "[d]espite the Pythagorean Lorenzo . . . practical algorism is the mathematics of *Merchant*" (14), and "Shylock is not alone in attempting to compute the 'worth' of men, replacing the Good with the reckonable Sufficient" (14).

It is in this same scene that Bassanio begins what Bady identifies as "the repeated attempt to determine the worth of Portia" in *The Merchant* (22).[9] When Antonio requests that Bassanio straightforwardly acquaint him with what "may by [him] be done" for his friend (1.1.158-59) the prodigal launches into a description of Portia, in which he touches on both pecuniary worth and personal virtue:

> In Belmont is a lady richly left,
>
> And she is fair, and fairer than that word,
>
> Of wondrous virtues.
>
> . . . . . .
>
> Her name is Portia, nothing undervalued
>
> To Cato's daughter, Brutus' Portia;
>
> Nor is the wide world ignorant of her worth . . . (1.1.161-67)

Bassanio's "main argument," as Bady remarks, "is a textbook *comparatio*, ornamented with classical allusion" (18). Yet, his "classical rhetoric" is notably "contaminated, as we may suspect his motives are, by Venetian calculation" (Bady 19), for "the lover" has

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[9] Bady calls this the "'action'" of "a full-length 'plot' for *Merchant*" (22). He defines this plot's "dynamic" as "the step-by-step transformations of an equation," and its "trajectory" as "the discoveries and reversals characteristic of the 'witte' of sixteenth century algebrists" (22). I agree with Bady's contention that various characters in *The Merchant of Venice* concern themselves with the matter of Portia's worth, including Portia, herself, and that characters' attempts to define the heiress's value are mathematical in nature. However, I am dubious of this critic's location of an elaborate "arithmetical pattern" (13) in the play which links characters' efforts to pin down Portia's worth to each other and, ultimately, to what Bady dubs "the computational point of the Ring Trick" – Portia's so-called successful bid to "reduce the claim of 'Antonio's love' to zero" (26).

"chosen a 'quantitative' version of *comparatio*" (Bady 18). This is "pricing rather than praising" (Bady 18), measurement rather than compliment.

Bassanio makes another valuation of Portia later in the play, this time after having wed the desirable lady of Belmont. Shortly before "Balthasar" passes "sentence" (4.1.293) on the Jew, Bassanio informs his generous friend:

> Antonio, I am married to a wife
> Which is as dear to me as life itself,
> But life itself, my wife, and all the world
> Are not with me esteemed above thy life.
> I would lose all, ay, sacrifice them all
> Here to this devil, to deliver you. (4.1.277-82)

Here, the main topic of deliberation is Bassanio's opinion of Antonio's worth. Portia's value is used as a mere factor in establishing Antonio's even greater value. Since Portia's worth to Bassanio is equated with his estimation of "life itself," the sum of Antonio's worth to Bassanio is expressed as greater than "two Portias plus the world in its entirety." It is, perhaps, Bassanio's feelings of guilt, his sense of responsibility for the situation in which Antonio finds himself (which is to say, at the mercy of the steadfastly merciless moneylender), that provokes Bassanio's amplification of Antonio's value in relation to Portia's.[10]

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[10] Bady makes a similar point: "[W]hen the newlywed returns to Venice, he is worked upon by the pitiful spectacle of the trial, which inflates his friend's value relative to the marital claims of Portia" (13).

As Balthasar, Portia responds to Bassanio's above appraisal with an "acerbic aside" that "puts a lid on" her husband's "price inflations" (Bady 13) – "Your wife would give you little thanks for that" (4.1.284). An objection to her placement in Bassanio's affections (beneath Antonio's) is discernible in this line. Yet, in valuing herself (as herself) in an earlier scene, Portia is conscious of her shortcomings. On the heels of Bassanio's choice of the casket in which Portia's portrait is "contained" (2.9.5), the suitor's sight is "confirmed, signed, [and] ratified" (3.2.148) by the "thrice-fair lady" (3.2.146):

> You see me, Lord Bassanio, where I stand,
> Such as I am. Though for myself alone
> I would not be ambitious in my wish
> To wish myself much better, yet for you
> I would be trebled twenty times myself,
> A thousand times more fair, ten thousand times more rich,
> That only to stand high in your account
> I might in virtues, beauties, livings, friends,
> Exceed account. (3.2.149-57)

In this passage, Portia employs the term "account" in both noun and verb forms, establishing a linguistic connection between one's regard for another and the act of counting, of computing another's worth. As I have illustrated, above, Portia has been the object of a problem in division; here, she pictures herself in the midst of a multiplication exercise, for she wishes to be sixty times herself, a thousand times more beautiful, and ten

thousand times wealthier. If subjected to this arithmetical process, she imagines, her merits might surpass Bassanio's summing skills and, as a result, he might think more highly of her.

In order to fully grasp Portia's desire to "exceed account" one might turn to Shakespeare's *Romeo and Juliet*, in which the play's female title character informs Friar Laurence and Romeo: "They are but beggars that can count their worth, / But my true love is grown to such excess / I cannot sum up some of half my wealth" (2.5.32-34). Clearly, Portia (like Juliet) recognizes that one's inability to tally his or her own worth has positive implications – it signifies a very large, perhaps infinite, value. Fortunately for Juliet, her "wealth" is in such excess that she is incapable of counting even its half. Unfortunately for Portia, however, the idea of exceeding account amounts only to wishful thinking. The lady of Belmont concludes her above mathematical vision with the pointedly anticlimactic judgment, "But the full sum of me / Is sum of something which, to term in gross, / Is an unlessoned girl, unschooled, unpractisèd" (3.2.157-59). The conjunction "but" carries the bulk of the weight of Portia's regrettable admission, and is followed closely by her pun on "sum" and "some."

It is important to note that "the Folio editors changed Portia's phrase ["sum of something"] to 'sum of nothing,' apparently to underscore the contrast between Belmontian modesty and Venetian greed" (Bady 23). But although Portia refers to her "worthless self" (2.9.17) when acquainting Aragon with the rules of her father's casket test, there is no indication that she believes (or wants Bassanio to believe) that her worth amounts to "nothing." Indeed, on the contrary, Portia explicitly registers her own

satisfaction with her personal value in the above passage – she would not "wish" herself "much better" for her own sake, only for Bassanio's. Moreover, in her desire to be "better," Portia longs only to be many "times" what she already is. She need not (and, according to most modern editors, does not) reduce her worth to naught in order to exhibit a respectable amount of feminine Belmontian modesty. She merely evaluates her worth as "something" summable which, in and of itself, is a humble gesture. Bady's claim that "[f]or the moment, justness of accounting rather than fervor is the measure of her love" (23) is valid, here, in the sense that Portia refuses to exaggerate the "full sum" of herself, opting, instead, for a vague but "gross" narration of her worth.[11]

Bassanio appears to approve Portia's ambiguous value, "something," and add to it his own when, after accepting the ring she gives to him along with "[t]his house, these servants, and this same myself" (3.2.170), he refers, metaphorically, to a

> buzzing pleasèd multitude,
> Where every something being blent together
> Turns to a wild of nothing save of joy,
> Expressed and not expressed. (3.2.180-83)

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[11] Bady's observation that Portia "*resists* the desire to 'exceed account'" (emphasis added 23) seems, however, somewhat misdirected. In this, the critic places undue emphasis on Portia's agency. He implies that the heiress consciously decides not to transcend the limits of reckoning so that her "bookkeeping" (23) efforts will prove successful – in other words, so that "whatever her ultimate value," she will be "in balance with herself" (24). Yet, it seems to me that Portia indulges in her desire to "exceed account" when envisioning her virtues as innumerable, and is rather unwillingly transported back to reality when forced to confront her actual worth.

The subject of "expression" emerges later in *The Merchant*'s third act as part of a preamble to Jessica's equational valuation of Portia. When Lancelot prompts his wife's judgment – "And now, good sweet, say thy opinion: / How dost thou like the Lord Bassanio's wife?" (3.5.62) – Jessica replies immediately in the tradition of "the knowing orator's boast disguised as a confession of incapacity" (Bady 19): "Past all expressing" (3.5.62). What follows, however, is Jessica's mathematical expression of the heiress's worth:

> Why, if two gods should play some heavenly match
> And on the wager lay two earthly women,
> And Portia one, there must be something else
> Pawned with the other; for the poor rude world
> Hath not her fellow. (3.5.69-73)

Bady notices that "Jessica's formula is unmistakably a correction of [Bassanio's] first act balance of 'two earthly women'" – Belmont's Portia and Brutus' Portia (19). In truth, Bassanio has left ample room for Jessica's "arithmetical revision" (Bady 19) since he has merely asserted that the former Portia is not inferior in worth to the latter. Jessica's point is far more flattering than the prodigal's. Bassanio's wife, she suggests, is not only "not inferior" to Cato's daughter, she is superior to all mortal women. In modern mathematical terms, Jessica proposes, here, that "Portia = Another + 'something else'"

(Bady 10).[12] Bady's analysis of Jessica's equational definition of Portia's value is insightful: "Jessica adds the increment of her indefinite term, 'something else,' outdoing Bassanio's and all other possible comparisons. The arithmetical form she chooses provides her with both a precise equation and a reticent 'unknown,' allowing her to make good on the rhetor's boast that she will express what is 'past expressing'" (21).

Jessica's emendation to Bassanio's valuation of Portia suggests that the spendthrift is ultimately ignorant of his wife's true worth, a notion which the play expands upon when Bassanio rewards "Balthasar" for saving Antonio's life with the ring Portia has given him. At Antonio's bidding, Bassanio adds the lawyer's "deservings" to his merchant friend's "love withal" and allows this sum to "[b]e valued 'gainst [his] wife's commandëment" (4.1.444-45). When he bestows the ring upon "Balthasar," Bassanio reveals the startling result of his mathematical comparison: he has rated the combination of the lawyer's accomplishments and Antonio's love above Portia's directive.[13] His wife's chiding near the play's close is well-deserved, for it seems, indeed,

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[12] It is important to note that "[a]t the time *Merchant* was written, algebraic relations were still stated in 'rhetorical,' or at best abbreviated ('syncopated') form" (Bady 11). Although the "symbolism" applied, here, by Bady, for modern clarification "was the last 'modern' element to appear in algebra, not taking hold until the middle of the seventeenth century" (Bady 11), this is surely an accurate representation of Jessica's mathematical meaning.

[13] Bady clearly misinterprets this equation when he reads it as "Portia = Balthasar + Antonio" (21). In prodding Bassanio to "let [Balthasar] have the ring" (4.1.445), Antonio pushes the prodigal to conclude that "Portia's commandment < Balthasar's deservings + Antonio's love." As Peter Holland writes in "*The Merchant of Venice* and the Value of Money," "Antonio carefully balances the deservings and love on the one hand and the orders of a wife on the other, a deliberately unequal equation" (27). Bady's misconstrual of this mathematical assessment leads him to argue that Antonio works to "eve[n] the odds" (10) when, in fact, the merchant plainly strives to create unbalance, here.

that Bassanio has demonstrated his ignorance of "half her worthiness that gave the ring" (5.1.199). Presumably, Portia finally remedies this situation by informing Bassanio of her alter ego in Balthasar and, thus, doubling her worth in his esteem.

There are additional remarks upon human worth in *The Merchant*. Morocco laments that with "blind Fortune leading" him, he might "[m]iss that [i.e., Portia] which one unworthier may attain" (2.1.36-37). Later, as he "survey[s] th'inscriptions" (2.7.14) on the three caskets of the casket test, he undertakes a specific assessment of his own value. Lingering at "the silver with her virgin hue" (2.7.22), which he evaluates as "ten times undervalued to tried gold" (2.7.53), the Prince reads, "'Who chooseth me shall get as much as he deserves'" (2.7.23). He stays to ponder the riddle:

> 'As much as he deserves': pause there, Morocco,
> And weigh thy value with an even hand.
> If thou beest rated by thy estimation
> Thou dost deserve enough, and yet 'enough'
> May not extend so far as to the lady. (2.7.24-28)

Morocco tries to measure his own value fairly so that he might determine whether or not he is truly deserving of Portia. Though he expresses some hesitation about his worth here, he concludes soon after, "As much as I deserve – why, that's the lady!" (2.7.31). He then proceeds to justify his deserving with individual merits: "I do in birth deserve her,

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Moreover, Bady's mistake leads, ultimately, to his arithmetical "substitution" and "solution" theory (21), which is inapplicable in the absence of the equality he proposes between "Antonio and Balthasar" and "Portia."

and in fortunes, / In graces, and in qualities of breeding; / But more than these, in love I do deserve" (2.7.32-34).

Bassanio, on the other hand, is less up-front about his worth. Just as he inflates Antonio's value, as discussed above, Bassanio overstates his own financial status when he first reaches Belmont. After receiving notice of Antonio's mercantile misfortunes, Bassanio is forced to admit to Portia that he has misrepresented his (lack of) wealth:

> Gentle lady,
> When I did first impart my love to you
> I freely told you all the wealth I had
> Ran in my veins: I was a gentleman;
> And then I told you true; and yet, dear lady,
> Rating myself at nothing, you shall see
> How much I was a braggart. When I told you
> My state was nothing, I should then have told you
> That I was worse than nothing . . . (3.2.251-59)

Bassanio's reappraisal of his finances ("My state was nothing") is simultaneously a self-assessment ("Rating *myself* at nothing" and "*I* was worse than nothing"). Breaking through the lower limit, "nothing," Bassanio properly locates his worth in the red. Luckily for the wastrel, Portia is wealthy enough that she is entirely indifferent to his absence of riches and his indebtedness to Antonio. She offers, willingly, to settle the merchant's debt to Shylock, jesting with her husband-to-be, "Since you are dear bought, I will love you dear" (3.2.312). Portia, perhaps, "remember[s]" that Bassanio was "worthy

of [Nerissa's] praise" in the play's first act (1.1.100-1), and, despite his poor spending habits and his mathematically negative self-appraisal, deems him worthy of becoming her husband.

The above discussion of *The Merchant*'s mathematical climate, from its Italian setting to its preoccupation with number, sums, equations, measurement, and human worth, has been prepared as a prelude of sorts to the following analysis of Shakespeare's use of mathematical elements for the purpose of containment. Arguably, this comedy's concern with all things mathematical culminates in its characters' utilization of mathematical elements to contain an "other" – for example, a situation, a particular action, or a character.

The "'clocking'" (Fisher 12) that takes place in *The Merchant*'s second act serves as a suitable starting point for this discussion. It is Bassanio who first expresses a concern about the time, when he instructs one of his men to "let it be so hasted that supper be ready at the farthest by five of the clock" (2.2.101-2). Yet it is Lorenzo and his friends who count the clock, computing the hours available for preparing and executing their plot to sneak Jessica out of Shylock's house while the Jew is "feed[ing] upon / The prodigal Christian" (2.5.14-15). "[W]e will slink away in supper-time, / Disguise us at my lodging, and return / All in an hour" (2.4.1-3), Lorenzo schemes with Graziano, Salerio, and Solanio. In response to his partners' concerns, such as Graziano's "We have not made good preparation" (2.4.4), and Solanio's "'Tis vile, unless it may be quaintly ordered, / And better in my mind not undertook" (2.4.6-7), Lorenzo calculates, "'Tis now but four o'clock. We have two hours / To furnish us" (2.4.8-9). Afterwards, Salerio and

Graziano keep tabs on Lorenzo's lateness. "His hour is almost past" (2.6.2) remarks the former, before the latter observes that "it is marvel he outdwells his hour, / For lovers ever run before the clock" (2.6.3-4). The risk involved in "play[ing] the thieves for wives" (2.6.23) is contained in these scenes by characters' attention to time and, more specifically, their ability to perform simple time-related calculations.

Risk is controlled in *The Merchant of Venice* via mathematics in various other cases. For instance, the "childhood proof" (1.1.144) offered by Bassanio as grounds for his deserving another loan from Antonio has the air of a controlled experiment. The prodigal declares:

> In my schooldays, when I had lost one shaft,
> I shot his fellow of the selfsame flight
> The selfsame way, with more advisèd watch,
> To find the other forth; and by adventuring both,
> I oft found both. (1.1.140-44)

Holland's rejection of this "argument" as "doubly unconvincing" is fair. "[F]irstly," he writes, "it is simply an account of a frequent, but not consistent, solution ('I *oft* found both'); secondly, it is simply a false account of effective archery, for the schoolboy who mistakes his aim will be unable to replicate the mis-shot on any but the rarest of occasions" (18). Nevertheless, Bassanio gives this analogy a tone of mathematical precision through the restated term "selfsame." In describing the two metaphorical arrows as being exactly the same in "size and weight" (1.1.141*n*) and as being fired in exactly the same direction, Bassanio works to limit the element of chance involved in the

archery test and, by extension, the risk inherent in loaning money to a profligate who is already burdened with "great debts" (1.1.128).

Of course, as a merchant, Antonio is accustomed to calculating risk. He practices "the defensive tactic of hedging [his] bets" (Crosby 200) in an effort to contain his gambles. "My ventures are not in one bottom trusted, / Nor to one place; nor is my whole estate / Upon the fortune of this present year" (1.1.42-44) he informs Salerio, who worries that "Antonio / Is sad to think upon his merchandise" (1.1.39-40). Furthermore, when Shylock, in "kindness" (1.3.139), proposes an unusual "forfeit" (1.3.144) during talk of Antonio's borrowing three thousand ducats – "an equal pound / Of your [Antonio's] fair flesh to be cut off and taken / In what part of your body pleaseth me" (1.3.145-47) – the merchant embraces it. Although Bassanio bids that he reject the offer – "You shall not seal to such a bond for me. / I'll rather dwell in my necessity" (1.3.150-51) – Antonio comforts his penniless friend with calculations:

> Why, fear not, man; I will not forfeit it.
>
> Within these two months – that's a month before
>
> This bond expires – I do expect return
>
> Of thrice three times the value of this bond. (1.3.153-55)

Thus, Antonio decides, via computation, that there is no real risk in "seal[ing] to" Shylock's "bond" (1.3.148). With a month of payment-time left to spare, he figures, he will bring in 27,000 ducats. This would enable him to pay his debt to the Jew nine times over. Despite these reassuring numbers, Bassanio's anxiety lingers. Yet, his cautionary "I like not fair terms and a villain's mind" (1.3.175) is disregarded by Antonio. "In this

there can be no dismay," the merchant reminds him in the spirit of quantification and control. "My ships come home a month before the day" (1.3.176-77).

Like Antonio, Shylock, in his position as moneylender, is required to assess and contain risk. In considering whether or not to advance the sum of three thousand ducats to Antonio, he enumerates the merchant's "means" (1.3.15): "He hath an argosy bound to Tripolis, another to the Indies. I understand moreover upon the Rialto he hath a third at Mexico, a fourth for England, and other ventures he hath squandered abroad" (1.3.15-18). After contemplating these numbers, the Jew comes to the conclusion that Antonio is "sufficient" (1.3.22). He will "take his [Antonio's] bond" (1.3.22-23), he decides, but "no doit / Of usance" (1.3.135-36). This leaves the door open for Shylock's "nominat[ion]" (1.3.145) of the fine of flesh to be extracted from Antonio's body in the case that he is unable to pay the Jew back "on such a day, / In such a place, such sum or sums as are / Expressed in the condition" of their agreement (1.3.142-44). Whether or not Shylock initially suggests the pound of flesh penalty in the spirit of "friendship" (1.3.164), as he claims, is perhaps debatable. But it is completely clear that this penalty (normally not only valued differently but also demanded as a means of containing the risk involved in moneylending) is the primary element in what becomes Shylock's clear-cut mission to contain Antonio – that is, envelop him by way of a rhetoric of precision and, ultimately, punish him by taking his life for "lend[ing] out money gratis, and bring[ing] down / The rate of usance . . . in Venice" (1.3.39-40).[14]

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[14] Shylock, in fact, quantifies his losses at the hands of the merchant when he estimates that Antonio has "hindered [him] half a million" (3.1.46-47).

Portia, herself, contained in the play's early stages – literally, in portrait-form in the casket of her father's choice, and figuratively by "the lottery that he [her father] hath devised" (1.2.25-26)[15] – employs number, arithmetic, and precision to counter-contain Shylock and, hence, free Antonio from his clutches.[16] Her work begins in the play's third act when, shortly after Jessica notes that Shylock "would rather have Antonio's flesh / Than twenty times the value of the sum / That he did owe him" (3.2.285-87), Portia reacts to Bassanio's announcement that his "dearest friend" (3.2.291) owes the Jew "[f]or me, three thousand ducats" (3.2.297):

> What, no more?
> Pay him six thousand and deface the bond.
> Double six thousand, and then treble that,
> Before a friend of this description
> Shall lose a hair thorough Bassanio's fault. (3.2.297-301)

The six thousand ducats offered, first, by the heiress is double the original amount of the bond. Though this should, she feels, be enough to "destroy" (3.2.298*n*) the contract, she volunteers to double and then triple the sum to the amount of 36,000 ducats. Even later,

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[15] White makes virtually the same point: "Not only is Portia's image contained within the chest; in effect, she herself is constrained by its power to limit her future" (11).

[16] White suggests that "Portia's containment of Shylock's vengeance is, in fact, a reflection of the loss of self-determination she herself has felt in her father's bizarre casket game to select her husband" (11).

she again ups her ante, informing Bassanio that he "shall have gold / To pay the petty debt twenty times over" (3.2.305-6).[17]

What follows, in the trial scene, is a flurry of calculations and attention to mathematical details. Shylock's containment efforts are met with some resistance from the Duke, who betrays his naivety by giving voice to his theory that Shylock's "strange apparent cruelty" (4.1.20) is part of a "performance" (4.1.18*n*) which the Jew will, in time, abandon before "loos[ing] the forfeiture" that the merchant owes him and "[f]orgiv[ing] a moiety of the principal," besides (4.1.23-25). Of course, the Jew's response to this hypothesis only exposes his resolve: he would "rather choose to have / A weight of carrion flesh than to receive / Three thousand ducats" (39-41). It is his "humour" (4.1.42), he retorts, likening the decision to another problem with a quantitative solution – one's choosing to expend "ten thousand ducats" to have a troublesome rat "baned" (4.1.43-45).

Bassanio's attempts to wear down the Jew are met with similar opposition. "For thy three thousand ducats here is six" (4.1.83), he proffers, only to be answered with Shylock's numerically focused refusal: "If every ducat in six thousand ducats / Were in six parts, and every part a ducat, / I would not draw them. I would have my bond" (4.1.84-86). This amounts, of course, to Shylock's rejection of each one of the 36,000

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[17] Holland explains Portia's offering the very sum which Jessica has already declared that Shylock will refuse: "Jessica makes her statement as forthrightly as she can but there seems to be some problem in Portia's taking in the information. Perhaps she is simply not listening to the account. Certainly Jessica's statement is not responded to at all . . ." (15). Holland also notes that this sum, 60,000 ducats, "represents the limits of Shylock's imaginings, a fantastical excess of over-repayment" (15). To be sure, the sum represents the same ceiling for Portia.

ducats offered earlier by Portia. The prodigal comforts Antonio, promising, "The Jew shall have my flesh, blood, bones, and all / Ere thou shalt lose for me one drop of blood" (4.1.111-12) and, afterwards, informs "Balthasar" that if "twice" the principal sum – 6,000 ducats – "will not suffice / I will be bound to pay it ten times o'er / On forfeit of my hands, my head, my heart" (4.1.205-7).

It is at this point that Portia, in disguise, takes over. Each of the mathematical elements she employs as resident legal expert serves as a stake in the fence which she constructs around Shylock until the threat he presents against Antonio's life is contained. She urges the Jew, twice, to take nine thousand ducats over Antonio's flesh. "Shylock, there's thrice the money offered thee" (4.1.222), she presses. Next, she prods him to "[b]e merciful. Take thrice the money. Bid me tear the bond" (4.1.229). She looks for the scales in which Antonio's flesh may be squarely weighed when cut. Finally, she "catch[es]" the Jew "upon the hip" (1.3.41), ruling that he may have his pound of flesh but not "[o]ne drop of Christian blood" (4.1.305). Shylock backtracks – "I take this offer, then. Pay the bond thrice, / And let the Christian go" (4.1.314-15) – but Portia refuses. She has already alerted him, "Thou shalt have justice more than thou desir'st" (4.1.312). Now she advises Bassanio, "He shall have nothing but the penalty" (4.1.317). In the passage in which Portia instructs Shylock on how to "cut off the flesh" (4.1.319) to which he is entitled, precision is paramount:

> Shed thou no blood, nor cut thou less nor more
> But just a pound of flesh. If thou tak'st more
> Or less than a just pound, be it but so much

As makes it light or heavy in the substance
Or the division of the twentieth part
Of one poor scruple – nay, if the scale do turn
But in the estimation of a hair,
Thou diest, and all thy goods are confiscate. (4.1.320-27)

The Jew's response to these impossible demands of accuracy – "Give me my principal, and let me go" (4.1.331), and, later, "Shall I not have barely my principal?" (4.1.337) – marks Portia's effective mathematical containment of his vengeance.[18]

If the heiress contains Shylock arithmetically, numerically, and precisely, she contains Bassanio (in a much more loving way) geometrically. "The geometry of" *The Merchant of Venice*, to borrow Fisher's characterization of *King Lear*, "is round" (42). The play's language suggests circularity. Bassanio "wind[s] about [Antonio's] love with circumstance" (1.1.154), and the three thousand ducats are judged, by Shylock, as "a good round sum" (1.3.99). *The Merchant* is also full of ciphers. Words such as "waste," "bankrupt," "void," "empty," and "loss" pop up throughout the play, while the word "nothing" appears with especial frequency. Moreover, the comedy ends on the word "ring": Graziano jokes, "Well, while I live I'll fear no other thing / So sore as keeping safe Nerissa's ring" (5.1.306), a "direct and bawdy pun" (Holland 23) which looks

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[18] Afterwards, amidst talk of halving Shylock's "goods" (4.1.348) and distributing them amongst various proposed parties, the Jew is directed to "become a Christian" (4.1.382) and "record a gift . . . of all he dies possessed / Unto his son, Lorenzo, and his daughter" (4.1.383-85). His reaction, "I am content" (4.1.389), reveals his "horrific sense of containment. He has," as White notes, "been surrounded by and contained within Venetian, Christian society that now demands he be content to transform his content from Jew to Christian" (11).

forward to the consummation of the two marriages as well as backward to Graziano's and Bassanio's giving away of their rings to "Balthasar" and his clerk. The "encircling ring" (White 12) which Portia gives to Bassanio shortly before he rushes to Antonio's side in Venice is symbolically the same as that given by Nerissa to Graziano, which the merry-maker refers to, reductively, as "a hoop of gold, a paltry ring" (5.1.146). After Bassanio gives in to "Balthasar's" request of his ring as payment for "his" legal services, Portia uses the words "ring" and "contain" together: she chides Bassanio for being ignorant of his "own honour to contain the ring" (5.1.200). In this, Portia "suggests not just his duty to 'retain' it, as footnotes suggest, but also his willingness to be defined by it" (White 12) – in other words, to be contained, encompassed, and controlled by it and all it represents.

One need only "open the lens" (Fisher 36) in order to behold the dramatist's use of the above mathematical elements for the purpose of containing the "intolerable upsurge of feeling" (Fisher 35) held within *The Merchant*'s lines. The play is "constructed in such a way that number . . . functions as the 'bound and outward circumference' of an intense surge of emotional energy" (Fisher 34), and is "organized" by "a numerical fencework" and "a certain kind of geometric structuring" (Fisher 35).[19] Number, equation, calculation, arithmetic, and geometrical shape – these elements, as I have already suggested, serve a variety of different purposes within the play. Yet, taken together and considered from "without" the play, from a more structural stance, these

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[19] Again, the notion of a mathematical structuring which contains a drama's emotion comes from Fisher's study of *King Lear*. Fisher uses these phrases to describe the "'disquantity' passage" (36) in *King Lear* which, she argues, "stands apart as perhaps *the* most elegant model in literature of a dramatic episode structured by a mathematical calculus" (34).

elements surely work as one to keep the drama's "affective content" – its dealings in love, hate, risk, revenge, religion, and mercy – within proper limits.

Chapter Four

Mapping the Cruel Mathematics of *King Lear*

In his introduction to *Playing the Globe: Genre and Geography in English Renaissance Drama*, John Gillies describes the map's impact on Elizabethan drama:

> [T]he characteristic cultural attitude of the Elizabethan drama to the map is one of deference. Maps are 'cited' in the theater, such that when alluded to or when physically introduced to the stage, a whole portmanteau of signifying practices is similarly introduced into the dialogue and staging. This is the hallmark of cultural success. Maps reproduce their own cultural niche at every moment of their cultural dissemination, including within the theater. (24)

King Lear is a prime point of reference for this theory. It is one of only two Shakespearean plays in which a map is introduced in the form of a prop onstage,[1] and it has been credited with containing "the deepest and most elusive moment of cartographic staging in Shakespeare: what has been called 'Lear's Map'" (Gillies, "The scene of cartography" 109).

Adopting the definition of the map proposed by J. B. Harley and David Woodward – "Maps are graphic representations that facilitate a *spatial* understanding of things, concepts, conditions, processes or events in the human world" (emphasis added qtd. in Gillies, *Shakespeare and the Geography of Difference* 91) – critics have discussed

[1] The other is, of course, Shakespeare's *1 Henry IV*, which contains what Terence Hawkes calls that "notable scene in which the rebels pore over their charts to divide their prospective but ill-gotten gains" (123).

Lear's map primarily in terms of the play's various representations of space. In "The scene of cartography in *King Lear*" Gillies refers to "the map and its culturally masterful spatial discourse" (109). He argues that "the stage talks back to the master discourse of cartography in *King Lear*, parading the cartographised spatial imagination only to collapse it back into the stage's own more deeply bodied spatial idiom" (130). In "Gelded Continents and Plenteous Rivers: Cartography as Rhetoric in Shakespeare," Bruce Avery suggests that Shakespeare introduces maps into *King Lear* and *1 Henry IV* in order to undermine their "monocular perspective" (47). He notes that "Shakespeare's theater . . . stage[s] characters in the act of constructing space and establishing perspectives on it," whereas "[m]aps . . . show space not as something actively constructed but as an object passively perceived" (60).

Although there is much to admire in these spatially-focused discussions of Lear's map, I wish to highlight a different set of the map's "signifying practices" – more specifically, what Gillies refers to as the "cartographic practices of measure, calculation, itemization and commodification" ("Introduction" 33). I will trace the ways in which these practices are reflected in the dialogue of *King Lear*, suggesting that Lear's map anchors the play's "cruel mathematics" (Bowers 369).[2]

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[2] I have borrowed this term (and the idea of applying it to a work of early modern drama) from Rick Bowers' essay, "The Cruel Mathematics of *The Duchess of Malfi*." The phrase is taken up by Bowers from Albert Camus' "The Myth of Sisyphus," in which the existentialist writes: "No code of ethics and no effort are justifiable *a priori* in the face of the cruel mathematics that command our [human] condition" (qtd. in Bowers 369). Bowers describes Camus' "cruel mathematics" as "a timeless sensibility having to do with subjective truth, irrational action, human responsibility, and certain death" (369) and argues that Webster dramatizes this "existential concern" in *The Duchess of Malfi* "through the language and implications of mathematics" (369). In this study I employ the

My first task – the task of demonstrating that maps are fundamentally mathematical – should not be an overly arduous one. To state the case in the simplest of terms, maps (even the early modern kind) depend upon arithmetical and geometrical modes of measurement. In "'The Doubtful Traveller': Mathematics, Metaphor, and the Cartographic Origins of the American Frontier," Jess Edwards points up mathematics' centrality to cartography. She explains that "the defining moments in the evolution of a 'modern' European cartography . . . are those through which it came to be established on a mathematical foundation" (131). "One such moment," she writes,

> is comprised in the fifteenth-century adoption of mathematical methods for projecting global geography onto two-dimensional maps, as described by Ptolemy. Another . . . is comprised in the sixteenth-century development of a method for applying the laws of surface geometry to the practice of local surveying: a method subsequently known as 'triangulation'.[3] (131)

In other words, map-making evolved in direct relation to practical mathematics. This is, of course, Sarah Tyacke's point in noting that "[a]s the drawing and use of maps and

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term to describe *King Lear*'s characters' brutally mathematical perception and treatment of love and life, and their "command" of an often ruthlessly reductionist mathematical rhetoric.

[3] Gillies argues that "Shakespeare advertises the surveying technique of triangulation, whereby unknown dimensions are calculated by their angle of incidence with known dimensions" in *King Lear*'s Dover Cliff scene "when suggesting that the ship is as big as its cock-boat, or that the cliff is more than ten masts in height" ("The scene of cartography" 128).

plans began to be integrated into everyday life, so to speak,[4] the allied crafts of measuring, arithmetic, geometry, surveying and instrument-making were also developing and influencing map making, drawing and production" (15).[5]

But did Shakespeare see maps as mathematical? Indeed, there is evidence that he did. One of the most explicit associations of mapping with mathematics in Shakespeare may be found in the first act of *Troilus and Cressida*, where Ulysses takes issue with the fact that Achilles and Patroclus have been "mocking" (1.3.146) their mathematically-minded fellow soldiers. Ulysses directs his fervent complaint towards Agamemnon, his Commander-in-Chief:

> They tax our policy and call it cowardice,
> Count wisdom as no member of the war,
> Forestall prescience and esteem no act
> But that of hand. The still and mental parts
> That do contrive how many hands shall strike
> When fitness calls them on, and know by measure

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[4] Tyacke claims that "[t]he increasing use and appreciation of maps of whatever sort amongst the educated and landowning sections of society seems to have occurred within the space of sixty years, from about the 1530s to the 1590s" (18). P. D. A. Harvey makes a similar point: "In the England of 1500, maps were little understood or used. By 1600 they were familiar objects of everyday life" (qtd. in Gillies, "Introduction" 19).

[5] Edwards also suggests that "the liberality, literally the 'largeness', or generosity [o]f this mathematical foundation in relation to cartography is confirmed in its being shared with other renovated Renaissance crafts: notably architecture and painting" (132). She goes on to show that the Renaissance painter, architect, and "mathematical cartographer" (133) each relies on "the universal language of mathematics" for his art's "mathematical framework" (132).

> Of their observant toil the enemy's weight,
> Why, this hath not a finger's dignity.
> They call this 'bed-work', 'mapp'ry', 'closet war'.
> So that the ram that batters down the wall,
> For the great swinge and rudeness of his poise
> They place before his hand that made the engine,
> Or those that with the finesse of their souls
> By reason guide the execution. (1.3.197-210)

In this passage, "mapp'ry" (like the work of the mathematically-skilled military man) is connected specifically to questions of number ("how many" and "weight") and, by extension, "a whole set of technical practices involving 'observant toil,' 'measure,' and engineering" (Gillies, "Introduction" 31). In other words, "mapp'ry" is linked expressly to mathematics, here. Gillies notes that "[t]o Ulysses, the accusation of 'mapp'ry' is equivalent to an attack on military science itself" ("Introduction" 30). Indeed, Ulysses expresses his anger over the depreciation of his mathematically-natured military contributions, and his feelings stem, in part, from Achilles' and Patroclus' charge that he and other military men responsible for the logistics of warfare are akin to mere map-makers. He strongly objects to the subordination of "reason" to force, and is flabbergasted by the fact that Achilles and Patroclus discount so entirely the importance of scientific "policy," "prescience," and "wisdom" – basically, all things having to do with the "still and mental" – in military matters. Yet, despite Ulysses' convincing defense, the alliance between the map-maker and the military coordinator is allowed to

stand on account of the fact that each of these men relies upon his mathematical skills when carrying out his professional duties.

In *Othello*, written between one and three years after *Troilus and Cressida*, Shakespeare gives a stronger voice to military mathematics' attacker. Iago criticizes Othello's choice of "lieutenant" (1.1.9), Michael Cassio, for his lack of practical military experience:

> And what was he?
>
> Forsooth, a great arithmetician,
>
> One Michael Cassio, a Florentine,
>
> . . . . . .
>
> That never set a squadron in the field
>
> Nor the division of a battle knows
>
> More than a spinster – unless the bookish theoric,
>
> Wherein the togaed consuls can propose
>
> As masterly as he. Mere prattle without practice
>
> Is all his soldiership; . . . (1.1.17-26)

Iago goes on to dismiss Cassio as a "debitor and creditor" and a "counter-caster" (1.1.30), both of which are "pejorative terms for an accountant" (1.1.30*n*). Gillies reads both Iago's disparaging assessment of Cassio's abilities and Ulysses' belittlement by Achilles and Patroclus as instances in which "Shakespearean soldier-technocrats . . . incur the scorn of their cartographically untrained comrades" ("Introduction" 30). He also points out that "[w]hether Cassio's work is specifically to do with drawing maps or not, it is

plainly related to the same set of practices [as those mentioned in *Troilus and Cressida*] involving 'measure' and calculation" ("Introduction" 31). In this, Gillies suggests (quite rightly, I think) that Cassio's mathematical skills are (if not directly, then indirectly) related, like Ulysses', to "mapp'ry."

These Shakespearean connections between mathematics and mappery recognize that successful military leaders make maps as part of a larger mathematical mode of combat-organization. In the final act of *Richard III*, Shakespeare alludes to this kind of "military cartography" (Gillies, "Introduction" 30) via Richmond's command (and subsequent explanation):

> Give me some ink and paper in my tent.
>
> I'll draw the form and model of our battle,
>
> Limit each leader to his several charge,
>
> And part in just proportion our small power. (5.4.21-24)

As Gillies notes, "Like a true Tudor – intellectually a man of the sixteenth century – Richmond draws a map" ("Introduction" 30). Moreover, this act is treated as one mathematical element in a general mathematical approach to warfare (i.e., Richmond also makes it a point to "divide" [5.4.24*n*] his troops in "just proportion").

Gillies refers to these three examples, among others, as "simpler ways in which mapmindedness is registered in Shakespeare,"[6] noting that "the more complex varieties of

[6] I have isolated only those instances in which mathematics and maps are related in Shakespeare's drama in order to highlight a pointedly mathematized strand of "mapmindedness." Gillies, on the other hand, offers a more expansive analysis of mapmindedness in Shakespeare in his "Introduction," which includes examinations of metaphorical maps in *The Rape of Lucrece*, *Sonnet 67*, *Sonnet 68*, *Richard III*, and

citation in Elizabethan drama" are "those that tend to be constructed around the introduction of actual maps to the stage" ("Introduction" 31). I agree with this premise, and will turn, now, to the first of Shakespeare's two material maps.

As I have already mentioned, Shakespeare introduces a prop map for the first time onstage in *1 Henry IV*. "Come, here's the map," Glendower[7] states in the play's third act, thus directing the attentions of his "coconspirators" (Avery 54) towards the cartographic document and asking, "Shall we divide our right, / According to our threefold order ta'en?" (3.1.67-68).[8] This gesture is Mortimer's cue, and he jumps in, taking control of the situation and, by extension, the map. He informs the others that "[t]he Archdeacon hath divided it / Into three limits very equally" (3.1.69-70), and proceeds to assign the pre-divided portions of land to himself, Glendower, and Hotspur. Of course, in doing this, he makes specific reference to the map – for example, when announcing that "England from Trent and Severn hitherto / By south and east is to my part assigned"

Twelfth Night.

[7] I have opted to use this modernized and more commonly used spelling of the Norton edition's "Glyndŵr."

[8] Interestingly, this is not the first reference to the map in *1 Henry IV*. Its presence is emphasized at the very beginning of the scene when Hotspur exclaims, "A plague upon it, I have forgot the map!" (3.1.5), and Glendower assures him, "No, here it is" (3.1.6). Arguably, Shakespeare has Percy forget the map (and Glendower remember it) in order to underline the moment in which it is inducted into the drama. (As Avery reminds us, maps "stimulated an almost giddy interest" in the Renaissance, and "bringing one onstage in a play . . . could produce a spectacular effect on the Globe audience" [49]). However, as Gillies points out, "[t]he group consultation of the map is no sooner set up" in *1 Henry IV* "than disrupted by a long and increasingly heated exchange of bragging and provocation between Glendower and Hotspur" which ends, though for only a short period of time, with Glendower's above refocusing on the map ("The scene of cartography" 11).

(3.1.71-72), he indicates the location "hitherto" on the document. The others likely look on attentively. As Avery notes, Hotspur has been characteristically argumentative for much of this scene, and Mortimer is "hoping," during his map-based demonstration, "that even Hotspur cannot argue with a map" (58). Of course, it is not the map itself with which Hotspur develops a problem, but the way in which the land represented by the map has been divided by the Archdeacon amongst the three men – in other words, the way in which the map has been "mathematically" inscribed.

After meting out the three parcels of land, "Mortimer manages ten lines that suggest conclusion and agreement without an interruption from Hotspur" and "Glendower makes a comment he intends as a farewell" (Avery 58). These remarks preface the "territorial dispute" (Gillies, "The scene of cartography" 112) that Hotspur instigates. Avery argues that it is Glendower's "implication that [Hotspur] might be subject to the feminizing influence of excessive love for a female" ("For there will be a world of water shed / Upon the parting of your wives and you" [3.1.91-92]) which sets the rebel off, so that he "looks at the map and threatens once more to disrupt the meeting" (58-59). But there is another way of staging this scene, in which Hotspur, having carefully observed Mortimer's division of the island, remains focused on the map and, consequently, oblivious to the continuing conversation. Though the others appear to be satisfied with the proposed distribution of land – indeed, as Avery notes, "these borders have already been agreed to by the deputies of the interested parties" and Mortimer is merely "using the map as a demonstration of that agreement" (58) – Hotspur mentally measures Mortimer's and Glendower's shares of the property and compares them to his

own. He abruptly brings the conversation back to the map after sixteen lines of non-map-related discoursing:

> Methinks my moiety north from Burton here
>
> In quantity equals not one of yours.
>
> See how this river comes me cranking in,
>
> And cuts me from the best of all my land
>
> A huge half-moon, a monstrous cantle, out. (3.1.93-97)

Hotspur's problem is a matter of mathematics: his cut of the land is not equal "in quantity" to (or, more specifically, is less than) Mortimer's and Glendower's respective shares.[9] Hotspur threatens to "have the current in this place dammed up" so that "the smug and silver Trent shall run / In a new channel fair and evenly" (3.1.99-100) and he can (as Worcester later points out) "on this north side win this cape of land" (3.1.109). Somewhat comically, Hotspur pits himself against the river's force: "It shall not wind with such a deep indent, / To rob me of so rich a bottom here" (3.1.101-02).[10] Mortimer,

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[9] Mortimer's and Glendower's portions are, presumably, equal to each other. Only Hotspur has been allegedly cheated.

[10] Avery's analysis of Glendower's immediate response to Hotspur's solution ("Not wind? It shall, it must; you see it doth" [3.1.103]) shows that Glendower is likely concerned that his own portion of land will decrease in both quantity and quality if the Trent is turned: "When Glendower says 'It shall,' he argues that the river will wind because he wants it to; it gives him a great increase in fertile landholdings. When he moves on to say 'it must,' he means that the river has to stay as it is because an alteration would reflect a loss for him and so impugn his honor. When the 'must' evolves into 'doth,' he portrays the map as fixed, drawn on paper, and therefore unchanging, stable. . . . Given that he profits from his acceptance of the map as it is, Glendower's naiveté is, at least, convenient and perhaps strategic" (Avery 59). In this, it appears that Hotspur is not the only rebel adamant about receiving his fair quantity of land.

Hotspur's "neighbouring party" (Gillies, "The scene of cartography" 112), tries to reason with him. He substantiates Hotspur's conviction that the river deprives him of some land, but traces the Trent's route on the map for him, illustrating that he is not unique among the rebels in suffering such land-loss:

> Yea, but mark how he bears his course, and runs me up
> With like advantage on the other side,
> Gelding the opposèd continent as much
> As on the other side it takes from you. (3.1.104-07)

Mortimer's point here is that the river has an equivalent "advantage" over the opposite shore – in other words, it cuts the same quantity of land ("like" and "as much / As") from "the opposèd continent" as it does from Hotspur's quota. In this, Mortimer – the master of the map – works to reinstate the Archdeacon's claim that the land has been divided "very equally."

I find all of this quibbling over the Archdeacon's division of the rebels' "right" especially interesting when considered in light of the anxiety surrounding accurate land measurement which presents itself in such early modern texts as Dee's "Mathematicall Præface" and Richard Benese's *This Boke sheweth the maner of measurynge of all maner of lande*. In the former, Dee defines "the feate of *Geodesie*, or Land Measuring" as "more cunningly to measure & Suruey Land, Woods, and vvaters, a farre of" (a3v). He then expressly qualifies his own definition:

> More cunningly, I say: But God knoweth (hitherto) in these Realmes of England and Ireland (whether through ignorance or fraude, I can not tell

> . . .) how great wrong and iniurie hath (in my time) bene committed by vntrue measuring and surueying of Land or Woods, any way. And, this I am sure: that the Value of the difference, betwene the truth and such Surueyes, would haue bene hable to haue fo[un]d (for euer) in eche of our two Vniuersities, an excellent Mathematicall Reader . . . . (a3v-a4)

In his own "lytle boke," Benese identifies a similar problem: "in measurynge of lande many menne, somtyme the sellers, by more measure th[an] ryght, somtyme [the] buers by lesse measure than ryght" because they are "not experte and connynge bothe in true measurynge of lande, and also in true comptynge and summynge the n[om]bre of acres of the same" (A1).

In each of these texts the importance of mathematical correctness when it comes to land surveying is stressed with reference to a very practical problem: if the size of a portion of land is miscalculated, one (whether he be a land-buyer, a land-seller, or, like Hotspur, a warmonger entitled to his fair share of conquered land) could find himself at the wrong end of a raw deal. Plainly, Hotspur is concerned precisely with this issue. Thus, I think it not unreasonable to suggest that, for this conspirator, the map *is* the island and the Archdeacon the suspicious surveyor of that land whose mathematical authority

must be questioned.[11] Later, when Glendower assures the malcontent, "Come, you shall have Trent turned" (3.1.132), Hotspur formulates his ambivalence:

> I do not care. I'll give thrice so much land
>
> To any well-deserving friend;
>
> But in the way of bargain – mark ye me –
>
> I'll cavil on the ninth part of a hair. (3.1.133-36)

In this, he talks back to his fellow conspirators, the Archdeacon, and, perhaps most importantly, the map in the very terms of its production and inscription – the terms of mathematics.

Gillies notes that, "[w]hile in the same generic league as the nation-divisio[n]" in *1 Henry IV*, "the division of the kingdom is much more complex and elusive in *King Lear*" ("The scene of cartography" 114). This is largely because in *King Lear* "the map is produced in the opening moments of the play. The division of the kingdom" – for which task the map is dramatically imperative – "precipitates the tragedy, it drives the plot. It is not a virtually extraneous detail as in *I Henry IV*" ("The scene of cartography" 114). Thus, while in Shakespeare's earlier work the map takes its place at the center of a single scene, mid-play, and its impact is essentially restricted to that moment, the map in *King*

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[11] Avery uses other evidence to suggest that Hotspur (along with "his cronies") sees the map, itself, as "the territory," and also argues that the conspirators, likewise, "see the territory as a representation of the map" (60). Of Hotspur's desire to rechannel Trent (and the conspirators' submission to this plan), Avery writes: "Rather than simply rewriting the map – say, drawing a new boundary across the disputed territory – the conspirators want to rewrite the *territory*, so the subsequently drawn map will reflect the 'natural' boundary between Glendower and Hotspur" (60). In other words, these characters "make the 'natural' world tell the map what they want the map to show, so it will appear once more as if the map is, after all, the territory" (60).

Lear is, as I intend to show, the visual and tangible anchor of a larger mathematical reductionism which the play performs again and again. Lear's map essentially makes a larger splash than Mortimer's. As such, the "*emblematic* force" (Hawkes' emphasis 121) of the map[12] is considerably stronger in *King Lear* than it is in the history play.

First, the "staging" of Lear's map (Gillies, "The scene of cartography" 109) should be considered. Only thirty-five lines into *King Lear*, the title character demands that the map be brought to him: "Give me the map there" (1.1.35). From the adverb in this sentence it is evident that the prop is already present onstage. It is presumably placed in Lear's hands on command, where it becomes the symbol of his "darker purpose" (1.1.34). In the hands of military leaders such as Ulysses and Michael Cassio, a "mathematical map" (Edwards 136) may very well be a good thing, a sign of educated strategizing and prudence. A map may even be the proper tool for a group of quarrelsome conspirators (such as Hotspur and company) to use in dividing their goods – to be sure, there is something strangely appropriate about a band of plotters (schemers) interrogating a plat ("a plan or diagram of anything" ["Plat," *n*[3]. Def. 2]) that has been plotted by a cartographer.[13] However, in the hands of a King who is looking to "shake all cares and business from our age, / Conferring them on younger strengths while we / Unburdened

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[12] Hawkes uses this term with reference to the lines through which King Lear calls for the map. I, however, am applying it directly to the map itself.

[13] Gillies points out that the two terms "plotting and platting" share "a kind of teleology, a mode of projection." He elaborates: "Whether one thinks of a plot as a model of space or as a model of an action yet to unfold in time, one is thinking of a schematic arrangement . . . whereby some object or process is seized and outlined from the vantage of a particular *telos* or purpose or end" ("Introduction" 28).

crawl toward death" (1.1.37-39), a map – along with the "mathematical 'perspective'" (Edwards 130) it represents and implicitly endorses – is, as Shakespeare shows in *King Lear*, a dangerous thing.

Perhaps a brief detour into an expression of opposition to early modern mapping might prove useful at this point. As Andrew Gordon and Bernhard Klein note, "even in early modern times maps could be seen as having a socially and politically disruptive influence" (4), a matter which John Norden takes up in his early seventeenth-century *The Surueyors Dialogue*. In this text, a farmer is unmoved by the surveyor's boast that "[s]ome haue the skill of plotting out of ground, and can neatly deliniate the same, and by Arithmetike can cast up the contents, which is a necessary point of a Surueyors office" (B8). "[W]e poore Country-men," the farmer responds, "doe not thinke it good to haue our Lands plotted out, and me thinks in deede it is to very small purpose: for is not the Field it selfe a goodly Map for the Lord to look vpon, better then a painted paper? . . . He can add nothing to his land, nor diminish ours: and therefore that labour aboue all may be saued, in mine opinion" (B8). Clearly, this character is resistant to mapping. Why? As Gordon and Klein interpret the passage, Norden's farmer is "giving voice to a genuinely felt anxiety" that "with the assistance of the map the intimate and closed social microcosm of the estate is in danger of turning into the quantifiable, anonymous and inherently desocialised object of commercial speculation" (4).[14]

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[14] I strongly agree with Gordon's and Klein's point that "the farmer's anti-mapping attitude is surely not wholly unfounded" even though "Norden was himself a practising surveyor when he wrote that dialogue, and such views [as the farmer's] are included in his promotional text only to be convincingly refuted" (4).

"Quantifiable"; "desocialised"; "object of commercial speculation." Each of these terms might easily be applied to the kingdom as it is depicted on the map in Shakespeare's tragedy and as it is treated by Lear (this play's map-master) in the map scene. Significantly, these terms might also be applied to Lear's treatment of his daughters' love for him in this same setting. Gillies has noted that "Lear's map . . . signals that the kingdom is being reduced to a 'property'" ("The scene of cartography" 114) – a large "estate" of sorts – which Lear, as Lord over it, can fragment at will for "commercial" purposes. This is exactly what he does when he trades various quantities of his kingdom for quantities of his daughters' love via the love test which, one must not forget, takes place around the map. Essentially, Lear appropriates the mathematical rhetoric of measurement, calculation, and control[15] epitomized in the map – the King's crutch in the play's first scene – for utilization in his dealings with his daughters, and one by one they respond in kind. I will now highlight the echoes of these mathematical "signifying practices" in Lear's and his daughters' dialogue.

After calling for the map, Lear notifies his daughters and sons-in-law, "Know that we have divided / In three our kingdom" (1.1.35-36), and soon after informs Albany and Cornwall, "We have this hour a constant will to publish / Our daughters' several dowers, that future strife / May be prevented now" (1.1.41-43).[16] Having created this link

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[15] Avery notes that "[m]apmakers . . . provided landowners with the means to quantify and control their holdings and the state with the means to manage territory" (48).

[16] There is, perhaps, a hint of nobility of purpose in Lear's claim to want to prevent "future strife" between his daughters. Of course, my mathematically-based analysis does not cover all aspects of Lear's psychology. But I would argue that any indication that Lear ultimately means to put his daughters' needs and desires first in this scene – in other

between the division of the map, his daughters, and their dowries, Lear begins what he hopes will amount to a bidding war for the one dowry which he is sure to mention "is greater than the others" (Blank 484) when inquiring of his daughters, "Which of you shall we say doth love us most, / That we our largest bounty may extend / Where nature doth with merit challenge?" (1.1.49-51). As Brian Rotman suggests, "The demand of 'most' for 'largest', the maximum amount of love for a ceremoniously, measurable portion of the kingdom, reveals that it is in the one-dimensional language of quantity – arithmetic – that Lear has constructed his deal" (79).

Goneril's response to her father's query is comprised of a wealth of quantitative comparisons: "more than"; "Dearer than"; "Beyond"; "No less than"; "As much as"; and concluding with, "Beyond all manner of so much I love you" (1.1.53-59). Goneril claims that hers is "[a] love that makes breath poor and speech unable" (1.1.58). Certainly, her language is impoverished, being bankrupt of all sincerity and subservient to what William Elton, in King Lear *and the Gods*, calls the "ethic of calculation" (124). For such "glib and oily art" (1.1.222) Lear rewards his "eldest born" (1.1.52) by way of the map with "all these bounds even from this line to this / With shadowy forests and with champaigns riched, / With plenteous rivers and wide-skirted meads" (1.1.61). Avery gives a convincing account of Lear's handling of the map, here: "Lear highlights the map's importance in the scene's ritual structure when Goneril responds as he wants her to. Turning to the map . . . he makes of it a sacrament that confirms her obedience, fussing

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words, that he is consciously working to keep dissent between them to a minimum and is striving to treat them as fairly as possible via the map – is subverted (indeed, overwhelmed) by his reductive mathematical perspective.

over its details and displaying for everyone her share of the new kingdom" (51). In this, Lear establishes an inextricable connection between his daughters' quantification of their love and the quantification of land on the map.[17] Interestingly, the adjectives employed by Lear during this rite to itemize the land his daughter has inherited suit Goneril's declaration of love, which itself is "shadowy" (i.e., suspect), and "riched" (i.e., made richer than it actually is) so as to seem "plenteous" and "wide-skirted." Thus, it seems as if the land conferred upon Goneril is, in fact, the embodiment of her silver-tongued speech.

Like Goneril, Lear's "second daughter" (1.1.65), Regan, "attempts to impose legal and scientific discourses of the precisely quantifiable onto the unstrained quality of love" (Hopkins 33). She equates herself with her sister in substance and value – "I am made of that self mettle as my sister, / And prize me at her worth" (1.1.67-68) – but not in daughterly devotion. In this area, Regan claims to offer more: "In my true heart / I find she names my very deed of love – / Only she comes too short" (1.1.68-70). Lear responds, once again, by turning to his map, bestowing upon her "this ample third of our fair kingdom, / No less in space, validity, and pleasure / Than that conferred on Goneril" (1.1.78-80). Notably, as critics such as Blank and Avery have pointed out, despite Regan's one-upmanship of Goneril's love-bid, she comes into the same quantity (and quality) of land as her sister.

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[17] Gillies, too, argues for a strong link between "the map" and "the love trial" ("The scene of cartography" 117).

Avery explains that "once he [Lear] has marked off the borders of the kingdom Cornwall gets through Regan, everyone can see that a third portion of the kingdom, more opulent and larger, remains, and that share belongs to Cordelia" (52). Of course, Lear makes no real attempt to hide the fact that he loves Cordelia the most, and means for her to inherit his "rest" (1.1.121).[18] He calls her "our joy, / Although our last and least"[19] before prompting her, "[W]hat can you say to draw / A third more opulent than your sisters?" (1.1.83-84), and charging her to "[s]peak" (1.1.84). Lear expects Cordelia to respond in a flurry of calculations. Having observed the size of her sisters' speeches and the "amounts" of love they have proffered to their father, and having visualized those speeches' counterparts in the map's quantities of land, Cordelia must be aware that, in order to be awarded the larger dowry, her speech and the quantity of love she extends to Lear should exceed both Goneril's and Regan's. However, Cordelia refuses to force the measure of her love into an equality with the measure of her potential land. She responds, reductively, "Nothing, my lord" (1.1.85), outrightly rejecting the map.

The quantity of land that Cordelia "inherits" is a direct reflection of her response to her father's love test. She articulates "Nothing," and likewise receives nothing. In this

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[18] In fact, part of the purpose in having Gloucester note, at the opening of the tragedy, that "now in the division of the kingdom it appears not which of the Dukes he [Lear] values most; for qualities are so weighed that curiosity in neither can make choice of either's moiety" (1.1.3-6), is that the Earl reveals to the audience (before the love test is even announced) that Albany and Cornwall are to receive equal shares of Lear's kingdom. The audience is to infer, later, that Cordelia will come into the one unequal share.

[19] Q1 reads, "our joy, / Although the last, not least in our dear love" (1.1.74-75). The sentiment is slightly different in Q1, what with its specific reference to Cordelia's rank in Lear's affections, but in each version Lear is undoubtedly suggesting that his youngest daughter is his favourite.

sense, her words (like Goneril's and Regan's) find expression in the map. Also, Cordelia does not reject what the map stands for: the mathematical perspective in general. In refusing the map, Lear's youngest daughter "*appears* to be taking" an "anti-quantitative stance" (emphasis added Hopkins 37), but she actually adopts, like her father and two sisters, the mathematical rhetoric of measurement and calculation exemplified in the map. When Lear urges her to "[s]peak again" (1.1.88), she informs him rather coldly in the spirit of exactitude, "I love your majesty / According to my bond, no more nor less" (1.1.90-91). When he advises her, "Mend your speech a little / Lest you may mar your fortunes" (1.1.92-93), she checks her own calculations against Goneril's and Regan's:

> Why have my sisters husbands if they say
> They love you all? Haply when I shall wed
> That lord whose hand must take my plight shall carry
> Half my love with him, half my care and duty. (1.1.97-100)

Here, she problematizes her sisters' hyperbolic "all" as a quantity, and harangues them for their blatant imprecision. By contrast, she is much more accurate with her sums. Her previous "'nothing', her failed attempt to remain silent" which evolved, for Lear, into "an answer – the arithmetically worst answer – to his question" (Rotman 81) is upgraded numerically to "half."

The subject of truth is raised shortly after this wrangling over quantities, when Cordelia emends Lear's characterization of her, "So young and so untender" (1.1.104), to,

"So young, my lord, and true" (1.1.105).[20] Finally, Lear accepts his daughter's formula: "Let it be so. Thy truth then be thy dower" (1.1.106). Bowers notes that "[s]ince the time of Euclid, the principles of mathematics have been established as the principles of truth in enlightened European thought. Mathematical truths," he explains, "are deduced logically and relied upon with complete confidence. . . . [O]nce proven they must be forever true" (369). Cordelia's "truth" is mathematically-based, grounded in the principle of "due proportion" (Blank 485), and she asserts the accuracy of her love-ethic with unflinching resolve. In reaction, Lear concludes (to borrow Bowers' phrasing) "with all the certainty of a mathematical problem solved" (374) that Cordelia loves him less than Goneril and Regan do, and banishes her as his "sometime daughter" (1.1.118). Kent, on the other hand, is as confident that Lear has mismeasured his daughters' affections as Lear is that he has not. "Answer my life my judgement," he erupts, "Thy youngest daughter does not love thee least" (1.1.149-50). But the damage has already been done. Lear has "disclaim[ed] all [his] paternal care, / Propinquity, and property of blood" (1.1.111) with relation to Cordelia, and instructed Cornwall and Albany to "digest the third" – Cordelia's – dowry (1.1.126).

What, one might ask, happens to Lear's map? Avery's account of its "upstaging" is impelling: "The effect [of Cordelia's response] on Lear and his map is immediate. Just at the moment when he should turn to the projection in grand fashion and make it speak for his overwhelming generosity, he instead releases a tirade. Abruptly, the map falls

[20] The Norton editors gloss Cordelia's "true" as "honest; faithful" (1.1.105*n*), but it seems just as likely to me that she is maintaining her "correctness" here.

from the center of the stage action" (53). Perhaps with little enthusiasm Lear gestures, dismissively, towards it one final time when directing his sons-in-law to "incorporate" (1.1.126*n*) the final portion of his kingdom into their present stores,[21] but the map descends into a virtual oblivion.

The map's fall from center stage, however, is not indicative of the play's general disengagement with the mathematical perspective. Although the appropriation of the "cartographic practices of measurement, calculation, itemization and commodification" by the King and his three daughters, and their personal applications of these practices in their dealings with each other initially point up the prop-map and reflect its mathematical nature, they eventually come to overshadow it, and the prop fades into the background. Gillies suggests that Lear takes on the role of "manic cartographer" when, during the love trial, he assigns cuts of land "in an unforgettable demonstration of the dangers of cartography" ("The scene of cartography" 117). Of course, Lear is the prime candidate for cartographer in this tragedy, since he (exclusively) controls the map and the kingdom it represents. Yet, I would argue that Goneril, Regan, and Cordelia become quasi-cartographers when they "map" (i.e., delineate through quantification and calculation as a means of exercising control) their affections for Lear. It is these "maps" that come to be the central focus of the scene during Cordelia's noncompliance with her father's implicit wishes. By mid-scene, then, Lear's map – the visual and tangible prop-map which, as

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[21] Avery suggests that, after Cordelia's refusal to indulge Lear during the love test, "no one refers to [the map] again in the play" (53). I, however, think it possible that Lear makes this one final motion towards the map. Q1's "digest *this* third" (emphasis added 1.1.117) certainly implies that Lear is making reference to a specific portion of land on the map.

Hawkes reminds us, "hints at a reductive quality in Lear's purpose that a largely pre-literate audience would have surely recognized and responded to" (123) – is less an active "participant" in the tragedy's mathematical dialogue than a potent emblem of Lear's and his family's general trend towards a brutal mathematical reductionism.

This cruel mathematical outlook radiates from *King Lear*'s first scene, pervading the play. The Fool, in particular, delivers several harsh mathematical-type lessons which hearken back to the map scene. First, he quizzes Lear with "a mathematical riddle" (Blank 493):

> Have more than thou showest,
> Speak less than thou knowest,
> Lend less than thou owest,
> Ride more than thou goest,
> Learn more than thou trowest,
> Set less than thou throwest,
> Leave thy drink and thy whore,
> And keep in-a-door,
> And thou shalt have more
> Than two tens to a score. (1.4.104-13)

The rhyme's preoccupation with "more" and "less" recalls Lear's daughters' (particularly Goneril's and Regan's) comparative valuations of their love for him, while the notion of not "gambl[ing] everything on a single cast of the dice" (1.4.9*n*) expressed in the verse's sixth line is clearly an allusion to the King's seeming mistake in laying his "rest" on

Cordelia's "kind nursery" (1.1.121-22). Moreover, and perhaps most importantly, this puzzle (like Lear's love test) takes a cruel mathematical twist at its conclusion. As Blank points out, "The Fool's advice takes the form of a series of additions and subtractions that seems to leave the beneficiary of his wisdom coming out ahead ('And thou shalt have more . . .'), but that 'more' is only apparent" (493). As Kent[22] figures correctly, there is absolutely no mathematical difference between "two tens" (twenty) and "a score." "This is nothing, Fool" (1.4.114), he points out. The riddle is deceiving and ultimately disappointing.

The Fool's egg demonstration is of a similar caste. Lear seems to be positioned at the favorable end of a bargain when, in return for just one egg, the Fool promises him "two crowns" (1.4.125). But on examination – "What two crowns shall they be?" (1.4.126) – the trade is exposed as a lesson in division and subtraction as well as a critique of Lear's conduct in the play's first scene. "Why, after I have cut the egg i'th' middle and eat up the meat, the two crowns of the egg," the Fool retorts (1.4.127-28). He then passes judgment on the King's earlier "rent[ing] of his land" (1.4.119): "When thou clovest thy crown i'th' middle and gavest away both parts, thou borest thine ass o'th' back o'er the dirt" (1.4.128-30). First, the Fool shows that that which is numerically less (i.e., one intact meat-filled egg, or, perhaps, the sincere amount of love which Cordelia professes for Lear) is, paradoxically, superior to that which is numerically greater (i.e., two broken eggshell halves emptied of meat, or Goneril's and Regan's substance-less

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[22] Q1 has Lear, not Kent, make this observation.

declarations of devotion).[23] Second, the Fool illustrates how one (kingdom) divided into two equal portions leaves naught. As in the previous mathematical proof, the solution here is nothing. Both lessons are designed to teach Lear about mathematical reductions to zero, in part so he can better understand himself when the Fool proclaims: "Now thou art an O without a figure. I am better than thou art, now. I am a fool; thou art nothing" (1.4.158-59). Both are bleak mathematical lessons which hearken back to Lear's division of his kingdom for, as Blank notes, "[t]he Fool knows well enough that Lear's division has left him with, and as, nothing" and "that what one has and what one is are equivalent, or should be equivalent" (493).

By the time the Fool declares that "[t]he reason why the seven stars are no more than seven is a pretty reason" (1.5.31-32), Lear has had enough education in the grim rationality of numbers – the arbitrariness of quantity – to provide the correct answer to this riddle: "Because they are not eight" (1.5.33). His teacher applauds him, "Yes, indeed, thou wouldst make a good fool" (1.5.34), thus upgrading him from nothing to a half-wit. The puzzle is positioned after Goneril's command that the King "disquantity" his "train" (1.4.210) of "a hundred knights and squires" (1.4..202), the number agreed upon in the map scene. "What, fifty of my followers at a clap? / Within a fortnight?" (1.4.257-58), Lear exclaims in disbelief at Goneril's proposed subtraction of half – no "little" part (1.4.210) – of his retinue. He departs in anger for Regan's place, the daughter he is certain "is kind and comfortable" (1.4.269). Of course, when the King meets his

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[23] The numbers, themselves, bear significance here. One represents Cordelia, two Goneril and Regan.

younger daughter in the play's second act, she is less than accommodating. Their dialogue recalls *King Lear*'s division scene: "Thy half o'th' kingdom hast thou not forgot, / Wherein I thee endowed" (2.2.345-46), Lear begins. But when Regan shows support for Goneril's decision ("What, fifty followers? / Is it not well? What should you need of more, / Yea, or so many . . ." [2.2.402-04]) and informs him that he can keep "no more" than "five and twenty" followers at her abode (2.2.212-14), Lear tells Goneril, "I'll go with thee. / Thy fifty yet doth double five and twenty, / And thou art twice her love" (2.2.424-26). Still quick to gauge his daughters' love based on quantities despite the Fool's arithmetic lessons and his newfound knowledge of numbers' arbitrariness, Lear has yet to learn how barbarous the mathematical perspective can be when put into practical use. The reduction of his retinue to nothing is swift. Goneril's "What need you five and twenty, ten, or five, / To follow in a house where twice so many / Have a command to tend you?" (2.2.427-29), followed immediately by Regan's "What need one?" (2.2.429) is enough to commence the "unsettl[ing]" of Lear's "wits" (3.4.145).

I find it significant that, driven out of doors by his daughters' cruel mathematical philosophy – what Gillies calls the "'rational'" and "pointedly mathematised" economy of the Goneril-Regan "generic household" ("The scene of cartography" 124) – and into the raging elements, Lear dares the "all-shaking thunder" to "[s]trike flat the thick rotundity o'th' world" (3.2.6-7) or, in other words, reduce the globe to a map. This potential earth-map and the prop map of the kingdom introduced in *King Lear*'s first scene are bookends of sorts to a range of cruelties defined by and expressed through mathematics. But if the first, tangible map represents and grounds Lear's and his family's cruel, reductive

mathematical perspective, the second, imaginary map captures Lear's rejection of such a view and allows him to fling it back to the world at large in defiance.

After Goneril and Regan "disquantity" Lear's retinue there is little cruel mathematical action in the play. Rather, characters are left to deal with the consequences of the mathematical cruelties that have already been perpetrated (or, in the Fool's case, taught). This is not to say that mathematical elements are entirely absent from the play's latter acts, but that these elements are of a different kind than *King Lear*'s earlier mathematics. There are mathematical-type reactions to several of the play's events. For example, Lear takes stock of how much man "is" when, denied access to his two eldest daughters' houses, he asks, "Is man no more than this?" (3.4.92). Edgar, when he uncovers Goneril's "plot upon her virtuous husband's life" (4.5.264), notes that "woman's will" is an "indistinguished space" (4.5.263) – a "limitless" (4.5.263*n*) and, thus, frighteningly unmeasurable, unmappable space. When Lear inquires of Kent in the play's final lines, "Who are you?" (5.3.252), Kent formulates the numerically-based answer, "If fortune brag of two she loved and hated, / One of them we behold" (5.3.254-55). As the Norton editors point out, his response is ambiguous. Kent is either declaring that Lear, alone, is one of a hypothetical "two supreme examples in the world of Fortune's ability to raise up and cast down," or that he and Lear (who are "looking at each other" when he delivers these lines) are the specified two, each able to behold the other one (5.2.255*n*).

There are also notable examples of mathematical exactitude. For instance, when he is a "ruined old man who perceives in his feverish rage and madness that the fantasy of

omnipotence is a fraud," and not when he is "the confident figure of supreme authority" wrapped up in measures at the play's beginning (Greenblatt 535), Lear asserts that he is "every inch a king" (4.5.104). Later, he pinpoints his age for Cordelia as "[f]ourscore and upward, / Not an hour more nor less" (4.6.54-55), a curious statement given the fact that the open term "upward" is matched with a sense of mathematical accuracy. Arguably, his failed attempt to be precise, here, serves as a sign of the fact that he is "a very foolish, fond old man" (4.6.53).

Three additional examples of mathematical precision stand out as having a sense of tenderness about them. First, Cordelia (as Queen of France) instructs her men to find her father and deliver him to her: "A century send forth. / Search every acre in the high-grown field, / And bring him to our eye" (4.3.6-8). Cordelia's dispatching of this numerically specific "century," this troop of one hundred men, is surely her recuperative response to her sisters' reduction of Lear's train, her attempt to make up for what her sisters have done to their father. This is John Baxter's point when he notes that "[t]he command to send out a 'century,' a battalion of 100 soldiers, implies that Cordelia . . . is both capable and desirous of restoring the 100 knights that her sisters had stripped away" (14). Second, Cordelia gives voice to her wish to "match" Kent's "goodness," though she, modestly, marks her inability to do so: "My life will be too short, / And every measure fail me" (4.6.2-3). Kent responds in the spirit of accuracy: "To be acknowledged, madam, is o'erpaid. / All my reports go with the modest truth, / Nor more, nor clipped, but so" (4-6). For perhaps the first time in *King Lear*, mathematical language is used to express gratitude and modesty. Third, in the play's Dover cliff scene,

Edgar uses mathematics to create the illusion of a cliff-top for the blind Gloucester. In this, Shakespeare not only draws upon "the surveying technique of triangulation," as I have noted above, but also upon "the technical language of perspective" (Gillies, "The scene of cartography" 128). Measuring from "above,"[24] Edgar claims that "[t]he crows and choughs that wing the midway air / Show scarce so gross as beetles" (4.5.13-14), that "one that gathers samphire . . . seems no bigger than his head" (4.5.15-16), and that "[t]he fishermen that walk upon the beach / Appear like mice" (4.5.17-18). After this mathematical mapping,[25] Edgar guides his father to "within a foot / Of th'extreme verge" (4.5.25-26). Later, from "below," he calculates and notifies Gloucester, "Ten masts a-length make not the altitude / Which thou hast perpindicularly fell" (4.5.33-34). Of course, all of this is carried out in an attempt to save Gloucester from desperation. "Why I do trifle thus with his despair / Is done to cure it" (4.5.33-34), Edgar informs the audience earlier in the scene, and after his father's "fall" Edgar tells him, "Thy life's a miracle" (4.5.55). Edgar's measuring is, thus, the opposite of a mathematical cruelty since, here, he uses mathematics in the hope of preventing Gloucester from bringing the ultimate cruelty, death, upon himself.

The mathematical tone of the tragedy changes drastically, then, following Lear's daughters' shrinking of his train. As I have already pointed out above, the shift seems to be due to the fact that characters no longer commit mathematical cruelties against (or

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[24] Gillies notes that "Dover cliff, it is often forgotten, is described from two positions: above and below; each to very different effect" ("The scene of cartography" 127).

[25] See Gillies' "The scene of cartography," pp. 126-30, for an in-depth discussion of *King Lear*'s Dover cliff scene as a "scene of chorography" (129).

teach such cruelties to) each other but, rather, go about dealing with those that have already been acted out. Interestingly, less than a full act after "the verbal rape of Lear's manpower" (Fisher 34), the general tone of the play changes significantly. Although the Fool has stuck around for some time to comfort the crazed Lear, he exits never to be heard from again.[26] It seems to me that the Fool's departure not only alters the tragedy's overall atmosphere, as other critics have noted, but also sparks one final reduction of numbers. To state the case in mathematical terms, the Fool is the first of *King Lear*'s main characters to be subtracted from the play. As Gloucester, Regan, Goneril, Cordelia, Edmond, and Lear follow, the tragedy winds to a close. This is a "disquantity"-ing of a different, but no less cruel, sort than Goneril's and Regan's. Thus, the mathematical reductiveness embodied in Lear's map at the play's beginning leads to a slow reduction of bodies at its end.

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[26] Many have argued that the Fool's exit from *King Lear* in the play's third act is due to the fact that "the parts of Cordelia and the Fool . . . were written for the same boy actor" (Stroup 127). This is theatrical "doubling" (Stroup 127), which boils down to a problem of quantities – the problem of distributing a certain number of parts among a certain (lesser) number of suitable actors.

Chapter Five

Conclusion

In the twentieth century and thus far into the twenty-first, there has been widespread prejudice against mathematics by arts students. Perhaps for this reason, relatively few who have become literary critics have displayed any extended interest in Shakespeare's use of mathematical elements in his drama. In *Where Mathematics Comes from: How the Embodied Mind Brings Mathematics Into Being*, George Lakoff and Rafael E. Nuñez refer to "the beautiful ideas of mathematics" (xi). They claim that "[m]athematics is deep, fundamental, and essential to the human experience" (xi). As I have shown in Chapter One, Renaissance apologists for mathematics such as Recorde, Hood, and Dee expressed this same sentiment in their writings. In Chapters Two, Three, and Four, I have tried to show that – no matter how difficult it may be for many modern-day pupils of the arts to comprehend – Shakespeare saw the value, the power, the versatility, and the aesthetic appeal of this "signifying system," too.

In direct opposition to this thesis, McClelland suggests that Shakespeare was "not . . . on" the mathematical "train of thought out of which emerged the modern world" (McClelland 30). Similarly, Blank notes a "contempt for arithmetic" in Shakespeare's plays (482). But both Blank and McClelland are somewhat hasty in highlighting those instances in which Shakespeare's characters vent unfavourable opinions of mathematics, and in taking such examples at face-value and as at least partially indicative (or at most entirely representative) of Shakespeare's personal attitude towards math. Although Blank argues that the playwright "took seriously enough the idea of mathematics as a system of

measurement" (482), she notes that "Shakespeare's dramatic characters . . . are generally dismissive of, if not condescending towards, 'arithmeticians'" (479) and that "'[n]umbering' is regarded by many of Shakespeare's characters as a matter of rote, prosaic, dully methodical, the business of unimaginative or simple-minded boors" (480). These observations are undoubtedly true, but it seems obvious that, when considered in context, Shakespeare's characters' digs at mathematics should not be taken as straightforward criticisms. In fact, what has hitherto been interpreted as evidence of the playwright's scoffing at mathematics and mathematicians actually confirms, rather than challenges, Shakespeare's appreciation for the subject.

For example, Blank takes Armado's defensive jab at "reckoning" in *Love's Labour's Lost* and Iago's embittered critique of Cassio's mathematical approach to warring in *Othello*, examples which I have discussed in Chapters Two and Four respectively, as unaffected, unmotivated denunciations. She neglects the fact that Shakespeare undermines these characters' perspectives on math by supplying the audience with ample reason to be skeptical of their uncomplimentary comments. Next, in citing Mercutio's declaration in *Romeo and Juliet* that Tybalt is "[a] braggart, a rogue, a villain, that fights by the book of arithmetic" (3.1.96-97), Blank fails to note the possibility that Mercutio's dismissal of Tybalt's arithmetically-aware style of duelling (a mode which requires that a fighter be knowledgeable in matters of "time, measure, proportion," and "distance" [McClelland 26]), is actually a critique of his own impulsiveness. Mercutio, after all, loses both the duel and his life to Tybalt, so what appears at first glance to be a condemnation of mathematics is likely a testament to its

importance.[1] Moreover, Blank marks Cressida's mocking response to Pandarus' claim, in *Troilus and Cressida*, that Troilus "has not past three or four hairs on his chin" (1.2.103-4): "Indeed, a tapster's arithmetic may soon bring his particulars therein to a total" (1.2.105-6). This is, perhaps, the most easily refuted "evidence" that Shakespeare might not have "deemed numbering in and of itself a worthy exercise" (Blank 482), for Cressida is clearly making fun of the small number of facial hairs which Troilus possesses and not the act of counting them. Her point, here, is that Troilus is so young that even a tapster, who is in command of only "the simplest" (1.2.105*n*) arithmetic, could quickly reckon the sum of his chin-hairs.

Like Blank, McClelland points to "the scorn that [Mercutio] heaps, by implication, on the 'book of arithmetic'" (18), but he argues that this example is unequivocal evidence of Shakespeare's disdain for mathematics. He also suggests that Iago's jealous sneering at Cassio is an "indication of the status of arithmetic within the Shakespearean scheme" (19). He turns to *Hamlet* for one additional reference to support the theory that Shakespeare despised arithmetic, citing the title character's sarcastic

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[1] Mercutio blames his defeat on Romeo: "Why the devil came you between us? I was hurt under your arm" (3.1.97-98). But, as McClelland argues, Mercutio is distracted by Romeo's interference because of his non-mathematically-focused duelling style. McClelland writes: "Tybalt's fighting style . . . is obviously arithmetical, in the sense that he is counting both his moves and his opponent's. It is obviously geometrical, because he is calculating the spatial relationships that separate the fighters and that determine the possibility of attack. And it is obviously a very cool, intellectual way of duelling, because he knows when to observe a pause and then resume the fight at precisely the most opportune moment, according to the rhythm of his opponent. Tybalt is able to 'thrust Mercutio in' when Romeo tries to interrupt the fight because, unlike his opponent, he has not broken his sequence of movements, his *tempo*" (24-25). Ultimately, as McClelland suggests here, it is Tybalt's arithmetical mode of duelling and not Romeo's intervention that does Mercutio in.

response to "the unwitting Osric's flattering description of Laertes" (McClelland 18): "Sir, his [Laertes'] definement suffers no perdition in you, though I know to divide him inventorially would dizzy th'arithmetic of memory, and yet but yaw neither in respect of his quick sail" (5.2.102.7-102.10). McClelland points out that, "[t]aken with the words 'divide' and 'inventorially,' 'arithmetic' here clearly denotes a kind of accounting, a commercial operation, the kind of thing that middle-class merchants do" (19). One might argue that if Shakespeare truly considered mercantile activities to be so lowly, his representation of Antonio in *The Merchant of Venice* would have been much worse than it is. But, perhaps more importantly, the "irony" in Hamlet's "remark" (McClelland 18) has little to do with the negative implications inherent in creating an inventory of Laertes' positive qualities. Here, Hamlet is toying with the question of worth just as, as I have shown in Chapters Two through Four, various Shakespearean characters in both comedy and tragedy do via mathematical rhetoric. The sarcasm in his lines is focused on the notion that an inventory of Laertes' characteristics would "dizzy th'arithmetic of memory" – in other words, that enumerating each of Laertes' merits "would confuse the memory's reckoning up (through recounting vast numbers)" (5.2.102.10*n*). Hamlet draws out his "parody" (Blank 479*n*) by maintaining that even if such a catalogue were possible it would merely "approximate" Laertes' "virtues" (5.2.102.10*n*). However, "[h]aving considered the difficulty of calculating his worth" (Blank 479*n*), Hamlet finally offers an estimate: "But in the verity of extolment, I take him to be a soul of great article" (5.2.102.10-102.11). Mathematically speaking, as Blank explains, the word "article" "refers to any of the multiples of ten" (479*n*). In the face of such creative use of

mathematical terms, it seems rather absurd to suggest that the playwright is demonstrating a contempt for mathematics, here. Quite the contrary, he is proudly exhibiting his "mathematical art," as he does in *Love's Labour's Lost*, *The Merchant of Venice*, and *King Lear*.

Crosby shows that "the manipulation of numbers is mathematics" (109), but Shakespeare shows that the manipulation of mathematics – not only number, but also calculation, equation, proportion, enumeration, measurement, and geometric shape – plays an important part in creating rich poetry and drama. This most brilliant of playwrights regarded mathematics as a system of signs that could be used as both "practical literary instruments" and artistic tools, a set of symbols that could be employed in both comic and tragic arenas as a part of modes of inquiry and expression. The texts I have discussed in Chapters Two to Four offer a diverse mix of "the ways a gifted author turns mathematical concepts to literary use" (Fisher 20). In these works, mathematical elements set tone, drive and shape plots, and assist in character development. They are sources of wit, puns, riddles, and rhymes in *Love's Labour's Lost*, as I have illustrated in Chapter Two, but, as I have shown in Chapter Four, they connote a cruel reductionism in *King Lear*. Although the idea of a human cipher is amusing in the former, it is profoundly tragic in the latter, and in *The Merchant of Venice* the idea of having and being nothing is both lamented (with respect to Bassanio and Antonio) and celebrated (with regards to Shylock). Moreover, Shakespeare explores the idea of control – both having it and losing it – to drastically different ends in these three plays through

mathematical language. The mathematical frameworks of these dramas, then, both connect and separate them from each other.

"[O]ur minds, which are at least as metaphorical and analogical as logical, are intolerant of short, straight paths that stop short at their destinations," Crosby writes. "We like twisting paths through bosky dells, and therefore have often adapted mathematics for nonmathematical motives" (121). Shakespeare was not, by any stretch of the imagination, a mathematician, but neither did he believe, as McClelland implies he did, that mathematics was "encroach[ing] on life and art" (30). On the contrary, this playwright embraced the language of mathematics and adapted mathematical concepts to fit his creative endeavours, thus weighing in on mathematics' value and making his art both poetically and dramatically richer.

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