Teaching Natural Philosophy and Mathematics at Oxford and Cambridge 1500 – 1570

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This dissertation is the result of my own work and includes nothing that is the outcome of work done in collaboration except where specifically indicated in the text.

The syllabus in natural philosophy and mathematics was radically changed in the course of the sixteenth century with new subjects, textbooks and methods introduced. Education became more practical and less dependent on medieval antecedents. Printing technology improved textbooks and made it possible to replace them with newer versions.

Following sweeping syllabus reform around 1500, the Cambridge Master of Arts course was heavily slanted towards humanism. The old scholastic textbooks were rejected and replaced with modern authors. The purpose of natural philosophy was explicitly to illuminate the providential work of the creator, especially through natural history (a newly developing subject in the sixteenth century thanks to newly translated and promulgated Greek texts) where examples of God's work were there for all to see. Oxford remained wedded to scholastic texts although the *trivium* was reformed along humanistic lines. Cromwell's visitors in 1535 outlawed scholasticism by decree but gave little indication of the alternative (their white list stipulating only Aristotle). The solution adopted by the Oxford masters was to import the Cambridge syllabus and textbooks wholesale. When the evangelical regime of Edward VI reformed the universities in 1549, the humanist natural philosophy syllabus was adjudged appropriate, especially those parts promoted by Philip Melanchthon at the University of Wittenberg. However, the visitors' background at court meant they valued ethics and politics more highly. The Reformation itself left natural philosophy largely unaffected although the barrier preventing Catholics from entering clerical careers after 1558 appears to have encouraged some to remain philosophers.

In mathematics, the 1549 visitation was highly significant. Cambridge University's initiative in 1500 in employing a university lecturer in the subject was in danger of stagnating due to inappropriate appointments. However, John Cheke's statutes in 1549 promoted the use of modern textbooks of practical arithmetic, finance and surveying useful to the centralised Tudor state. He also introduced the new subject of geography as a result of his contacts at court with merchants and explorers.

The thesis concludes that during the second half of the sixteenth century, English students could expect a mathematical and philosophical education comparable to that of their Italian peers. This was sufficient to provide graduates with the knowledge they needed to carry these subjects forward in the seventeenth century.

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Chapter One: Introduction

"Arethmetike, musicke, geometrie and astronomie, and with them all skill in perspectives, are now smallie regarded."[1]

William Harrison in his *Description of England* (1577)

These words of William Harrison (1535 – 93) represent the common opinion of the attitudes of Oxford and Cambridge towards mathematics, and indeed natural philosophy as well, from the sixteenth century onwards. Disparaging the universities for a lack of interest in science dates at least as far back as Sir Francis Bacon who wrote,

> In the customs and institutions of schools, academies, colleges and similar bodies destined for the abode of learned men and the cultivation of learning, everything is found adverse to the progress of science.[2]

Among modern historians, Richard Westfall claimed, "the universities were the principal centres of opposition for the new conceptions of nature which modern science constructed."[3] Charles Webster largely agreed.[4] E. G. R. Taylor suggested that the ancient universities were somehow left behind by a new practical and artisan-based science, which arose around 1600 and could be attributed to Gresham College.[5] Hallmarks of this movement, she believed, included the use of texts in English, real-world applications for science and the manufacture of navigational and other instruments. This trend was one of the factors that led to empirical science. Meanwhile the backwardness of the early-modern universities had become a historical commonplace. The drought extended, we were told, into the seventeenth century. W.T. Costello found the situation at Cambridge so bad, that "one could hardly believe

[1] Quoted in Nan Cooke Carpenter, *Music in the Medieval and Renaissance Universities* (Norman, 1958). p. 156.
[2] Roy Porter, "The Scientific Revolution and Universities," in *A History of the University in Europe: Universities in Early-modern Europe 1500 - 1800,* ed. Hilde de Ridder-Symoens (Cambridge, 1996). p. 532.
[3] John Gaiscoigne, "A Reappraisal of the Role of the Universities in the Scientific Revolution," in *Reappraisals of the Scientific Revolution,* ed. D.C. Lindberg and R. Westman (Cambridge, 1990). p. 208.
[4] Charles Webster, "The Curriculum of the Grammar Schools and Universities: 1500 - 1650," *History of Universities* IV (1975). 51 – 68.
[5] E. G. R. Taylor, *The Mathematical Practitioners of Tudor and Stuart England 1485 - 1714* (Cambridge, 1968). p. 50.

Newton came out of such a mathematical Nazareth."[6] The canonical statement of the reactionary nature of the universities was Christopher Hill's 'A Note on the Universities', which appeared as an appendix to his *The Intellectual Origins of the English Revolution.*[7]

These views are no longer widely held in the academy. Following the work of Mark Curtis,[8] which provoked the wrath of Hill, other scholars, including Roy Porter and John Gaiscoigne, have tried to achieve a balanced assessment of the universities. Porter pointed out that the majority of seventeenth-century Royal Society members, not to mention most other mathematicians, were educated at Oxford or Cambridge.[9] Gaiscoigne extended his survey over Europe and found a large majority of important mathematicians and natural philosophers were university educated.[10] Mordechai Feingold has effectively refuted the contention that Gresham College was central to the rise of science, labelling it as a failure as an educational institution all of whose professors came from the ancient universities.[11] However, he conceded that it did enjoy some success as a research establishment which neither Oxford nor Cambridge can claim. Thus, the ancient universities remained pre-eminent as pedagogical establishments and educated most of the exponents of the new philosophy.

This thesis will argue that the universities were able to provide the education required by the pioneers of the new philosophy because they had radically reformed their teaching between the 1490s and 1560s. These changes went beyond replacing one set of textbooks with another. The whole process by which the syllabus was determined was remoulded from one where existing texts remained privileged for generations to one where change was the new normality. From venerating a set of fourteenth-century Scotist tomes, the universities turned to a constantly renewed set of textbooks written in the previous few decades. Furthermore, both mathematics and natural philosophy expanded their horizons with the introduction of new subjects. Geography and natural history, recently established by the translation of ancient Greek texts, were introduced because they met the needs of the sixteenth century.

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[6] W. T. Costello, *The Scholastic Curriculum of Early Seventeenth Century Cambridge* (Cambridge MA, 1958). p. 103.
[7] Christopher Hill, *The Intellectual Origins of the English Revolution* (Oxford, 1965). pp. 268 – 281.
[8] Mark H. Curtis, *Oxford and Cambridge in transition 1558-1642* (Oxford, 1965).
[9] Porter, "The Scientific Revolution and Universities." p. 542.
[10] Gaiscoigne, "A Reappraisal of the Role of the Universities in the Scientific Revolution." p. 209.
[11] Mordechai Feingold, *The Mathematicians Apprenticeship: Science, Universities and Society in England, 1560 - 1640* (Cambridge, 1984). p. 168.

Many Englishmen travelled abroad for their education. Sometimes this was voluntary, such as when Roger Collingwood (fl. 1498 – 1517) left Cambridge to study canon law in Paris.[12] However, many were exiles who found they had to complete their courses on the continent when the religious climate at home changed. This movement has been most closely studied in the case of Padua.[13] The cross-fertilisation between England and the rest of Europe was undoubtedly influential in bringing the latest continental books and ideas to Oxford and Cambridge. However, it has been suggested that foreign-educated Englishmen were an important reason for the achievement in English natural philosophy during the seventeenth century. Thus, there is no need to postulate that anyone was learning anything useful at Oxford or Cambridge. After all, as Christopher Hill believed, in 1560, England was "a backward country in science."[14] This thesis will argue that, although the Italian schools could boast many fine professors, at the level of the undergraduate, by 1570 there was no great gulf between English and continental mathematical and philosophical education.

Knowledge of the natural world was categorised and combined in many different ways during the sixteenth century. This thesis deals with the quadrivium and natural philosophy, a grouping for which there was no early-modern name. However, we will encounter plenty of evidence that the subjects of the quadrivium were often, although certainly not always, thought about together as pre-requisites or adjuncts to natural philosophy. For instance, William Thomas (d. 1554), claimed "the discourse of the sphere is the foundatione of natural knowledge,"[15] and the links between astronomy and Aristotle's *De caelo* are clear to see. The pseudo-Aristotelian *Problemata*, a popular textbook at Oxford and Cambridge, contains questions on both natural philosophy and mathematics[16] and the booklists that form a major source of evidence for this thesis show that the same readers commonly owned books on both subjects. Thus, to consider these subjects together is logical. Given the shortage of contemporary nomenclature, I have occasionally made use of the anachronistic term

[12] A. M. Clerke, "Collingwood, Roger (*fl.* 1495–1517)", rev. Anita McConnell, *Oxford Dictionary of National Biography*, Oxford University Press, 2004 [http://www.oxforddnb.com/view/article/5932, accessed 1 Dec 2006]
[13] Jonathan Woolfson, *Padua and the Tudors* (Toronto, 1998).
[14] Hill, *Intellectual Origins*. p. 15.
[15] London, British Library, MS Egerton 837, fol. 4r.
[16] Book 15 of the *Problemata* is devoted to mathematics and Book 19, on music, also contains some mathematical questions.

'science' to describe the combination of natural philosophy and the four subjects of the quadrivium.

The extent of the changes to teaching has been disguised to some extent by the central place that Aristotle continued to occupy in the syllabus. Costello assumed that that Aristotelianism could automatically be equated with scholasticism.[17] On the contrary, we will see that the Aristotle of the late-sixteenth century universities was no longer scholastic in any meaningful sense. Costello's *The Scholastic Curriculum of Early Seventeenth Century Cambridge* is misnamed as well as unfairly severe.

Charles Schmitt correctly noted the decline of scholasticism at Oxford. Commenting on the mid-sixteenth century, he wrote,

> The medieval mainstays of natural philosophy and metaphysics had retreated from the central place they once held in the university curriculum.… One's general impression is that there was a significant decline in interest not only in the specifically medieval forms of inquiry and instruction but in the scientific core of Aristotle as well.[18]

Here we must respectfully disagree. Aristotle's work remained the mother lode of natural philosophy even when the advances of his medieval followers had been abandoned. Schmitt took the 1549 statutes at face value but if we look behind them, we find that Aristotelian textbooks were still eagerly consumed by students.

On the other hand, J. M. Fletcher understated the degree of change in the period. He noted of Oxford, "Neither the legislation of Edward VI in 1549 nor the *nova statuta* of 1564 – 5 seriously altered the structure or curriculum of the [Arts] faculty." The most significant feature of the Oxford Arts Faculty was "the absence of any serious attempt to modify its structure or curriculum by radical statutory change."[19] On the contrary, this thesis will argue that change was radical and very largely came about through the drafting and creative interpretation of the statutes.

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[17] Costello, *The Scholastic Curriculum of Early Seventeenth Century Cambridge*. p. 103.
[18] Charles Schmitt, *John Case and Aristotelianism in Renaissance England* (Toronto, 1983). p. 19.
[19] J. M. Fletcher, "The Faculty of the Arts," in *A History of the University of Oxford: The Collegiate University*, ed. J.K. McConica (Oxford, 1986). pp. 159 and 157.

The Drivers of Change

Humanism

The main agents of reform at the universities are familiar to students of Tudor history. They included John Fisher (1469 – 1535), Thomas Cromwell (1485 – 1540), Stephen Gardiner (c. 1495 – 1555), John Cheke (1514 – 1557), Reginald Pole (1500 – 1558) and William Cecil (1520 – 1598). These men were not united by religion nor did they share their full range of intellectual interests. They were not all educated at the universities themselves nor were they all of the same social class. All of them, however, promoted teaching the classics. They were proficient in Greek, except perhaps Cromwell who certainly understood its importance to education.[20] All were what we call humanists, by which I mean people who were interested in the study and promotion of the classics. As Diarmaid MacCulloch noted, "Bishop Gardiner and Cardinal Pole can be seen as humanist scholars just as much as their Protestant opponents like William Cecil and Sir John Cheke."[21] Furthermore, they all took a positive interest in religious reform whether they were Catholics or Protestants.[22] This combination of classical learning and a desire for Christian renewal has become known as Christian humanism. James McConica identified Erasmian humanism, based around the thought of Desiderius Erasmus (c. 1467 – 1536), as a long-term agenda among influential Tudor politicians in the period under review. McConica wrote,

> The Erasmian gospel, undogmatic yet definite and discernable, provides a continuous thread, turned and twisted in the course of controversy yet always retaining its essential identity as the link between the "fellow-work" of the Oxford reformers and the peculiar climate of the Elizabethan settlement.[23]

Christian humanism is broader than Erasmianism in that in encompassed both Catholics and Protestants. Paul Oskar Kristeller, while somewhat suspicious of the term, defined Christian humanists as "those humanists who applied their classical

[20] Fisher was taught by Erasmus himself; Cromwell demanded that both universities fund Greek lectures in 1535; Cheke was the first Regius Professor of the subject; Pole was a noted theologian who used the Greek fathers; and Cecil's personal library contained many Greek works.
[21] Diarmaid MacCulloch, *The Later Reformation in England 1547 - 1603* (London, 1990). p. 67.
[22] It is clear that even Pole took considerable account of Luther's theology and was satisfied that justification was through faith. He eventually found himself accused of heresy by Paul IV. See Thomas Mayer, *Reginald Pole: Prince & Prophet* (Cambridge, 2000).
[23] J. K. McConica, *English Humanists and Reformation Politics* (Oxford, 1965). p. 12.

scholarship to biblical and patristic studies and who adopted and defended in their writings some tenets of the Christian religion."[24]

We shall see how the influence of humanism on the reform of the natural philosophy and mathematics syllabus, while significant, was largely indirect. Cromwell, seeking in 1535 to eradicate scholasticism from the theology syllabus incidentally outlawed Oxford's entire natural philosophy syllabus as well. It has often been noted that humanists did not like scholasticism.[25] As Charles Nauert has pointed out, "northern humanists of the early sixteenth century did express distaste for scholasticism frequently enough that it must count as one of their defining characteristics."[26] As far as English humanists were concerned, a scholastic (although they rarely used the word before 1600) was a medieval author who wrote obscure theology in bad Latin. Usually, they would personalise the matter by calling someone a 'Scotist', after the Franciscan theologian John Duns Scotus (c. 1265 – 1308).[27] Once Scotism was banished, a new natural philosophy syllabus had to be found to take its place.

In mathematics, the influence of humanism was probably negative. Cheke's pupil, Roger Ascham, was one of many writers who attacked the study of mathematics even though (or perhaps because) he had once been paid to teach it.[28] Those whom Harrison said "smallie regarded" the quadrivium echoed the humanist sentiments of Ascham.[29] That mathematics also enjoyed modernisation and increased its coverage was, as this thesis argues, largely due to the actions of John Cheke himself. His motivation, however, was not specifically his humanism, but his desire to provide the Commonwealth with useful skills.

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[24] P. O. Kristeller, "Humanism," in *Cambridge History of the Renaissance Philosophy*, ed. Charles Schmitt and Quentin Skinner (Cambridge, 1988). p. 133.
[25] This point has been re-emphasised by Erika Rummel, *The Humanist-Scholastic Debate in the Renaissance and Reformation* (Cambridge: MA, 1995).
[26] Quoted in Ibid. p. 17.
[27] See for instance the letters of Robert Joseph in H. Aveling and W. A. Pantin, eds., *The Letter Book of Robert Joseph, Monk-scholar of Evesham and Gloucester College, Oxford, 1530 - 3*, Oxford Historical Society New Series 19 (Oxford, 1967). pp. 28, 53 and 166 where Scotus stands for the whole of Oxford scholasticism.
[28] Roger Ascham, *The Whole Works of Roger Ascham: Now First Collected and Revised, with a Life of the Author*, ed. J. A. Giles, 4 vols. (London, 1865). v. 2, p. 103.
[29] Carpenter, *Music in the Medieval and Renaissance Universities.* p. 156.

External forces

In order to effect change at the universities, individuals required money, political power, support on the ground and a motivation. That meant the agents of change had to enjoy a powerbase outside the universities themselves. Simply being vice-chancellor or an influential theologian was sometimes a necessary but always an insufficient qualification.

John Fisher had all he needed – money, royal contacts through Lady Margaret Beaufort (1443 – 1509) and like-minded helpers at Cambridge (as well as the reputation of Erasmus). He carried out his programme by founding colleges, writing statutes and occupying a number of influential executive and non-executive positions. The result was that by 1510, the BA and MA syllabuses at Cambridge contained no scholastic writers and used contemporary or classical textbooks instead.

At Oxford, the court made its presence felt through the even more substantial figure of Cardinal Thomas Wolsey (c. 1470 – 1530). However, there were important differences that meant the reform programme could make only limited progress at the older university. A major problem was that Wolsey's motivation was self-aggrandisement rather than improving education. Secondly, he left the work to agents and so did not bring his full influence to bear. Thirdly, Oxford was larger and had a more powerful theology faculty than Cambridge. The senior faculty had decisive influence in keeping the MA course on the same Scotist lines as the theology course. The great medieval traditions at Oxford also contributed to inertia. What reform there was at Oxford came from the bottom up as new students demanded humanist education. This meant the trivium changed but the MA course was untouched. Thus, although humanism was the dominant intellectual force of the moment, even able to affect the trivium at Oxford, it could achieve total control of the arts faculty at Cambridge only because Fisher saw it as one way to reform theology as well.[30]

By the 1530s, we find that Cambridge had a humanist natural philosophy syllabus and Oxford did not. In 1535, Thomas Cromwell launched his own visitations. Here, it was the influence of national policy that drove the reform, although for our subjects, it was in a very roundabout way. The injunctions of 1535 were framed for reasons of state and religion. There was no conscious intention to sweep away the

[30] Richard Rex, *The Theology of John Fisher* (Cambridge, 1991). ch. 3.

Oxford natural philosophy syllabus in particular. But, by outlawing the logical and theological scholastic authors, Cromwell made the position of the natural philosophy course untenable if not illegal.

In 1549, the court returned to the universities to institute another round of change. This thesis will argue that the prime mover in this reform was John Cheke. He probably penned the 1549 statutes and occupied several important executive positions at Cambridge. When the visitation to Oxford took place a little later, Cheke's statutes were used there too. So, the interaction between court and the Cambridge milieu produced a syllabus that was then applied to Oxford as well. The philosophy syllabus set out by Cheke closely followed his interests and those of the 'goodly harvest' of his pupils.[31] There was no room for natural philosophy because it had little practical purpose in the circles in which Cheke moved. Instead, he provided for ethics and politics, subjects he also taught the young king and thought more useful to the Commonwealth. To a great extent, Oxford and Cambridge masters did not share this disdain for natural philosophy and continued to teach the subject along the same lines as before.

Thus, external forces, wielded by those with close links to the universities, were very largely responsible for the major reforms of the sixteenth century. In particular, they are the reason we see practical mathematics taking over from theoretical arithmetic. They also explain why time spent by students on natural philosophy was reduced in favour of ethics or politics.

Printing technology

Printing helped make rapid evolution of the syllabus a practical proposition. A good reason to use old texts was that they were common and easily available. It was an expensive business to produce enough manuscript copies for a whole cohort of students to use (even allowing for the various mechanisms universities had to disseminate texts). It was also far harder for a new text to make an impact if there were initially few copies of it.

With printing that changed. The initial changeover from manuscript to print had happened by 1500 and did not much affect the books used. Printers were conservative at first and began by producing titles already in demand. However, this

[31] Ascham, *Whole Works of Roger Ascham*. v. 1, p. 351.

thesis argues that the next stage of printing enabled a rapid turnover of textbooks. When a lecturer made his name in Wittenberg or Paris, it was worthwhile to print his books for the guaranteed local market. These copies spread far faster than manuscripts because they were cheap and there were lots of them. In this way, a new textbook could break into other markets and become the dominant teaching text over a wide area relatively quickly.

Rapid advances in printing technology during the sixteenth century also tended to drive texts towards a rapid obsolescence. Diagrams, indexes, illustrations, layout and format all provided printers with ways to improve the saleability of their product. These aids for readers gave them extra reasons for investing in new books and increased the chances of new titles breaking into the market.

The Reformation

The notion that the Reformation was important to the rise of seventeenth-century natural science originated with the sociologist, Robert Merton. It started life as his doctoral thesis which was later printed in *Osiris*.[32] Merton's methodology has been found to be too narrow but the idea has been restated by Reijer Hooykaas and recently by Peter Harrison. "The co-incidence of the 'new learning' and the 'new doctrine', then, is a fact," asserted Hooykaas; although he admits "it is not easy to give its explanation."[33] He went on to note that the majority of sixteenth-century European botanists were Protestants, but this is a very narrow specialty on which to base any wide-ranging claims.[34] Harrison suggested that literal interpretations of the Bible by Protestant exegetes led to a more realist view of the natural world conducive to natural science.[35] The problem for all these theories is not so much the difficulty of linking Christianity to science, but the need for them to exclude Catholicism. None of the features of either Puritanism or Protestantism identified as formative of science were completely lacking in contemporary Catholic thought. The large amount of data gathered together in this thesis allows us to ask whether there was a difference between Catholic and Protestant attitudes to science. However, we will not find any

[32] Robert K. Merton, "Science, Technology and Society in Seventeenth Century England," *Osiris* 4 (1938).
[33] Reijer Hooykaas, *Religion and the Rise of Modern Science* (Edinburgh, 1972). p. 99.
[34] Ibid. p. 99.
[35] Peter Harrison, *The Bible, Protestantism and the Rise of Natural Science* (Cambridge, 1998). p. 8.

evidence that there was, even if political factors do seem to have driven Catholics towards teaching philosophy as they were barred from the theology faculty.

New subjects

One of the major changes at the universities in the period under review was the introduction of the new subjects of natural history and geography. Both owed their origins to discoveries and translations in the fifteenth century.

In the case of natural history, the translations were of *De plantis* by Theophrastus and Aristotle's books on animals. The latter had been known in the Middle Ages but it was in the version of Theodore of Gaza (1398 – 1478) that they enjoyed a new lease of life. The subject was of interest to several kinds of people, all of whom were at home in universities. Humanist philologists wanted to untangle the complex technical language and codify all the new words. Finding out exactly what they meant involved finding the actual plants and animals to which they referred. This gradually turned the eyes of naturalists from books to nature.[36] John Claymond (c. 1467 – 1536) and Edward Wotton (1492 – 1555) represent this school at Oxford.[37]

A second reason for interest in natural history was its religious utility. This, it will become clear, was a possible of its popularity at Cambridge and then Oxford. From the start of the sixteenth century, Aristotle's animal books began to be used as sources of examples of the wisdom of providence. Natural history served this purpose better than any other science, with the exception of astronomy.

Modern geography began with the translation of Ptolemy's *Geographia* in the early fifteenth century. By the 1490s, the discoveries of antipodes in both the southern and western hemispheres had shown that Ptolemy's facts were deficient. But his method was indispensable for those trying to understand the new shape of the world. At court, the university visitors John Cheke and Thomas Smith (1513 – 77) came into frequent contact with navigators and explorers trying to obtain royal funding and patronage. Enough of these men did not leave empty handed to show that there was official support for their schemes. It will be argued that Cheke added geography to the 1549 syllabus partly as a result of this. The other factor was the need of the

[36] For a recent detailed study of the rise of natural history in a mainly Italian context see Brian Ogilivie, *The Science of Describing* (Chicago, 2006).
[37] We will meet their works such as Edward Wotton, *De differentiis animalium libri decem* (Paris, 1552). and Claymond's commentary on Pliny in Oxford, Corpus Christi College MSS 178 – 81.

centralised Tudor state for surveyors and navigators. At the start of the century, these had come from abroad but a Protestant Commonwealth needed to be self-sufficient.[38] Hence there was a necessity for men with these skills to be trained at home.

Humanists also had their own interest in geography. Their awareness of history and the ancient world as a place distinct from the present meant that they needed to analyse classical gazetteers. Cheke recognised the priorities of his fellow humanists by allowing them to study non-mathematical works rather than Ptolemy in satisfaction of the geographical requirement in the syllabus. At Oxford, we shall see that the availability of this option meant that mathematical geography never got off the ground.

Arithmetic was not a new subject but it did change radically enough for us to think of it as one. Theoretical arithmetic, which trained the mind for logic, was abandoned in favour of practical sums and algebra, illustrated with examples from trade and finance. Cheke, seeking graduates with skills useful to the commonwealth, gave this subject a central place in his 1549 curriculum. The financial crisis under the Duke of Somerset only increased the need for men like Walter Mildmay, skilled in mathematics, to be placed in charge of the nation's purse strings.[39]

Methodology

Both multi-volume sets of the histories of Oxford and Cambridge are now complete.[40] From them, we learn about the arrival of humanism in the English universities, the movement towards students being members of colleges, the upheavals of the Reformation and the Elizabethan settlement. Frequent reference is made to these works. For the analysis of the curriculum, details of the Oxford and Cambridge syllabuses have been extracted from the standard volumes by Heywood,[41]

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[38] See the biographies in Sarah Bendall, *Dictionary of Land Surveyors and local Map Makers 1530 - 1850*, 2 vols. (London, 1997).

[39] L. L. Ford, "Mildmay, Sir Walter (1520/21–1589)", *Oxford Dictionary of National Biography*, Oxford University Press, 2004 [http://www.oxforddnb.com/view/article/18696, accessed 28 April 2007]; Mildmay's heavily annotated mathematics textbooks are preserved in Emmanuel College library.

[40] The relevant volumes are: Jeremy Catto and T.A.R. Evans, eds., *Late Medieval Oxford*, vol. 2, *A History of the University of Oxford* (Oxford, 1992)., J. K. McConica, ed., *The Collegiate University*, vol. 3, *A History of the University of Oxford* (Oxford, 1986)., D. R. Leader, *The University to 1546*, vol. 1, *A History of the University of Cambridge* (Cambridge, 1989). and Victor Morgan and Christopher Brooke, *1546 - 1750*, vol. 2, *A History of the University of Cambridge* (Cambridge, 2004).

[41] James Heywood, ed., *Collection of Statutes for the University and Colleges of Cambridge* (London, 1840).

Hackett[42] and Gibson.[43] Gibson's collection is a critical edition but no such work yet exists for Cambridge apart from Hackett's edition of the earliest statutes. Various versions of college statutes have also been used. These are, inevitably, of varying quality.

A major part of the evidence in this thesis is a detailed numerical analysis of booklists. There exist several hundred lists of books belonging to private individuals during the sixteenth century. These have been employed much less than the statutes, largely because they were confined to manuscripts, not all of which were in good condition. Lisa Jardine makes excellent use of the Cambridge lists in her work on the reform of the trivium.[44] Other authors have preferred to dip into the lists rather than work with them systematically. Now, thanks to the care and dedication of Elisabeth Leedham-Green, among other scholars, these lists have been brought to print.

The most fruitful source of booklists is the inventories produced for the probate court of the Chancellor of Cambridge. 140 of the probate lists edited by Leedham-Green have been analysed in this thesis, for those individuals who were granted their MA or similar degree before 1570. [45] To these lists are added the booklists of Bryan Rowe (d. 1521),[46] John Caius (d. 1573),[47] Sir Thomas Smith (d. 1577),[48] William Cecil (1520 – 1598),[49] and Reuban Shirwoode (d. 1599)[50], which are

[42] M. B. Hackett, ed., *The Original Statutes of the University of Cambridge: The Text and its History* (Cambridge, 1970).
[43] Strickland Gibson, ed., *Statuta antiqua universitatis oxoniensis* (Oxford, 1931).
[44] Lisa Jardine, "The Place of Dialectic Teaching at Sixteenth Century Cambridge," *Studies in the Renaissance* 21 (1974). 31 – 62.
[45] E. S. Leedham-Green, *Books in Cambridge Inventories: Books from the Vice-Chancellor's Court Probate Inventories in the Tudor and Stuart Periods*, 2 vols. (Cambridge, 1986).
[46] F. J. Norton, "The Library of Bryan Rowe, Vice-Provost of King's d. 1521," *Transactions of the Cambridge Bibliographical Society* 2 (1958). 339 – 51.
[47] Philip Grierson, "The Library of John Caius," in *Gonville and Caius College Biographical History VII*, ed. M.J. Prichard and J.B. Skempe (Cambridge, 1978). 513 – 522.
[48] John Strype, *A Life of the Learned Thomas Smith, Kt* (Oxford, 1820). p. 279.
[49] Herendeen and Bartlett attributed the library to Cuthbert Tunstall. However, the library contains too little mathematics or Aristotlelian ethics to be Tunstall's. Even the edition of Tunstall's own *De arte supputandi* is the 1529 Paris edition and not the 1522 London *editio princeps.* Furthermore, I have examined the volume in the Cambridge University Library on which Herendeen and Bartlett base their attribution. They identify a *sammelband* in the library (shelf mark Inc.2.B.3.146) containing Ammonius, *In praedicamenta Aristotelis commentarius* (Venice: 1500) bound with Simplicius, *In Aristotelis categorias commentarium* (Venice: 1499) as being found in the catalogue. This it may be, but there is no good evidence to associate it with Tunstall, apart from a late annotation. Besides, this volume arrived at Cambridge decades after the rest of the Tunstall bequest and was assumed to be his only because it was shelved with his Greek books. The library catalogue is almost certainly William Cecil's. As Herendeen and Bartlett acknowledge, almost all the books appear in the sale catalogue of his books in 1687. See W. H. Herendeen and K. Bartlett, "The Library of Cuthbert Tunstall, Bishop of Durham," *Papers of the Bibliographical Society of America* 85 (1991). 235 – 96.

available from other sources. Sir Thomas Smith's books are listed in a catalogue of his private library dating from 1566 while Cecil's books are found in a catalogue that dates from the mid-1550s. In addition, the account books of bookseller Garrett Godfrey (d. 1539) from around 1530 have been included.[51] As the probate lists contain two booksellers, it does not seem unreasonable to include the titles from another even though they come from his daybook rather than a probate list. This has given us a total of over 15,000 books including 500 or so that might be defined as covering mathematics, natural philosophy or geography.

For Oxford, the booklists come from volumes 1 – 6 of the *Private Libraries of Renaissance England* project, which covers the Chancellor's court probate lists from 1507 – 1653. Again, the inventories of those who took their MA or equivalent degree before 1570 are included in the analysis. The number of books is much smaller than at Cambridge due to the lower number of preserved records, which do not run continuously as the Cambridge ones' appear to. In addition, the much-discussed daybook of bookseller John Dorne dating from 1520 is utilised for the same reasons as Garrett Godfrey's daybook.[52] Finally, Alexander Nowell (d. 1602) made several lists of his books in his commonplace book of which the most complete has been selected.[53] These sources provide 98 booklists totalling over 7,000 titles of which 200 or so are relevant to this thesis.

The major criteria for a book list to be included in the analysis is that it should either be complete or a random selection from a complete list. Thus, a list where a random page is missing can be included but a list where only particular titles have been picked out is excluded. This means that information from the donor lists to college libraries, for instance as listed by Emden,[54] are rejected because these are not complete collections and do not show anything the college was not interested in having.

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[50] James Hannam, "The Library of Reuban Shirwoode," *Transactions of the Cambridge Bibliographical Society* XIII:2 (2005). 175 – 186.
[51] E. S. Leedham-Green, D. E. Rhodes, and F. H. Stubbings, *Garrett Godfrey's Accounts c. 1527 - 33* (Cambridge University Press, 1992).
[52] F. Madan, "The Daybook of John Dorne, Bookseller in Oxford AD1520," in *Collectanea I*, ed. C.R.L. Fletcher (Oxford, 1885). 71 – 177.
[53] Oxford, Bodleian Library, MS Brasenose College 31 p. 65/fol . 47r.
[54] A. B. Emden, *A Biographical Register of the University of Oxford from AD 1501 to 1540* (Oxford, 1974). pp. 714 – 742.

John Dee catalogued his library in 1557.[55] At the time, he owned practically every mathematical book mentioned in this thesis and a good deal of the natural philosophy. This catalogue does not form part of the sample of booklists used. The reason for this is that he spent many years at foreign universities such as Louvain and Paris where he seems to have acquired very many of his books.[56] His collection, therefore, does not tell us much about what was being read at Cambridge and, besides, it is so exhaustive that the fact Dee owned a particular text does not tell us very much about its popularity. In 1557, he owned no less than seven copies of Euclid, as many as are found in the entire Oxford set of booklists. In sixteenth century England, Dee was exceptional and this is a thesis concerned with the typical. We will, however, look briefly at his own comments on being a student at St John's College in his *Compendious Rehearsal*.

In interpreting the booklists, some methodological issues have arisen. When an entry shows an author's *Opera*, it is marked as a single copy in the relevant category. For instance, Aristotle's *Opera* count as one work of natural philosophy. This is a trade off between instances where an individual bought the collected works without much interest in the section on natural philosophy, and those who were interested in the *Physica* and *De anima* to the exclusion of all the logic, whether old or new. Of course, most readers occupy a space between these extremes. Where a title is not identified, I sometimes guessed it based on the other works on that list or over all the lists. For instance, by far the most common work of Gemma Frisius (1508 – 1555) on probate lists is his textbook *Arithmeticae practicae methodus facilis* (1540), which also appears in the syllabuses. Therefore it seems fair that an unidentified 'Phrisius' refers to this book.

The tentative opinions of the various editors of the booklists have usually been followed in these identifications but sometimes I felt justified in ignoring their caution. Another complication is that it we commonly find *sammelbands*, where several works, often but not always by one author, were bound together.[57] While lists sometimes include the word '*et alia*' or similar expressions, we cannot even assume

[55] Julian Roberts and Andrew G. Watson, *John Dee's Library Catalogue* (London, 1990).
[56] John Dee, "Compendious Rehearsal," in *Johannis Glastoniensis Chronica*, ed. Thomas Hearne (Oxford, 1756). p. 501.
[57] For example, the London, British Library, 715.i.24 contains Jacques Lefèvre d'Etaples commentaries on the *Arithmetica* of Jordanus and the *De musica* of Boethius, his epitome of Boethius on arithmetic and a treatise on the game of *Rithmimachia* by Fox's predecessor at Durham, John Shirwood.

that these were the only cases of multiple works making up one package. In the booklists, it is likely that multiple bindings are identified by the name of the first book whose title appears in the volume. Given this will be more or less random, multiple bindings do not affect my methodology

In combining and comparing the lists from Oxford and Cambridge, the question arises about the extent to which they are commensurable. The fact that there are over twice as books recorded at Cambridge than at Oxford is easily dealt with by remembering that any comparison must double the numbers coming from Oxford. The summary lists of books in appendix one give absolute numbers for each title and so readers must remember to make this adjustment when comparing the lists. There is no reason to assume that the compilers of the probate lists at Oxford and Cambridge varied their methods so that certain kinds of books were not recorded. In both cases, it is likely that very small books were ignored and *sammelbands* generally identified only by the book bound in at the front. Having read through both sets of lists in full, I have noticed no qualitative difference between them that would make a comparison impossible, apart from the distribution of dates and the absolute numbers. We do know that John Dorne's accounts contain all the works he sold whereas Garrett Godfrey's feature only the books bought on credit. This obviously means that the customer profiles for the two sets of data will be very different. Dorne sold many popular devotional works for cash and it is likely that Godfrey, too, sold these to a passing trade as well as the recorded books to his regular customers on account. In general terms, this means that we cannot compare the proportions of a title or subject sold by Dorne with those recorded by Godfrey. In spite of this limitation, some comparisons between the two sources remain instructive (for instance that Dorne sold twenty-two books by Duns Scotus and Godfrey sold none at all on credit). Furthermore, Dorne did not note who his customers were while Godfrey did. This raises the possibility that Dorne may have been selling his books to people who were not members of the university and hence have no relevance to this thesis. However, all the books of interest to us that Godfrey sold and where we know his customers' identities went to university members. It is very likely that the vast majority of Dorne's sales of Latin academic and textbooks were also sold to students or masters.

We can statistically test whether the Oxford and Cambridge lists can be deemed to be samples prepared in the same way. At first, the two sets of lists look

very different. The mean number of books per list at Cambridge is 106, and at Oxford 76. However, the standard deviations (a measure of the variation in the size of the book lists) for both samples are also large at about 250. The question is whether the difference in the mean values of the numbers of books is likely to be caused by a different sampling method at Oxford and Cambridge. We can test this using a 'z-test' which determines the probability that two means are compatible with a single sample. This is called a significance test and statisticians tend to call a result significant if it is less than 5%. We find that there is a 35% chance that the two samples come from a single population. Thus, although we have no reason to reject the hypothesis that the two sets of booklists are statistically similar, care must be taken in making comparisons. In general, these have been kept qualitative and I have never felt able to state that a particular book was x times more or less popular at one university on the basis of the booklists.

Our overall sample of 22,000 books, although quite large, is obviously a tiny fraction of the total number of books in Oxford and Cambridge between 1500 and 1570. Between 100 and 400 students a year matriculated at each of the universities, meaning between 20,000 and 40,000 students passed through or stayed on during our period.[58] Our sample consists of less than 300 booklists, heavily biased towards more senior members of the university, which represents about one per cent of the individuals who passed through.

We should bear in mind that each book had a life of its own. They were bought and sold, given away and bequeathed, lent and stolen. Very occasionally, we can see this process happening. Garrett Godfrey's sold a book to William Buckmaster which, in all likelihood, later appears in his probate list.[59] We can sometimes see books in a will that subsequently appear in a later probate list.[60] Lending also took place. Lawrence Nowell passed his textbooks on to his brother,[61] while Robert Joseph also lent out his books.[62] This means that each book came into contact with

[58] Lawrence Stone, "The Size and Composition of the Oxford Student Body 1580 - 1909," in *The University in Society*, ed. Lawrence Stone (Princeton, 1974). p. 16.
[59] See his copy of Pius II's *Cosmographia* in Leedham-Green, Rhodes, and Stubbings, *Garrett Godfrey*. p. 26 and Leedham-Green, *BCI*. v. 1 p. 80.
[60] Leedham-Green, *BCI*. v. 1, p. 261 notes a fortuitous case where Nicholas Sampson bequeathed some books to Thomas Lorkin who in turn donated them the Cambridge University Library. There they remain, still with Sampson's name inscribed.
[61] Oxford, Bodleian Library, MS Brasenose College 31, fol. 47r.
[62] Aveling and Pantin, eds., *Robert Joseph*. p. 19.

many individuals who could have used it and goes a little way towards making up for the paucity of our sources.

The nature of the statistical evidence means that we are more likely to miss a common book than falsely believe a rare book to be common. In a small, essentially random sample, it is quite likely that there will be only one or two copies of some books that are much more common in the entire population. For this reason, where a book (such as the commentary on *De anima* of Alexander ab Alexandria discussed in chapter two) is rare in the booklists but other evidence suggests it is widely used, it is fair to assume that it is much more common in the wider population. On the other hand, it is unlikely that a book that features many times in a small sample is actually quite rare in the wider population (unless, of course, all the examples come from a single source). In summary, this means that the booklists are much less likely to mislead us with a false positive than leave us ignorant with a false negative. There may well have been textbooks in common use that have escaped my notice.

Of the 22,000 books in our samples, just 700 or so are related to mathematics, natural philosophy or geography. This is a small proportion of the total. Indeed, 54 booklists at Oxford and 42 at Cambridge contain no relevant titles at all. When Peter Mack worked on the dialectical textbooks in these probate lists, he had a much larger total to play with. This meant it made sense for him to analyse the lists by college and by five-year period.[63] He also noted which books tended to be found together.[64] Again, my totals are not large enough to attempt this is a systematic manner, but I have noted associated books where it seems appropriate.

For chapters two and three, which deal with the period before 1535, I have assembled a sample of booklists that includes all those that date from the first thirty-five years of the sixteenth century. To these are added the probate lists that relate to individuals who took their MAs before 1535. Although inexact, this pre-1535 sample does allow us to draw some conclusions about natural philosophy and mathematics at the universities before Cromwell's visitation. Summary lists are given in appendix one.

[63] P. Mack, "Permeations of Renaissance Dialectic in English Discourse, c. 1570 - 1620" (MPhil Dissertation, University of London, 1978). p. 44.
[64] Ibid. p. 47.

Many of the booklists also include prices or valuations for the books. For the booksellers' account books some of these represent new prices for books including the binding. That said, some of John Dorne's sales are unbound and all booksellers would have sold substantial numbers of second hand books as well. The valuations given in the probate lists are always for bound second-hand books suffering from a varying amount of wear and tear. The exceptions are the probate inventories for booksellers. Nicholas Pilgrim's estate included many unbound copies and presumably some other new books as well. This means that the price attributed to a particular title can vary by a factor of ten or more. Luckily, there does not appear to have been a huge change in the general price that books fetched in the period under review. Although they only analysed the prices of English books, H. S. Bennett and F. R. Johnson found that prices remained fairly constant in the period up until 1550.[65] After this date, prices approximately doubled in the period up to 1570.[66] This price increase followed a general inflation caused by the debasement of the currency in the mid-sixteenth century.

With these points in mind, I have calculated the average valuation for the most popular books of mathematics and natural philosophy for Oxford and Cambridge. These figures are included in the analysis in appendix one. Despite the limitations inherent in not usually knowing whether a book is new or in good condition, this does enable us to compare the relative prices of books. From these, I have inferred that cheaper books are more likely to be aimed at the student market than more expensive works. It is clear from the textbooks that are examined in this thesis that smaller formats are preferred by students. In chapter six, we will see how publishers trying to capture the student market have usually done so by packing plenty of information into a small space. It is by no means always the case that students could not afford many books (Edward Beaumont had a fine collection of 117 when he died in 1552 shortly after determining for his BA),[67] but in general their collections were smaller than the older Masters and Professors. Thus, as a further strand of evidence to establish which books were commonly used by students, a cheaper price may be useful. Where

[65] H. S. Bennett, "Notes on English Retail Book Prices 1480 - 1560," *The Library, Fifth Series* 5 (1950). p. 174.
[66] Francis R. Johnson, "Notes on English Retail Book Prices, 1550 - 1640," *The Library, Fifth Series* 5 (1950). p. 89.
[67] E. S. Leedham-Green and R. J. Fehrenbach, *Private Libraries in Renaissance England: a Collection and Catalogue of Tudor and Early Stuart book-lists* (Marlborough, 1993). v. 2, pp. 204 – 221.

helpful, I have discussed the prices of particular texts where they are discussed in the body of the thesis.

By way of prosopography, appendices two to five of this thesis contain details of all the lecturers and professors of mathematics or natural philosophy that I have been able to locate in the primary sources. The list is certainly incomplete and the fragmentary nature of the sources means that it is difficult to draw many conclusions. In particular, students who never got as far as taking a degree rarely leave any trace. The tables of lecturers do suggest an increasing number of masters were qualifying in medicine or becoming physicians. Although medicine is, unfortunately, outside the scope of this thesis, chapter four suggests some reasons why the subject may have been encouraged after 1549. I have followed the more general conclusions about student numbers and social origins found in the standard university histories referenced above as well as the seminal work of Lawrence Stone.[68]

Scope and Plan of the Thesis

The period studied in this thesis extends from about 1500 to 1570. As we shall see in chapter three, a sustained reform of the arts faculty at Cambridge began shortly before 1500 and this is the logical starting point for any discussion of how the medieval syllabus was replaced at both universities. This date also represents the earliest booklist evidence we have, with the exception of a couple of late fifteenth century inventories. We will examine how this reform took root at Cambridge, spread to Oxford and was affected by the flurry of statutory reform that took place in the mid-sixteenth century. The last sets of new statutes were issued in 1565 and 1570 at Oxford and Cambridge respectively. These two contrasting enactments represent the considered reaction of the universities to the upheaval of the reformation and the resulting Elizabethan settlement. After so many changes, both sets of statutes would remain in force for a considerable period – decades at Oxford and centuries at Cambridge. Consequently, they represent a convenient point at which to conclude this thesis. It is true that the amount of evidence available for the later part of the sixteenth century is much greater than for the beginning. I have drawn on some of this late evidence in chapters seven and eight for the light it sheds on the earlier period.

[68] Lawrence Stone, "The Size and Composition of the Oxford Student Body 1580 - 1909," in *The University in Society*, ed. Lawrence Stone (Princeton, 1974).

However, by 1570, the overthrow of scholasticism in natural philosophy and the quadrivium was complete. The process by which both universities moved from a syllabus based on medieval texts to one based on early-modern textbooks, and which makes up the bulk of this thesis, was complete.

The scope of this thesis is restricted to teaching rather than learning – that is it looks at the experience of students from the top down. It is the point of view of the masters interpreting the statutes that we will examine rather than independent learning and reading by the students themselves. The biases of the probate lists towards older members of the university who spent many years there and were more likely to die *in situ* reinforce this. It is, of course, certain that private reading took place, even if the extent to which John Dee claimed to be an autodidact was an exaggeration.[69] Subject to availability, a student could use any book they chose to read around a topic upon which they have heard a lecture. Deciding why a particular book was being read is next to impossible. Thus, although it makes use of annotations in early-modern books where possible, this thesis does not form part of the history of reading. We can, however, identify the textbooks being imposed or recommended by masters for their students. We follow Charles Schmitt's definition of 'textbook' is a book written specifically for classroom use, rather than a text that is studied by students but was not originally intended for that purpose.[70] When we read such a book, it is almost always obvious if this was the reason that it was written. Obviously, many books used in the classroom were not originally supposed to be textbooks but with the help of other evidence, such as statutes and surviving copies, we would hope to be able to identify these too. The most convincing evidence that a particular book was being used in class is the fact that it is relatively common and being bought in bulk. Thus, identifying titles that appear frequently in the booklists is the first step in finding which ones were being used for teaching.

Chapter two argues that, despite humanist reform of the trivium, the natural philosophy and mathematics syllabus at Oxford before 1535 remained avowedly medieval. The analysis of the book lists and the other evidence reveals a tightly knit curriculum leading to the study of Scotist theology. Chapter three turns our attention to Cambridge. There, we find that humanist reforms, beginning in the 1490s, had

[69] Dee, "Compendious Rehearsal." p. 500.
[70] Charles Schmitt, "The Rise of the Philosophical Textbook," in *Cambridge History of the Renaissance Philosophy*, ed. Charles Schmitt and Quentin Skinner (Cambridge, 1988). p. 792.

extended all the way through the syllabus up to inception for the Master of Arts degree. This, it is demonstrated, was very much a consequence of the powerful position occupied by John Fisher and his followers. Contrary to Leader and Rose,[71] we will discover that mathematics did not enjoy a much-improved status following these reforms.

The remaining chapters deal with the period of the Reformation and the Elizabethan settlement, beginning with the visitation of Thomas Cromwell's agents in 1535. Chapter four shows that Cromwell's reforms made little difference to Cambridge arts studies but led to the abandonment of Oxford's scholastic natural philosophy course. Finding a ready-made alternative at Cambridge, the Oxford masters adopted the books already in use at the other university. Led by Cheke, the 1549 visitors defined a completely new syllabus for the quadrivium and emphasised moral over natural philosophy. Cheke was driven by the desire to furnish the Commonwealth with men who had the skills it needed. Chapter five examines how the visitations changed the make up of the college libraries and especially investigates claims that the reformers deliberately targeted mathematical books for destruction. The chapter supports the conclusion that no such policy was in effect, but that changing intellectual trends and the move to printed materials led to considerable neglect of the manuscript heritage. Chapter six will argue that printing led to an increased turnover in books as new titles with new aids for readers quickly penetrated the student market. This further increased the pressure to change over to newer textbooks as printing technology made old books obsolete. Chapter seven looks at the period after 1549 when the various reforms were consolidated. The resulting ways of doing natural philosophy were far more varied than had been the case previously and mathematics was resolutely practical. By the time Elizabeth took the throne, both universities had largely come to terms with the changes and there was no effort to turn back the clock. They now both offered a contemporary education based on textbooks changed every few years. One thread of evidence that runs almost throughout the period covered by this thesis is the questions set for new masters at Merton College. Chapter eight asks if these questions confirm the picture of the change from scholastic to humanist philosophy. My conclusions form chapter nine.

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[71] See D. R. Leader, "Professorships and Academic Reform at Cambridge: 1488 - 1520," *Sixteenth Century Journal* 14 (1983), 215 - 27. P. L. Rose, "Erasmians and Mathematicians at Cambridge in the Early Sixteenth Century," *Sixteenth Century Journal* 8 (1977), 47 - 59.

Chapter Two: Oxford before 1535

"There are in England two illustrious universities: of which one – I mean Oxford – is famous even among foreigners."[1]

John Major, 1522

Few of Oxford's dreaming spires had been erected by 1500. The pinnacle of St Mary's Church was already two centuries old and Merton College's chapel had acquired its tower in 1450. But Magdalen College's Great Tower was only half up and would not be completed until 1509.[2] The town as a whole was a medieval warren of smelly narrow lanes, dangerous hostelries and latent tension. Students relied on their clerical status and the financial clout of the university to keep them out of trouble, if they were not looking for it themselves.

The course of study for Oxford bachelors until 1535 was governed by a set of statutes issued in 1431. However, they would have looked much the same had they been issued even earlier. Most of the texts required by the statutes were either classical, or dated from late antiquity. A few were written by early schoolmen in the thirteenth century and none of them were more recent than that. However, the basic texts stipulated by the statutes tell us only a part of the story. To determine the true state of natural philosophical and mathematical teaching at late-medieval Oxford, we must use other sources as well.

By analysing booklists, library catalogues and other sources, this chapter will show that the natural philosophy syllabus at Oxford before 1535 was almost untouched by humanism. Rather its 'philosophical tone' was Scotist.[3] This is in contrast to the trivium that, judging from John Dorne's daybook in 1520, was already dominated by Erasmian and similar textbooks.[4] The quadrivium, on the whole, maintained its traditional position as a step on the way towards theology. The chapter

[1] H. C. Porter and D. F. S. Thomson, eds., *Erasmus and Cambridge: The Cambridge Letters of Erasmus* (Toronto, 1963). p. 22.
[2] John Hooper Harvey, "Architecture in Oxford, 1350-1500," in *A History of the University of Oxford: Late Medieval Oxford*, ed. Jeremy Catto and T.A.R. Evans (Oxford, 1992). 747 – 68.
[3] J. M. Fletcher, "Developments in the Faculty of Arts," in *A History of the University of Oxford: Late Medieval Oxford*, ed. Jeremy Catto and T.A.R. Evans (Oxford, 1992). p. 344.
[4] Of the 2,500 books mentioned in Dorne's daybook, 151 or 6% were written by Erasmus. F. Madan, "The Daybook of John Dorne, Bookseller in Oxford AD1520," in *Collectanea I*, ed. C.R.L. Fletcher (Oxford, 1885). pp. 155 – 7.

will argue that the reason for this was the different interests of those able to exert pressure for change from above and below.

Pressure from below came from fee-paying students who wanted to study subjects useful to them without necessarily staying long enough to get a degree. Lawrence Stone estimated that even in the first third of the sixteenth century, only one in four freshmen went on to receive a BA degree.[5] Thus, most students, such as Thomas More who moved on to the Inns of Court, did not stay on for long enough to experience the MA syllabus.[6] In 1521, John Major wrote that Oxford and Cambridge students were "in large part of gentle birth."[7] This must be an exaggeration but it does mean that there was a constituency of gentlemen who were noticeable and as such were probably not preparing for an ecclesiastical career. Those of lower birth might have been training to become teachers in grammar schools were a sound knowledge of the classics was essential.[8]

In order to attract these students, the university had to offer them a course that met their needs and aspirations. They wanted to acquire good letters and the kind of rhetorical skills then in vogue.[9] However, this pressure from below only reached as high as the first few years of the undergraduate course. Those students who stayed longer were studying for a different reason. In general, they would have harboured an ambition to enter one of the higher faculties, most probably the theology faculty. This meant that students following the bachelors' course wanted to be taught whatever was required to start their careers as theologians. They might moan about scholastic logic, but they were in no position to demand a new syllabus.

The theologians were in a position to effect change if they so desired. However, as I shall argue, they required that new masters of arts coming into the theology faculty had a sound knowledge of Scotist philosophy, a basic understanding of cosmology, some Boethian number theory and a good grasp of logic. Although logic lies outside our scope, we shall examine the rest of the bachelors' syllabus at some length to show that it was intended to meet the requirements of the theologians.

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[5] Lawrence Stone, "The Size and Composition of the Oxford Student Body 1580 - 1909," in *The University in Society*, ed. Lawrence Stone (Princeton, 1974). p. 91.
[6] Peter Ackroyd, *The Life of Thomas More* (London, 1999). p. 35.
[7] T. A. R. Evans, "The Numbers, Origins and Careers of Scholars," in *A History of the Univeristy of Oxford: Late Medieval Oxford*, ed. Jeremy Catto and T.A.R. Evans (Oxford, 1992). p. 515.
[8] Fletcher, "Developments in the Faculty of Arts." p. 343.
[9] J. K. McConica, "Scholars and Commoners in Renaissance Oxford," in *The University in Society*, ed. Lawrence Stone (London and Princeton, 1975). p. 152.

Scotist natural philosophy and the traditional quadrivium, we will see, remained entrenched in the requirements for the MA degree.

The theology faculty of Oxford was predominantly guided by Scotus[10] and, as we will see in chapter four, by 1535 the university visitors assumed he was the dominant intellectual authority. This is reinforced by books featuring in the account book of John Dorne in 1520. He sold twenty-two books by Duns Scotus and another thirteen by his fifteenth century followers Nicholas D'Orbelles (d. 1475) and Pierre Tartaret (d. 1515). In comparison, he sold three books by Thomas Aquinas and seven by Bonaventure. Only Oxonian Walter Burley (sixteen copies) and the wide-ranging Albertus Magnus (fifteen copies) came close to matching Duns Scotus in popularity.[11] A similar picture emerges from the earliest volume of Oxford probate lists where Duns Scotus is, if anything, even more dominant over other scholastic authorities.[12]

Just a few years earlier, Cardinal Wolsey had allowed Scotus as the only alternative to the Bible for the book upon which his theology lecture should be based.[13] Wolsey had grand plans for Oxford with his new college and its attendant professorships. This chapter will argue, however, that his efforts did not lead to change in teaching natural philosophy and mathematics. This was partly because he never brought the full weight of his influence to bear on university reform. Much of the work at Oxford was left in the hands of his agent Thomas Cromwell, who was able to form his own ideas, later realised, about what needed to be done. Neither did Wolsey have the allies at the university or the executive position himself to bring about reform. Even if he had, it is doubtful that he would have seen such a move as necessary to his own plans for self-aggrandisement.

The following analysis is restricted to trying to establish what was taught to students rather than provide a picture of the intellectual milieu of Oxford as a whole. While I shall argue this milieu had an important influence on the syllabus, we would not expect to see every facet reflected in what happened in the lecture halls. The teaching of students was probably much more homogenous than the sum total of what

[10] Jeremy Catto, "Theology after Wycliffism," in *The History of the University of Oxford: Late Medieval Oxford*, ed. Jeremy Catto and T. A. R. Evans (Oxford, 1992). p. 270.
[11] Madan, "John Dorne." 71 – 177 and F. Madan, "Supplementary Notes to The Daybook of John Dorne, Bookseller in Oxford AD1520," in *Collectanea II*, ed. M Burrows (Oxford, 1890). 453 – 478.
[12] E. S. Leedham-Green and R. J. Fehrenbach, *Private Libraries in Renaissance England: a Collection and Catalogue of Tudor and Early Stuart book-lists* (Marlborough, 1993). v. 2.
[13] S. L. Greenslade, "The Faculty of Theology," in *The History of the University of Oxford: The Collegiate University*, ed. J.K. McConica (Oxford, 1986). p. 307.

interested the senior masters. The analysis begins with the texts and textbooks that the different strands of evidence suggest were used.

For the analysis in this chapter, I have used the pre-1535 sample delineated in Chapter one. In all, this sample is made up of fifty booklists containing a total of 4,075 books, of which approximately 2,500 appear in John Dorne's daybook. These booklists contain about fifty entries for books related to the quadrivium, which is roughly the same total as for natural philosophy, albeit split between four subjects.[14]

Late Medieval Mathematics at Oxford

The four subjects that made up the quadrivium, collectively also called mathematics, were arithmetic, music, geometry and astronomy. The word 'quadrivium' was first coined by Boethius (480 – 525) in his treatise on arithmetic, *De institutione arithmetica*.[15] An early-sixteenth-century definition of these subjects is found in the preface to book one of *De arte supputandi* (1522), by the English humanist and soon-to-be bishop, Cuthbert Tunstall. He defined the subject of arithmetic as the art of counting, music as being the art of harmony, geometry the art of measuring and astronomy as calculating the motion of the stars according to fixed rules.[16] The syllabus laid down the texts upon which a bachelor must have heard lectures in the schools and the duration of each one as follows:

Arithmetic:	Boethius	1 term
Music:	Boethius	1 term
Geometry:	Euclid, Alhazen or Witelo	2 terms
Astronomy:	*Theoricum planetarum* or Ptolemy	2 terms[17]

[14] See appendix one.
[15] Olaf Pedersen, *The First Universities*, J. D. North trans. (Cambridge, 1997). p. 8; Boethius, *Boethian Number Theory: a Translation of the De institutione arithmetica*, Michael Masi trans. (Amsterdam, 1983). p. 71. The earliest manuscripts refer to the '*quadruvium*'. The word 'trivium' was coined under Charlemagne and the spelling of both words probably harmonised thereafter. Pedersen, *The First Universities*. p. 23.
[16] Cuthbert Tunstall, *De arte supputandi* (Strasbourg, 1538). Praefatio. "Nam cum mathematicae discipline quattuor existant, Arithmetica, quae numerandi artem atque universam numerorum uim explicat, Musica, quae sonorum concentus atque harmoniam discernit, Geometrica, quae terrae et aliarum rerum metiri magnitudinem instituit, Astrologia, quae caeli atque astrorum motus certa nature lege invariabiles docet."
[17] Strickland Gibson, ed., *Statuta antiqua universitatis oxoniensis* (Oxford, 1931). "Presentatos igitur ad incipiendum in artibus et philosophia supponimus formam determinatoribus indictam audiendo complesse, necnon in scolis arcium, septem artes liberales et tres philosophias per octo annorum

This course was intended to prepare students for more advanced study in philosophy and theology. We will examine each of the authors mentioned later in this chapter.

For Boethius, writing in late antiquity, the quadrivium was the precursor to true philosophy,

> Hardly anyone has been able to reach the highest perfection of the disciplines unless the nobility of such wisdom was investigated by him in the … quadrivium. If a searcher is lacking knowledge of these four sciences, he is not able to find the truth…. He who spurns these, the paths of wisdom, does not truly philosophise. [18]

However, the relatively small amount of evidence directly relating to the quadrivium suggests it was treated as of only secondary importance. Certainly, we have much less evidence for how the quadrivium was taught than we do for natural philosophy, even though it presumably occupied students for twice as long – six terms rather than the three terms set aside for natural philosophy. We know of only one regent master who taught from the quadrivium for his regency – Thomas Roswell of All Souls in 1508.[19] He lectured on *De sphera* of John Sacrobosco (fl. 1221 – 56).

Some of the colleges supplemented the lecturing from the regent masters with internal teaching. For example, Merton College ordered two of its masters, Thomas Mosgrove (d. 1527) and Lawrence Hewlett (MA 1535) to lecture on Sacrobosco in 1515 and 1535, as well as stipulating Euclid's *Elementa* to John Holder (d. 1544) in 1515.[20] In his 1517 statutes for Corpus Christi College, Oxford, Richard Fox decreed that undergraduates stave off boredom and idleness during the long vacation by hearing lectures from the bachelors on an *Algorismus*, a tract on the sphere (probably Sacrobosco's) or on the motions of planets or some other mathematical book.[21] In about 1520, Thomas Wolsey founded some lectureships without endowment. The lecturers were lodged in Corpus Christi College and covered at least the subjects of

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terminos, termino quolibet ad minus continente xxx dies legibiles, secundum formam sequentem ascendendo gradatim, ordinarie et attente audisse:... Arithmetricam per terminum anni, videlicet Boecii; Musicam per terminum anni, videlicet Boecii; Geometricam per duos anni terminos, videlicet librum Geometrie Euclidis, seu Alicen Vitulonemne in perspectivam; Astronomiam per duos terminos anni, videlicet Theoricam Planetarum, vel Tholomeum in Almagesti." p. 234.

[18] Boethius, *Boethian Number Theory.* p. 71.

[19] W.T. Mitchell, ed., *Register of Congregations 1505 - 17*, 2 vols. (Oxford, 1998). v. 2, p. 165.

[20] See appendix five for details.

[21] *Statutes of the Colleges of Oxford: with Royal Patents of Foundation, Injunctions of Visitors and Catalogues of Documents Relating to the University Preserved in the Public Record Office*, 3 vols. (Oxford, 1853). "Corpus Christi", p. 57.

the Humanities and Theology.[22] It is possible that Nicholas Kratzer (1486 – 1550), a German mathematician, was one of these lecturers during his sojourn at Oxford in 1523. He read Sacrobosco and Ptolemy's *Geographia* as ordinary lectures in the schools.[23] In the same year, Merton's Thomas Mosgrove may have been appointed Wolsey's reader in Medicine.[24] Wolsey's Humanities readership was filled by such luminaries as Thomas Lupset (1495 – 1530) and Juan Luis Vives (1492 -1540).[25] However, the only text we know Lupset covered was the astronomical *De sphera* of Proclus in the translation of Thomas Linacre (c. 1460 – 1524) during 1521.[26] There is doubt about whether Wolsey appointed a lecturer in mathematics, but Kratzer and Lupset could both have filled the post if he did. If Wolsey had been trying to bolster teaching of the quadrivium by appointing lecturers, which is by no means certain, his efforts were completely inadequate, not least because he supplied no endowment to ensure the lectures would survive him. There is no hint that he tried to shift the syllabus to a more practical basis by stipulating alternative textbooks. Nor was there a consistent policy of appointing a mathematical specialist. The presence of Kratzer and Vives shows that Wolsey was capable of bringing in outsiders if Oxford could not supply skilled lecturers on the quadrivium itself. However, his lecturers seem to have existed in parallel to the main teaching effort of the regent masters. Indeed, Kratzer's lectures needed a special dispensation to be counted as ordinary at all.[27] Thus Wolsey did not radically reform Oxford's quadrivium syllabus, which remained a theoretical primer for theological studies.

Astrology at Oxford

In the booklists, there are very few advanced mathematical texts of a sort that would be of interest outside the classroom. Few masters seemed to have persisted in

[22] G. D. Duncan, "Public Lectures and Professorial Chairs," in *A History of the University of Oxford: The Collegiate University*, ed. J.K. McConica (Oxford, 1986). p. 339.
[23] John D. North, "Nicholaus Kratzer - The King's Astronomer," *Studia Copernicana* XVI (1978). p. 218.
[24] Gillian Lewis, "The Faculty of Medicine," in *A History of the University of Oxford: The Collegiate University*, ed. J.K. McConica (Oxford, 1986). p. 220.
[25] Duncan, "Public Lectures and Professorial Chairs." p. 338. Duncan excludes both Kratzer and Mosgrove from Wolsey's lecturers.
[26] J. M Fletcher, "Linacre's Lands and Lectureships," in *Linacre Studies: Essays on the Life and Work of Thomas Linacre c. 1460 - 1524*, ed. Francis Maddison, Margaret Pelling, and Charles Webster (Oxford, 1977). p. 121.
[27] Mitchell, ed., *Register 1505 - 17.* p. 67.

the subject once they had covered the minimum required by the syllabus. Those who did tended to be astrologers.

It is an inaccurate modern cliché that astrology and astronomy were one and the same in the pre-modern period. The subjects were discrete and rarely confused. What is true, however, is that the words 'astrology' and 'astronomy' were often used interchangeably, such as by Cuthbert Tunstall in the excerpt quoted above.[28] Conrad Gesner, in his early attempt at a universal bibliography, laments at the way the terms were used indiscriminately.[29] Sometimes their meanings were even reversed.[30] This thesis will not follow sixteenth-century convention but instead will use the term astronomy only for the description of the movements of the heavens. By astrology, we will understand the study of the heavens' influence on earth. In the fifteenth century, John Baconthorpe (d. 1346) divided academic astrology into three sub-divisions: mathematical astronomy, horoscope astrology and horology.[31] This same demarcation is used by James VI of Scotland in his *Demonologie* (1597) and it is clear from this that only mathematical astronomy, dealing with the motions of the planets, the prediction of eclipses and chronology was non-controversial.[32]

The case of medical astrology was a special one. In Italian schools, where medicine was the most important faculty, astrology rode on the physicians' coattails – the chair of astrology was part of the medical faculty at Bologna.[33] Physicians were expected to have some expertise in astrology so that they would know when to have their patients bled. It was an official part of the syllabus and casting prognostications was one of the astrology lecturers' duties.[34] It seems likely that the low status of astrology in the English universities was closely tied to the lack of power enjoyed by the medical faculty. In England, the physicians lacked the numbers or influence to fully overcome theological hostility towards astrology.

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[28] See note 5, above.
[29] E. S. Leedham-Green, *Books in Cambridge Inventories: Books from the Vice-Chancellor's Court Probate Inventories in the Tudor and Stuart Periods*, 2 vols. (Cambridge, 1986). v. 1, p. xxv.
[30] For example Leopold Duke of Austria, *Compilatio Leupoldi ducatus Austrie filii de astrorum scientia* (Venice, 1520). sig. A.iii.v.
[31] John D. North, "Astronomy and Mathematics," in *A History of the University of Oxford: Late Medieval Oxford*, ed. Jeremy Catto and T.A.R. Evans (Oxford, 1992). p. 105.
[32] James VI and I, *Daemonologie* (London, 1924). p. 13.
[33] Olaf Pedersen, "The Corpus Astronomicum and the Traditions of Medieval Latin Astronomy," *Studia Copernicana* XIII (1975). p. 90.
[34] Nancy Siraisi, *Medieval and Early Renaissance Medicine: An Introduction to Knowledge and Practice* (Chicago, 1990). p. 67.

Astrology was widespread at Oxford but never entirely acceptable. John North has noted a steady decline in academic astrology at the university throughout the sixteenth and seventeenth centuries, even while popular astrology was enjoying a resurgence.[35] In contrast with the situation in Italy, other northern universities shared these suspicions about astrology.[36] Simon de Phares (fl. 1490 – 1498), who ran an upmarket astrology practice in Lyon, had had several books in his library declared suspect by the Theology Faculty of Paris.[37] In 1535, Michael Servetus was unable to persuade even the physicians of Paris that astrology was essential to their profession.[38] The Cologne Theology Faculty ordered the local astrologers Hartungus (fl. 1488) and Johann Lichtenberger (fl. 1492) to desist from their practices, as it considered them altogether too ignorant to study such dangerous things. The later was even to be investigated by a local inquisitor.[39]

In 1502, Magdalen College had consulted astrologers to help them find some stolen property.[40] This was almost certainly pushing the boundaries further than they were supposed to go. In 1520, William Atwater (c. 1450 – 1522), Bishop of Lincoln, condemned astrology during his visitation to Oriel College.[41] He found that Walter May (d. 1558), recently a college lecturer on Aristotle's *De Anima*, had been "publicly practicing judicial astronomy".[42] Atwater was a traditionalist in his scholarly interests and contributed to the library to equally traditionalist Brasenose College.[43] However, he approved of the study of astronomy and natural philosophy. The few Oxford fellows of the early sixteenth century who were noted for their interest in astronomy were actually astrologers. Foremost among them was John Robyns (1500 – 1558), a fellow of All Souls who then moved to Henry VIII College

[35] J. D. North, "The Reluctant Revolutionaries: Astronomy after Copernicus," *Studia Copernicana* XIII (1975). p. 171.
[36] North, "Astronomy and Mathematics." p. 114.
[37] J-P. Boudet, *Le recueil des plus celebres astrologues de Simon de Phares*, 2 vols. (Paris, 1999). v. 2, p. 335.
[38] Lynn Thorndike, *History of Magic and Experimental Science*, 8 vols. (New York, 1923 - 58). v. 5, p. 288.
[39] Ibid. v. 4, p. 545.
[40] A. B. Cobban, *English University Life in the Middle Ages* (London, 1999). p. 159.
[41] H. E. Salter and G. C. Richards, eds., *The Dean's Register of Oriel 1446 - 1661* (Oxford, 1926). p. 386.
[42] A. B. Emden, *A Biographical Register of the University of Oxford from AD 1501 to 1540* (Oxford, 1974). p. 392.
[43] Margaret Bowker, "Atwater, William (*d.* 1521)", *Oxford Dictionary of National Biography*, Oxford University Press, 2004 [http://www.oxforddnb.com/view/article/879, accessed 16 March 2006]

in 1532 and successfully ingratiated himself with the king.[44] Several of Robyns' works survive in manuscript and indicate that he was an accomplished mathematician and astronomer. His *De cometis*, dedicated to Henry VIII, survives in at least three manuscripts.[45] There is no record that he ever taught the subject, although he would probably have done so as a regent master in 1525, the year of his MA. Despite his various writings on astrology, Robyns appears to have avoided getting into trouble with the authorities.

The astronomy textbooks demanded by the syllabus do not have anything to say about astrology although commentaries on them might do so.[46] However, I can find no direct evidence that astrology was taught, as opposed to practised, in sixteenth century Oxford. The only possible exception is the allowance of "some other book of Ptolemy" in the 1564/5 Oxford statutes, which might theoretically provide an opening for his astrological *Tetrabiblios* to be used.[47] The lack of astrology in the quadrivium is evidence of the degree of control that the theologians had over what was taught. Their disapproval was sufficient to marginalise the subject and ensure that it was not part of the mainstream syllabus. This may represent a hardening of attitudes from the fifteenth century when a special dispensation given in the 1450s for a regent master to lecture on the Arabian astrologer Alcabitius (d. 967) or some other astrological work.[48]

The borderline status of astrology meant that it cannot have been what the university intended astronomy to be used for. It could, however, have been exactly why individual students found astronomy interesting. Thus, the presence of several astrologers at Oxford in the early-sixteenth century probably did promote the quadrivium. It is even possible that individual lecturers spiced up their teaching with references to astrological works, or sought to encourage attendance by emphasising that astronomy was an essential precursor to astrology.

Let me now turn to the four components of the quadrivium.

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[44] Steven A. Walton, "Robins, John (c.1500–1558)", Oxford Dictionary of National Biography, Oxford University Press, 2004 [http://www.oxforddnb.com/view/article/23825, accessed 15 March 2006]
[45] James Halliwell, *Rara mathematica* (London, 1839). p. v.
[46] Most obviously the commentary of Cecco D'Ascoli on *De sphera* of Sacrobosco. See Lynn Thorndike, *The Sphere of Sacrobosco and its Commentators* (Chicago, 1949). 343 – 411.
[47] Gibson, ed., *Statuta*. p. 378.
[48] W.T. Mitchell and W. A. Pantin, eds., *Register of Congregation 1448 - 1463* (Oxford, 1972). pp. 101, 129 and 224.

Arithmetic

The purpose of teaching arithmetic to Oxford students was not to enable them to do sums. Instead, they studied the theoretical arithmetic of Boethius to prepare their minds for the metaphysical perfections they would encounter in the theology course. To the Greeks, such as Nicomachus of Gerasa (AD 60 – 120), on whom Boethius based his work,[49] arithmetic meant studying the theory and properties of integers. Thus, arithmetic included matters such as proportion, prime numbers and perfect numbers. It emphasised mathematical elegance. This was a subject that was completely descriptive, one might even say prescriptive. A student was expected to do little more than learn which numbers were triangular or square without the need to actually manipulate them at all. The aim was to illuminate the student's mind with profound truths about reality. Mathematics opened a window into a truly eternal world of unchanging perfection. Time was explicitly excluded from any kind of mathematical construction because it was tainted by the concept of change.[50] Change could play no part in the ideal realm of mathematics, which incidentally made it extremely hard to relate mathematical models to the sub-lunar world. Boethius claimed that arithmetic "holds the principal place and position of a mother to all the rest."[51] Until 1549, his was the only arithmetical work required at Oxford.

Boethian arithmetic can seem difficult to grasp for modern minds because it is neither practical nor with any modern equivalent outside the boundaries of pure maths. Here numbers are not just tools but wonderful and deeply mysterious things worthy of contemplation and study in their own right. For example, the first of the two books of Boethius' *De institutione arithmetica* is made up of classifying different numbers according to their properties. Thus, we learn about odd and even numbers; even numbers can be perfect, imperfect or superabundant while odds can be primes, secondary and mixed. A perfect number, which fascinated the Pythagoreans, is one whose factors add up to the whole (for example 6 = 1+2+3 and 28 = 1+2+4+7+14) while for an imperfect or deficient number the factors add up to less (for example 14, where the factors are 1+2+7 = 10). Likewise, superabundant numbers have factors that add up to more than the whole. Boethius describes such numbers as:

[49] Boethius, *Boethian Number Theory*. p. 67.
[50] Amos Funkenstein, *Theology and the Scientific Imagination from the Middle Ages to the Seventeenth Century* (Princeton, 1986). p. 302.
[51] Boethius, *Boethian Number Theory*. p. 74.

> …similar to someone who is born with many hands more than nature usually gives as is the case of the giant who had a hundred hands, or three bodies joined together such as the triple-formed Geryon. Or this number is like some monstrosity of nature which suddenly appeared with a multiplicity of limbs.[52]

As for deficient numbers, they are like "…one born with some limb missing or with an eye missing like the ugliness of the Cyclops' face."[53] Here, most clearly, we can see that the thrust of Boethian mathematics is not practical at all.

De institutione arithmetica was one of the earliest arithmetical works to be printed – the *editio princeps* of his *Opera* arrived in 1488.[54] The only other editions known were published at Augsburg in about 1489 and Paris in 1521. In 1531, Joachim Ringelburgius (1499 – 1531) still places Boethian arithmetic in pole position in his own encyclopaedia of the arts.[55] Nicomachus himself was not printed until 1538 when a Greek text was published in Basel.[56] Despite being considered so important and influential, the fact is that at Oxford and Cambridge, *De institutione arithmetica* was not a common book. It appears twice in the probate lists, but long after 1535.[57] It is found only in the 1505 catalogue for All Souls College among early-sixteenth-century college library catalogues.[58]

The form in which we tend to find Boethius's ideas at Oxford is in the *Epitome in duos libros Arithmeticos diui Seuerini Boetij* (1496) by Jacques Lefèvre D'Etaples. John Dorne had four copies of this in stock (although it is absent from the probate lists).[59] There is but one copy in the Cambridge probate lists relating to before 1535.[60] There were at least twelve editions, ten of them prior to 1515, making it a far more popular book than Boethius's own work. The *Epitome* is obviously intended as a guide to help students get to grips with Boethius' treatment of arithmetic. The preface ties Boethius very firmly to the Pythagoreans and their 'ancient wisdom' (*prisca sapientia*) making it clear that Lefèvre is under no illusions that Boethian mathematics

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[52] Ibid. p. 97.
[53] Ibid. p. 97.
[54] D. E. Smith, *Rara arithmetica: A Catalogue of the Arithmetics Written before the Year MDCI with a Description of those in the Library of George Arthur Plimpton of New York* (London, 1908). p. 25.
[55] Boethius, *Boethian Number Theory*. pp. 49 – 53.
[56] Smith, *Rara arithmetica*. p. 186.
[57] Nicholas Abythell, late mathematics lecturer at Cambridge in 1586 and John Tathan at Oxford in 1576. See Leedham-Green, *BCI*. v. 1, p. 366 and Leedham-Green and Fehrenbach, *PLRE*. v. 4, p. 260.
[58] N. R. Ker, *Records of All Souls College Library 1437 - 1600*, Oxford Bibliographical Society New Series 16 (Oxford, 1971). List XVI, no. 176.
[59] Madan, "John Dorne." pp. 157 – 8.
[60] William Framyngton (d. 1537) Leedham-Green, *BCI*. v. 1, p. 7.

is an aid to philosophy, closely tied to music theory, rather than a practical art.[61] He also appreciates that it is not easy. His dedicatory letter to John Stephan Ferrero, Bishop of Vercelli in Italy, makes this very clear.

> For [Boethius' work] is so densely organised that, unless the mind should have been prepared properly in advance, it will take no benefit from any teaching. For as skilled doctors administer a drink and digestive with strong medicines, from which they bring about firmer health, so also in every kind of teaching, it is worthwhile to prepare so that our understanding may follow instruction more easily and bring about the health of our mind.[62]

Lefèvre's *Epitome* is arranged into four parts of which the first is a glossary. The second and third parts roughly correspond to the two books of Boethius' original. The fourth part is a summary table of where different theorems can be found in both Boethius' text and the *Arithmetica decem libris demonstrata* of Jordanus Nemorarius. This was another work often bound together with the epitome of Boethius together with Lefèvre's notes on it. The first few editions all featured both these works as well as a summary of music and a treatise on the mathematical game of Rithmomachia.[63] This game was intended to "teach and exercise principles of Boethian mathematics" and in John Sherwood, had a fifteenth-century English exponent.[64] Other versions were packaged with a textbook on geometry, the sphere or practical mathematics. This frequent shuffling of Lefèvre's university textbooks partly explains his popularity and makes for an extremely complicated publishing history.[65] The printer, Henri Estienne (c. 1460 – 1520) of Paris, targeted his many editions of Lefèvre directly at the student market and they have "For the use of the philosophy students of the University of Paris" prominently on the title page.[66]

Boethius' theoretical arithmetic occupied its privileged place in the syllabus because it was thought to be the foundation of both the rest of the quadrivium and of

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[61] E. F. Rice, ed., *The Prefatory Epistles of Jacques Lefèvre d'Etaples* (New York, 1972). p. 34.
[62] Ibid. p. 34. "*Ita enim ferme comparatum est ut nisi mens rite praeparata fuerit, nullum in disciplinis capiat emolumentum. Ut enim periti medici potiones digerentiaque fortibus praemittunt pharmacis quo firmiorem inducant valatudinem, ita quoque in omni disciplinarum genere operae pretium est introductiones praemittere, ut faciliorem assequitur disciplinae intelligentiam, velut quandam perfectam nostrae mentis sanitatem.*"
[63] Ibid. p. 17.
[64] Ann Moyer, *The Philosophers' Game: Rithmomachia in Medieval and Renaissance Europe* (Ann Arbor, 2001). p. 2.
[65] Rice, ed., *Epistles of Lefèvre*. pp. 542 – 6.
[66] John Sacrobosco of Holywood, *Textus de sphaera,* ed. Jacques Lefèvre d'Etaples (Paris, 1514). Title page. "*ad utilitatem philosophiae Parisiensis Academiae*".

philosophy. The way it dealt with timeless entities prepared the way for metaphysics and theology while the treatment of triangular and square numbers had an important bearing on geometry. Thus, arithmetic was embedded in an overarching scheme of learning and secured in place by its relationship to the other subjects studied.

Practical mathematics did also have a place at Oxford although it is hard to determine exactly what its status was. The evidence for this is the ten copies of an *Algorismus* sold by John Dorne.[67] This slim work, which is examined in more detail in the next chapter, covered basic calculation. The fact it never appears in the probate lists is likely due to it being a flimsy pamphlet that did not warrant an individual valuation, if it was noticed at all. Dorne was selling them, presumably new, at just two pence a piece. The unanswered question is whether or not practical mathematics was being taught at Oxford. Aside from Dorne's sales, there is no evidence that it was and neither is it consistent with what we will find to be quite a coherent syllabus. However, the number of copies sold by Dorne and the fact he twice managed to shift more than one at a time, suggests that practical arithmetic was being taught to students as no other large enough constituency existed. Whether this teaching was extra-curricula or formed a course unacknowledged by the statutes is impossible to determine. On the basis of the other evidence presented in this chapter, I would argue that even if this useful skill was taught, it does not appear to cohere with the rest of the syllabus.

Music

Music was always the poor relation among the mathematical sciences. In theory, it further advanced a student's study of harmony and proportion – concepts that could be carried over to understanding the heavens, created unchanging and perfect by God. At Oxford, the statutes of 1431[68] and 1564/5[69] called for the study of Boethius' *De institutione musica* and a regent master was appointed as lecturer each year. However, these lecturers were frequently given dispensations to drop the subject, usually due to a lack of students. This occurred twice in the 1530s[70] and

[67] Madan, "John Dorne." p. 146.
[68] Gibson, ed., *Statuta*. p. 234.
[69] Ibid. p. 378 and p. 390.
[70] Mitchell, ed., *Register 1505 - 17*. p. 189.

seven times in the fifteen years from 1564 – 79.[71] Despite one version of Cromwell's injunctions calling for arts students to study music, the subject remained unpopular after 1535.[72] "It seems likely," a modern commentator suggests, "that candidates could get by with the merest smattering of the subject."[73] There is little further evidence from the probate lists. Boethius' *De institutione musica* is found there three times at Oxford but not at all at Cambridge.[74] Given that there was no separate edition of *De institutione musica* until 1652,[75] the copies on the lists must be manuscripts.[76] And, as manuscripts were rarely mentioned by title in the probate lists of the period, we cannot rule out that there were several other copies of *De musica* that the probate clerks have not deigned to mention. A copy, certainly a manuscript, existed at Clare College, Cambridge in 1496[77] and All Souls in 1505.[78]

De institutione musicae itself is in four and a half books, although it is unclear whether it was never completed or just transmitted deficiently. The first four books are a free paraphrase of a lost work by Nicomachus, the authority also for the *De institutione arithmeticae*. The last fragment begins running through the *Harmonics* of Ptolemy which, if completed, would have taken a further three books giving a total of seven.[79] In his introduction, Boethius distinguishes between *musica mundana* or "the music of the spheres", *musica humana* or the rhythms of life, and *musica instrumentalis*, which meant artificial music by means of both voice and instruments. However, his treatise says nothing about composing and deals exclusively with *theorica musica*.[80] This requires an appreciation of such matters as the "proportional architecture of the tempo changes" which are a tribute to the "notions of beauty and proper order" even if they are actually imperceptible to the unaided ear.[81]

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[71] Andrew Clark, ed., *Register of the University of Oxford (1571 - 1622)*, vol. 1, Oxford Historical Society Publications (Oxford, 1887). p. 100.
[72] *Letters and Papers, Foreign and Domestic, of the Reign of Henry VIII*, vol. 9 (London, 1862 - 1910). 615.
[73] John Caldwell, "Music in the Faculty of Arts," in *A History of the University of Oxford: The Collegiate University*, ed. J.K. McConica (Oxford, 1986). p. 203.
[74] John Dorne (1520),Madan, "John Dorne." p. 148, Edmund Burton (1529) and Master Bisley (1543): Leedham-Green and Fehrenbach, *PLRE*. v. 2, pp. 117 and 175 (perhaps).
[75] Caldwell, "Music in the Faculty of Arts." p. 204.
[76] Dorne's copy is probably Lefèvre's commentary, together with one of his books on arithmetic.
[77] R. W. Hunt, "Medieval Inventories of Clare College Library," *Transactions of the Cambridge Bibliographical Society* 1 (1950). pp. 105 – 125, no. 1.
[78] Ker, *All Souls College Library*. List XIV, no. 142.
[79] Boethius, *Fundamentals of Music*, ed. Claude V. Palisca, Calvin M. Bower trans. (New Haven, 1989). p. xxxviii.
[80] Caldwell, "Music in the Faculty of Arts." p. 202.
[81] Boethius, *Boethian Number Theory*. p. 26.

As well as the teaching in the arts faculty, there was also a special music degree peculiar to Oxford and Cambridge. It was first awarded in the mid-fifteenth century and was intended for composition. Examination was by the production of a specified piece of religious music and there was no internal teaching at the university.[82] At Oxford, the recipient of this degree was instructed by Congregation to lecture on the text of Boethius but there is no sign that anyone ever actually did this.[83]

Among the reasons for music being a required part of the quadrivium, Robert Grosseteste (c. 1170 – 1253) mentioned its importance in promoting good health.[84] Where the study of music theory continued to excite interest, Boethius' treatise became increasingly ignored except as a window on the historical subject of ancient Greek music for which he remains the most important source.[85] Lefèvre's compendium of arithmetic discussed above included a short *Musica libris demonstrata quattuor* (1496)[86] and this may have been the text usually used for musical teaching. Brasenose has a 1496 copy liberally sprinkled with "Nota" and "Bene notanda" in a sixteenth century hand.[87] As this book was always bound with other more substantial works, it is not mentioned in the booklists and its presence can only be inferred.[88] Lefèvre's preface consists of a run down of ancient authorities on music from Mercury, Orpheus and Pythagoras all the way down to Boethius. It is this rich pedigree, he claims, that guarantees the worthiness of studying music.[89]

Another possible source of musical knowledge was the *Margarita Philosophica* of Gregor Reisch (c. 1476 – 1525).[90] This is the best known of several attempts to produce compendiums of all the material required for a grounding in the seven liberal arts, natural philosophy and ethics. It was first published in 1500, reprinted and added to for the next fifty years or so.[91] The book is striking for its considerable size and beautiful woodcut illustrations that can be found adorning many

[82] Frank Harrison, "Music at Oxford before 1500," in *A History of the University of Oxford: Late Medieval Oxford*, ed. Jeremy Catto and T.A.R. Evans (Oxford, 1992). p. 367.
[83] Mitchell, ed., *Register 1505 - 17*. v. 1, p. 252.
[84] Pearl Kibre and Nancy Siraisi, "The Institutional Setting: The Universities," in *Science in the Middle Ages*, ed. D.C. Lindberg (Chicago, 1978), p. 130.
[85] Boethius, *Fundamentals of Music*. p. xiii.
[86] Rice, ed., *Epistles of Lefèvre*. p.17.
[87] Oxford, Brasenose College, shelf mark UB/S I 78.
[88] Excepting only Dorne's copy referenced above.
[89] Rice, ed., *Epistles of Lefèvre*. p. 30.
[90] The copy examined is Cambridge, University Library, Shelf mark Adams 6.50.2 printed at Strasbourg in 1504.
[91] Juan-Luis Vives, *On Education*, Foster Watson trans. (Cambridge, 1913). p. 206.

a modern monograph. It is found six times in the probate lists and despite it's considerable size was sometimes available cheaply (on average just five and a half pence at Cambridge but nearly two shillings at Oxford). Given its wide range, it is, perhaps, surprising that we do not find more of them.

Reisch, a Carthusian monk, devotes a book to each of the trivium and quadrivium subjects and then turns to natural philosophy and ethics. Book four deals with arithmetic. Reisch clearly understood the distinction between speculative number theory and practical calculation. He also touched on the use of the abacus ("*denarius projectilibus"*).[92] The other quadrivium subjects are also divided into their theoretical and practical components. For music in book five, this means theoretical Boethian theory as opposed to practical composition; for geometry it is Euclidean demonstration against the practice of measuring areas and volumes; and for astronomy in book seven it is theoretical astronomy and practical astrology. The material included is introductory but quite comprehensive. Reisch does not seem to have made any effort to update his sources, declaring that the tropics and arctic regions of the world were not habitable ("*non habitabilem*").[93] He also believed that the spheres of earth and water were not concentric but have differing centres so some of the earth can poke out of the water as dry land.[94] This is something he might have found in Pierre D'Ailly's (1350 – c. 1420) cosmographical work,[95] but the discovery of the new world rendered the theory untenable.

All of book five of the *Margarita Philosophica* is given over to music. Reisch begins with a section on *musica speculativa* which follows Boethius' theorectical treatment quite closely. He then presents a short section on the practice of music and on musical notation. Although quite modest, the information provided by Reisch probably gave students a sufficient grounding in the subject for the purposes of their degree. Some may even have preferred to use this source rather than the available lectures or specialised textbooks. Music owed its continuing presence in the syllabus to the perceived importance of harmony for the appreciation of creation. It followed on directly from theoretical arithmetic and built on the themes of perfection and proportion. Supposedly, then, music's importance was not due to its own utility, but

[92] Gregor Reisch, *Margarita Philosophica* (Strasbourg, 1504). sig. n. iiii. v.
[93] Ibid. sig. x. i. r.
[94] Ibid. sig. u. vi. r.
[95] Anthony Grafton, *New Worlds, Ancient Texts* (1995). p. 79.

its place in the scheme of learning as a precursor to metaphysics and theology. In practice, the principles learnt during the arithmetic course were adjudged sufficient for budding theologians.

Geometry

The timeless and unchanging world of geometry was a far better way of contemplating perfection than musical studies. The Oxford statutes of 1431 instructed bachelors to spend two terms on geometry, studying Euclid's *Elementa*, Alhazen's *Perspectiva* or Witelo's *Perspectiva*.[96] The latter two works are devoted to the medieval ancestor of optics. Witelo (fl. c. 1270) was a Pole working in Rome. He appears to have been influenced by Roger Bacon (1214 – 94), some evidence at least that Bacon's *Opus maior* actually reached the papal circle.[97] Witelo's massive treatise in ten books covered advanced geometry, light propagation and a theory of vision. In the *Nova statuta* (1564) at Oxford, it is listed again as an alternative to Euclid for the geometry course.[98] This perhaps means only the first book because it contains a summary of the geometrical knowledge assumed by the rest of the work.[99] Alhazen's (965 – 1039) great treatise combined the various Greek approaches to light and it was the ultimate source of Bacon's and Witelo's work.[100] Medieval Franciscans, starting with Grosseteste, through Bacon and onto John Peckham (d. 1292), had developed a metaphysics of light which encouraged them to develop the subject of *perspectiva*.[101] However, as none of these authors on *perspectiva* appears in the Oxford probate lists, we can assume no one paid the subject much attention. All Souls College library did have a copy of Alhazen's book in 1505 but it was lost by 1548.[102] The compendious *Margarita philosophica* does contain a very short section on *perspectiva* in book six but this is more concerned with how to create the illusion of depth in a picture (our modern meaning of perspective) than the theories of vision and light found in medieval authors.

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[96] Gibson, ed., *Statuta*. p. 234.
[97] David Lindberg, *Roger Bacon and Origins of Perspectiva in the Middle Ages* (Oxford, 1996). p. xix.
[98] Gibson, ed., *Statuta*. p. 378.
[99] Sabetai Unguru, *Book One of Witelo's Perspectiva*, vol. XV, Studia Copernicana (1977). p. 29.
[100] David Lindberg, "The Science of Optics," in *Science in the Middle Ages*, ed. David Lindberg (Chicago, 1978). p. 343.
[101] Andrew Cunningham and Roger French, *Before Science: The Invention of the Friar's Natural Philosophy* (Aldershot, 1996). pp. 231 – 47.
[102] Ker, *All Souls College Library*. List XIV, no. 141.

The *Elementa* of Euclid is probably the most famous mathematical text in history. It was an early book off the press and the *editio princeps* of 1482 was followed by several more incunabular editions.[103] Some editions included less than the full thirteen books, with the first six on the basics of geometry being a popular abridgement. Still more contain two extra books, making fifteen, added during antiquity. Simon Grynaeus (1493 - 1541) produced the first Greek edition at Basel in 1533 after he had visited England in search of useful manuscripts. He was lent a manuscript belonging to Corpus Christi College, Oxford that contained Proclus' commentary on the first book of the *Elementa,* which he returned marked up for printing. John Claymond (1467 – 1536), the first president of Corpus, whom we will meet many more times, received commendation for the loan in both the dedicatory epistle to Cuthbert Tunstall and in a letter from Grynaeus to John More (1509 – 1547), Sir Thomas More's son.[104]

Commentaries and epitomes of Euclid are relatively rare because the *Elementa* is quite easy to understand and follow, at least as long as one has a good edition with clear diagrams and few typos in the cross referencing. For instance, Lefèvre does not seem to have written anything on geometry although one of his pupils, Charles de Bovilles, edited pseudo-Boethius' *Introductio in geometriam* (1501).[105] Euclid's work also far exceeds what a student was expected to know and so it did not need to be supplemented by other works. Juan-Luis Vives, no enthusiast for the quadrivium, says that he wishes Euclid to be "very carefully explained" to students.[106] John Dorne had three copies of the book in stock and it appears on two other probate lists of individuals who took their MA at Oxford before 1535.[107] The only reason that it was not even more popular was probably the price – Dorne demanded a steep five shillings per copy.[108] At Cambridge later in the century, the price dropped precipitously but many copies continued to be worth a shilling or more.[109]

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[103] Smith, *Rara arithmetica.* p, 11.
[104] Jonathan Woolfson, "John Claymond, Pliny the Elder and the Early History of Corpus Christi College, Oxford," *English Historical Review* 112 (1997). p. 894.
[105] Rice, ed., *Epistles of Lefèvre*. p. 90.
[106] Vives, *On Education.* p. 206.
[107] F. Madan, "The Daybook of John Dorne, bookseller in Oxford AD1520," in *Collectanea I*, ed. C.R.L. Fletcher (Oxford, 1885). p. 157; Edward Hoppe (d. 1538) (possible) and Bisley (d. 1543) in Leedham-Green and Fehrenbach, *PLRE*. v. 2, pp. 158 and 174.
[108] Madan, "John Dorne."
[109] Leedham-Green, *BCI.* v. 2, p. 323.

The conservative bishops, Attwater and Longland, both gave copies to Brasenose College.[110] New College received copies from its warden, John Young (d. 1526) and Christopher Longolius (d. 1555).[111] All Souls had a copy too.[112] John Claymond of Corpus Christi also gave a copy to his college, inscribing it:

> Pray for the soul of John Claymond, once the first president of this college who gave this book for the use of students so that they could copy out the theorems of Euclid for their college lectures.[113]

As an essential but expensive volume, *Elementa* was an obvious gift to give for the benefit of the students and Corpus Christi's copy is well thumbed.

Euclid's geometry is a rather more practical proposition than Boethius' arithmetic. Astronomy uses plenty of geometrical constructions and is impossible, except at a most basic level, without them. Any student attracted to astrology would also need to have grasped the basics of geometry to calculate prognostications. This might, as I said above, explain the interest of students but it does not tell us why geometry held a place in the syllabus. To understand that we need to look briefly at how Euclid's work is presented.

The *Elementa* are arranged into thirteen books of which the first six are on plane geometry, seven to ten on number theory and eleven to thirteen on solid geometry. It is designed to be worked through in order with the initial definitions leading to a series of propositions either demonstrating a construction or a proof. Previous propositions are referred to so that the corpus of geometry is seen to proceed in an orderly way from proof to proof. This is what makes the *Elementa* so appealing to those who enjoy the schema of rigorous demonstrations and logical deduction that underpins them. Here we see the link between geometry and arithmetic. Both deal with an unchanging and eternal world of perfection. Euclid admits no constructions that require a time element. Demonstration itself is properly understood not as an application or example. Instead, it is a certain demonstration that brooks no

[110] Oxford, Brasenose College, shelf marks UB/S I 32 and 67.
[111] Oxford, New College Library, Benefaction book p. 34.
[112] It is missing from the 1505 catalogue but is present in both earlier and later lists. Ker, *All Souls College Library*. List XVI, no. 113.
[113] Oxford, Corpus Christi College, shelf mark delt.10.1. "Orate pro anima Joannis Claymondi olim primi presidis huius collegii qui hunc librum in usum discipulorum et ut inde ex scriberent theoremata euclidis pro lectura in aula eidem dedit."

disagreement. This concept is carried into natural philosophy by Aristotle who believes that he can demonstrate, that is prove, physical propositions.

Metaphysics was defined as the subject that dealt with infinite and eternal concepts as opposed to physics, which handled only the finite.[114] Geometry can also deal with the infinite in a way that natural philosophy cannot. There are infinite lines in Euclidean space and it has no boundaries. Thinking about these concepts helped students come to terms with metaphysics and then theology. Questions about whether matter consisted of indivisibles or was a continuum frequently featured in commentaries on the *Sententiae* and scholastic theologians found the *Elementa* is useful weapon in tackling them.[115] William Chubbes (c. 1444 – 1505), expounding on Scotus on the second book of the *Sententiae* in about 1499, found a use for Euclid, as well as Aristotle and Ptolemy.[116]

Astronomy

God's handiwork could be most readily apprehended in the unending rotations of the heavens. While the causes of their motions were within the ambit of natural philosophy, the description and prediction of the planets' position required mathematical skills. The acquisition of these skills was essential to astrology, which might explain why astronomy was the most popular of the quadrivium. For the theologians, the importance of the subject was the glimpse it afforded of an uncorrupted realm that still ran as God had originally ordained that it should. Thus, Oxford's medieval syllabus stipulates the *Theorica planetarum* or Ptolemy's *Almagest* for the two terms devoted to astronomy.[117]

The thirteen books of the *Mathematical Synthesis* of Ptolemy, renamed *Almagest* or *The Great* by the Arabs, hold a central place in the history of astronomy. Despite this, it never turns up on any of the Oxford booklists, although All Souls College library did hold two manuscript copies in 1505.[118] The rarity of this book can

[114] Sachiko Kusukawa, *The Transformation of Natural Philosophy: The Case of Philip Melanchthon*, Ideas in Context (Cambridge, 1995). p. 17.
[115] John E. Murdoch, "'Mathesis in philosophiam scholasticam introducta' The Rise and Development of the Application of Mathematics in Fourteenth Century Philosophy and Theology," in *Arts libéraux et philosophie au Moyen Age: Congrès international de philosophie médiévale (4th: 1967: Montreal)* (Montreal and Paris, 1969). p. 217.
[116] Richard Rex, *The Theology of John Fisher* (Cambridge, 1991). p. 19.
[117] Gibson, ed., *Statuta*. p. 234.
[118] Ker, *All Souls College Library*. List XIV, nos. 140 and 155.

be put down to its extreme difficulty, especially in the medieval translation of Gerard of Cremona (1114 – 1187) who worked from the Arabic rather than directly from the Greek.[119] George of Trebizond (1395 – 1486) did produce a new translation in the fifteenth century but his accompanying commentary proved sufficiently controversial to blight the whole work.[120] Henry Savile (1549 – 1622) felt compelled to translate his own version from the Greek in 1568 because he thought Gerard of Cremona's language was "utterly foul, strange and foreign" while George of Trebizond could not do the maths.[121] Few printed editions were available in the early-sixteenth century. The *editio princeps* of the *Almagest* in Latin did not finally appear until 1515 and the Greek edition in 1537.[122] Like the Greek Euclid, this was prepared by Simon Grynaeus in Basel, who dedicated it to Henry VIII.

No other comprehensive treatise on mathematical astronomy survives from antiquity because they were all superseded by Ptolemy's great work. He begins with his basic axioms, that the universe is a sphere and the earth is an immovable point at the centre. Using the star catalogue of Hipparchus (fl. 150BC) containing about 1,000 stars, as well as many other observations, Ptolemy produces a system of the world that matched reality as closely as anyone could measure. To do this, he was forced to sacrifice the Aristotelian principle of uniform circular motion by introducing the 'equant point'.[123] It is this "contradiction of the first principles of regularity of movement" which Copernicus found so obnoxious and eliminated from his own heliocentric system.[124]

Theorica planetarum was the alternative for astronomy at Oxford in the 1564 statutes as well as in 1431.[125] This medieval work, first printed at Ferrara in 1472, was made obsolete in the late-fifteenth century by *Theoricae novae planetarum* of Georg Peurbach (1423 – 61) and the criticisms of Regiomontanus (1436 – 76).[126] Philipp

[119] David Lindberg, "Transmission of Greek and Arabic Learning," in *Science in the Middle Ages*, ed. David Lindberg (Chicago, 1978), p. 66.
[120] Brian Copenhaver and Charles Schmitt, *Renaissance Philosophy* (Oxford, 1992). p. 86.
[121] Robert Goulding, *Studies on the mathematical and astronomical papers of Sir Henry Savile*, PhD, Warburg Institute, University of London (1999), p. 27.
[122] Jim Bennett, "Practical Geometry and Operative Knowledge," *Configurations* 6 (1998). p. 202.
[123] Alan Musgrave, "The Myth of Astronomical Instrumentalism," in *Beyond Reason: Essays on the Philosophy of Paul Feyerabend*, ed. Gonzalo Munévar (London, 1991), p. 272.
[124] Nicolaus Copernicus, *On the Revolutions of the Heavenly Spheres*, Charles Glenn Wallis trans. (Amherst, 1995). p. 5.
[125] Gibson, ed., *Statuta*. p. 378.
[126] Olaf Pedersen, "The Decline and Fall of the 'Theorica Planetarum'," *Studio Copernicana* XVI (1978). p. 185.

Melanchthon (1497 – 1560) esteemed Peurbach's work highly enough to say it surpassed the classics:

> The ancients praise Archytas and various works by Archimedes, but that brief work, the *Theorica* of Peurbach, is far more admirable. It contains the whole of the very long work of Ptolemy and sets before our eyes the positions of the orbits.[127]

We find no copies of *Theorica planetarum* in the probate lists either but this may be illusionary. As we will see in chapter six, this book was very often published as a compendium together with Sacrobosco's *De sphera* and other astronomical works. Of the fourteen editions of *De sphera* that I have examined, six include the *Theorica* and often many other works besides, including Peurbach's. The clerks assembling probate lists did not worry about listing all the works in a volume. John Dorne did note that he had sold one copy but the high price of 1s 6d suggests that this was a *sammelband* as well.[128]

The *De sphera* of John Sacrobosco was the most popular astronomy textbook at Oxford but it did not appear on the syllabus. John Dorne sold five copies and it appears six more times in sample of the probate lists that we have been using.[129] Sacrobosco is believed to have been an Englishman who wrote the short treatise, *De sphera*, in the first half of the twelfth century at the University of Paris.[130] It rapidly attracted a commentary tradition that expanded on its rather basic content and it remained a standard introductory work on astronomy until the seventeenth century. The *editio princeps* came out in 1478 and there were at least 120 further editions during the sixteenth century.[131] Bishop Longland gave a volume to Brasenose College containing Sacrobosco, the *Theorica planetarum* and, rather incongrously, the fifth-century astrology manual by Firmicus.[132] Inevitably, All Souls also had a copy in 1505.[133]

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[127] Philipp Melanchthon, *Orations on Philosophy and Education*, ed. Sachiko Kusukawa, Christine F. Salazar trans., Cambridge Texts in the History of Philosophy (Cambridge, 1999). p. 108.
[128] Madan, "The Daybook of John Dorne, bookseller in Oxford AD1520." p. 136.
[129] Ibid. p. 163 and Madan, "Supplementary Notes to John Dorne." p. 475; Edmund Burton (d. 1529) (two copies), Edward Hoppe (d. 1538), Bisley (d. 1543) and Thomas Allen (d. 1561) Leedham-Green and Fehrenbach, *PLRE*. v. 2, pp. 117, 159 and 174; v. 3, p. 46.
[130] John F. Daly, "Sacrobosco, John," in *Dictionary of Scientific Biography*, ed. Charles C. Gillespie (New York, 1970 - 80). v. 12, p. 60.
[131] Owen Gingerich, "Sacrobosco as a Textbook," *Journal for the History of Astronomy* 19 (1988). p. 267.
[132] Oxford, Brasenose College, shelf mark UB/S I 46.
[133] Ker, *All Souls College Library*. List XIV, no. 149.

We could dismiss *De sphera* for being too basic and insufficiently mathematical but this fails to do justice to the text and misunderstands it purpose. Sacrobosco's work is indeed basic but that is precisely what it is intended to be. It is successful at presenting all the concepts it addresses in a way that is both accurate and lucid. Generations of students will have been grateful for Sacrobosco's limpid prose and simple exposition. *De sphera* is clearly the introductory text that other masters built upon rather than the end of astronomy. This becomes clear when we examine the commentary tradition. Commentaries are generally organised into a series of lectures that go through the *De sphera* using its introduction of each concept as a springboard to present further ideas and discussion. A course of lectures on *De sphera* would go far beyond Sacrobosco himself but he was a vital starting point. Nevertheless, it was the enormous virtue of Sacrobosco's *De sphera* as an introductory text that guaranteed it the first place in astronomy for so long. But, even before astronomy was reformed in the seventeenth century, Sacrobosco's was never the last word.

Precisely how much the teaching encompassed is a harder question to answer. We can be reasonably sure that when Cecco D'Ascoli lectured on the *De sphera* at Bologna in the fourteenth century he was using it to present his own rather more esoteric ideas on astrology. His commentary set these out.[134] Likewise, Robert Angelicus in thirteenth-century Paris.[135] No such commentary exists from the hand of the mathematics lecturers at an English university in the sixteenth century but commentaries in possession of the Cambridge masters by the likes of Lefèvre d'Etaples give an idea of how much further they would go. Issues that Lefèvre raised include the number of celestial spheres, whether eight according to Plato, nine according to Alfraganus (d. c. 861) (a major source for Sacrobosco)[136] and ten in late-medieval works like Georg Puerbach (1423 – 1461).[137] These extra spheres were incorporated to explain the procession and trepidation of the equinoxes.[138] Lefèvre also includes a lengthy discussion of the size of the earth and the distances to the

[134] Thorndike, *The Sphere of Sacrobosco.* pp. 343 – 411
[135] Ibid. pp. 143 – 198.
[136] Ibid. p. 15.
[137] Jacques Lefèvre D'Etaples, *Textus de Sphaera de Ioannis de Sacrobosco: introductoria additione commentarioque, Iacobi Fabri Stapulensis Commentarii* (Paris, 1500). lib 1, cap 7.
[138] James Lattis, *Between Copernicus and Galileo: Christoph Clavius and the Collapse of Ptolemaic Cosmology* (Chicago, 1995). p. 83.

planets.[139] The former had become controversial since the fifteenth century translation of Ptolemy's *Geographia* into Latin whose figure for the Earth's circumference is smaller than that in Pliny and used by Sacrobosco. This was of contemporary interest due to Columbus deciding on the smaller and erroneous figure but Lefèvre makes no mention of the New World. However, both the arctic and torrid zones, uninhabited according to the classical tradition, can now be lived in 'with difficulty' (*aegre*) as indeed many people did.[140] Tables of latitude and longitude from Ptolemy are inserted into the commentary as a long aside.[141]

Lefèvre's work on the sphere, a handsome folio written for use at Paris, called *Textus de sphaera de Ioannis de Sacrobosco: introductoria additione commentarioque, Iacobi Fabri Stapulensis commentarii*, interspaces his comments with Sacrobosco's text using a different typeface, much like the layout of manuscript theological commentaries. John Dorne had three copies in stock and it may be that several of the other copies of the *Sphere* found in Oxford and Cambridge booklists also attached this commentary.[142] The *editio princeps* was from 1495 and the copy examined was printed in 1538 at Paris.[143] In his dedicatory epistle to the philanthropist, Charles Bourré (d. 1498), Lefèvre explained that he is writing the commentary at the urging of one George of Sparta who felt the job needed doing now that George of Trebizond was no longer around to do it. He also mentions that Sacrobosco's *De sphera* is the standard astronomy textbook at the University of Paris.[144]

Astronomy was one of the branches of mathematics because it dealt only with the description of the heavenly movements, the so-called 'saving of appearances.' Dealing with the physical reality of the heavens was within the domain of natural philosophy. If astrology was what a student wanted to practice, they did not need to go beyond mathematical astronomy to have the skills necessary to make prognostications. That was not why the university taught the subject. It was a

[139] Lefèvre D'Etaples, *Textus de Sphaera de Ioannis de Sacrobosco: introductoria additione commentarioque, Iacobi Fabri Stapulensis Commentarii*. lib 1, cap 24 – 35.
[140] Ibid. lib 2, cap 28.
[141] Ibid. lib 2, cap 16.
[142] Madan, "The Daybook of John Dorne, bookseller in Oxford AD1520." p. 162.
[143] London, British Library, shelf mark: 533.i.5.(1.)
[144] Rice, ed., *Epistles of Lefèvre*. p. 27.

necessary prerequisite for studying the heavens through which a student could come to appreciate the perfection and unchanging nature of God through his creation.

The Quadrivium's Purpose

As we have seen, when he studied the four subjects of the quadrivium, an Oxford student was not acquiring many practical skills. Any knowledge he gained was incidental to the purpose of the subjects. Rather the quadrivium lifted the minds of students away from humdrum reality towards a higher plane of being. To summarise, arithmetic demonstrated the immutable properties of numbers. This was a language of eternity in which, according to Boethius, God himself could think.[145] Boethian music also trained the mind to appreciate patterns and harmonies. Likewise geometry, where Euclid restricted himself to constructions that do not require any sort of temporal element. There is no untidiness in the world of Euclidean geometry. Everything is in its proper place and it is logically impossible for things to be other than they are. Astronomy also dealt with a higher reality. The heavens above the moon were not thought to be subject to corruption or change and so they better exemplified God's creation than the Earth.

If this all sounds very Platonic, that is hardly surprising given that Boethius' textbooks were written before the re-emergence of Aristotle's philosophy in the twelfth century. More surprising is the way that mathematics, which sometimes openly conflicted with Aristotelianism, managed to remain in the syllabus throughout the Middle Ages. The evidence suggests three reasons for this. The first is inertia. The syllabuses were old and rarely changed. If a textbook was stipulated once, it might take centuries to get rid of it. Despite this, mathematics was becoming less popular and few took an interest in it outside the classroom. The second reason is that theoretical mathematics trained the mind to deal with abstractions and reject the clutter of the everyday world. This was a useful attitude to bring to metaphysics and any other sort of idealising philosophy. Finally, mathematics did have many practical uses, the most obvious to the university master being astrology. The culture of the university was loose enough to allow practical matters time in the classroom and their usefulness helped maintain demand for mathematics.

[145] Boethius, *Boethian Number Theory*. p. 74.

The college libraries reflected ambivalence about mathematics. All Souls was an exception to this rule. In 1505, it owned copies of every single book mentioned in the 1431 quadrivium syllabus (except Witelo's) and almost no other mathematical works.[146] The presence of all these otherwise unusual books may even reflect a deliberate policy to buy the books that students required. This condescension to the interests of the junior members was not shared by any other Oxford or Cambridge college.

Natural Philosophy at Oxford

Natural philosophy was studied after the quadrivium and was the next step in a student's trek towards the theology faculty. The syllabus of 1431 stated that bachelors should hear three terms of lectures on the following natural philosophy texts:

> The books of *Physica*, *De caelo* and *De mundo*, or *De proprietatibus elementorum* or *Meteorologica*, or *De vegetabilibus* and *De plantis* or *De anima*, or *De animalibus* or some of the short books [*Parva naturalis*], and this from the corpus of Aristotle. [147]

The drafter of these statutes clearly believed that every one of these texts came from the pen of Aristotle himself but today we consider *De mundo*, *De propertatibus elementorum*, *De vegetabilibus* and *De plantis* to be spurious. For example, the pseudo-Aristotelian *De plantis* is now thought to have been compiled by a Greek philosopher called Nicholaus Damascanus (fl. c. 15 – 13BC).[148] It had formed part of the Aristotelian corpus from the thirteenth century and, in England, it was subject to a standard teaching gloss.[149] Despite the presence of some pseudonymous works, it was Aristotle who formed the backbone of the natural philosophy syllabus just as he done from the earliest statutes of the European universities in the thirteenth century.[150]

The philosophy syllabus, taking three years in total, was taught to bachelors who would have completed the course of the seven liberal arts in four years before they determined. Then they faced three years of philosophy before they could incept.

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[146] Ker, *All Souls College Library*. List XIV.
[147] Gibson, ed., *Statuta*. p. 234. continued from n. 14 above. "*....libros Physicorum vel Celi et Mundo vel de Proprietatibus Elementorum aut Metheorum, seu de Vegetabilibus et Plantis, sive de Anima, vel de Animalibus, aut aliquem de minutis libris, et hoc de textu Aristotelis*"
[148] Thomas DaCosta Kaufmann, "Empiricism and Community in Early Modern Science and Art: Some Comments on Baths, Plants and Courts," in *Natural Particulars: Nature and the Disciplines in Renaissance Europe*, ed. Anthony Grafton and Nancy Siraisi (Cambridge, MA, 1999). p. 403.
[149] Roger French, "Teaching Aristotle in the Medieval English Universities: 'De plantis' and the physical 'Glossa ordinaria'," *Physis* 34 (1997). p. 228.
[150] See, for instance, the Parisian statutes of 1255 in Pedersen, *The First Universities*. p. 278.

We have quite a lot of evidence for the lectures in natural philosophy, which were heard after the bachelors had spent their first year at lectures on ethics. We know whom the regent masters giving the lectures were when they appear in the *Register of Congregation* for some reason.[151] This is usually because something has gone wrong or the regent master is not happy with the subject he has been allocated. Appendix four summarises the information gleaned from this source. Some of the colleges also hosted lectures and their lecturers, as far as they are known, are given in appendix five.

Magdalen College put on public lectures open to the whole university. The statutes that William Wayneflete (c. 1400 – 1486) wrote for his college, promulgated in 1479, had stipulated public lectures in theology, ethics and natural philosophy.[152] In fact, the lectureships appear to have been filled even earlier in 1476.[153] As Magdalen's lectures were public, Corpus Christi College took advantage of this resource to send its students along and, doubtless, other colleges did too.[154] We have a fairly full record of the holders of these posts although the two philosophy lectureships are not always clearly distinguished.[155] Looking at the holders, we see several eminent individuals early in their careers. A very high proportion went on to obtain higher degrees. John Piers (1522 – 94), who lectured 1553 – 4, later became Archbishop of York. Thomas Starkey (c. 1498 – 1538), lecturer 1521 – 2, was one of the Italian travellers who brought back humanist ideals. He wrote the political treatise, *A Dialogue Between Pole and Lupset*, against tyranny but later swung to the monarch and served Henry VIII.[156] He left his books to Edward Wotton (1492 – 1555), lecturer from 1518 – 19. Sadly, no probate lists survive for any of the Magdalen lecturers and I have been unable to locate any of their books in the college library. Nor do we have records of what books they were required to lecture upon.

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[151] I have only been able to examine the published register in Mitchell, ed., *Register 1505 - 17*. Other registers remain in manuscript in the Oxford University Archives.
[152] *Statutes of the Colleges of Oxford*. v. 2, "Magdalen", p. 47.
[153] A. B. Cobban, *The Medieval English Universities: Oxford and Cambridge to c.1500* (Aldershott, 1988). p. 199.
[154] *Statutes of the Colleges of Oxford*. volume 2, "Corpus Christi College", p. 54.
[155] The information has been extracted from J.R. Bloxam, *A Register of the Presidents, Fellows, Demies of St Mary Magdalen College in the University of Oxford: The Demies*, 4 vols., vol. 1 (London, 1873). and William Dunn Macray, *A Register of the Members of St Mary Magdalen College, Oxford* (London, 1894). It is set out in appendix five of this thesis.
[156] T. F. Mayer, "Starkey, Thomas (*c*.1498–1538)", *Oxford Dictionary of National Biography*, Oxford University Press, 2004 [http://www.oxforddnb.com/view/article/26318, accessed 18 July 2006]

The notices in the various registers are most useful when they include the book upon which the regent master was expected to lecture. This data is summarised in Table 2.1. The figure in the right hand column shows the number of times each text is stipulated in one of the registers.

Aristotelian text	
Physica and John Canonicus's *Questiones*	10
De generatione	12
De anima	15
Parva naturalia	11

Table 2.1

Comparing this list to the syllabus shows that the spurious works did not get lectured on. The *Questiones* of John Canonicus (fl. 15th century) are named in nine out of the ten mentions of the *Physica*. I deal with this important work in full below. The strangest omission from the syllabus is *De generatione*. There is no doubt that this is a central text of the Aristotelian corpus and the university authorities agreed. Perhaps the syllabus's drafter thought that it was included in the *Parva naturalia*.

The Aristotelian Corpus

The *Physica* is the central plank of Aristotle's natural philosophy. Measured by the number of commentaries that it acquired, it generated a good deal more interest than any of Aristotle's other works of natural philosophy.[157] It covers the famous four types of cause, definitions for change, time, place and void and the resulting theories about motion. It is in the *Physica* that we find Aristotle proposing that the speed an object falls is proportional to the density of the medium through which it is moving. He attacks atomism and insists that matter must be infinitely divisible. He defines place and refutes the void. One of the most striking points about reading the *Physica* with an awareness of the commentary tradition it has spawned is how such small sections have led to such an enormous amount of annotation. For example, the brief

[157] J. D. North, "Natural Philosophy in Late Medieval Oxford," in *A History of the University of Oxford: Late Medieval Oxford*, ed. Jeremy Catto and T.A.R. Evans (Oxford, 1992), p. 69.

note in book six, chapter eight on the way that a dense medium impedes a body moving through it produced voluminous comment by medieval thinkers all the way back to John Philoponus (c. 490 – c. 570). All Aristotle seems to be doing is trying to construct an argument against the void (and not a very successful one at that) by saying that a medium of zero density would allow an object to move through it at infinite speed. It is well beyond the scope of this thesis to attempt any criticism of Aristotle's ideas or medieval responses to them. However, it is necessary to appreciate just how challenging his thought was and how much he packed in. Book eight was of particular interest to Christians because it sets out one of Aristotle's cosmological arguments for the existence of God, the unmoved mover required as a source for all other change.

De anima was considered part of natural philosophy rather than metaphysics, although what could be said on this subject was sharply curtailed by Church injunctions aimed at preserving human beings' moral autonomy and personal immortality. The famous Paris injunctions of 1277 were echoed at Oxford by Robert Kilwardby (c. 1215 – 1279) shortly afterwards and the same sentiments can also be found in the Marian statutes of 1556.[158] Arranged in three books, it is a work of much broader scope than the Latin title suggests. The first book is made up of criticisms of the theories of Aristotle's materialist predecessors while the second deals with the question of what it means to be alive. Only in the third book do we move to questions about intellect and imagination. The popularity of the work, despite its fundamental disagreement with Christian dogma over the immortality of the soul, had much to do with its broad remit.

The *Parva naturalia* are seven short books also largely devoted to psychology but in a more empirical manner, covering the senses, dreams, sleep, memory and other related matters. *Meteorologica* is about the atmosphere and weather but includes a number of phenomena we might consider celestial, such as comets and meteors, which Aristotle believed to be sub-lunar occurrences. *De caelo,* in two books, describes the position of the earth in the universe, the orbits of the planets and the celestial spheres. This book is a surprising omission from table 2.1. It is probably explained best by the fact that students would already have done a course on astronomy. Although this was supposed to deal only with a mathematical description

[158] Gibson, ed., *Statuta*. p. 373.

of the movements of the planets, it probably covered quite a few physical questions as well. These included the number of celestial spheres, what they were made of and by what mechanism the planets moved. None of these questions had definite answers in the early-sixteenth century.

Of the works on the syllabus now known to be spurious, only *De mundo* enjoyed much popularity in the sixteenth century. It was usually packaged as the second half of *De Caelo* and commentated on together with this genuine work as, for example, in *Expositio in libros de caelo et mundo* of Gaetanus de Thiene (1387 – 1465). I have found no trace of the other spurious works either in the booklists or contemporary college library catalogues.

If we judged the teaching of natural philosophy from the syllabus alone, we might expect that students were being taught Aristotle's thought directly from his own works. In fact, as we will see, much of the evidence shows that this was not the case.

Let me first turn to the college library catalogues. Lincoln College's catalogue of 1476 shows that they held a certain *Textus philosophie naturalis.*[159] This is probably Aristotle's *Physica* together with some others of his natural works. The same title appears at All Souls College in 1505.[160] Otherwise, neither library contains Aristotle's natural works on their own. We also have four catalogues from the library of Canterbury College, which occupied the site of Worcester College, dating from 1501, 1510, 1521 and 1524. Here we do find copies of several of Aristotle's works. There are two copies of *De caelo et de mundo* as well as single copies of *De anima* and *Physica* in 1521.[161] Overall, however, a text of Aristotle's natural philosophy without an accompanying commentary was a rare book. Indeed, we can guess that even where it appears in a catalogue there is a commentary attached that goes unmentioned.

The booklists do not contain many of Aristotle's natural works either. Of the 1,200 books in the probate lists relating to before 1535, there is one copy of *Physica*,

[159] Robert Weiss, "The Earliest Catalogues of the Library of Lincoln College," *Bodleian Quarterly Review* 8 (1937). no. 96.
[160] Ker, *All Souls College Library*. List XIV, no. 127.
[161] Canterbury College 1501, 1510, 1521 and 1524 in W. A. Pantin, *Canterbury College, Oxford*, 4 vols., vol. 1 (Oxford, 1947). Inventories C, E, F and G. Professor Andrew Watson has kindly shown me his list of corrections to these inventories although none of the mistakes he found is material to the books of natural philosophy.

one copy of *De mundo* and one copy of *De animalibus.*[162] On top of this, two people owned Aristotle's *Opera* although this does not automatically demonstrate an interest in natural philosophy.[163] John Dorne's daybook shows that he sold two copies of *De anima*, two copies of *De animalibus* and a set of Aristotle's *Opera*.[164] In addition, the booklists feature three copies of the pseudo-Aristotelian *Problemata* which we will meet in chapter four.

The summary of the booklists in appendix one shows textbooks and commentaries on natural philosophy far outnumbered the texts of Aristotle himself. Furthermore, the average price for a copy of Aristotle's *Opera* at Oxford was five shillings, which probably put it out of the reach of most students to own.[165] They had access to Aristotle himself through their teachers or the libraries, but the books they owned and hence probably used from day to day were not his original works. Copies of the individual books by Aristotle (*Physica*, *De anima* and such like) were comparatively rare. Even allowing for students who shared and passed around copies, the greater number of textbooks compared to original texts suggests the former were in heavier use. This trend has also been noted at the German universities of Freiberg and Ingolstadt where the texts of Aristotle himself do not appear to have been used.[166]

The reason for this must be that many of Aristotle's works are simply too difficult to be used in class. The exception would seem to be *De animalibus*. The three copies on the booklists suggest that it was read on its own when it was read at all. There are no commentaries on it to be found in either the college libraries or the book lists. However, when it came to *Physica* or *De anima*, students were not being exposed to the unadulterated Aristotle, but rather Aristotelian philosophy mediated by one of the Scotist commentators popular at the university.

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[162] Owned by John Morcote (d. 1508), Bisley (d. 1543) and John Clement (d. 1572). See Leedham-Green and Fehrenbach, *PLRE*. v. 1, pp. 25 and 174; A. W. Reed, "John Clement and his Books," *The Library* 6 4th series (1926). p. 378.
[163] Clement again (his copy is in Greek) and William Grocyn (c. 1449 – 1519). See M Burrows, "Linacre's Catalogue of Grocyn's Books followed by a Memoir of Grocyn," in *Collectanea 2nd series* (Oxford, 1890). p. 319.
[164] Madan, "The Daybook of John Dorne, bookseller in Oxford AD1520." pp. 147 – 8.
[165] See appendix one.
[166] Kristian Jensen, "Textbooks in the Universities," in *The Cambridge History of the Book in Britain: 1400 - 1557*, ed. J.B. Trapp and Lotte Hellinga (Cambridge, 1999). p. 366.

Commentaries and Questions on Aristotle

The commentary was among the most significant types of scholastic literature. It was a way of explicating the text of one of Aristotle's works where the commentator aimed to make the true meaning of Aristotle clear to the reader through a series of glosses.[167] In practice, each commentary set out its own interpretation of Aristotle. However, the essence of a commentary was that it was not written in opposition to the Aristotelian text but attempted to bring it around to the commentator's own point of view. There was no clear relationship between specific commentators and translations, with medieval commentaries often being used with early-modern translations with all the attendant confusion over technical terms.[168]

Medieval commentators (by which I mean those who were active between 1200 and 1500) were far more popular at Oxford than either ancient or Arab ones. Recall that we found only five books containing unadorned texts of Aristotle's natural philosophy in the college library catalogues from All Souls, Lincoln and Canterbury that we examined. In comparison, there are twenty-five medieval commentaries. Among individuals' booklists, we find eighteen commentaries. These include three copies of *Expositio super librum Physicorum* by Walter Burley (1274 – c. 1344), three commentaries by Gaetano de Thiene and various works from Albertus Magnus (1206 – 1280) and Thomas Aquinas (1225 – 1274). John Dorne has another five natural philosophy commentaries in stock.

Burley was one of the greatest of the golden generation of philosophers to emerge from Oxford in the first half of the fourteenth century. He took his MA at Merton in 1301 and taught the arts at Oxford for another ten years. Then he migrated to the theology faculty of Paris where he received his DTh in 1324.[169] The last twenty years of his life were spent on the road on various diplomatic and ecclesiastical missions.[170] The *Expositio super librum Physicorum* was begun at Paris but occupied Burley on and off for another ten years after he left. It was first published at Padua in 1476 and thence in Venice three more times before 1501. Burley was a realist in the

[167] Edward Grant, *The Foundations of Modern Science in the Middle Ages* (Cambridge, 1996). p. 104.
[168] Charles Schmitt, *Aristotle and the Renaissance* (1983). p. 20.
[169] Charles Lohr, "Medieval Latin Aristotle Commentaries: Authors G - I," *Traditio* 24 (1968). p. 171.
[170] M. C. Sommers, "Burley, Walter (*b.* 1274/5, *d.* in or after 1344)", *Oxford Dictionary of National Biography*, Oxford University Press, Sept 2004; online edn, May 2006 [http://www.oxforddnb.com/view/article/4037, accessed 30 May 2006]

Scotist tradition and his natural philosophy followed Albertus Magnus and Robert Grosseteste.[171]

Unlike Walter Burley, Gaetano de Thiene (1387 – 1465) is not a writer who will be familiar to non-specialists. To begin with, he should not be confused with the later Saint Gaetano de Thiene (1480 – 1547) who founded the Theatine Order and was canonised for his efforts. Our Gaetano hailed from Vicenza and studied under Paul of Venice (c. 1369 – 1429) at the University of Padua where he taught from 1432 until his death.[172] He is best known today as a central link of the chain of Aristotelians whom John Randall Jr and William A Wallace have, in some sense, identified as being precursors to Galileo at Padua.[173] What has not been previously remarked is the surprising degree to which his work penetrated at Oxford in the sixteenth century. Given that Gaetano's teacher, Paul of Venice, was educated at Oxford before moving back to the continent, it is possible to see some connections. Gaetano also wrote about the Merton Calculators who continued to excite admiration in England even if there is little evidence that their work was understood.[174] His *Expositio in libros de caelo et mundo* was written after 1439 and, like Burley's work mentioned above, was first printed at Padua in 1476 before being published three more times. An incunabula set of Gaetano's books on the *Physics*, *De anima* and *De caelo* was given to Brasenose by Bishop Longland although it does not appear to have had much use. Only the *Meteorologica* has any annotation.[175] Two individuals also owned his works.[176]

Neither Burley nor Gaetano appear to have been used for teaching students. They do not appear in any list of prescribed reading nor are lecturers instructed to cover them. Instead, their presence in the booklists demonstrates that the climate of opinion among those seriously interested in philosophy was realist and Scotist.

John Canonicus and Alexander ab Alexandria

By far the most common scholastic text was John Canonicus's *Questiones super octo libros Physicorum*. In the sixteenth century, the antiquarian John Bale

[171] William A. Wallace, *Causality and Scientific Explanation*, vol. 1 (Ann Arbor, 1972). p. 56.
[172] Charles Lohr, "Medieval Latin Aristotle Commentaries: Authors A - F," *Traditio* 23 (1967). pp. 390 – 2.
[173] Wallace, *Causality and Scientific Explanation.* pp. 127 – 130.
[174] Robert Recorde, *Castle of Knowledge*, Facsimile ed. (Amsterdam, 1975). p. 98.
[175] Oxford, Brasenose College, shelf mark UB/S I 52.
[176] Thomas Thomson (1514) and William Bidwell (1512) had copies. See: Leedham-Green and Fehrenbach, *PLRE*. v. 2, pp. 58 and 99.

(1495 – 1563) had identified him as an early Oxford follower of Duns Scotus and this view predominated until the mid-twentieth century. His *Questiones super octo libros Physicorum* reveals that he was actually Juan Marbres, a Catalonian who lectured at the University of Toulouse in the early fourteenth century and wrote his *Questiones* shortly after 1324.[177] The reason that Bale thought that John Canonicus was English, or at least an Oxford man, was probably the enormous popularity of his *Questiones* at the university around 1500.

We come across him at Merton in 1491 when we learn of a copy of the *Questiones* being given to the college for the use of the junior members. At the same time, the college received *Questiones super duodecim libros metaphisice* of Antonius Andreae (d. c. 1320) with which John Canonicus's book is often associated.[178] Andreae's work was printed in London in 1480.[179] The donor was John Trowell (fl. 1480s) who made the gift before retiring to Syon Monastery.[180] Merton's surviving copy of John Canonicus did not come into the library until the bequest of Robert Barnes (d. 1604) in 1594.[181] However, it is inscribed by several other owners including a Master Hancock, probably John Hancock (d. 1563 – 74) of Merton, who was Junior Linacre lecturer from 1565.[182] Oriel is where we find most of the evidence that the book was used as a teaching text. As we can see from appendix five, between 1515 and 1533, seven Oriel masters were instructed by the college to lecture on John Canonicus as part of their regency. Andreae's *Questiones* were almost as popular and, unlike John Canonicus, a manuscript of this work survives in the college library. This was annotated by William Griffith (d. 1512),[183] who was a lecturer on Duns Scotus.[184] John Davenport (fl. 1500s) was also ordered by congregation to lecture on John Canonicus as well as the *Physica* and *De generatione et corruptione* in 1505.[185]

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[177] Dirk-Jan Dekker, "John the Canon on Time and Motion: A Case Study in Aristotelian Natural Philosophy and Early Scotism," in *The Dynamics of Aristotelian Natural Philosophy from Antiquity to the Seventeenth Century*, ed. J.M.M.H. Thijssen, Cees Leijenhorst, and Christoph Lüthy (Leiden, 2002). p. 228.
[178] H. E. Salter, ed., *Registrum annalium Collegii Mertonensis, 1483 - 1521* (Oxford, 1923). p. 144.
[179] A. W. Pollard et al., *A Short-title Catalogue of Books Printed in England, Scotland, & Ireland and of English Books Printed Abroad, 1475-1640*, 2nd ed., 3 vols. (London, 1976 - 1991). STC 581.
[180] F.M. Powicke, *The Medieval Books of Merton College* (Oxford, 1931). p. 219.
[181] Oxford, Merton College, shelf mark 121.A.9.
[182] See appendix five. Emden suggests the Augustan Nicholas Hancock (d. 1560) in Emden, *Oxford 1501 to 1540.* p. 263.
[183] Ibid. p. 250.
[184] Oxford, Oriel College, MS26 for which see Salter and Richards, eds., *The Dean's Register of Oriel 1446 - 1661*. p 390.
[185] Mitchell, ed., *Register 1505 - 17.* v. 1, p. 352.

Of the thirty surviving manuscripts of John Canonicus, he is found six times at Oxford and thrice at Cambridge.[186] However, one copy at Cambridge was a gift from John Warkworth (d. 1500),[187] a fellow of Merton College who migrated and became master of Peterhouse to which he gave the manuscript, among many others, in 1481.[188] The college library catalogues show that there were another three lost manuscripts at Cambridge around 1500 at Clare Hall, King's College and Pembroke College.[189] At Oxford, nearly all the manuscripts have English provenance. Balliol's MS 96 was written in England and given by William Gray (c. 1414 – 1478),[190] Bishop of Ely and a noted early humanist with Italian connections. MS 117 at the same college was once bound with Andreae's *Metaphysics* and provides another example of how the texts were connected.[191] Edmund Norton (fl. 1467), a fellow of Balliol, also owned a copy, which he bought for ten shillings.[192] Another fifteenth-century manuscript, that in all likelihood belonged to Merton, is found in the binding of seven books belonging to that college, the latest of which was published in 1589.[193] Perhaps this is what happened to the book given by Trowell in 1491. All Souls College had plenty of John Canonicus in 1500. Robert Harlow (d. 1476) and John Saunder (d. 1485) both left copies and at least two others existed in the library at one point.[194] The survivor is English, dating from 1473.[195] New College received a copy from William Holden in about 1500 together with a work of Scotus.[196] Neither survives. Nor do the copies owned by Canterbury College in 1501 or seen by John Leland in Oxford's

[186] Charles Lohr, "Medieval Latin Aristotle Commentaries. Jacobus - Johannes Juff," *Traditio* 26 (1970). p. 184. Oxford, Balliol College, MSS 96 and 117; New College, MS 235; Lincoln College, MS 102; All Souls College, MS 87; Magdalen College MS 16. Cambridge, University Library, Peterhouse MSS 188 and 240; Caius College MS 167.
[187] A. B. Emden, *A Biographical Register of the University of Oxford to AD 1500*, 3 vols. (Oxford, 1957). v. 3, p. 1992.
[188] Peter Clarke, *University and College Libraries of Cambridge*, vol. 10, Corpus of British Medieval Libraries (London, 2002). UC48.424.
[189] Ibid. UC14.53, UC29.13, UC43.157 and UC48.166.
[190] Sir Roger Mynors, *Catalogue of the Manuscripts of Balliol College Oxford* (Oxford Clarendon Press, 1963). MS 96.
[191] Ibid. MS 117.
[192] L.E. Boyle and R.H. Rouse, "A Fifteenth Century List of the Books of Edmund Norton," *Speculum* 50 (1975). p. 286.
[193] N. R. Ker, *Pastedowns in Oxford Bindings*, Oxford Bibliographical Society New Series (Oxford, 1951). p. 97.
[194] Ker, *All Souls College Library*. pp. 107 and 109.
[195] Andrew G. Watson, *A Descriptive Catalogue of the Manuscripts of All Souls College, Oxford* (Oxford, 1997). MS 87.
[196] Oxford, New College Library, Benefaction Book, p. 30.

University Library about 1535.[197] At Oxford, the booklists relating to before 1535 include five copies of John Canonicus including two in the stock of John Dorne.[198]

The *Questiones* is John Canonicus' only surviving work but it went through eight editions up until 1520. The *editio princeps* was printed at Padua in 1475 and there were at least five more Venetian editions up until 1520. Following the fifteenth-century manuscripts, an edition was published at St Albans in 1481. As this was one of the few books of natural philosophy to be printed in England, it is worth asking why it was chosen. The English edition is now exceedingly rare (the only complete copies in the ESTC are in the Bodleian and the Rosenbach Museum and Library, Philadelphia),[199] but the Paduan and Venetian editions come to another fourteen copies in the libraries reviewed. Of the surviving Italian copies, by far the most interesting is held at the Bodleian.[200] It is bound with three other Scotist works and annotated in humanist hands.[201] Most intriguing of all, one of the early sixteenth-century owners was a John Smith who corresponds to an Oriel lecturer on this very book in 1533.[202] He went on to become Lady Margaret Professor of Divinity. However common a name John Smith might be, there cannot be that many of them with such a clear interest in owning a John Canonicus. Sadly, the annotations reveal little except that the owner was a stickler for distinctions, which he notes several times in the margin.

As mentioned above, Merton's surviving copy of Canonicus, printed in 1505, was given by Robert Barnes, the senior Linacre lecturer together with many other volumes.[203] However, several inscriptions show that the copy was passed around other masters in the earlier sixteenth century. The annotations are concentrated in the first eight folios, which contain the questions, "Whether natural finite substance in its own common concept in particular is the first and sufficient substance of natural

[197] Pantin, *Canterbury College, Oxford*. Inv. D; Rod Thomson and Andrew G. Watson, *University and College Libraries of Oxford*, Corpus of British Medieval Libraries (London, Forthcoming). UO4. 31.
[198] Thomas Thomson (1514), Dunstan Lacy (1534) in Leedham-Green and Fehrenbach, *PLRE*. v. 2, pp. 100 and 149.
[199] Pollard et al., *ESTC*. STC 14621.
[200] Oxford, Bodleian Library, shelf mark L.1.13(3) Jur.
[201] Alan Coates et al., eds., *A Catalogue of Books Printed in the Fifteenth Century now in the Bodleian Library, Oxford*, 6 vols. (Oxford, 2005). J113.
[202] Salter and Richards, eds., *The Dean's Register of Oriel 1446 - 1661*. p. 94.
[203] Oxford, Merton College, shelf mark 121.A9.

science?" and "Whether universals are known first by the intellect?"[204] The copy at Brasenose only arrived in the early-seventeenth century but contains evidence of earlier sixteenth-century use. It has a manuscript index at the front and a summary of the questions at the end. A binder has sheared off the book's heavy annotations making them practically illegible.[205] New College's copy is also heavily annotated and cruelly cropped. It belonged to Roger Edgeworth (c. 1488 – 1560) who passed it on to his grandson, Richard (MA 1563).[206] The elder Edgeworth was a prominent humanist, moderate Catholic and a fellow of Oriel College,[207] where we have seen that Canonicus was very popular before 1535. The disappearance of Canonicus from the Dean's register of Oriel after 1535 is probably related to the banishment of Scotus by Cromwell. For while Bale was wrong to say that he was not a contemporary disciple, the *Questiones* are indubitably a Scotist work that draws heavily on the ideas of the master. As the colophon states,[208] the reader will "reach nearer to the mind of the subtle doctor."[209]

The *Questiones* is a scholastic work where each question is followed by a long series of arguments and counterarguments. The use of distinctions, a scholastic technique of showing how two cases are not equivalent and so can be subject to different conclusions, features heavily. There is also a strong bias towards the earlier parts of Aristotle's *Physica*. The first book is the subject of ten questions while the last book, which is about the unmoved mover, gets just one. The questions themselves are also reasonably typical. It is asked of book six "whether anything continuous is always built up out of smaller parts and always divided into smaller parts?" (indeed so). The question for book eight asks, "whether it is repugnant for anything created or produced permanently or in succession to have been fixed from eternity?" (apparently

[204] John Canonicus, *Super VIII libri physicorum* (Paris, 1516). p. 1. "Utrum substantia finita in suo conceptu communi inquantum naturalis sit primam substantiam et adequatum scientiae naturalis?" and "Utrum magis universalia sint magis nota et prius nota ab intellectum?".
[205] Oxford, Brasenose College Library, shelf mark UB/S I 48.
[206] Joseph Foster, *Alumni Oxonienses: the members of the University of Oxford, 1500-1714*, 4 vols. (Oxford, 1891 - 2). v. 2, p. 445.
[207] Janet M. Wilson, "Edgeworth, Roger (*c.*1488–1559/60)", *Oxford Dictionary of National Biography*, Oxford University Press, 2004 [http://www.oxforddnb.com/view/article/8479, accessed 8 May 2006]
[208] London, British Library, 1505/309.
[209] Canonicus, *Super VIII libri physicorum.* fol. 71r. "que ad mentem doctoris subtilis propius accedunt."

not).[210] What makes John Canonicus unusual and especially relevant for a natural philosophy course leading on to theology is the degree of influence he betrays from the *Sententiae* commentaries.[211] In dealing with physical questions, he draws on these commentaries, which often dealt with natural philosophy in a theological context, while also using St Augustine as an authority.[212] Thus, the *Questiones* look like exactly the sort of book that a Scotist theologian would like to see natural philosophy students studying in preparation for joining his higher faculty.

It would be tempting to lay the blame for the eclipse of John Canonicus entirely at the feet of Cromwell's commissioners. After all, he is precisely the kind of Scotist scholastic whom we shall see they were trying to outlaw in their 1535 injunctions. However, the fact is that John Canonicus was never reprinted after 1520. He joined a group of fifteenth-century authors who barely made it into the sixteenth century. Lambertus de Monte (d. 1499), John de Magastris (fl. 1480s) and Gaetano de Thiene all enjoyed several incunabula editions of their natural philosophy before fading into obscurity. By 1505, none of their works would be published again (before a couple of modern editions) excepting only the 1516 and 1520 John Canonicus. Cromwell's action was part of a Europe-wide trend and Oxford was later in abandoning such authors than many other centres of learning. Lambertus, a Thomist and leading light of the Cologne theology faculty,[213] was not even reprinted by the flourishing publishers of his Catholic hometown.

While the *Physica* was being approached via John Canonicus, some evidence suggests that Aristotle's other works of natural science were being enjoyed in the original as well as through textbooks. Appendices four and five show that *De anima* was specified both by congregation and by the colleges, while the shorter works also get a mention from time to time. It is true that simply by virtue of their brevity, these texts are more approachable than the *Physica* although no one could call *De anima* an easy read. Indeed, even though John Dorne sold two copies of the text, commentaries

[210] Ibid. fol. 64v. "Utrum continuus proponat ex semper divisibilibus dividatur in semper divisiblia." fol. 69r. "Utrum cuilibet creabili vel producibili permanenti vel succesivo repugnat formaliter fuisse ab eterno."
[211] Dekker, "John the Canon on Time and Motion: A Case Study in Aristotelian Natural Philosophy and Early Scotism." p. 230.
[212] Ibid. p. 247.
[213] M. J. F. M. Hoenen, "Late-Medieval Schools of Thought in the Mirror of University Textbooks: The 'Promptuarium argumentorum' (Cologne, 1492)," in *Philosophy and Learning: Universities in the Middle Ages*, ed. M. J. F. M. Hoenen, J. H. J. Schneider, and G. Wieland (Leiden and New York, 1995). p. 333.

are much more common. The book lists from individuals who took their MA before 1535 show six commentaries on *De anima* from Aquinas, Albertus Magnus, Johannes Versor (d. 1485) and Gaetano de Thiene. The most interesting commentary belonged to William Thomas (d. 1507) of University College – "Alexander de anima".[214] This could refer, as PLRE states, to either Alexander of Aphrodisias, a second century Greek Aristotelian or Alexander ab Alexandria (d. 1314). This later Alexander studied at Paris before he became general of the Franciscan order in 1313. He died at Rome the next year.[215] His philosophical outlook was much informed by his fellow Franciscan, Duns Scotus. His commentary appears unambiguously in the Lincoln College catalogue of 1474 and may also have been at Canterbury College in the early sixteenth century.[216] Given the Scotist link, Alexander ab Alexandria seems the more likely identification. Manuscripts of his *De anima* commentary survive at Oriel and Magdalen Colleges as well as Peterhouse. A further manuscript once from Balliol is also in existence.[217]

In 1481, Magdalen College bought no less than five copies of Alexander ab Alexandria's commentary on *De anima* from the printer (and the college's tenant) Theodoric Rood, of which two still survive.[218] Eight other Oxford Colleges also have copies of this edition.[219] Both Magdalen's copies appear to have been used by students. The first contains interlining and annotations in perhaps two hands. The notes mainly repeat what the text says, for instance Alexander's insistence that investigation of the soul yields knowledge that is both more noble and surer than in other fields.[220] The other copy, with the same seventeenth-century reverse-calf binding and decorative title page, has been much more heavily used. Its pages are dirtier and covered in interlining. Bored students have added aphorisms, doodles and

[214] Leedham-Green and Fehrenbach, *PLRE*. v. 2, p. 13.
[215] Anon, *Dictionnaire d'histoire et de geographie ecclesiastiques*, ed. A Baudrillart, vol. 2 (Paris, 1914). col. 254.
[216] Weiss, "The Earliest Catalogues of the Library of Lincoln College." no. 99. "Alexander super de anima" is found in all the sixteenth century inventories in Pantin, *Canterbury College, Oxford.* We cannot be sure this is Alexander ab Alexandria.
[217] Peterhouse MS 239, Magdalen MS 80 and Oriel MS 58. See Lohr, "Medieval Latin Aristotle Commentaries: Authors A - F." p. 353.
[218] Christine Ferdinand, "Magdalen College and the Book Trade: the Provision of Books in Oxford 1450 - 1550," in *The Book Trade and Its Customers 1450 - 1900*, ed. Arnold Hunt, Giles Mandelbrote, and Alison Shell (Winchester, 1997). p. 177.
[219] Pollard et al., *ESTC*. STC 314.
[220] Oxford, Magdalen College Old Library, shelf mark Arch.B.III.1.4, sig. a. iiij. recto "studia de anima est nobilior aliis studias", sig a. iiij, verso "studia de anima est certior aliis studias".

one lewd picture of an individual in sixteenth-century dress.[221] Magdalen College also possessed a fourteenth-century manuscript of his commentary on *De anima*, which might explain their interest in buying five more. Certainly, there is little reason for Theodoric Rood to print this rather obscure text unless it was already a common part of the Oxford syllabus. Another of Rood's copies was owned by John Warner of All Souls College, who took his MA in 1525.[222]

So far, we have covered the texts used to teach *Physica* and *De anima*. Table 2.1 makes clear that *De generatione* and *Parva naturalia* were considered every bit as important. Yet we lack evidence that either the texts themselves or commentaries on them were especially widespread. However, there was one popular book that could have been used to cover the material in them: *Textus abbreviatus philosophiae naturalis* by Thomas Bricot (d. 1516). The *editio princeps* was printed in Paris in 1494 and there were at least another eight editions up until the last in 1523. It is relatively common today in Oxford libraries and even the surviving edition in Cambridge once belonged to Thomas Kendall (d. 1537), a member of Balliol College.[223] John Dorne had three copies in stock and three more appear in the booklists from individuals who took their MAs before 1535.[224] Bricot was a native of Amiens and a victim of Rabelais's barbed quill (by whom he is credited with a treatise *On the Making of Soups*) who took his DTh at Paris in 1490 and taught there at the Collège de Sainte-Barbe until his death in 1516.[225] He took part in the commission that investigated the work on the Hebrew cabbala carried out by Johannes Reuchlin (1455 – 1522).[226] Bricot's book covered all of natural philosophy and was intended for the use of his students at the University of Paris. Although not a true textbook, Bricot's work was a simplified abridgement of Aristotle's text complete with a full collection of cross-references.[227] This was a new idea that would soon eclipse the medieval books of questions for teaching purposes.

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[221] Oxford, Magdalen College Old Library, shelf mark Arch B.III.1.5., sig. l. iiij. verso.
[222] London, British Library, shelf mark IB 55315.
[223] Cambridge, University Library, shelf mark P*.9.25. Kendell (BTh 1532) was executed for his part in the Pilgrimage of Grace. Emden, *Oxford 1501 to 1540*. p. 327.
[224] Madan, "John Dorne." p. 151; William Thomson (1507), John Morcote (1508) and Bisley (1543) in Leedham-Green and Fehrenbach, *PLRE*. v. 2, pp. 14, 25 and 175.
[225] Thomas Bricot, *Tractatus insolubilium*, ed. E. J. Ashworth, vol. 6, Artistarium (1986). p. xiii.
[226] Anthony Levi, *Renaissance and Reformation: the Intellectual Genesis* (New Haven, 2002). p. 218.
[227] Charles Schmitt, "The Rise of the Philosophical Textbook," in *Cambridge History of the Renaissance Philosophy*, ed. Charles Schmitt and Quentin Skinner (Cambridge, 1988). p. 794.

As befits a Parisian theologian, Bricot was a nominalist and not a Scotist like Canonicus and Alexander.[228] He refers frequently to his Parisian predecessor, John Buridan, another nominalist and an original thinker on the theory of forced motion.[229] It is slightly odd that a nominalist theologian should find his book popular at Scotist Oxford. There was no Ockhamist party at the university at this time – Ockham does not even appear in the index of the relevant volume of *PLRE*.[230] It is therefore likely that Bricot's coverage of all of Aristotle's natural philosophy in a single volume was what made his work popular. Students being lectured on *De generatione* or the *Parva naturalia* could refer to Bricot so as not to have to tackle the Aristotelian texts unaided.

Scholasticism at Oxford

When an Oxford master lectured on natural philosophy, he was not reading an unadulterated text of Aristotle. Instead, he used a commentary or book of questions from the Scotist stable – principally Alexander ab Alexandria on *De Anima* or John Canonicus on *Physica*. Bricot's book, although written by a nominalist, was merely a paraphrase and did not risk imparting dangerous ideas. So, Oxford students learnt about Scotus' Aristotle rather than Ockham's or Philoponus', let alone the genuine Greek version.

There were plenty of masters at Oxford for whom Scotus was not the pre-eminent authority. We find a wide variety of scholastic, patristic and early modern authors being read, but none that could be said to dominate to the extent that Scotus did. This domination was even more pronounced in the texts taught to students. We have seen that the texts being used for teaching natural philosophy had a pronounced Scotist bias, even if this was less obvious in the university overall. The situation with the quadrivium was less clear cut. We saw how a coherent syllabus existed which formed part of a theological, if not necessarily Scotist, education. This theological justification for theoretical mathematics was necessary because it did not have the

[228] Charles Lohr, "Medieval Latin Aristotle Commentaries," *Traditio* 29 (1973). p. 273.
[229] Thomas Bricot, *Textus abbreviatus in cursum totius physices et metaphysicorum Aristotelis* (Lyon, 1508). fol. 17r et al.
[230] Although it may be historically unjustified, by the late fifteenth century, nominalists looked back on Ockham as the founder of their school of thought. See William Courtenay, "Was There an Ockhamist School?" in *Philosophy and Learning: Universities in the Middle Ages*, ed. M. J. F. M. Hoenen, J. H. J. Schneider, and G. Wieland (Leiden and New York, 1995). p. 265ff.

practical utility of the *algorismus*. Such was the usefulness of calculation, that it could exist in parallel to the theoretical aspects of the quadrivium.

Thus, Scotist natural philosophy took its place between the quadrivium and metaphysics. Mathematics was taught so that it fed into natural philosophy, which in turn flowed towards metaphysics. In this way, they were prepared to meet the theology of Scotus that dominated the higher faculty. The syllabus as taught formed a seamless whole intended to lead to that end. This meant that changing little bits of the course was not possible. One could not simply adopt a different version of Aristotle without the entire edifice descending into incoherence. This might explain the reluctance of the university authorities to engage in much syllabus reform – it would have to be root and branch change to be worthwhile and there was never the will to push through such a thing. Outsiders, even Cardinal Wolsey, also had no appetite for this level of change. He would have had to throw out much of the theology syllabus to which natural philosophy inexorably led. He had no great intellectual scheme or plan to do this. His meddling at Oxford was intended to do nothing else but magnify his own name and allow him to bask in some of the reflected glory of his college. Without a full-scale intellectual and theological agenda, any reform would be just tinkering at the margins. It was all or nothing.

The persistence of the medieval syllabus then, was partly down to the impossibility of replacing any part of it without the whole system crashing down. We do see some early discontent about the dominance of Scotus, for instance in the comments of Robert Joseph (fl. 1530 – 44) to his correspondents. He was a Benedictine monk at Gloucester College who took his BD in 1535. Joseph wrote to a friend saying that he "used to touch him only as the Jews touch pork, but now I have returned to my vomit." [231] It is not flattering, but Joseph insisted that Scotus, however hard he was to tackle, had value that cannot be discounted. He urged his friends to take the Scotist texts seriously and not insult them without knowing what they said.[232]

Oxford masters also had good reasons to view natural philosophy with affection and resist attempts to downgrade its importance. Until the fourteenth century, Oxford was a recognised centre of the subject when such luminaries as John

[231] H. Aveling and W. A. Pantin, eds., *The Letter Book of Robert Joseph, Monk-scholar of Evesham and Gloucester College, Oxford, 1530 - 3*, Oxford Historical Society New Series 19 (Oxford, 1967). p. 53.
[232] Ibid. p. 28.

Duns Scotus himself, Walter Burley and the Merton Calculators were working there. The memory of Robert Grosseteste, Roger Bacon, Michael Scot (d. 1235) and other medieval philosophers was still alive.[233] The shadow of these masters over the university, their presence in the libraries and their continuing fame must have helped to support the old ways. This gave Oxford's masters an intellectual confidence that they were doing the right thing. Their syllabus cohered not only in itself, but also with tradition. They did not want to abandon the subject that had first brought their university to prominence.

[233] Robert Recorde invokes them in Recorde, *Castle of Knowledge*. p. 98 and Robert Recorde, *Pathway to Knowledge*, Facsimile ed. (Amsterdam, 1974). preface.

Chapter Three: Cambridge before 1535

"At Cambridge, about thirty years ago, nothing was taught but those ancient Aristotelian rules ... subsequently, good letters were added and a knowledge of mathematics and a new, or at least refurbished, Aristotle."[1]

Erasmus to Henry Bullock, 1516

Erasmus first came to Cambridge with Henry VII (1459 – 1509, r. 1485 – 1509) in 1506 while the King was on a progress to the shrine of Our Lady of Walsingham. The great humanist stayed at the Queens' College where John Fisher was president. The two men were already acquainted and became close friends.[2] In August 1511, Erasmus returned to Cambridge, borrowing a horse from Henry Bullock (d. 1526) who had been a fellow of Queens' during his previous visit and was now the lecturer of mathematics.[3] Erasmus lodged at Fisher's college and with the bookseller Garrett Godfrey. During his time at the university, he taught Greek (Bullock was one of his pupils) and lectured on the *Epistles* of St Jerome.[4] When he departed in 1513, he felt that Cambridge was well on its way to "rivalling the leading modern schools."[5]

Certainly, the reform of the syllabus at Cambridge in the early-sixteenth century went much further than it did at Oxford. Not only was the trivium overhauled according to Erasmian principles,[6] but natural philosophy and the quadrivium were also cleansed of scholastic books in favour of contemporary humanist texts, largely disseminating from Paris. However, it would be a mistake to think that humanism at Cambridge began with Erasmus. Reform had begun at least ten years before his first brief visit.

It becomes clear the moment we examine the booklists that the books used by bachelors at Cambridge were very different from those we found at Oxford. We will look in some detail at the most popular texts because they clearly demonstrate how the intellectual climate diverged between the two universities. The reason for the difference, this chapter will argue, was the existence of reforming forces at

[1] H. C. Porter and D. F. S. Thomson, eds., *Erasmus and Cambridge: The Cambridge Letters of Erasmus* (Toronto, 1963). p. 195.
[2] D. R. Leader, *The University to 1546*, vol. 1, A History of the University of Cambridge (Cambridge, 1989). p. 292.
[3] Porter and Thomson, eds., *Cambridge Letters of Erasmus.* p. 107.
[4] Leader, *The University to 1546.* p. 295.
[5] Porter and Thomson, eds., *Cambridge Letters of Erasmus.* p. 195.
[6] Leader, *The University to 1546.* p. 301.

Cambridge with the resources to carry through their programme. Like all reforms, this one initially left large areas untouched. Many masters remained loyal to the traditional texts and scholastic authorities continued to enjoy a good deal of respect. However, in the area of teaching, with which this thesis is concerned, we see a more thoroughgoing reform than anything experienced in the high faculties. In the quadrivium, we see much less of the theoretical mathematics that we met at Oxford. Rather, practical mathematics appeared to have the whip hand.

Much has been made of the influence of Erasmus. He certainly lent his considerable prestige to the humanist project, but lacked the ability to carry any changes through on his own account. Instead, we will find that John Fisher was the major catalyst to change. He desired a reform of theology to include the use of the ancient languages and renewed emphasis on the text of the Bible.[7] He was enthusiastic about the Agricola's *De inventione dialectica*, the work of Pico della Mirandola and the ability of the cabala to reveal ancient secrets.[8] However, Fisher never lost his affection for the schoolmen that he had studied under William Melton and continued to believe that there was a place for them in the arts course.[9] Thus, rather than driving through a programme of humanist reform, Fisher opened doors by allowing choice. At St John's College he allowed a lecture either on Hebrew or Scotus and also listed several other scholastic authorities which could be used.[10] This meant that a thorough knowledge of Scotist philosophy was no longer compulsory, although it did not mean natural philosophy could be dropped altogether. It continued to be an important way to study the providential work of creation through the second of the two books ordained by God, that of nature. Thus we shall see that the humanist textbooks promoted at Cambridge were far more directly concerned with everyday nature rather than the metaphysical conundrums of Scotus. These textbooks were also more explicitly religious in scope, pointing to God's work wherever possible.

Doubtless, some people at Oxford were thinking like this too. But they lacked the resources that Fisher had at his disposal to drive through a programme of reform.

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[7] Richard Rex, *The Theology of John Fisher* (Cambridge, 1991). p. 50ff.
[8] H. C. Porter, "Fisher and Erasmus," in *Humanism, Reform and the Reformation: the Career of Bishop John Fisher*, ed. Eamon Duffy and Brendan Bradshaw (Cambridge, 1989). pp. 82 and 89.
[9] M. G. Underwood, "John Fisher and the Promotion of Learning," in *Humanism, Reform and the Reformation: the Career of Bishop John Fisher*, ed. Eamon Duffy and Brendan Bradshaw (Cambridge, 1989). p. 26.
[10] Mayor, ed. *The Early Statutes of St John's College, Cambridge*. p. 252.

The dry statutes and booklists, which are the only evidence of the reforms extant, give little idea of the debate that must have occurred at the time. Nowhere do we find Fisher writing letters or speeches in support of his case. But he was the only person who could have carried through the changes – no one else had both motive and opportunity.

Lecturing on Philosophy

Humanist reform at Cambridge began in 1495 with a statute that laid out the requirements for the BA as two years of Terence, one year of dialectic and one year of philosophy.[11] 'Terence' lectures, after the Roman playwright whose works are a smorgasbord of obscure constructions, were the university's lectures on grammar.[12] More radically, the university tried to appoint three regent masters to become university lecturers in grammar, dialectic and philosophy.[13] Damian Leader dated the statute that appointed these lecturers to 1488, but 1506 is a more likely date. The payments for the new Terence lecture do not explicitly begin until 1507 – 08, when John Phillippe was paid for the previous two years,[14] although *ad hoc* payments to lecturers are recorded before this date. Also, the statute appointing the lecturers clearly runs on from the previous statute in the series, which in turn runs on from another dated July 1506.[15] However, as the order of the statutes has become confused over the years, this can be viewed as circumstantial evidence only.

The university's *Grace Books* record a few more payments to Terence lecturers over the next few years.[16] However, the rarity of these payments suggests that the reform was stymied by a lack of funds. In all likelihood, money was not available to pay all three lecturers regularly and the priority appears to have been grammar. This is exactly what we would expect if the main emphasis of the reform were to improve standards of Latin composition to the level humanists demanded. Alternatively, a single lecturer might have been appointed to cover all three subjects, but called the Terence lecturer in recognition of his major role. This would have been an economising measure put in place until a secure source of funds was available.

[11] James Heywood, ed., *Early Cambridge University and College Statutes* (London, 1855). p. 155.
[12] Leader, *The University to 1546.* p. 249.
[13] Heywood, ed., *Early Statutes*. p. 126.
[14] M. Bateson, ed., *Grace Book B, Parts I and II*, 2 vols. (Cambridge, 1903). pt. 1, p. 232.
[15] Heywood, ed., *Early Statutes*. p. 125.
[16] Leader, *The University to 1546.* p. 251.

Luckily, the money was soon found. Sir Robert Rede (d. 1519), Chief Justice from 1509 until his death, made provision in his will to endow the three lectureships through a benefaction bequeathed to Jesus College. The trust deed was eventually agreed on 10th December 1524 whereby three free lectures in humanities, logic and moral or natural philosophy were funded.[17] These payments duly appear in the college account rolls from then on but do not give the names of the lecturers until 1557.[18] The endowment of these posts ensured their long-term survival and justified the university's intensive lobbying. Thus from 1524, Cambridge had a salaried lecturer on philosophy. In a further boon for the subject, the old Friday grammar disputations were replaced by philosophy shortly after the Rede lectureships were endowed, in 1528.[19]

College lectureships in philosophy began to appear at about the same time as the Rede lectures.[20] The Queens' College established the lectureship in philosophy in 1529, although there had been a single earlier appointment in 1504.[21] Only in the case of the first lecturer, John Gough in 1529, is the appointment labelled as 'natural philosophy' in the accounts and it is likely that ethics was covered as well.[22] There is certainly plenty of ethics in the extant probate lists of the lecturers. The college's president at the time that the philosophy lecture started was Simon Haynes (d. 1552), a radical evangelical and one of the 1549 visitors at Oxford.[23] He might have been the motive force behind the improvement to the teaching in the arts that the philosophy lecture represented. He was certainly a man ready to make changes when he saw fit. John Fisher instituted an examinership in philosophy at St John's College in his foundation of 1524. Their duties were to question students on the public lectures or give lectures in college on days when no public lecture took place.[24]

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[17] Cambridge, Jesus College Archives, Caryl 7.22.
[18] Cambridge, Jesus College Archives, Account Rolls 10.3 – 10.13, Bursar's Accounts 1557 – 8.
[19] Heywood, ed., *Early Statutes*. p. 148.
[20] A full list of all Cambridge college lecturers that I have identified is given in appendix three of this thesis.
[21] Cambridge, University Library, Queens' College Archives volume 1, "Journale 1484 – 1517", fol. 173r.
[22] Cambridge, University Library, Queens' College Archives volume 2, "Journale 1518 – 35", fol. 122r.
[23] C. S. Knighton, "Haynes , Simon (*d.* 1552)", *Oxford Dictionary of National Biography*, Oxford University Press, 2004 [http://www.oxforddnb.com/view/article/13174, accessed 18 July 2006]
[24] J. E. B. Mayor, ed., *The Early Statutes of St John's College, Cambridge* (Cambridge, 1859). pp. 246 – 7.

Improving the provision of teaching was but half the story of Cambridge reform. The syllabus also needed to be upgraded. Both the late medieval statutes of c. 1385 and the new humanist syllabuses of 1495 and 1506 required undergraduates to study philosophy in their third and fourth years. Only the medieval statutes actually mention the texts upon which lectures must be heard and so I assume that these remained unchanged. They were:

> 3rd year: *Physica* (2 terms); *De generatione*, *De anima*, *De caelo*, *Meterologica* or *Ethica* (1 term).
>
> 4th year: *Physica* or *Metaphysica* (2 terms); *De generatione*, *De anima*, *De caelo*, *Meterologica* or *Ethica* (1 term).[25]

After determining, the MA course was very similar. Another statute, dating from about 1390, calls for bachelors to hear lectures in the schools on:

> The books of Aristotle: *Physica*, *De caelo* and *De mundo*, *Meteorologica*, *De anima*, *De sensu et sensibilibus*, *De somno et vigilia*, *De memoria et reminiscentia*, *De iuventute et senectute* [Collectively half the *Parva naturalia*], *De motu animalium*, *De plantis.* [26]

Obviously, there is considerable overlap between the undergraduate and graduate course. In 1500, this point was bemoaned in the statute that set up the paid mathematics lecture:

> The authority of our ancestors has formerly enacted that our questionists are, besides the ordinary lectures, to hear from a bachelor cursorily the whole course of logic and, after they have begun study of the *Posteriora Analectica*, they should each read many lectures themselves. And again, those about to incept in the arts shall hear a master on the philosophy of Aristotle and those who have incepted are required to give ordinary lecturers on the required days of the year. This fourfold mode of lecturing, has now, from being quite obsolete or not attended to, become quite vain, troublesome and useless.[27]

[25] M. B. Hackett, ed., *The Original Statutes of the University of Cambridge: The Text and its History* (Cambridge, 1970). p. 299.
[26] Ibid. p. 277. "In universitate rite audierit in scolis libros Aristotelis phisicorum. celi et mundi. de generacione. metheororum. de anima. de sense et sensato. de sompno et vigilia. de memoria et remeniscencia. de morte et vita. de plantis. de motu animalium."
[27] Heywood, ed., *Early Statutes*. p. 135. (adapted)

In an effort to tidy this up, another statute in 1506 emphasised that inception required three years of lectures on both philosophy and mathematics.[28] Thus, it can be seen that the requirements under Cambridge's ancient statutes for natural philosophy are very similar to those at Oxford. Up until about 1500, it is likely that the texts used were similar as well. We saw in the last chapter how John Canonicus was found in several Cambridge libraries in the fifteenth century. However, no copies of his book are found in the Cambridge booklists of the sixteenth century and there are precious few other medieval works of natural philosophy. Although most of the lists date from after 1530, we would expect some copies to turn up in later lists if a book was at all popular earlier in the sixteenth century. In fact, apart from the copies in the college libraries, there is no trace of John Canonicus at Cambridge at all. This suggests that his work fell from favour at the same time as the syllabus reforms of 1495 and is further evidence of radical change at this time.[29]

The Cambridge college libraries had even fewer works of natural philosophy in them than they had at Oxford. Catalogues from the Queens' College in 1473 and St Catherine's College in 1522 each contain nothing at all on this subject or the quadrivium.[30] Clare College in 1496 is better stocked. As well as the Canonicus volume already mentioned, it held Giles of Rome on *De anima* and three volumes of Averröes' commentaries on Aristotle.[31] However, these surely reflect the books in use before the humanist reform of the 1490s. To find out which books were being used from then on instead of the medieval authors, we must turn, once again, to the booklists. I have followed the same procedure as I did for Oxford, assembling all the booklists and probate lists that relate to an individual who took their MA in 1535 or earlier. To these lists, I have added the account book of the bookseller Garrett Godfrey dating from about 1530.[32] This gives thirty-five lists with a total of 4,700 books of which just over a thousand are from Godfrey's accounts.[33]

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[28] Ibid. p. 125.
[29] Leader, *The University to 1546.* p. 242.
[30] Peter Clarke, *University and College Libraries of Cambridge*, vol. 10, Corpus of British Medieval Libraries (London, 2002). UC 50 and UC 53.
[31] R. W. Hunt, "Medieval Inventories of Clare College Library," *Transactions of the Cambridge Bibliographical Society* 1 (1950). pp. 105 – 125.
[32] E. S. Leedham-Green, D. E. Rhodes, and F. H. Stubbings, *Garrett Godfrey's Accounts c. 1527 - 33* (Cambridge University Press, 1992).
[33] See appendix one.

It is clear from the booklists that neither the original texts of Aristotle, nor his medieval commentators were the main sources of teaching natural philosophy at Cambridge in the early sixteenth century. Eight unnamed works by the Scotist theologian Nicholas d'Orbelles (d. 1475) are listed in the probate lists.[34] These could be his *Cursus liborum philosophiae naturalis* (1494) or *Compendium dignissmum considerationis mathematice* (1485). However, I would expect that if the compilers of the probate inventories do not include the name of a work, this means that the title should be a common one. By far the most common work of d'Orbelles is his commentary on the *Sententiae,* available in numerous editions. As well as the three copies on the probate lists, two more were sold by Garrett Godfrey.[35] Of the unnamed books in the probate lists, none are associated with works of mathematics or natural philosophy, while two are listed next to or one away from the *Sententiae* itself.[36]

In total, the booklists from Cambridge relating to before 1535 show no definite works of medieval natural philosophy, while at Oxford there were at least twenty in the equivalent list. A few such commentaries do appear in the later probate lists, for example in the collections of Henry Dilcock and Edmund Peerpoint, but not in the numbers we would expect for books used regularly by students.[37] There is a copy of the Scotist book of questions *Commentarii in libros philosophiae naturalis et metaphysicae Aristotelis* by Pierre Tartaret in Cambridge University Library, but it seems to have only arrived at the university in the 1550s.[38] It does not appear in the booklists, although some of Tartaret's works on logic do.[39] Likewise, there are some scholastic commentaries covering other branches of philosophy. However, the books used by students are likely to be reasonably uniform and we would expect to see several copies of each of them. A smattering of individual scholastic texts is more likely to mean these remained of interest to particular masters rather than that they were used for teaching.

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[34] E. S. Leedham-Green, *Books in Cambridge Inventories: Books from the Vice-Chancellor's Court Probate Inventories in the Tudor and Stuart Periods*, 2 vols. (Cambridge, 1986). v. 2, p. 584.
[35] Leedham-Green, Rhodes, and Stubbings, *Garrett Godfrey*. p. 153.
[36] Leedham-Green, *BCI*. v. 1, pp. 19 and 76.
[37] Ibid. v. 1, pp. 133 and 163.
[38] Sachiko Kusukawa, "The Reception of Melanchthon in Sixteenth-Century Cambridge and Oxford," in *Melanchthon - Schriften der Stadt Bretten*, ed. G. Frank and K Meerhoff (Stuttgart, 2002). p. 251.
[39] Leedham-Green, *BCI*. v. 2, p. 736. The seven copies of Tartaretus's logical works do show some interest in scholastic logic at Cambridge, but they are swamped by humanist textbooks such as the forty copies of Agricola's *De inventione dialectica* (p. 9).

This rarity of scholastic texts is a sure sign of humanist influence. Erasmus mocked the "concepts, relations, instants, formalities, quididities and ecceites"[40] of scholastic logic and rationalism while his friend Thomas More quipped that the main scholastic textbook on dialectic, the *Little Logicals* of Peter of Spain (c. 1215 – 1277), was "probably so called because it contains little logic."[41] Philip Melanchthon did not even leaven his criticism with wit, claiming that scholasticism "produced men like Thomas, Scotus, Durandus and all the rest a progeny more numerous than the Cadmean brood [of warriors grown from a dragon's teeth]". They were "teachers of ignorance" who dealt in a "corrupt and truncated Aristotle."[42] Let us now examine the books which we do find in numbers and that the old scholastic authors were probably replaced with.

The Texts used in Cambridge Natural Philosophy

Aristotle and Theophrastus

Returning to the booklists and looking first at the copies of Aristotelian texts, we note that there are many more copies of Aristotle's books on natural history and of *De plantis* of Theophrastus (372 – 286BC) than there were at Oxford. Theophrastus was the literary executor of Aristotle and his successor as head of the peripatetic school at the Lyceum. He wrote a large number of books on ethics, physics and natural history of which only about ten per cent survive.[43] Among the surviving works are two treatises on the history and parts of plants, extant in their entirety.[44] These are his *Historia plantarum* and *De causis plantarum*. They were translated into Latin by Theodore of Gaza around 1450 and printed by the Aldine press in its *editio princeps* in 1495 – 8.[45] Theophrastus treated much of the same material in relation to plants that Aristotle covers for animals. Book one of the *Historia plantarum* covers the parts of plants and their taxonomy while book two is on propagation. There are then sections on trees, shrubs, herbs and cereals. The final book covers the uses of plant

[40] D. Erasmus, *In Praise of Folly*, Betty Radice trans. (Harmondsworth, 1993). p. 88.
[41] Thomas More, *The Complete Works of St Thomas More*, ed. Daniel Kinney, vol. 15 (1986). p. 29.
[42] Erika Rummel, *The Humanist-Scholatic Debate in the Renaissance and Reformation* (Cambridge: MA, 1995). p. 141.
[43] Charles Schmitt, "Theophrastus in the Middle Ages," *Viator* 2 (1971). p. 252.
[44] Ibid. p. 269.
[45] Ibid. p. 269.

materials, especially their medicinal properties.[46] In all it covers about 550 species. *De causis plantarum* moves on to the reproduction of plants and other aspects of their aetiology.[47] The Cambridge booklists relating to before 1535 include five copies of Theophrastus on plants.

Five genuine works on animals have come down to us from the pen of Aristotle. These are *Historia animalium*, *De partibus animalium*, *De generatione animalium*, *De motu animalium*, and *De incessu animalium*. Theodore of Gaza's Latin translation of the *Historia*, *De partibus* and *De generatione*, first printed in 1476, was called *De animalibus*, which is the title that appears in the probate lists.[48] This translation dominated the market in the sixteenth century and it is reasonable to assume a reference to *De animalibus* means Theodore's collection of these three texts. *De animalibus* appears seven times in the pre-1535 booklists and twenty times in total at Cambridge, more than any other single work of Aristotle's natural philosophy except the *Physics*. There are only five copies recorded at Oxford.

The greater abundance of these works at Cambridge is clear. The reasons are harder to make out but may be found by reading these texts and comparing them to Aristotle's other natural books. Nothing written by the Philosopher is an easy read, but his animal books are a great deal less indigestible than the *Physica*. These books also impart information about the world in a more directly descriptive way that could be relevant and useful for studying literature or rhetoric. Gathering examples and commonplaces for future use was a favourite activity among humanists and it is easy to imagine they found the animal books full of useful scraps of information. As Ann Blair has shown, looking at a slightly later material, the commonplace book was also a tool of humanist natural philosophy.[49]

Another thing that the animal and plant books were useful for and the *Physica* was not was demonstrating the glorious design of God. There is not much that can be gleaned about the creator in the *Physica*, largely because Aristotle thought no creator

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[46] Theophrastus, *Enquiry into Plants*, Sir Arthur Hort trans., 2 vols., Loeb Classical Library (Cambridge, MA, 1948 - 9).
[47] J. B. McDiarmid, "Theophrastus," in *Dictionary of Scientific Biography*, ed. Charles C. Gillespie (New York, 1970 - 80). p. 331.
[48] John Monfasani, "The Pseudo-Aristotelian 'Problemata' and Aristotle's 'De animalibus' in the Renaissance," in *Natural Particulars: Nature and the Disciplines in Renaissance Europe*, ed. Anthony Grafton and Nancy Siraisi (Cambridge, MA, 1999). p. 205.
[49] Ann Blair, "Humanist Methods in Natural Philosophy: The Commonplace Book," *Journal of the History of Ideas* 53 (1992).

existed and the universe was eternal. His books on animals provide us with altogether firmer evidence of God's wonderful providence. Aristotle's explanations of animal traits tend to be teleological, that is, they are there for a purpose. The contradiction between a teleological way of thinking and an eternal universe does not seem to have worried him. For Christians, though, this teleological bent, most evident in *De partibus animalibus*, meant that they could use Aristotle to illustrate the work of God. Aristotle explains, "nature, which fashioned [all the animals], gives amazing pleasure in their study. To all who can trace links of causation and are inclined to philosophy... every realm of nature is marvellous."[50] To pick a few examples at random from this work: Man's nails are "skilfully contrived", "nature devised blood vessels", "bones are a contrivance to give security."[51] Simply substituting nature for God, and *De partibus animalium* becomes a perfect vehicle for Christian apologetics that can be bound closely to the first two chapters of Genesis.

Aristotle's natural history did not attract very much commentary in the Middle Ages. In popular devotional works, such as the *Imitation of Christ*, this world was neglected in favour of looking forward to the next. When the design argument appeared, it was more likely to be taken from the regularity of the heavens than the variety of the natural world.[52] Theological conceptions of nature were found in the compendiums such as Bartholomew Angelicus's *De proprietatibus rerum*. This was primarily intended as a summary of Christian knowledge. It has a heavy emphasis on the bible and mentions all the animals contained therein. However, the information on animals and plants can be traced to classical sources including Pliny and even Aristotle.[53] A heavy influence on Bartholomew was his membership of the Franciscans.[54] This provided him with his taxonomy of man separated from nature and closer to God. *De proprietatibus rerum* remained popular throughout the sixteenth century and was translated into English three times before 1600.[55] In 1491, Wynkyn de Worde printed an English version although the university booklists, where it occurs six times, tend to include the Latin version, first published at Lyon in 1482.

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[50] Aristotle, *The Complete Works of Aristotle*, ed. Jonathan Barnes (Princeton, 1984). v. 1, p. 1004.
[51] Ibid. v. 1, pp. 1072, 1037 and 1018.
[52] Brian Ogilivie, *The Science of Describing* (Chicago, 2006). p. 103.
[53] Charles Raven, *English Naturalists from Neckham to Ray* (Cambridge, 1947). p. 14.
[54] Andrew Cunningham and Roger French, *Before Science: The Invention of the Friar's Natural Philosophy* (Aldershot, 1996).
[55] Raven, *English Naturalists from Neckham to Ray*. p. 13.

The direction of argumentation in Bartholomew, is to begin with God.[56] From there he moves down the hierarchy of substances, reaching the natural world only in book eight.[57] At a popular level, medieval bestiaries which served as a form of popular theological education, argued in a similar way.[58] The meaning of the natural world is illuminated through the knowledge of God and the animal fables given an explicitly theological moral. For example, the story that the beaver bites off its testicles to evade the hunter teaches that man must cut himself off from sin in order to escape the clutches of the devil.[59]

In suggesting that Aristotle's animal books could be used to illustrate the creative work of God, the direction of the design argument is reversed. We learn about the divine from the study of nature. We can see this process in action in a work of popular natural history, John Maplet's *A Greene Forest*, which emerged from the Cambridge milieu in the mid-sixteenth century.

Maplet studied at St Catherine's College, Cambridge in the 1560s and his book was published in London in 1567.[60] Charles Raven viewed the book as a hopeless step backwards towards medieval conceptions.[61] It is certainly highly derivative. In his list of authorities, Maplet cites the usual classical writers such as Aristotle and Pliny (indubitably his main sources) but also mentions Albertus Magnus (doubtless *De mineralibus*), Avicenna, Jean Ruel, Ermolao Barbaro and Girolamo Cardano.[62] Admittedly, his use of the contemporary authorities is largely philological and his text also cites facts from Christian writers like Augustine and Isodore. *A Greene Forest* is in three books. The first is a brief survey of minerals, the second on plants and the third a rather fuller treatment of animals. All the old stories are here. The bear who licks her young into shape is joined by the beaver that bites off its "owne stones" to evade pursuit.[63] There is nothing remotely technical or critical about the content besides a smattering of unreliable information on etymology of the kind favoured by Isidore of Seville.

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[56] Cunningham and French, *Before Science*. p. 213.
[57] Ibid. p. 214.
[58] Jerry Stannard, "Natural History," in *Science in the Middle Ages*, ed. D.C. Lindberg (Chicago, 1978). p. 435.
[59] Ogilivie, *The Science of Describing*. p. 102.
[60] Lauren Kassell, 'Maplet, John (*d.* 1592)', *Oxford Dictionary of National Biography*, Oxford University Press, 2004 [http://www.oxforddnb.com/view/article/18016, accessed 1 Nov 2007]
[61] Raven, *English Naturalists from Neckham to Ray*. p. 33.
[62] John Maplet, *The Greene Forest*, ed. W.H. Davies (London, 1930). p. 9.
[63] Ibid. pp. 126 - 7.

Of more interest is what Maplet does not include. The Christian allegories which were the central point of the bestiaries have all gone. The pelican is still slain by its brood and the phoenix still rises from the ashes, but an explicit religious explanation is not included.[64] Instead, it is in nature herself that Maplet expects his readers to find the religious message. He prefixes each book with an extract from the Psalms, most tellingly Psalm 104 "O Lord, howe meruellous are they woorkes: in wisedome hast thou made them all, the earth is full of thy riches."[65] He concludes by explaining his primary purpose in writing was to inform his readers, "so that if they haue any consideration at all, they may be moued at this working of God in these such his inferiour Creatures."[66] It is this argument, that the work of God can be clearly seen in nature, which I suggest could have inspired Maplet's Cambridge predecessors and contemporaries to closely study Aristotle's books on nature.

Jacques Lefèvre D'Etaples

The preference for humanist authors is best demonstrated by the ubiquity of Jacques Lefèvre D'Etaples. His *Totius philosophiae naturalis paraphrases* was, by far, the most popular book on natural philosophy at Cambridge in the period up until 1535. The booklists relating before 1535 show eight copies of the various editions at Cambridge, but only two at Oxford. The account book of the Cambridge bookseller, Garrett Godfrey, shows that he sold two copies in 1530 but John Dorne did not sell any.[67]

Lefèvre was born about 1460, the son of a man of modest property in Etaples, northeastern France. He received his MA from the University of Paris in 1480 and thereafter he decided to remain a regent master in the arts faculty rather than going on to take a theology degree. He lectured the Picard nation at the Collège de Cardinal Lemoine until his retirement from teaching in 1508. His published works on the liberal arts all date from this period, which was broken by at least three visits to Italy where he became acquainted with such humanist luminaries as Pico della Mirandola (1463 – 94), Ermolao Barbaro (1454 – 93)[68] and the less luminous Cuthbert

[64] Ibid. p. 165.
[65] Ibid. p. 9.
[66] Ibid. p. 184.
[67] Leedham-Green, Rhodes, and Stubbings, *Garrett Godfrey*. p. 136.
[68] E. F. Rice, ed., *The Prefatory Epistles of Jacques Lefèvre d'Etaples* (New York, 1972). p. 12.

Tunstall.[69] His circle of students has been linked to a concern for medieval mystics, the church fathers and a disdain for scholasticism.[70] This group at Collège de Cardinal Lemoine stood in opposition to John Major's logicians at the Collège de Montaigu, where Erasmus had such a wretched time. Paris was the home to many different intellectual persuasions.[71] After 1508, Lefèvre's work swung decisively towards theology despite his never having taken a degree in the subject. He produced commentaries and French translations of the scriptures as well as finding time to involve himself in church reform and tutor the children of King Francis I (1494 – 1547, r. 1515 – 1547).[72] Lefèvre also tried to prove that the works alleged to be by Dionysius the Areopagite were not pseudonymous but genuinely by St Paul's Athenian convert. Lefèvre went as far as to associate this Dionysius with St Denis of Paris.[73] He was close to Erasmus and shared with him a desire to reform rather than abolish the Catholic Church.[74] He also absorbed many other contemporary streams of thought including Platonism and natural magic, on which he wrote a treatise based on Pico.[75] Despite their shared appreciation of Pico and the Hermetic corpus, John Fisher parted company with Lefèvre in 1519 over the question of how many different women called Mary are mentioned in the New Testament.[76] However, the fact that Fisher thought it worth devoting two treatises to refuting Lefèvre's views on this matter shows that he realised he was a writer of substance. Given how many of Lefèvre's books had been in use at Cambridge for the previous twenty years, it is no surprise that Fisher took him seriously.

Lefèvre enjoyed an extremely prolific career as a writer on the liberal arts. In all, over 350 editions and reprints of his works had been published by 1550.[77] Although a fair proportion was theological, very many covered the trivium, quadrivium and three philosophies. We have already met his textbooks on astronomy, music and arithmetic, which were being used at Oxford. On the trivium, Lefèvre's

[69] Charles Sturge, *Cuthbert Tunstal, Churchman, Scholar, Statesman, Administrator* (London, 1938). p. 14.
[70] E. F. Rice, "The Humanistic Idea of Christian Antiquity: Lefèvre d'Etaples and his Circle," *Studies in the Renaissance* 9 (1962). p. 126.
[71] Brian Copenhaver and Charles Schmitt, *Renaissance Philosophy* (Oxford, 1992). p. 96.
[72] Rice, ed., *Epistles of Lefèvre*. p. 14.
[73] Anthony Levi, *Renaissance and Reformation: the Intellectual Genesis* (New Haven, 2002). p. 416.
[74] Phillip E. Hughes, *Lefèvre: Pioneer of Ecclesiastical Renewal in France* (Grand Rapids, 1984). p. 110.
[75] Ibid. p. 18.
[76] Porter, "Fisher and Erasmus." p. 90.
[77] Rice, ed., *Epistles of Lefèvre*. p. 14.

Introductiones logicales (1496) was exceedingly popular although the master himself seemed to view the work with a good deal of distaste. He only wrote it because his students could not escape having to know some dialectic.[78] Unperturbed, students lapped it up. Garrett Godfrey alone sold thirteen copies in the fragment of his accounts that survive.[79] It appears dozens of times in the booklists and we even find Robert Joseph of Gloucester College lending it to a friend as a great favour.[80]

While he stuck to the medieval authorities for the trivium and quadrivium, Lefèvre completely renounced them for his philosophical textbooks. As far as he was concerned, the only author one needed to study for knowledge of the three philosophies is Aristotle himself. God, he said, had divinely illuminated the mind of the Philosopher whose work was thus entirely consistent with Christianity. Indeed, philosophy was but a step on the road to theology with metaphysics just one step below study of the fathers and the Bible itself. As one recent scholar has noted, "the union and concord of Christianity and Aristotelianism were guaranteed by a common inspiration."[81] Lefèvre produced substantial works on the Philosopher's ethics and metaphysics as well as natural philosophy. His *Introductiones* to various works by Aristotle were intended to provide the necessary context to fully appreciate the original text.

Lefèvre prepared two treatises on natural philosophy – the *Totius Aristotelis philosophiae naturalis paraphrases* (1492) and the *Introductiones* or *Dialogi in physica* (1492). The paraphrases consist of introductions to the *Physica* and *De anima* as well as the actual paraphrases of both these works, *De caelo*, *De mundo*, *Meteorologica*, *De generatione et corruptione*, and the *Parva naturalia*. The introductions are made up of two dialogues on the *Physica* called Hermeneus and Enantius which cover 'easy' and 'difficult' issues respectively. Originally, all these treatises were all bound together and the *editio princeps* published at Paris in 1492 for the benefit of students at the university. As one might expect for a student textbook, it is dedicated to the Chancellor of the University of Paris, Ambrose de Cambrai.[82] The subsequent publishing history of Lefèvre's natural philosophy is very complicated and

[78] Copenhaver and Schmitt, *Renaissance Philosophy*. p. 95.
[79] Leedham-Green, Rhodes, and Stubbings, *Garrett Godfrey*. p. 107.
[80] H. Aveling and W. A. Pantin, eds., *The Letter Book of Robert Joseph, Monk-scholar of Evesham and Gloucester College, Oxford, 1530 - 3*, Oxford Historical Society New Series 19 (Oxford, 1967). p. 19.
[81] Rice, ed., *Epistles of Lefèvre*. p. xix.
[82] Levi, *Renaissance and Reformation*. p. 171.

the treatises were often sold separately in later editions.[83] One of his students, Josse Clichtove (c. 1472 – 1543), was responsible for seeing the works through the press as well as providing commentaries to later editions. For this reason, he is sometimes identified as the author in the booklists. Clichtove was from Flanders and so, like Lefèvre, would have joined the Picard nation at the University of Paris. Unlike his master, he moved to the theology faculty after incepting in the arts and received his doctorate there in 1506.[84]

At Cambridge, Lefèvre's natural philosophy textbooks enjoyed a high degree of popularity. They appear twenty three times in the complete set of booklists under a variety of titles. At Oxford, there are only eight copies.[85] Additionally, we have already come across his many texts on the seven liberal arts. Outside the booklists, direct links between Lefèvre and England are difficult to ascertain. Thomas More was aware of his non-theological work and praised him for restoring "true logic and true philosophy, especially that of Aristotle."[86] Roger Collingwood was in Paris for two lengthy stays in the early 1500s while Lefèvre was teaching there and would have been exposed to his work.[87] Perhaps he encouraged its use among his mathematics students when he returned.

The essence of Lefèvre's Christianised Aristotle is that he can be read at many different levels and that the true spiritual sense is not always the most obvious one. Clichtove's commentary on Lefèvre's introductory epistles to the *Paraphrases* presents a ten-point plan for reading the work. The Philosopher, we are assured, always has his eye on higher things.

> Aristotle, limiting all the philosophy of nature to natural things subject to generation and corruption, rises equally to the divine and prepares the road showing the way to understand the heavens. He moves from physical movements to the contemplation of the prime mover of metaphysics; from the passing of time to the fixed and permanent duration of eternity; from motion to the constant stability and stillness of the heavens; from the ordinary disposition of this inferior mechanism to the knowledge of the most

[83] Rice, ed., *Epistles of Lefèvre*. p. 535 – 8.
[84] Charles Lohr, *Latin Aristotle Commentaries: Aristotle in the Renaissance* (Florence, 1988). p. 94.
[85] See appendix one.
[86] E.F. Rice, "Humanist Aristotelianism in France: Jacques Lefèvre d'Etaples and his Circle," in *Humanism in France,* ed. A.H.T. Levi (Manchester, 1970). p. 132.
[87] M. G. Underwood, "Lady Margaret and her Cambridge Connections," *Sixteenth Century Journal* 13 (1982). p. 80.

> wise author and principle of things; in order that they show what follows more openly.[88]

Likewise, we must understand Aristotle in an analogous sense and the commentary can help us do that.

> Analogy is spread (although secretly) through all natural philosophy, as through the remaining books of Aristotle. It is the certain likeness of one thing to another and the way that uncertain things are established from the more certain. For this kind of Aristotle's teaching is homely and familiar and offering the easiest and most accommodating way to anyone seeking correct understanding. In the commentaries on the paraphrase, this is explained as far as possible for everyone, by the addition of our clarifying notes where the text demands them.[89]

This did not go down well with the proponents of rigorous scholastic logic and Pierre Tateret (d. 1522), commentator on Scotus and Peter of Spain's *Summulae*, launched an attack on these introductory letters in 1495.[90] Lefèvre's reply is contained in his own introduction to logic, which denounced the 'Gothic trap' into which the humanities had fallen.

When he said "Ficino gave Plato to Italy; Lefèvre d'Etaples restored Aristotle to France,"[91] Reuchlin was more right than he probably realised. Just as Ficino in his *Platonica Theologia* had sought to show that the ancient wisdom of Plato was the forerunner of Christianity, so Lefèvre thought Aristotle preserved divine truth.[92] Thus, he attempted to extract Christian theology from Aristotle's natural books in an unhistorical manner, a task that might seem even harder than Christianising Plato. In fact, a review of the *Paraphrases* and *Dialogi* reveal them to be reasonably straight Aristotelian textbooks. Lefèvre intended the *Paraphrases* to express the mind of

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[88] Rice, ed., *Epistles of Lefèvre*. p. 7. "Aristoteles in tota naturali philosophia de rebus naturalibus generationi corruptionique obnoxiis determinans ad divina pariter assurgit, et ad caelestium naturam cognoscendam viam parat aditumque pandat. Nempe ex moventibus physicis ad primi moventis metaphysici contemplationem evehit, ex temporis successione ad aeternitatis fixam permanentemque durationem, ex motu ad caelestium firmam et semper eandem stabilitatem, ex huius inferioris machinae ordinatissima dispositione ad sapientissimi auctoris et rerum principiis agnitionem subvehit, ut sequentia apertius ostendent."

[89] Ibid. p. 10. "Per totam naturalem philosophiam, ut reliquos Aristotelis libros, passim analogia (quamvis latenter) spargitur, quae est certa rei ad rem proportio, quae incerta sunt per certiora comprobans. Est enim id docendi genus Aristoteli domesticum et familiare et ad quicquam recte intelligendum facillimam et accommodatissimam praebens viam. Quae in commentariis paraphrasi ad omnium utilitatem adiectis ubi locus expetit pro tenuitate nostra utcumque aperietur."

[90] Levi, *Renaissance and Reformation*. p. 170.

[91] Quoted in: Rice, "Humanist Aristotelianism in France." p. 132.

[92] Ibid. p. 143.

Aristotle rather than interpreting him as a commentary would do. He wrote that his aim was "to make the text clear and easy in all the practicable ways and to eliminate as far as possible cause for confusion."[93] The text of Aristotle himself is not printed with the *Paraphrases*. Instead, Clichtove effectively provided a commentary on Lefèvre's text. The *Dialogi* served as introductions and Lefèvre recommended that they be read first because they gave an overview of Aristotle's entire natural philosophy.[94]

Many of the editions were handsome (and hence expensive) folio volumes, which put them beyond the reach of most students. Around 1530, Garrett Godfrey sold a copy of the *Paraphrases* (together with Cato's *Disticha*, which is usually a very cheap book) for 20d.[95] And in 1537, the *Paraphrases* alone was valued at 20d. It settled down to about 12d in the next few years.[96] However, by the 1550s Lefèvre's textbook, as we will see in chapter seven, had been superseded and the prices he demanded fell further. This fall might also be due to the appearance of more compact editions although even as late as 1539, his work was still being printed in folio,[97] despite the tendency of books to get smaller as the sixteenth century progressed. The earliest octavo edition appeared in 1522.[98] For this reason, it seems likely that the book, although explicitly intended for teaching at the University of Paris, was actually used by masters rather than their students.[99] The *Paraphrases* follow the text of Aristotle's natural works very closely, echoing the standard divisions of books and chapters. The much more voluminous commentary of Clichtove follows in a smaller type after each chapter and further explicates the Aristotelian text. The book is complete in itself and it would not be necessary to have a copy of the original Aristotle at hand to understand what Lefèvre and Clichtove are saying.

If we needed a further demonstration of how completely humanist writers had rejected the natural philosophy of the Middle Ages, Lefèvre and Clichtove would

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[93] Quoted in: Eckhard Kessler, "Introducing Aristotle to the Sixteenth Century: The Lefèvre Enterprise," in *Philosophy in the Sixteenth and Seventeenth Centuries: Conversations with Aristotle*, ed. Sachiko Kusukawa and Constance Blackwell (Aldershott, 1999). p. 13.
[94] Ibid. p. 14.
[95] Leedham-Green, Rhodes, and Stubbings, *Garrett Godfrey*. p. 80.
[96] Leedham-Green, *BCI*. pp. 333 – 334.
[97] London, British Library, shelf mark C.74.e.14.
[98] Rice, ed., *Epistles of Lefèvre*. p. 535.
[99] Jensen suspects the same of his editions of *De sphera*. See Kristian Jensen, "Textbooks in the Universities," in *The Cambridge History of the Book in Britain: 1400 - 1557*, ed. J.B. Trapp and Lotte Hellinga (Cambridge, 1999). p. 373.

provide it. In five hundred or so folio pages of the *Paraphrases* and *Dialogues*, neither of them sees fit to mention a single western medieval writer. Only ancient authorities are permitted. It is this removal of medieval glosses and commentary on which, in 1516, Erasmus congratulated Cambridge for getting rid of in favour of a "new, or at least refurnished Aristotle".[100] Clichtove allows himself one exception when he cannot resist taking a swipe at Averröist views on the soul. He says, referring to *De anima*, that "In addition, the opinion and belief of the commentator, Averröes (lest I should say contriver) must be refuted and debunked by this point."[101] Clichtove's analogical method asks us to find rarefied meanings for the text that look as if they fly in the face of Aristotle's own materialist philosophy.[102]

Trinity Hall possesses a copy of the *Philosophiae naturalis paraphrases* (which includes the *Dialogi* and a paraphrase on the *Metaphysica*) that is heavily annotated in at least four hands.[103] The volume still sits chained to a late-sixteenth-century desk but must have been so attached long after its usefulness had come to an end. Most annotation is a matter of the reader stressing what he thinks important or, in the case of most students, what they have been told is important. We saw with the annotated books by John Canonicus and Alexander ab Alexandria from Oxford that interlining, paraphrase and other kinds of highlighting make up almost all the annotation. This is not so much the reader carrying out a dialogue with the book as his harvesting it for the information he needs. What annotation can tell us is which sections of a large book have been most read. Recall again the copy of Canonicus in Merton College, where only the first few questions had been marked up. The Trinity Hall Lefèvre is exceptional because annotation continues throughout. This volume has received very heavy use. The paraphrases of the first five books of the *Physica*, *De generatione* and the first book of *De caelo* are perhaps most densely covered. It would not be surprising if this represents the most commonly studied of Aristotle's natural books. A few jottings from one of the annotators suggest some medical concerns. He explains that cholera is a disease when Clichtove mentions it, and later notes "The

[100] Porter and Thomson, eds., *Cambridge Letters of Erasmus*. p. 195.
[101] Jacques Lefèvre D'Etaples, *Philosophiae naturalis paraphrases*, ed. Josse Clichtove (Paris, 1518). fol. 204r. "Confutanda insuper & despeuenda est illa Commentatoris (ne dicam commentitoris) Auerrois sententia atque opinio."
[102] For example, Ibid. fols. 24r and 46r.
[103] Cambridge, Trinity Hall Old Library, E* Chained.

slime running out from catarrh in illness is called phlegm in Greek."[104] Otherwise, the annotators have little to say for themselves beyond advertising which parts of Aristotle held the most interest.

There was one other specifically pedagogical text that seems to have been used to teach natural philosophy at Cambridge around this time. This was the *Paraphrases* of Themistius (d. c. AD390), a pagan held in high esteem by the early Christian emperors. The Aristotelian *Paraphrases*, covering the *Physica*, *De anima* and *Parva naturalia* appear to be the work of his youth and contain little that is original. They were intended primarily as teaching texts for his students, who included the imperial family at one point.[105] The *Paraphrases* were translated by Ermolao Barbaro and first published in Latin in 1481.[106] At least nine more editions followed by 1570 in addition to a Greek Aldine version in 1534. They appear eight times in the Cambridge probate lists, but only twice in the lists referring to before 1535.[107] However, the book was also owned by one of the individuals whom we know lectured on natural philosophy. As shown in appendix three, there is a record of William Bond being paid by Queens' College to lecture on philosophy in 1504.[108] He later retired to Syon Monastery, which, like his college, was patronised by Lady Margaret Beaufort, where he died in 1530. He left his library of twenty-nine books to Syon, including a copy of Themistius' *Paraphrases in Aristotelem*.[109] Much later, in 1564 and just before he became junior Linacre lecturer, John Hancock was given permission to take Merton College's copy of Themistius with him on an errand.[110] However, as he was a teacher of medicine, he probably was not reading it to lecture on it.

Themistius was acceptable at Cambridge because he predated medieval scholasticism and was close to the antique world so respected by humanist thinkers. Also, unlike many early-modern authors, Themistius did not go out of fashion and

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[104] Ibid. fols. 18v and 21r "*pituita morbus ex catharro proveniens grece flegma dicitur*."
[105] G. Verbeke, "Themistius," in *Dictionary of Scientific Biography*, ed. Charles C. Gillespie (New York, 1970 - 80). p. 308.
[106] Jill Kraye, "Philologists and Philosophers," in *The Cambridge Companion to Renaissance Humanism*, ed. Jill Kraye (Cambridge, 1996). p. 142.
[107] At Cambridge :Thomas Ockley (1538), William Buckmaster (1546) in Leedham-Green, *BCI*. v. 2, p. 741.
[108] Cambridge, University Library, Queens' College Archives 1, "Journale 1484 – 1517", n.p.
[109] A. B. Emden, *A Biographical Register of the University of Cambridge to AD 1500* (Cambridge, 1963). p. 72.
[110] J. M. Fletcher, ed., *Registrum annalium Collegii Mertonensis, 1521 - 1567* (Oxford, 1974). p. 237.

remained moderately popular throughout the sixteenth century, while Lefèvre, as we will see, fell from favour in the 1540s. Thus, Cambridge natural philosophy was taught either with a modern textbook that eschewed medieval sources or with antique texts where these were accessible to students. Aristotle's animal books were especially popular because they taught about God's wonderful providence in a way that students could easily understand but still had Aristotle's immense philosophical prestige.

John Fisher and humanist reform

We saw above the earliest reforming statute at Cambridge dated from 1495 and changed the undergraduate syllabus. The previous year, John Fisher had been proctor, a position from which he could very well have instigated the statute. It was while he was proctor that Fisher met Lady Margaret Beaufort, the mother of Henry VII. This quickly developed into an important relationship.[111] After a spell when he was chaplain in her household, she had endowed the Lady Margaret Professorship in Divinity at both universities. Then, at the apparent insistence of Fisher, she founded the first of her two Cambridge colleges, Christ's. This was a refoundation of the existing college, Godshouse and Lady Margaret obtained the royal charter for Christ's College from her son in 1505.[112] She also provided the funding and donated thirty-nine books to the college's library.[113] Fisher drew up the statutes. These date from 1506 and they appointed a college lecturer to read rhetoric, logic, philosophy and grammar.[114] When she died in 1509, preparations for the foundation of St John's were already advanced enough to survive the sabotage attempted by her grandson Henry VIII.[115]

Fisher himself lectured in the humanities in 1496,[116] was vice-chancellor in 1501 and President of Queens' College from 1505 – 08. He could also influence or control three colleges: Queens' (where he was President for three years), Christ's and St John's (for both of which he wrote the statutes). Furthermore, as a bishop and royal

[111] Underwood, "Lady Margaret and her Cambridge Connections." p. 68.
[112] Leader, *The University to 1546.* p. 228.
[113] Cambridge, Christ's College, MS BB 39.
[114] H. Rackham, *Early Statutes of Christ's College, Cambridge: with the Statutes of the Prior Foundation of God's House* (Cambridge, 1927). p. 99.
[115] Underwood, "Lady Margaret and her Cambridge Connections." p. 78.
[116] D. R. Leader, "Professorships and Academic Reform at Cambridge: 1488 - 1520," *Sixteenth Century Journal* 14 (1983). p. 220.

confidant, he moved high up in court circles with influence over both Henry VII and Henry VIII. Finally, he was Chancellor of the University from 1514 – 35,[117] over twenty years. He treated this more as an executive than honorary role with frequent interventions in university affairs. It is likely that there were others in positions of influence at the university who followed Fisher's lead but his importance is indisputable.[118]

Perhaps most significant was his status as a theologian and his control over who should be appointed Lady Margaret Professor. He held the job himself for a while and other friends, such as Humphrey Walkden who were sympathetic to humanism and friendly with Erasmus, were also occupants.[119] This meant that he could exercise considerable influence over the theology faculty, which we have seen is essential to any reform of the bachelors' syllabus. The Cambridge theology faculty was becoming increasingly eclectic. Fisher himself was concerned about improving knowledge of the ancient languages of Greek and Hebrew.[120] In 1516, he appointed Richard Croke (1489 – 1558) who had studied under William Grocyn as well as abroad, to be the first university lecturer in Greek.[121] His successor, George Day (1502 – 1556), appointed to read Greek from 1524, was a member of St John's College where Fisher was the dominant influence.[122] Erasmus noted that Fisher's protection was sufficient to ensure that Greek could be taught at Cambridge in 'complete tranquillity' compared to the arguments at Oxford.[123] However, Richard Croke, the Greek lecturer that Fisher brought to Cambridge turned out to be more a radical man than he, supporting Henry VIII's divorce.[124]

Walkden, despite being associated with humanism, lectured on Duns Scotus' *Sententiae* commentary before receiving his DTh in 1520.[125] Incunabula versions of this book are found in five Cambridge college libraries as well as a binding from

[117] Richard Rex, "Fisher, John [St John Fisher] (c.1469–1535)", Oxford Dictionary of National Biography, Oxford University Press, 2004 [http://www.oxforddnb.com/view/article/9498, accessed 20 March 2006]
[118] For the intellectual life of John Fisher see Richard Rex, *The Theology of John Fisher* (Cambridge, 2003).
[119] Richard Rex, "Lady Margaret and her Professors, 1502 - 1559," in *Lady Margaret Beaufort and Her Professors of Divinity at Cambridge 1502 to 1649*, ed. Richard Rex and Graham Stanton (Cambridge, 2003). p. 34.
[120] Rex, *The Theology of John Fisher*. p. 50.
[121] Leader, "Professorships and Academic Reform." p. 225.
[122] Ibid. p. 226.
[123] M. Dowling, *Fisher of Men: a Life of John Fisher 1469-1535* (London, 1999). p. 22.
[124] Underwood, "John Fisher and the Promotion of Learning." p. 32.
[125] Leader, *The University to 1546.* p. 314.

Emmanuel.[126] The probate lists include fifty or so copies of Peter Lombard's *Sententiae* together with commentaries by Scotus and Bonaventure in roughly equal numbers.[127] However, it is perhaps Garrett Godfrey's accounts that give us the best snapshot of what people were buying and hence reading in the 1530s. These contain no Scotus at all, but four books by Aquinas and Bonaventure's *Sententiae* commentary.[128] The Scotists are represented by two copies of Nicolas d'Orbelles' *Sententiae* commentary (also found in several of the probate lists), but the church fathers, especially John Chrysostom, out number the scholastics by some margin.[129] Thus Scotists rubbed shoulders with experts on patristics, Thomists, followers of Bonaventure and Christian humanists. Overall, across all the probate lists examined at both universities, Duns Scotus and his followers were roughly three times more popular at Oxford than at Cambridge, while the proportions of Petrus Lombardus, Thomas Aquinas and Bonavanture were roughly comparable. John Fisher's tastes were similarly eclectic as evidenced by the impressive breadth of works referred to in his own writings.[130] Some of his colleagues probably had fingers in more than one pie and no one group could hope to set the tone for the theology faculty, let alone dictate the arts syllabus. This meant that Fisher could institute reform, largely to promote languages and good letters, without there being a dominant faction able to oppose him.

Another factor worked in favour of reform. Cambridge may have been easier to reform simply because it was smaller. Oxford is estimated to have had about 1,700 members compared to 1,300 at Cambridge.[131] More significant would have been the stronger medieval traditions at Oxford. Cambridge had few famous alumni to boast of and so was probably more susceptible to changing the way it did things. After all, there is nothing like past success to bring about the ossification of an institution and nothing like relative failure to encourage reform. The make up of the faculties also had an effect. Cambridge's theology faculty had been dominated by the friars, who did not pass through the arts faculty. As their numbers dried up through the fifteenth

[126] Leedham-Green, Rhodes, and Stubbings, *Garrett Godfrey*. p. 91.
[127] Leedham-Green, *BCI*. v. 2, p. 612, p. 135 and p. 288.
[128] Leedham-Green, Rhodes, and Stubbings, *Garrett Godfrey*. pp. 121 and 126.
[129] Ibid. pp. 153 and 143.
[130] Rex, *The Theology of John Fisher*. pp. 193 – 203.
[131] J. K. McConica, "Studies and Faculties: Introduction," in *A History of the University of Oxford: The Collegiate University*, ed. J.K. McConica (Oxford, 1986). p. 152.

century, the theology faculty was further weakened.[132] The lawyers, who represented a third of students, also did not need an MA although some did have one.[133] Thus, the arts faculty was a law unto itself with less oversight from the theology faculty. At Oxford, the theologians were more powerful, both by tradition and in numbers. Half of the theology students had come up through the arts faculty in the early-sixteenth century.[134] This meant that the higher faculty had good reason to be very interested in what bachelors studied for their MAs to prevent the syllabus from being subject to radical change.

The Quadrivium at Cambridge

In mathematics, the theoretical arithmetic of Boethius that was seen as an important element of pre-theological education at Oxford seems to have never enjoyed much influence at Cambridge. There, practical mathematics was traditionally taught. This left the subject peculiarly exposed because it did not lead to anything beyond its own utility. A particular problem was the shortage of qualified people to teach it. A partial solution to this was to set up a salaried lectureship but even the prospect of £4 a year could not ensure that a mathematically-minded master would always be available.

Like their Oxford counterparts, Cambridge students did not start to learn about mathematics until after they had determined as bachelors. However, the syllabus they followed, which is found in the same statute that set out the philosophy syllabus for bachelors, is very different. It stipulated lectures be heard on the *Algorismus* for arithmetic, the first three books of Euclid's *Elementa* for geometry and *Tractatus de sphera* or a *Computus* for astronomy.[135] There is no mention of music. The work on the sphere required almost certainly implies Sacrobosco's short text discussed in the previous chapter. The most notable thing about this syllabus is that there is no reference to Boethius. Nor does he appear in the booklists, although there is a single copy of Lefèvre's epitome of *De institutione arithmeticae*.[136] Instead, the emphasis is on logistics – what we would call doing sums. The demarcation between theoretical and practical mathematics was preserved in the Middle Ages when the study of

[132] Leader, *The University to 1546.* p. 171.
[133] Ibid. p. 195.
[134] McConica, "Studies and Faculties: Introduction." p. 155.
[135] Hackett, ed., *Original Statutes*. p. 277.
[136] William Framyngton (1537) in Leedham-Green, *BCI*. v. 1, p. 26.

arithmetic was based around Boethius and his commentators like Jordanus Nemorarius.[137] Logistics was contained in the practical tractates called *Algorismus* after the work of ninth-century Arabic writer Al-Kharazmi (c. 790 – c. 840).[138] By the early 1500s, the word 'algorismus' had been dropped and manuals on how to calculate were given titles like *Arithmetica experimentalis* or *Arithmeticae practicae methodus.*[139] It was clearly in everybody's interests that the prestige of Boethian mathematics be carried over to the more useful practical studies. Thus, the word 'arithmetic' came to cover the logistics of the 'algorismus' as well as theoretical mathematics.

The entry of calculation into the Western consciousness is detailed most fully by Alexander Murray in chapters six, seven and eight of *Reason and Society in the Middle Ages.*[140] The story he tells is of calculation initially making in-roads into the lives of merchants and not the universities. He even suggests that universities tried to outlaw Arabic numerals on the basis that booksellers were using them to hide prices from students and masters.[141] Certainly, the dozens of different types of numerals caused considerable confusion.[142] By the fourteenth century, calculation was being taught at schools and appeared, as we can see, on the Cambridge syllabus.

This emphasis on practical mathematics at Cambridge long pre-dated the humanist reforms of the late-fifteenth century. As you do not need to be able to extract square roots or perform long division to successfully study Scotist philosophy, this suggests that the coherence of the medieval syllabus at Cambridge was not as great as at Oxford. Whatever the practical mathematics course was for, it certainly was not a useful preparation for either scholastic philosophy or theology. Fisher himself drew a lesson from Euclid that if you fail to understand one iota of an argument in theology, then you fail to understand it at all.[143]

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[137] Boethius, *Boethian Number Theory: a Translation of the De institutione arithmetica*, Michael Masi trans. (Amsterdam, 1983). p. 49.
[138] Michael S. Mahoney, "Mathematics," in *Science in the Middle Ages*, ed. D.C. Lindberg (Chicago, 1978). p. 150.
[139] Roger Collingwood, *Arithmetica experimentalis* (c. 1508) for which see below and Gemma Frisius, *Arithmeticæ practicæ methodus facilis* (Antwerp, 1540).
[140] Alexander Murray, *Reason and Society in the Middle Ages*, New ed. (Oxford, 1985).
[141] Ibid. p. 171.
[142] Ibid. p. 168.
[143] Rex, *The Theology of John Fisher*. p. 23.

Practical mathematics was not very helpful for dealing with Lefèvre's brand of Aristotle either. Rather it was simply a set of skills that the drafters of the syllabus thought that students needed. They would be useful skills for medical practitioners but it is hard to believe that the tiny number of physicians trained at medieval Cambridge would have had much of an influence on the arts syllabus.[144]

There were plenty of versions of the *Algorismus*, the arithmetic textbook demanded by the medieval Cambridge statutes. The most popular was attributed to John Sacrobosco. It was printed for the first time in 1488, attached to the *Computus manualis* of Anianus (fl. c. 1300).[145]

Sacrobosco, if indeed he is the author, produced an admirably short and clear work. The copy examined was the 1488 edition,[146] which, despite being an octavo with a black letter typeface, still squeezes everything into ten folios. The treatise begins with counting and moves on to the four basic arithmetical functions of addition, subtraction, multiplication and division. Between subtraction and multiplication, the functions of halving and doubling are also covered. Progressive series are briefly mentioned and then an inadequately brief explanation of how to extract square and cube roots. The treatise concludes with an appendix on the abacus, or '*denarius projectilis*'. Overall, this little book is too brief to be anything but an *aide memoire* for the student of arithmetic.

The *Computus*, a work allowed as an alternative to the *Sphere* at Cambridge, is a short manual on the calendar. The importance of this was the requirement by the church to calculate the moveable feasts of Christian year, most especially Easter, to which many of the others were linked.[147] *Computus* means 'calculation' and the calendar had been a matter of inquiry for Christian scholars since the fifth century.[148] The famous Gregorian calendar reform was still nearly a century away and so this was an area of active research rather than settled decisions. Of course, Cambridge students did not have to do more than know how to use basic astronomical observations and tables to work out when Easter should be. The *Computus manualis* of Anianus

[144] Leader, *The University to 1546.* p. 202.
[145] D. E. Smith, *Rara arithmetica: A Catalogue of the Arithmetics Written before the Year MDCI with a Description of those in the Library of George Arthur Plimpton of New York* (London, 1908). p. 31.
[146] Cambridge, University Library, Inc. 5.A.2.14[171].
[147] Arno Borst, *The Ordering of Time: from the Ancient Computus to the Modern Computer*, Andrew Winnard trans. (Cambridge, 1993). p. 76
[148] Murray, *Reason and Society in the Middle Ages*. p. 146.

contained all the essentials in concise form and, as we saw above, was packaged in 1488 with Sacrobosco's *Algorismus*. In addition, Sacrobosco himself wrote a *Computus* in 1232, which criticised the Julian calendar and suggested reform.[149] In 1538, an edition of Sacrobosco's *De sphera*, edited by Melanchthon for the use of his students at Wittenberg University, included a *Computus* as an appendix. At Oxford, these skills were no less important even if not mentioned in the syllabus. Dorne has three *Computus* manuals in stock and we know that an Oxford *Computus Manualis Oxoniae*, which uses finger reckoning and tables, was published in 1520, the year of Dorne's daybook.[150] The lack of any copies of the *Computus* in the booklists is again probably down to its insignificant size.

The mathematical lectureship and reform

In about 1500, a new statute appointed a lecturer to teach a course of practical mathematics. The decree states:

> Since we do not think it improper to give support to the mathematical sciences which are now somewhat in danger, by effecting a commodious change in these lectures, we enact that every year before vacation, some master skilled in these arts, chosen by the majority of regents, shall at one o'clock read lectures to the bachelors and students. We bind all the bachelors to attend arithmetic and music for the first year, geometry and perspective for the second and astronomy for the third.[151]

The textbooks to be used are not stated but the tradition of the *Algorismus* was strong enough at Cambridge for us to assume that the works of Boethius were not intended. Although music and perspective are mentioned, there is little evidence that these subjects were actually taught as part of the mathematical course. The only place we find them in the booklists are the three copies of the *Margarita philosophica* discussed in the last chapter. If the subjects were being taught, it was only at a very basic level.

The most intriguing part of the statute is the observation that mathematical subjects "are now somewhat in danger." The preface to the statute, which we

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[149] John F. Daly, "Sacrobosco, John," in *Dictionary of Scientific Biography*, ed. Charles C. Gillespie (New York, 1970 - 80). p. 62.
[150] Christopher Wordsworth, *The Ancient Kalander of the University of Oxford* (Oxford, 1904). pp. 157 – 175.
[151] James Heywood, ed., *Collection of Statutes for the University and Colleges of Cambridge* (London, 1840). p. 87.

examined above, certainly gives the impression that it is scholastic logic and philosophy that is threatening to swamp mathematics. Bachelors, we are invited to believe, had to spend so long going through Aristotle over and over again, that the maths course had been squeezed out. In fact, the problem was probably more simply stated – they had no one to teach the quadrivium. There are three possible reasons for this. Firstly, the decay of the quadrivium meant that no one with the right qualifications was available. Secondly, unlike the theoretical mathematics of Boethius, practical calculation did not lead to anything else and may have appeared an academic backwater. This meant that few would aspire to master it in order to further their careers. In an exceptional case, the University awarded William Malleveray a Bachelor of Geometry degree in 1492 but this precedent was not repeated.[152] Finally, the humanist antagonism towards the subject, which we will see demonstrated below, meant that the traditional reverence paid to mathematics had been substantially eroded.

The subject does not get much coverage from the popular educational theorists of the day. For instance, Erasmus had little time for the quadrivium. Although he conceded that those with a natural aptitude should be encouraged to take up maths and music, he gives the impression that it is a second best option.[153] In his *De ratione studii* (1511), he does accept that "astronomy must not be passed over," but his reasons are literary, "since the poets liberally sprinkle their creations with it."[154] Thomas Elyot's (c. 1490 – 1546) *Booke of the Governor* (1531) asked, "is there any astronomer that more exactly setteth out the ordre and course of the celestiall bodies ... than Virgil doth recite"[155] and mentioned the quadrivium only in passing in his chapter on painting. The idea of the quadrivium as a mental gymnasium for minds that need the exercise was as much credit as some other humanists were willing to grant it. Juan-Luis Vives, the Spanish humanist who was educated at Paris and appointed by Cardinal Wolsey to his humanities lectureship at Oxford in 1523 had an unsympathetic attitude towards mathematics. "The mathematical sciences", he wrote in 1531 "are particularly disciplinary to the flighty and restless intellects which are

[152] A. B. Cobban, *English University Life in the Middle Ages* (London, 1999). p. 156.
[153] Anthony Grafton and Lisa Jardine, *From Humanism to the Humanities: Education and the Liberal Arts in Fifteenth- and Sixteenth-Century Europe* (Cambridge MA, 1986). p. 149.
[154] D. Erasmus, "De ratione studii," in *The Collected Works of Erasmus*, ed. Wallace K. Ferguson (Toronto, 1978). p. 674.
[155] Thomas Elyot, *The Boke Named the Governor* (London, 1531). fol. 33r.

inclined to slackness."[156] The booklists confirm this lack of enthusiasm for mathematics. There is very little of it in the lists relating to before 1535. Sacrobosco's *De sphera*, so popular at Oxford, appears only twice. [157] There are just four arithmetic textbooks and a single copy of Euclid.[158]

Luckily, when the statute of 1500 appeared, there was a man available to teach the quadrivium. This was Roger Collingwood who had taken his MA in 1499 at The Queens' College. Collingwood had been admitted as a fellow of Queens' College in 1497. He was university proctor in 1513 – 14 and away studying canon law at Paris between his spells as mathematical lecturer. The second period of study abroad was supported by Lady Margaret herself,[159] no doubt working through John Fisher, president of the college from 1505 – 8. Under the regency rules, Collingwood could only be obliged to teach one of the four subjects of the quadrivium for a single year. To persuade him to teach all four subjects indefinitely, he required some pecuniary compensation. It seems entirely plausible that the statute authorising the creation of a paid mathematical lecturer was drafted with him in mind.

Unfortunately, it is impossible to know on whose initiative the mathematical statute appeared. The vice-chancellor at the time was John Smith, a fellow of Peterhouse and Lady Margaret's first professor of divinity from 1498.[160] Although the vice-chancellor was first among equals and only held office for a year, Smith had the job in 1497, 1499, 1500 and 1504. This means he must have exercised considerable influence. However, I date the statute to 1501 because that is the year that payments to Collingwood first appear in the Grace Books.[161] At that time, it was John Fisher who was vice-chancellor and there is plenty of evidence both for his enthusiasm for mathematics and, as we have already seen, his desire for reform. We know he was taught Euclid by William Melton (d. 1528) and valued the experience enough to recall it in later years.[162] In 1524, when he set up his foundation for St John's College,

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[156] Juan-Luis Vives, *On Education*, Foster Watson trans. (Cambridge, 1913). p. 202.
[157] John Cheswryght (1537) and Geofrrey Blythe (1542) in Leedham-Green, *BCI*. v. 1, pp. 4 and 26. Like may editions, Cheswryght's copy includes commentaries and the *Theoricum planetarum*.
[158] Edward More (1539) owed Euclid in Greek. Ibid. v. 1, p. 12. Sir Thomas Smith, who is strictly speaking part of this sample, owned plenty of mathematics in 1566, but it is hard to relate it to the earlier period before 1535.
[159] Underwood, "Lady Margaret and her Cambridge Connections." p. 80.
[160] Ibid. p. 69.
[161] Bateson, ed., *Grace Book B, Parts I and II*. pt. 1, p. 163.
[162] E. E. Reynolds, *Saint John Fisher* (Glasgow, 1972). p. 5.

among his four salaried examinerships was one in mathematics.[163] In the 1530 statutes of St John's, students were told to cover arithmetic, geometry, perspective and either a tract on the sphere or cosmography.[164] Perhaps most intriguingly, the 1530 statutes also suggest that the university lectures might be too hard for beginning students. In that case, the mathematical examiner is to give his own lecturers for three days a week and demonstrate exercises for the other three.[165]

Collingwood kept the job of mathematics lecturer for almost ten years on and off, so it is not surprising that he eventually decided to write his own textbook. Under the punning name of *Carbo in ligno,* he wrote the ninety-one folios of *Arithmetrica experimentalis* in about 1508.[166] The work is dedicated to Bishop Richard Fox (1448 – 1528) and states that Cambridge appointed Collingwood to teach the quadrivium. As its author was the first and longest-serving incumbent of the mathematics lectureship, this work is of considerable interest. The manuscript, a neat copy in a much abbreviated secretary hand without corrections, was composed in several sections as demonstrated by the different pens and ink used. In fact, although the dedication, written at the time of the initial instalment, says the work is unfinished, the additional sections do complete it. The dedicatory epistle to Richard Fox dates the first section to about 1508 when Fox had the "governance of the nation" upon his shoulders.[167] However, the manuscript did not come to Corpus Christi College, Oxford through Fox, the college's founder, but rather from a donation in 1617 from the noted antiquarian and mathematician, Thomas Allen (1542 – 1632),[168] who was patronised by the Earls of both Northumberland and Leicester[169] and taught Henry Savile.[170]

Arithmetica experimentalis begins with an introduction on the utility and accessibility of maths. To know nothing of numbers is to know nothing of man or science, we are told, and anyone who cannot handle basic arithmetic is stupid.[171]

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[163] Mayor, ed., *The Early Statutes of St John's College, Cambridge*. p. 343.
[164] Ibid. p. 106.
[165] Ibid. p. 246.
[166] Oxford, Corpus Christi College, MS 102 "*Arithmetica Experimentalis*", fol. 1r and 1v.
[167] Ibid. fol. 1v.
[168] Ibid. fol. 1r.
[169] Anthony à Wood, *Athenae Oxonienses*, ed. P Bliss (Oxford, 1813). v. 2, p. 542.
[170] Robert Goulding, "Testamonia humanitatis: the Early Lectures of Henry Savile," in *Sir Thomas Gresham and Gresham College: studies in the intellectual history of London in the sixteenth and seventeenth centuries*, ed. Francis Ames Lewis (Aldershot, 1999). p. 144.
[171] Oxford, Corpus Christi College, MS 102. fol. 2r. "Ait eum ad numerandum qui aptus non est, is se sciat ad nullam humanarum divinarum ve rerum scientiam habile est.... Atque ita qui numerare nesciat... discernos careat. At quum quis discernere non possit: talem stultum dicere, nemo dubitat."

Number was used by God to make the world (although we cannot comprehend this) and is needed by merchants who deal in frankincense and wine. Collingwood informs us that he will not be covering the arithmetic of Boethius or the geometry of Euclid.[172] The first twelve folios cover counting, then the basic arithmetical operations up to folio 22, then a long exposition on the extraction of square and cube roots including six methods of dealing with the former. Finally, from folio 50 to 64 he deals with fractions. The manuscript ends with twenty-four worked problems up to folio 91.

Collingwood used Arabic numerals throughout the work but wrote all formulae along the line rather than according to the tabular form used by Cuthbert Tunstall's *De arte supputandi*. However, if this manuscript represents what Collingwood was teaching his students, it shows he expected them to have a thorough grounding in basic arithmetic, fractions and roots as well as the ability to turn this knowledge to practical use. Those who could not manage this were 'thick' (*stolidum*)[173] although he cannot have had many such cases in his classes as he returned to the job for another three years in 1514 – 17. As his introduction mentions, there is very little by way of arithmetic of the Boethian tradition and as this manuscript comes from the hand of the Cambridge mathematics lecturer, it is clear evidence that it was practical and not theoretical arithmetic that predominated at this university.

We can learn more about what Cambridge students needed to know in the early-sixteenth century from a set of textbooks bound together and housed in the library of Pembroke College.[174] The quarto volume contains seven works, all dating from before 1515. The first is Wynkyn de Worde's *Libellus Sophistarum ad Usum Cantabrigiensis* (London, 1510), a logical textbook that covers what students required for the logic section of the trivium. The presence of this book makes it almost certain that the whole volume belonged to a Cambridge student whose annotations appear across all seven works.

As well as some standard works on astronomy, the volume contains three books on arithmetic. The first is an *Algorismus* (Paris, 1514) with heavy annotation and workings in the margins, then a copy of Thomas Bradwardine's (d. 1349)

[172] Ibid. fol. 2v. "In arithmetica boetii, in geometrica euclid non inductum esse oportebit."
[173] Ibid. fol. 3r.
[174] Cambridge, Pembroke College, shelf mark C35.

Arithmetica speculativa (Paris, n.d.) with just a few interlines and notes compared to the practical arithmetic of the *Algorismus*. Finally, there is a mysterious volume called *Triplex lilium arithmetice sive enchiridion*. It was published by one M. Gorlium of Zurich in 1514 and has no advertised author. There is no trace of this title or its publisher in any catalogue of the major national libraries. Even more surprisingly, it is not included in D. E. Smith's *Rara Arithmetica*.[175] H. M. Adams's catalogue of sixteenth-century books in Cambridge mistakenly attributed it to William Lily.[176] It turns out to be a pirated version of Johann Huswirt's *Enchiridion nuvos algorisi* first published by Heinrich Quentell at Cologne in 1501. Pembroke's very rare bootleg version is printed on poor quality paper and heavily annotated by its owner. Huswirt's textbook appears twice on the Cambridge book lists but not at all at Oxford.[177] It is a fairly concise guide to arithmetic, the abacus, fractions and algebra. The final section is entitled "On the rules of merchants", emphasising the book's practical nature.[178] That the two texts on the *Algorimus* show such heavy use compared to Bradwardine's theoretical work tells us that it was the later than demanded the most attention from Cambridge students.

The mathematics statute goes on to say the new mathematics lecturer was to be paid £4 per annum from funds gathered from students, an amount that appears in university accounts almost without exception each year. The problem was that once Collingwood was no longer available, there was no guarantee that a suitably qualified individual would be found to replace him.

In his article 'Erasmians and Mathematicians at Cambridge in the Early Sixteenth Century',[179] Paul Lawrence Rose used published sources, principally the Grace Books and registers, to assemble a list of the lecturers up until 1546 after which time the relevant details are only available in manuscript. His means of identifying the lecturers was to note to whom the Grace Books said the lecturers' stipends were paid and to look up the names in the Venns' *Alumni Cantabrigienses.*[180] The Grace Books

[175] Smith, *Rara arithmetica.*
[176] H. M. Adams, *Catalogue of Books Printed on the Continent of Europe 1501 - 1600 and in Cambridge Libraries*, 2 vols. (Cambridge University Press, 1967). L680.
[177] Leedham-Green, *BCI.* v. 2, p. 444. Now Cambridge, Peterhouse, Perne Library, shelf mark S. 258.
[178] Cambridge, Pembroke College, shelf mark C35, sig. D iii r, "de Regulis mercatorum."
[179] P. L. Rose, "Erasmians and Mathematicians at Cambridge in the Early Sixteenth Century," *Sixteenth Century Journal* 8 (1977).
[180] J. Venn and J. A. Venn, *Alumni Cantabrigienses. Part One: From the Earliest Times to 1751*, 4 vols. (Cambridge, 1922).

do not always give precise information and Rose assumed, unless other facts were available, that the unnamed recipients were the same as the previously named individual.

The full list of lecturers is given in appendix two, but it is worth noting a few relevant details about the holders of the office here. William Peyton is probably William Peyto, later a Catholic exile and appointed both cardinal and Bishop of Salisbury by the Pope in 1547.[181] We have already met Henry Bullock, one of Erasmus' many friends, to whom he gave the Latin pet name *Bovillus.*[182] He was Lady Margaret Preacher in 1514, DD in 1520 and vice-chancellor in 1524. With three others, including Humphrey Walkden, Bullock was one of the theologians dispatched to London in 1521 to decide on the matter of the Luther's writings and joined in their condemnation.[183] His library was purchased by his college in 1526 and included a Greek Aristotle and Linacre's translation of Galen's *Methodus*, but no mathematics.[184] Bullock's friendship with Erasmus and enthusiasm for humanism did not mean he had any sympathy for religious reform. In the 1520s, Hugh Latimer (c. 1495 – 1555), the future Protestant bishop and martyr, warned his students against Bullock's theology.[185] Bullock's friend, Humphrey Walkden also took a DD and became Lady Margaret Professor of Divinity before his death in 1523.[186] Like Bullock, he was a religious conservative who, despite his friendship with Erasmus lectured on the theology of Scotus.[187] It would not be until Cromwell's visitations of 1535 that the scholastics were banished from the theology faculty even though they had departed from the arts faculty already.

Humanism and Mathematics

The main thrust of Rose's article and Leader's on the same topic,[188] is that humanism helped foster practical mathematics at Cambridge. However, judging by the occupants of the chair, there was usually a chronic shortage of qualified teachers who had anything but a financial interest in doing the lecturing. If we can thank Fisher

[181] Jonathan Woolfson, *Padua and the Tudors* (Toronto, 1998). p. 264.
[182] Leader, *The University to 1546.* p. 292.
[183] Ibid. p. 320.
[184] Clare Sargent, "Two Sixteenth-century Book Lists from the Library of Queens' College, Cambridge," *Transactions of the Cambridge Bibliographical Society* 12 (2001). p. 168.
[185] H. C. Porter, *Reformation and Reaction in Tudor Cambridge* (Cambridge, 1958). p. 44.
[186] Rex, "Lady Margaret and her Professors, 1502 - 1559." p. 34.
[187] Rex, *The Theology of John Fisher*. p. 19.
[188] Leader, "Professorships and Academic Reform."

for instigating the mathematics lecture, then the survival of the subject through these years is probably down to his initiative alone. Finally, however, in 1534, the university appointed a mathematics lecturer who knew the subject well. This was Edward More (d. 1539). He died in the job and the probate list of his library is extant.[189] It contains plenty of natural philosophy and mathematics as well as nine Hebrew books. These include the only copy of the *Almagest* explicitly appearing in the probate lists, Euclid's *Elementa* in Greek, an early-modern practical arithmetic textbook by Gemma Frisius and plenty of mathematical geography. If he could understand all these works, More was probably the finest mathematician of his day at Cambridge. However, in his first year as lecturer, he obtained a grace to read Greek or Hebrew, probably due to the royal visitation in 1535 demanding a lectureship in those subjects.[190] He even got a pay rise. The rest of his probate list makes clear that More was a gifted humanist scholar and mathematics may have been secondary, even to him. This is most evident from what I take to be his choice of astronomy textbook – the *Institutiones astronomicae* by Joachim Fortius Ringelbergius first published in 1528. As well as More's copy, Garrett Godfrey sold two copies and William Framyngton (d. 1537) also owned it.[191] Later on, it was the *Opera* (1531) of Ringelbergius that people bought, incorporating the *Institutiones* and a large number of short educational tracts, some of which, like the *Institutiones*, had previously appeared separately, covering the seven liberal arts. Of the sections making up the *Opera*, it is the *Institutiones* that tends to be more heavily annotated.[192] The *Opera* was not cheap, up to two shillings, but the *Institutiones* was available for a couple of pennies putting it within reach of many students.[193]

As an astronomy textbook, Ringelbergius's work is very classical in its outlook with plenty of ancient authors quoted (in Greek as applicable) but nothing that can be described as technical. The section on the continents makes no mention of the New World at all, presumably as this was unknown to the ancients and hence irrelevant to Ringelbergius's conception.[194] He calls geometry "*chaos mathematicum*", referring to the Greek word *chaos* sometimes meaning 'empty space'

[189] Leedham-Green, *BCI.* v. 1, p 12.
[190] W. G. Searle, ed., *Grace Book G* (Cambridge, 1908). p. 310.
[191] Leedham-Green, *BCI.* v. 2, p. 667.
[192] Joachim Fortius Ringelbergius, *Opera* (Lyon, 1556). London, British Library, 832.b.3.
[193] Leedham-Green, *BCI.* v. 2, p. 667.
[194] Ringelbergius, *Opera*. p. 403.

and another example of his classicism. This is what we would expect a humanist astronomy textbook to look like. The lack of medieval authorities and the use of Greek are typical of other humanist textbooks. It is intended more as an aid to understanding astronomical references in the ancient authors rather than a practical guide to the subject. This, we recall, is what Erasmus said was useful about learning astronomy. Ringelbergius's book, rather than the medieval *De sphera* of Sacrobosco, met the needs of humanists who wanted to know something of astronomy of relevance to their literary interests.

The evidence that most humanists did not have much time for practical mathematics, even though they accepted the need for astronomy as part of a literary education, is further reinforced by the treatise *De tradendis disciplinis* (1531) by Juan-Luis Vives. In it, he did pay some attention to the quadrivium and recommended a series of books. Some of his choices for study do not inspire confidence. For example, he recommended Proclus on the astrolabe by which he presumably means *De sphera* attributed to Proclus.[195] In fact, this short treatise is an abridgement of a first century text by one Geminus, of whom we know nothing else.[196] At Cambridge there were eight copies of Pseudo-Proclus' *De sphera*, although all but one appear in a single batch in the inventory of the bookseller Nicholas Pilgrim (d. 1546).[197] This would be Thomas Linacre's Latin translation. Even though Robert Recorde later recommends it,[198] it is a 'trivial'[199] late-Greek work. Nonetheless, it went through dozens of editions including one printed in London in 1522.[200] In 1521, Oxford University wrote a congratulatory letter to Linacre in which they mention that Wolsey's lecturer Thomas Lupset was lecturing on his translation of Proclus.[201] The reason that the humanist Lupset preferred Proclus to Sacrobosco must be his preference for a late-antique authority over a medieval one. It cannot have had

[195] Vives, *On Education.* p. 206.
[196] Anthony Grafton, "The Availability of Ancient Works," in *Cambridge History of the Renaissance Philosophy*, ed. Charles Schmitt and Quentin Skinner (Cambridge, 1983). p. 789.
[197] Leedham-Green, *BCI.* v. 1, p. 61.
[198] Robert Recorde, *Castle of Knowledge*, Facsimile ed. (Amsterdam, 1975). p. 98.
[199] J. D. North, "Astronomy and Mathematics," in *A History of the University of Oxford: Late Medieval Oxford*, ed. Jeremy Catto and T.A.R. Evans (Oxford, 1992). p. 116.
[200] Giles Barber, "Thomas Linacre: A Bibliographical Survey of his Works," in *Linacre Studies: Essays on the Life and Work of Thomas Linacre c. 1460 - 1524*, ed. Francis Maddison, Margaret Pelling, and Charles Webster (Oxford, 1977). p. 292.
[201] J. M Fletcher, "Linacre's Lands and Lectureships," in *Linacre Studies: Essays on the Life and Work of Thomas Linacre c. 1460 - 1524*, ed. Francis Maddison, Margaret Pelling, and Charles Webster (Oxford, 1977). p. 121.

anything to do with their relative merits as textbooks. Pseudo-Proclus' *De sphera* was, by virtue of its great brevity, the first astronomical book to be translated into English. William Salysbury (c. 1520 – 1600), more regarded for his Welsh dictionary,[202] worked from Linacre's Latin in 1550 after he had not found any English book on the subject in the whole of St Paul's Churchyard, then the book market of London.[203]

Vives also suggested Aratus' *Phenomena* as a suitable astronomy book for reading out of school.[204] Aratus was active in the third century BC and his well-known Greek astronomical poem was translated into Latin several times during antiquity. It owed its popularity among Christians to the fact that St Paul quoted from it when addressed the Athenians in *Acts of the Apostles*. It is really just a guide to star gazing and contains no technical material.[205] The fact that it was a literary work might account for its popularity as a humanist astronomy book, with its ancient Greek pedigree further enhancing its reputation. It meant that the need to cover astronomy stipulated in the statutes could be combined with a humanist concern for classical poetry. It appears six times in the Cambridge probate lists and not at all at Oxford where we have seen humanism made much less impression on the quadrivium. It was also cheap – available for as little as a penny.[206]

Vives's suggestion for learning arithmetic was the relevant chapters of the *Margarita philosophica* of Gregor Reisch. Overall, Vives's choices are clearly those of a man of literary and not mathematical bent. That he also recommended some rather better books does not mean he could distinguish them from the bad ones.

Conclusion

Overall, the early-sixteenth century syllabus at Cambridge was in transition. Students began with a humanist trivium, much like they would have encountered at Oxford.[207] As bachelors, they covered some practical mathematics that stood on its own. This was the Cambridge tradition set out in the ancient statutes rather than being

[202] R. Brinley Jones, "Salesbury, William (*b.* before 1520, *d. c.*1580)", *Oxford Dictionary of National Biography*, Oxford University Press, 2004 [http://www.oxforddnb.com/view/article/24546, accessed 29 May 2006]
[203] Francis R. Johnson, *Astronomical Thought in Renaissance England: a Study of the English Scientific Writings from 1500 to 1645* (New York, 1968). p. 121.
[204] Vives, *On Education*. p. 168.
[205] Simon Hornblower and Antony Spawforth, eds., *Oxford Classical Dictionary, Revised Third Edition* (Oxford, 2003). p. 136.
[206] Leedham-Green, *BCI*. v. 2, p. 35.
[207] Leader, *The University to 1546*. p. 301.

a new development in the early-sixteenth century. Humanism in itself did not encourage the study of mathematics beyond the need to understand the astronomical references in classical literature. The institution of a salaried lecturer certainly kept mathematical instruction going but it was not considered of much importance. Unlike at Oxford, humanism did directly influence the teaching of natural philosophy. Students used early-modern or late-antique textbooks, which I have suggested were intended to teach them about God's wondrous creation. Medieval natural philosophy, alive and well at the other university, had almost disappeared from Cambridge.

Not so in theology where, scholasticism remained strong although not dominant. The reform of the arts syllabus left many areas untouched and the senior masters could continue to follow the authorities to which they had devoted their career. However, the complete lack of John Canonicus at Cambridge when he was a pillar of the syllabus at Oxford must be highly significant. This is especially the case as we saw that Canonicus was being acquired by Cambridge college libraries in the late-fifteenth century. Even if we allow that some of the books in the probate lists by Tartaret or D'Orbelles did relate to natural philosophy, they are too few in number to overturn our conclusion that the humanist author Jacques Lefèvre D'Etaples had very rapidly become the dominant author of the natural philosophy syllabus.

Thus, the bachelors' syllabus was no longer much preparation for a theology degree. It was in the study of the biblical languages of Greek and Hebrew that the Chancellor of the University, John Fisher, thought was the best preparation for entry into the theology faculty. In time, it is likely that Christian humanism would have fully colonised the theology faculty as well in a way that it probably could never have managed unaided at Oxford. However, this evolutionary process was accelerated massively by Cromwell's visitation of 1535. To this, we now turn.

Chapter Four: The Visitations of 1535 and 1549

"We have set Dunce in Bocardo and banished him from Oxford forever."[1]

Richard Leighton to Thomas Cromwell, 1535

Towards the end of the summer of 1535, Thomas Cromwell's agents, fresh from surveying the doomed monasteries, descended on Oxford and Cambridge. Cromwell knew that it was important to keep a tight rein on the universities. Academic theologians throughout Europe had played a large role in the matter of the King's divorce and Cromwell recognised the importance scholars could yet play.[2] The divorce also indirectly led to him being elected the chancellor of Cambridge in 1535 because the vacancy existed only after John Fisher had been beheaded for refusing to assent to the royal supremacy.[3]

The universities were not part of the initial plan that included the visitation to the monasteries. However, by late summer of 1535, the scheme for academic reform was hatched. Cromwell wanted the universities to sign up to the Act of Supremacy. Furthermore, to ensure they adapted their ways to suit the new order, Cromwell issued a revolutionary set of injunctions to install a theological syllabus inspired by Christian humanism, which also touched on almost all aspects of academic life.[4]

As we have seen from the last two chapters, scholasticism was already on the retreat at Cambridge. The emphasis on outlawing Scotism and other scholastic authors in Cromwell's injunctions points to them being formed in an Oxford milieu. Cromwell, of course, had both the desire and resources to bring about the wholesale changes which had previously been resisted at Oxford. The MA syllabus was not his priority during the 1535 visitations; instead he took aim at theology and canon law. Even the textbook authors recommended in the injunctions wrote primarily to expound on the trivium. However, Oxford's philosophy course, based on Scotus, became untenable as a side effect of the reform of the theology syllabus. It is hardly surprising that reforming theology had this knock-on result given that bachelors were

[1] *Letters and Papers, Foreign and Domestic, of the Reign of Henry VIII*, vol. 9 (London, 1862 - 1910). 350.
[2] Anthony Levi, *Renaissance and Reformation: the Intellectual Genesis* (New Haven, 2002). p. 335.
[3] D. R. Leader, *The University to 1546*, vol. 1, *A History of the University of Cambridge* (Cambridge, 1989). p. 331.
[4] F. Donald Logan, "The First Royal Visitation of the English Universities, 1535," *English Historical Review* 106 (1991). p. 863.

primarily studying philosophy with the intention of becoming theology students. But there was no guidance in the injunctions on what to replace Scotus with, so, this chapter argues, the Oxford masters picked up the existing Cambridge philosophy course as the only readily available alternative. At Cambridge, some of Cromwell's injunctions were probably superfluous, even if the theology faculty still had some affection for the scholastics. The arts faculty could have continued much as it had before the visitation.

If the 1535 injunctions were forged at Oxford, the 1549 statutes and reform emanated from Cambridge. The prime mover in the reform of the syllabus, we shall see, was John Cheke. As well as a stellar academic career where he became the first Regius Professor of Greek, Cheke was a privy councillor and tutor to Edward VI (1537 – 53, r. 1547 – 53). As a scholar, humanist and educational reformer, he had all the desire and power he needed to bring about a wide-ranging change. His new syllabus was intended to provide students with the skills he believed they needed to become valuable members of the Protestant Commonwealth. In philosophy this meant an emphasis on politics and ethics. In mathematics, he modernised and expanded the practical calculation tradition of his university, stipulating the latest textbooks and rejecting Boethian theory.

His most radical idea, however, was to introduce the new subject of geography to the bachelors' syllabus. This chapter will argue that his move was a result of the need for home-grown surveyors to replace the Italians used previously and his exposure to explorers coming to court in search of funds. Navigation and the new trade routes were clearly skills that the Commonwealth could usefully harness.

The Visitation of 1535

Initially, Cromwell considered visiting the universities for himself, especially as he was Chancellor of Cambridge. This plan was abandoned and by early September, his agents Richard Leighton (c. 1498 – 1544) and John Tregonwell (c. 1498 – 1565) were in Oxford. Leighton was a northerner, related to Cuthbert Tunstall, who entered Wolsey's service after training in Civil Law at Oxford. He received his DCL in 1531. He survived Cromwell's fall in 1540 and continued to serve Henry VIII

until he died in Ghent while serving as an ambassador.[5] He is renowned as a loyal and cunning servant of whoever was best placed to feather his nest. The library of St Catherine's College, Cambridge holds several works by Bartolus da Saxoferrato (1314 – 1357) that belonged to Richard Leighton, which is the sort of book we would expect a civil lawyer to own.[6]

John Tregonwell was a more experienced lawyer than Leighton. He obtained his DCL in 1522 and stayed at Oxford for about another five years. From 1527, he practiced in the Archbishop of Canterbury's court of appeals (the Court of the Arches) and as an Admiralty Judge (the law of the sea being based on civil and not common law).[7] In 1529, he was called into royal service and served Henry VIII loyally. However, despite his part in the dissolution of the monasteries, Tregonwell remained a Catholic for life. He was knighted by Mary I and became an MP, although his career ended under Elizabeth.[8] Given the anti-scholastic bias of Cromwell's injunctions, it is strange to find Tregonwell's own copy of Walter Burley's *Expositio super librum Physicorum* (Venice, 1491) in New College's library.[9] Either there was another unrecorded Tregonwell or perhaps he was not as zealous as the visitors' reputation suggests. This shows that the visitations, even if not carried out by Cromwell in person, represent his will and not the initiative of the visitors themselves. They were simply agents carrying out the duty of their master with all the enthusiasm of men who expect to be well rewarded.

As the visitors set about their work at Oxford, letters from the colleges began to arrive at court offering compliance with the new order. John Claymond and the fellows of Corpus Christi accepted the royal supremacy on 9th September.[10] That same day, the fellows of Magdalen wrote a letter that bent over backwards to accommodate the visitors' desires, insulting Dun Scotus and replacing the founder's logic lecture with Greek.[11] On the 12th September, Leighton and Tregonwell wrote to Cromwell summarising their efforts at reform. They had established lectures in the classics at

[5] Peter Cunich, "Layton, Richard (*c.*1498–1544)", *Oxford Dictionary of National Biography*, Oxford University Press, 2004 [http://www.oxforddnb.com/view/article/16226, accessed 6 Dec 2006]
[6] J.B. Bilderbeck, *Early Printed Books in the Library of St Catharine's College, Cambridge* (Cambridge, 1911). nos. 10 – 15.
[7] Brian Levack, *The Civil Lawyers in England 1603 - 1641* (Oxford, 1973). p. 19.
[8] Anthony N. Shaw, "Tregonwell, Sir John (*c.*1498–1565)", *Oxford Dictionary of National Biography*, Oxford University Press, 2004 [http://www.oxforddnb.com/view/article/27683, accessed 6 Dec 2006]
[9] Dennis Rhodes, *A Catalogue of Incunabula outside the Bodleian* (Oxford, 1992). no. 464.
[10] *Letters and Papers*. 306.
[11] Ibid. 312.

Magdalen, New College, All Souls, Queen's and Merton, and converted all lectures on canon law into civil law. Summing up, they made the famous boast that features at the head of this chapter, that they had imprisoned Duns Scotus in the university prison. Later, as I shall cover in more detail in the next chapter, they found leaves of Scotist manuscripts scattered around the quad of New College. [12]

The Cambridge visitation began in mid-October. John ap Rice (1501/2 – 1555) and Thomas Leigh (d. 1545) were carrying out similar work to their colleagues at Oxford on Cromwell's behalf.[13] Rice (or Price) appears to have been a moderate man with some scholarly interests. He collected manuscripts from the monasteries that he was dissolving and was happy to tack with the prevailing religious wind. He had studied civil law at Oxford but did not finally receive his BCL, from Cambridge, until the time of the visitation.[14] Leigh was educated at Cambridge and received his DCL in 1531. He then took on various ambassadorial roles for the King before Cromwell employed him in the visitations. He made himself unpopular by insisting on strict observance of the injunctions made to each religious house. After the visitations to Cambridge, Leigh continued to be involved in the dissolutions and helped set up Christ Church for the King in 1545.[15]

Writing to Cromwell, Rice admitted their work was being resisted by the 'old sort' such as Leonard Metcalf (d. 1541), Geoffrey Blyth (d. 1542), William Buckmaster (d. 1545), and Richard Harrison (d. 1543).[16] As luck would have it, the probate inventories of two of these men have been preserved. They suggest that even these stick-in-the-mud doctors of theology were more exposed to the new learning than we might expect. For instance, Buckmaster had four books on geography as well as Gemma Frisius' popular arithmetic textbook. Blyth has less science but plenty of works by Erasmus.[17] It is hard to see what someone completely wedded to scholasticism would be doing with these books, although they had no shortage of the

[12] Ibid. 350.
[13] Logan, "First Royal Visitation." p. 863.
[14] Huw Pryce, "Prise, Sir John [Syr Siôn ap Rhys] (1501/2–1555)", *Oxford Dictionary of National Biography*, Oxford University Press, 2004; online ed., May 2005 [http://www.oxforddnb.com/view/article/22752, accessed 6 Dec 2006]
[15] Anthony N. Shaw, "Legh, Sir Thomas (*d.* 1545)", *Oxford Dictionary of National Biography*, Oxford University Press, 2004 [http://www.oxforddnb.com/view/article/16363, accessed 6 Dec 2006]
[16] *Letters and Papers*. 661.
[17] E. S. Leedham-Green, *Books in Cambridge Inventories: Books from the Vice-Chancellor's Court Probate Inventories in the Tudor and Stuart Periods*, 2 vols. (Cambridge, 1986). v. 1, pp. 23 – 28 and 78 – 81. The Leonard Metcalfe whose inventory is preserved was executed for murder while still a bachelor. See p. 21.

schoolmen in their libraries either. Leigh also reported mixed views about the visitation at Cambridge. He noted that while younger men at Cambridge welcomed reform "many of the heads [of colleges], being addicted to sophistical learning were not content with what we have done and labour for some relaxation".[18]

The visitors issued a set of injunctions to both Oxford and Cambridge in the name of the King but they were the work of Cromwell.[19] They called for the study of Greek and Hebrew, for theology based on the Bible and not on reading the *Sententiae* of Peter Lombard, and "that students in the arts should be instructed in logic, arithmetic, geometry, music and philosophy." The authors specified were George of Trebizond (for Greek grammar), Philipp Melanchthon (Latin grammar), Rudolf Agricola (1444 – 1485) (rhetoric) and Aristotle (philosophy). Books banned by the injunctions were scholastic commentaries by Duns Scotus, Walter Burley, Antonio Trombetta (d. 1518), Thomas Bricot and Stephan Brulifer (d. c. 1499).[20]

The agents responsible for the visitation were highly educated men, but, with the exception of Tregonwell, we lack evidence for their academic interests. It is possible that their actions during the visitations were informed by more than just their master's will. However, the author of the injunctions and the motive force of the visitations was certainly Thomas Cromwell himself. Unfortunately, he is almost as much of a dark horse as his agents. We do know that he was not a university man, but practiced successfully as a lawyer in London. From there, he moved into the service of Cardinal Wolsey who used him to manage the foundation of Cardinals College at Oxford. This gave Cromwell experience not only of the university, but also of dissolving the religious houses whose assets Wolsey used to endow his college.[21] It is significant that Cromwell was in close contact with Oxford and not Cambridge. This fact probably explains the ferocity of the assault on scholasticism engendered by his injunctions. At Cambridge, humanist reform had already gone much further and the injunctions were pushing on an open door. Oxford, on the other hand, required the full force of Cromwell's authority to change course.

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[18] *Letters and Papers*. 708.
[19] Logan, "First Royal Visitation." p. 865.
[20] James Heywood, ed., *Collection of Statutes for the University and Colleges of Cambridge* (London, 1840). p. 201.
[21] Howard Leithead, "Cromwell, Thomas, Earl of Essex (*b.* in or before 1485, *d.* 1540)", *Oxford Dictionary of National Biography*, Oxford University Press, Sept 2004; online edn, May 2006 [http://www.oxforddnb.com/view/article/6769, accessed 11 Dec 2006]

After Wolsey's fall, Cromwell had passed into the service of the King. Although he considered himself a Catholic unto death (or so he claimed), Cromwell fully supported the Erasmian agenda in theology and the arts. His injunctions amounted to a systematic demolition of scholasticism and its replacement with a Christian humanist education along the lines delineated by Erasmus and his followers. Erasmian reform continued to be Cromwell's chief inspiration in the following five years.[22] He based theology on study of the Bible in its original languages and the arts on the new humanist textbooks and the original text of Aristotle.[23] For Cromwell, attacking scholastic theology was as much part of his campaign for Christian reform as was negating the power of the pope. The dislike of Duns Scotus and his 'obscure glosses' was a commonplace among humanists and had much to do with how hard he was to comprehend. Even some more traditional scholars evinced distaste for the complexities of Scotist thought. John Bale reported that doctors of divinity "professed that in 28 years study they could not understand [Duns Scotus] rightly."[24]

Other aspects of the visitations and injunctions were consistent with Cromwell's policy. The need for the oath transferring ultimate loyalty from the Pope to the King is obvious. Furthermore, the abolition by Cromwell's agents of the study of canon law followed directly from Henry VIII becoming supreme head of the church. There was now only one law in England.

The Effect of the 1535 Injunctions on Natural Philosophy

The 1535 injunctions do not have much to say about natural philosophy. However, we shall see how they did have serious consequences for this subject, most especially at Oxford where scholasticism was still the dominant influence.

The blacklist of books in the injunctions covered a good deal of natural philosophy even if it was aimed at medieval logic and theology.[25] As well as Duns Scotus and his followers, Walter Burley had remained popular at Oxford and was another scholastic author whose natural philosophy would have been covered by his inclusion on the blacklist. The injunctions are usually assumed to have been an attack

[22] J. K. McConica, *English Humanists and Reformation Politics* (Oxford, 1965). p. 160.
[23] Alistair Hamilton, "Humanists and the Bible," in *The Cambridge Companion to Renaissance Humanism*, ed. Jill Kraye (Cambridge, 1996). p. 113.
[24] Anthony à Wood, *The History and Antiquities of the University of Oxford: Annals of the University of Oxford*, ed. J. Gutch, vol. 1:2 (London, 1796). p. 62.
[25] Heywood, ed., *Collection of Statutes*. p. 201.

on medieval writers but in fact, apart from Burley and Duns Scotus, the other blacklisted authors were all Parisian masters who had died within the last forty years. Thus, the injunctions were an assault on scholasticism itself, not just the work of the Middle Ages. Stephen Brulifer and Anthony Trombet were outlawed despite the fact that neither had much impact at Oxford or Cambridge. True, they were both Scotists but that was hardly an unusual affliction. Thomas Bricot, who was also banned, is harder to fit into that box. He probably owed his inclusion to his *Tractatus Insolubilium*, an important work of logic, rather than his nominalism. Quite why Brulifer and Bricot, two French scholars and Trombet, an Italian friar, were picked on has never been adequately explained. Cromwell would be unlikely to have had any experience of Parisian logic or come across these authors in his law studies.[26] Rather, it is best to see them as archetypes representing what Cromwell thought was worst about scholastic thinking – a dependence on medieval logic and Scotus. Thus, the blacklist actually applies to all authors who fall under the category of either scholastic logistician or Scotist. This meant many of the works read by natural philosophers at Oxford masters were caught in the wider meaning of the injunctions even if they were not mentioned by name. Johannes de Magistris (fl. 1480), a Parisian doctor whose *Questiones super tota philosophica naturali* was owned by John Morcote at Oxford (d. 1508),[27] was one natural philosopher firmly within the Scotist tradition.[28] John Canonicus was another follower of Scotus and his stock fell dramatically at this point. Oriel's masters were no longer ordered to lecture on him after 1535.[29]

There was nothing unusual about the authorities banning particular authors at universities under their jurisdiction. Louis XI had outlawed the nominalists and William of Ockham in particular at Paris in 1473.[30] Of course, Cromwell was not about to ban Ockham who was one of the outstanding anti-papal writers of the Middle Ages although it does seem that he was finally outlawed at Oxford in 1546.[31] The real difference between Cromwell and Louis is that, unlike the King of France, Cromwell did not have to revoke his ban under academic or ecclesiastic pressure. This was

[26] Logan, "First Royal Visitation." p. 268.
[27] E. S. Leedham-Green and R. J. Fehrenbach, *Private Libraries in Renaissance England: a Collection and Catalogue of Tudor and Early Stuart book-lists* (Marlborough, 1993). v. 2, p. 26.
[28] Charles Lohr, "Medeival Latin Aristotle Commentaries," *Traditio* 27 (1971). p. 257.
[29] H. E. Salter and G. C. Richards, eds., *The Dean's Register of Oriel 1446 - 1661* (Oxford, 1926). p. 105ff.
[30] Levi, *Renaissance and Reformation*. p. 161.
[31] Wood, *History and Antiquities.* p. 81.

because, once Henry VIII became supreme governor of the Church in England, it was no longer possible for the universities to play Church off against state or pope against king. Henry's word, emanating from Cromwell's mouth, was law.

The only writer of natural philosophy on the white list was Aristotle himself (Melanchthon's books on the subject were not published until 1540). It was probably the intention of Cromwell's visitors that students should read Aristotle in the original rather than rely on commentators. Turning to the original ancient sources in their naked state was, as we have seen, a central, if rather idealistic, aim of humanist pedagogy. Whatever the aims, we can imagine the surprise of the bachelors coming up to Oxford at the start of the Michaelmas term 1535 to find their entire philosophy syllabus had been outlawed and, as yet, there was nothing to replace it with. Perhaps their consternation at this turn of events was mellowed by the fact that they would not have to study Duns Scotus after all.

Very few probate lists survive at Oxford for the period between the 1535 and 1549 visitations, but two other very interesting inventories are extant. The first, dating from c. 1550 is found in the commonplace book kept by Alexander Nowell during his bachelor days. Nowell was a notable late-sixteenth-century theologian who later became Dean of St Paul's.[32] Sadly, there is nothing in his commonplace book about natural philosophy or the quadrivium, but he does list his books several times. It is extremely likely that these contain the texts that he had to study for his MA. The books on natural philosophy are remarkably similar to those we have already met at Cambridge. He owned Gaza's edition of *De animalibus* including Theophrastus on plants and the *Opera* of Ringelbergius. He also possessed natural philosophy textbooks by Johann Velcurio and Franz Titelmann, which we will discuss in detail in chapter seven.[33] Both of these were lent to Alexander's brother Lawrence who arrived at Christ Church in 1550.[34] This is consistent with these books being schoolbooks that could be passed on to current students.

The second surviving inventory is a list of the possession of one Master Bisley, who is most likely Richard Besley. At the time of the inventory in 1543,

[32] Stanford Lehmberg, "Nowell, Alexander (*c.*1516/17–1602)", *Oxford Dictionary of National Biography*, Oxford University Press, 2004 [http://www.oxforddnb.com/view/article/20378, accessed 17 Oct 2006]
[33] Oxford, Bodleian Library, MS Brasenose College 31, fol. 47r.
[34] Retha M. Warnicke, "Nowell, Laurence (1530–*c.*1570)", *Oxford Dictionary of National Biography*, Oxford University Press, 2004 [http://www.oxforddnb.com/view/article/69731, accessed 17 Oct 2006]

Besley was a theology student and as he did not die until after 1550, the purpose of the inventory is unclear. It has been suggested that Besley was a teacher because he held multiple copies of several basic textbooks.[35] Certainly, he had a good collection of works suitable for teaching the quadrivium and natural philosophy, including Euclid, Sacrobosco's *De sphera*, perhaps Boethius' *De musica*, Lefèvre's *Paraphrases* as well as both Velcurio and Titelmann. It seems quite likely, then, that the response of Oxford masters to the loss of Scotus and his followers was to use the textbooks such as Lefèvre's, which were already in use at Cambridge. They also decided to devote more attention to Aristotle's books on animals as Cambridge masters were already doing. We know of one John Norfolke who was required to give his regency lectures on *De animalibus* in 1539 rather than the more traditional physical books of Aristotle.[36]

We can see from these booklists that Oxford natural philosophy in the period after 1535 was remarkably similar to that at Cambridge in the years immediately prior to the visitation. It seems very likely then, that Oxford masters, denied the old syllabus, picked up their new one from the other university. As far as we can tell, the changeover was almost instantaneous. We find little humanist natural philosophy at Oxford before 1535 and almost none of the scholastic variety after this date. Meanwhile, Cambridge continued to use Lefèvre as its main authority in natural philosophy, while gradually moving on to Titelman and Velcurio as the 1540s progressed. As the university had already adopted a humanist natural philosophy syllabus, the subject was largely unaffected by the 1535 injunctions.

The Effects of the 1535 Visitations on Mathematics

The visitors also had relatively little to say about the quadrivium but they do stipulate that arts students should study logic (humanist logic, of course), music, arithmetic, geometry and philosophy.[37] This is too broad to tell us much and could be interpreted as the universities saw fit. We have almost no evidence of mathematical teaching at Oxford in the period directly after 1535, mainly because few of the probate lists from the time are extant. The inventory of Besley suggests that the quadrivium limped on much as it had before. However, the integrated scholastic

[35] Leedham-Green and Fehrenbach, *PLRE*. v. 2, pp. 171 – 192.
[36] W.T. Mitchell, ed., *Register of Congregations 1505 - 17*, 2 vols. (Oxford, 1998). v. 1, p. 189.
[37] *Letters and Papers*. 615.

syllabus, of which Boethius was a part, had been destroyed by the 1535 injunctions. If Boethius stood between humanist trivium and philosophy courses, he was going to look increasingly incongruous. Thus, we should not rule out the possibility that mathematics was slowly decaying at Oxford between 1535 and 1549.

The Cambridge university mathematics lecturers in the period from 1535 to 1549 were no more inclined towards their subject than the incumbents had been in the period before 1535. Indeed, the first effect of the visitors was to force the university to abandon the lecture completely until 1539 in make way for Greek and Hebrew.[38] Things hardly improved after that. In 1539, Roger Ascham was appointed to lecture in mathematics and kept the job for two years.[39] He is well known as a literary courtier in the mid-sixteenth-century. He showed political and religious dexterity in switching patrons and, despite occasional hiccups, managed to stay in royal service throughout the religious changes during the reigns of Henry VIII to Elizabeth I. As he says in his posthumously published, *The Scholemaster* (1570), he was tutor to both Princess Elizabeth and Lady Jane Gray, getting the jobs from John Cheke.[40] Ascham earnestly implored the vice-chancellor William Buckmaster (d. 1545) for the position of mathematical lecturer, even though his later career betrays no interest in mathematics at all.[41] Much later, he warned the Earl of Leicester in 1562,

> The quindrinalls be sciences good for respect, not best in degree; common, not most excellent.… I think you did yourself an injury in changing Tully's wisdom with Euclid's pricks and lines; the one doctrine is better of itself, apter for your nature, fitter for your place than the other.[42]

The problem with the quadrivium (and medicine) for Ascham is that brute beasts seem better at these subjects than men. Birds excel at music, mammals know the seasons (thus, astronomy), spiders are first-rate geometers and all animals know herb lore. As these sciences are not unique to humans, they lack the honour associated

[38] W. G. Searle, ed., *Grace Book G* (Cambridge, 1908). p. 310ff.
[39] See appendix two.
[40] Rosemary O'Day, "Ascham, Roger (1514/15–1568)", *Oxford Dictionary of National Biography*, Oxford University Press, 2004 [http://www.oxforddnb.com/view/article/732, accessed 14 July 2006]
[41] Roger Ascham, *The Whole Works of Roger Ascham: Now First Collected and Revised, with a Life of the Author*, ed. J. A. Giles, 4 vols. (London, 1865). v. 1, p. 5.
[42] Ibid. v. 2, p. 103. Ascham conflates the quadrivium with medicine into the 'quindrinalls.' Despite the efforts of the medical humanists, he sees physic as a practical and not learned subject.

with the humanities.[43] He elaborated his feelings about mathematics in *The Scholemaster*:

> 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, & 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 themselues, how vnfit to liue with others, & how vnapte to Som sciences hurt mens wits, and mar mens maners.[44]

Richard Mulcaster was rather confused about Ascham's lack of enthusiasm for mathematics given that he came from the circle of Sir John Cheke, who was keen on the subject.[45] However, many who have struggled with geometry will find it quite understandable. The job Ascham really wanted was Regius Professor of Greek, which he begged William Paget, Secretary of State, to arrange for him when Cheke left for court. In his letter to Paget, Ascham lists his achievements as a lecturer and orator but passes over his experience teaching mathematics in silence.[46] As it turned out, Cheke kept the chair in absentia for three years, which suggests its pedagogical function was not taken as seriously as it might have been.

Neither of the following two mathematics lecturers betrayed much interest in the subject. John Young made his name as a Catholic reactionary, being appointed vice-chancellor in the first year of Mary's reign. In 1554, he became master of Pembroke College and then Regius Professor of Divinity. However, he was deposed under Elizabeth and imprisoned for much of the rest of his life. He left a map of the world to his brother.[47] William Barker enjoyed a spell at Padua and Rome before returning to serve as an MP and finally ending up implicated in the fall of his patron the Duke of Norfolk.[48]

Thus, we see little change in mathematical teaching at Cambridge following Cromwell's visitation. Nor should we expect to. As humanism became more

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[43] Ibid. v. 2, p. 103.
[44] Roger Ascham, *The Scholemaster* (London, 1570). fol. 5v.
[45] Richard Mulcaster, *Positions Concerning the Training up of Children* (London, 1581). p. 243.
[46] Ascham, *Whole Works of Roger Ascham*. v. 1, p. 50.
[47] Judith Ford, "Young, John (1514–1581/2)", *Oxford Dictionary of National Biography*, Oxford University Press, 2004 [http://www.oxforddnb.com/view/article/30267, accessed 14 July 2006]
[48] Jonathan Woolfson, *Padua and the Tudors* (Toronto, 1998). p. 211.

prominent, mathematics inevitably suffered. At least the 1535 injunctions contained the bare instruction that mathematics must be studied and so it could not be abandoned completely.

From 1535 to 1549

Cromwell fell from grace in 1540 and Stephen Gardiner, Bishop of Winchester, replaced him as chancellor of Cambridge. Gardiner was a moderate Catholic who, like Cuthbert Tunstall of Durham, could live with the royal supremacy but was deprived by the evangelical regime of Edward VI.[49] However, again like Tunstall, Gardiner was a humanist and engineered the endowing of five Regius Professorships of Greek, Hebrew, Physic, Civil Law and Divinity with a generous stipend of £40 per annum at Cambridge in 1540.[50] Oxford received its endowment for the same five professorships in 1546.[51] This considerably increased the prestige of a teaching career and meant that top European scholars could be recruited and retained. Under Edward VI, Martin Bucer (1491 – 1551), Paul Fagius (c. 1504 – 1549) and Peter Martyr Vermigli (1500 – 1562), major intellectual figures of the Reformation, were persuaded to travel to England to take up Regius Professorships.[52] The first crop of professors was taken from the humanists who had made their names at the universities in recent years. John Cheke, as we saw, took the chair in Greek at Cambridge and Sir Thomas Smith in Civil Law (despite not receiving a degree in the subject until two years later). The former mathematics lecturer and Cheke's brother in law, John Blythe became Regius Professor of Medicine.[53]

Henry VIII's last two acts in relation to the universities were to take the power to close any college and to found two new ones. Christ Church was actually a refoundation of Wolsey's languishing Cardinal College and Trinity College, Cambridge sat upon the suppressed Michaelhouse and King's Hall. The Act of Parliament that allowed the dissolution of university colleges lapsed on Henry's death

[49] C. D. C. Armstrong, "Gardiner, Stephen (*c.*1495x8–1555)", *Oxford Dictionary of National Biography*, Oxford University Press, Sept 2004; online edn, Oct 2005 [http://www.oxforddnb.com/view/article/10364, accessed 5 June 2006]
[50] Leader, *The University to 1546.* p. 337.
[51] G. D. Duncan, "Public Lectures and Professorial Chairs," in *A History of the University of Oxford: The Collegiate University*, ed. J.K. McConica (Oxford, 1986). p. 345.
[52] McConica, *English Humanists.* p. 237.
[53] Alvin Vos, ed., *The Letters of Roger Ascham* (New York, 1989). p. 32.

and its successor, the Chantries Act 1547, specifically excluded the colleges of Oxford and Cambridge.[54] The universities had survived the Reformation.

The 1549 Visitations

Edward VI's government ordered that another pair of visitations to the universities should take place in 1549. The one to Oxford was to take in Winchester College and the one to Cambridge to include Eton. While the power of the pope had been thrown off, the universities remained Catholic and extensive work was necessary to equip them for furthering Protestantism. In addition, the visitors to Cambridge were to set up colleges for medicine and for civil law.[55] By expanding the provision for these subjects, the visitors were hoping to increase the number of doctors and lawyers available to the Commonwealth.

Both sets of visitors consisted of a number of senior privy councillors and a bishop or two to provide the necessary authority. Most of the work, however, was carried out by university men with close links to the court but more junior positions. The Cambridge visitors were led by Nicholas Ridley (1502 – 1555), the Bishop of London with the assistance of the Comptroller of the Household Sir William Paget (c. 1505 – 1563) and Sir Thomas Smith, Principal Secretary and Provost of Eton. Smith does not appear to have actually been at Cambridge at the time, occupied as he was with helping to prop up the Duke of Somerset's regime. However, his secretary William Rogers kept him informed of goings on during the visitation.[56] The work appears to have been done by John Cheke, provost of King's College, aided by Thomas Wendy (c. 1500 – 1560), the King's physician.

The visitors first went to Eton. Sir Thomas Smith had already removed any images from the chapel.[57] The Flemish murals on the sidewalls were defaced, probably by the visitors, but there could have been few complaints given that Smith was already in-charge. They then moved on to Cambridge where a good deal of documentation regarding their activities survives. As recorded in a contemporary diary, they set to work in May 1549 by first presenting the new statutes to Cheke,

[54] Jennifer Loach, "Reformation Controversies," in *A History of the University of Oxford: The Collegiate University*, ed. J. K. McConica (Oxford, 1986). p. 366.
[55] C.S. Knighton, ed., *Calendar of State Papers, Domestic Series of the Reign of Edward VI, 1547 - 1553* (London, 1992). 164.
[56] Ibid. 223 et al.
[57] Tim Card, *Eton Established: A History From 1440 - 1860* (London, 2001). pp. 41 – 2.

representing the university, in King's College chapel.[58] Then they began a round of the colleges and were not always pleased by what they found. The fellows of Trinity College were 'mostly bad' according to the report of Rogers to Smith.[59] However, the visitors gave most colleges a clean bill of health and they even found time to indulge in a spot of iconoclasm at Jesus College where they smashed six altars and destroyed some images.[60] The university thus being purged of popery, the difficult question of setting up a college for civil law arose. The visitors were already armed with an enabling Act of Parliament to merge Trinity Hall with its neighbour, Clare College, into a single college, but the fellows of Clare were not happy. They had sensed which way the wind was blowing and had already made off with all the college plate and most of the library, leaving behind only a few old law books.[61] Then Bishop Ridley got cold feet about replacing a college of theologians with lawyers. Smith was unable to move him and the Clare fellows decided to stand firm and refuse to be dissolved. Ridley asked to be excused, thus robbing the venture of much of its legitimacy, so the college survived on condition the fellows brought the plate back.[62] No one seems to have worried about the library and not a single book from the 1496 catalogue resides there today. Even by 1556, the college only had eighteen books.[63]

Sources for the near simultaneous Oxford visitation from 24th May to 4th June, 1549 are very scant. The visitors began by listening to Peter Martyr reading a sermon at the university church of St Mary's and again visited each college at least once. They were led by Henry Holbeach (d. 1551), Bishop of Lincoln and the Principal Secretary Sir William Petrie (1505/6 – 1572).[64] They were assisted by the university men Richard Cox (c. 1500 – 1581), Dean of Christ Church and Chancellor of the University and Simon Haynes. The Oxford visitors concluded their work by issuing the new statutes and listening to some disputations. It appears that they did have plans

[58] John Lamb, ed., *A Collection of Letters, Statutes, and other Documents, from the Manuscript Library of Corpus Christi College: Illustrative of the History of the University of Cambridge, during the Period of the Reformation* (London, 1838). p. 109.
[59] Knighton, ed., *State Papers 1547 - 1553.* 222.
[60] Lamb, ed., *Collection.* p. 111.
[61] Knighton, ed., *State Papers 1547 - 1553.* 223.
[62] Ibid. p. 258.
[63] Peter Clarke, *University and College Libraries of Cambridge*, vol. 10, *Corpus of British Medieval Libraries* (London, 2002). UC 15 and 16.
[64] Wood, *History and Antiquities.* p. 95.

for converting All Souls into a college exclusively for Civil Law although this seems to have been dropped without the rumpus witnessed over Clare College, Cambridge.[65]

The 1549 Statutes

The main business of the 1549 visitations was the issuance of new statutes to both universities. Unlike the injunctions of 1535, these statutes replaced the ancient laws of the university and covered almost all aspects of governance. The intention was primarily to make the universities safe for Protestantism to flourish. Of most interest to us, however, is the fact that they laid down a detailed syllabus of study, which was identical at both Oxford and Cambridge. There was a precedent for this attempt to create a Protestant syllabus of which the visitors may well have been aware. This was the creation of a Lutheran syllabus by Philipp Melanchthon at the University of Wittenberg in the 1530s. His pedagogical books for the trivium were in widespread use at Cambridge by 1530 to judge from their frequent appearance in Garrett Godfrey's accounts.[66] Melanchthon was well known in court circles too. Henry VIII had been obsessively keen to meet him while Archbishop Cramner attempted to bring him over to England to participate in an ecumenical council. In 1553, he was appointed Regius Professor of Divinity at Cambridge and the Privy Council voted £100 in relocation expenses.[67] For Cheke and Smith, educated at Cambridge and as members of the privy council, Melanchthon would have been one of the most familiar and influential intellectuals in Europe.

Melanchthon valued mathematics and philosophy because of what they could tell him about the providence of God.[68] This is similar to the logic that we saw motivated the study of Aristotle's *De animalibus*. However, Melanchthon chose two different subjects to be his canonical examples – the first was astronomy and the second was the soul. In his preface to Sacrobosco's *De sphera* (1531), he wrote

[65] Claire Cross, "Oxford and the Tudor State 1509 - 1558," in *A History of the University of Oxford: The Collegiate University*, ed. J.K. McConica (Oxford, 1986). p. 136.
[66] E. S. Leedham-Green, D. E. Rhodes, and F. H. Stubbings, *Garrett Godfrey's Accounts c. 1527 - 33* (Cambridge University Press, 1992). pp. 150 – 1.
[67] Sachiko Kusukawa, "The Reception of Melanchthon in Sixteenth-Century Cambridge and Oxford," in *Melanchthon - Schriften der Stadt Bretten*, ed. G. Frank and K Meerhoff (Stuttgart, 2002). p. 238 – 9.
[68] Sachiko Kusukawa, *The Transformation of Natural Philosophy: The Case of Philip Melanchthon, Ideas in Context* (Cambridge, 1995). p.202.

> For this reason – if astronomy corroborates belief about God in the minds of men – we have to consider that Plato, when he said that eyes are given to us because of astronomy, spoke not only learnedly but also piously.[69]

The English textbook writer Robert Recorde (1512 – 58) made exactly the same point in the preface to *Castle of Knowledge* in 1556

> Let him [the reader] think that for this intent were eies geven unto men, that they might with them beholde the heavens: whiche is the theatre of Goddes mightye power and the chiefe spectakle of al his divine works.[70]

He continued later, "Learninge this good use in this natural arte [of astronomy], that it leadeth men wonderfully to the knowledge of God and his highe mysteries."[71] The juxtaposition of a classical pagan authority (here, as is often the case, Plato) with a Christian argument is completely typical of sixteenth century humanists. Many could never quite bring themselves to accept that the Greek sages were not followers of a true religion and this fuelled enthusiasm for the *Corpus Hermeticum*, a late-antique synthesis of magic, Christianity and neo-Platonism that purported to predate Moses.

The wonderful order of the universe revealed by astronomy is why it is so conducive to belief in the creator. William Thomas, translating Sacrobosco's *De sphera* into English, told his patron, the Duke of Suffolk:

> The discourse of the sphere is the foundatione of natural knowledge [with which] man, in sight of the wonderfull order of the visible corporations, may ascende unto the knowledge of goddes invisible maiestie, the Creator and governoure of al.[72]

Melanchthon would have agreed and pointed to the turning of the seasons and even the regularity of night and day as examples of God's providence.[73] We have also seen that his views are echoed by English writers. Hence, they provide a lens through which the wide-ranging reforms of the 1549 visitors can be resolved. This is helpful because the visitors themselves tell us very little about what they were up to. The letters from Rogers to Sir Thomas Smith referred to above do not cover the syllabus and neither do the surviving writings of the other visitors.

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[69] Philipp Melanchthon, *Orations on Philosophy and Education*, ed. Sachiko Kusukawa, Christine F. Salazar trans., Cambridge Texts in the History of Philosophy (Cambridge, 1999). p. 106.
[70] Robert Recorde, *Castle of Knowledge*, Facsimile ed. (Amsterdam, 1975). Preface to the reader.
[71] Ibid. p. 284.
[72] London, British Library, MS Egerton 837, fol. 4r.
[73] Melanchthon, *Orations*. p. 114.

The Quadrivium Textbooks in the 1549 Syllabus

Up until 1549, mathematics had been the poor relation among subjects studied in the arts faculties of Oxford and Cambridge. The new syllabus made a bold and partly successful effort to change that. First-year undergraduates were to cover arithmetic before anything else. Bachelors were required to cover astronomy and perspective (the latter probably standing in for geometry). Mathematical lectures were scheduled four days a week for an hour from 12pm. Set books were specified: Tunstall or Cardan for arithmetic, Euclid for geometry and Ptolemy for astronomy.[74]

The first thing to note about this list is that the medieval writers, John Sacrobosco and Boethius, have disappeared. While classical authorities are preferred for geometry and astronomy, in arithmetic the stipulation is for recent practical textbooks. Girolamo Cardano (1501 – 1576) is an odd choice nonetheless. He was an Italian polymath whose interests spanned natural magic, mathematics, medicine and astrology. He did write an arithmetic textbook called *Practica arithmeticae* in 1539, for which he even had a Protestant distributor.[75] However, this never appears in the booklists. A more significant work was his *Ars Magna* of 1545, an advanced text on algebra. This was owned by Nicholas Abithell, who was Cambridge University mathematics lecturer in 1557, but as he died thirty years later after a period of exile at Douai we cannot assume he used it for his lecturing.[76] Cardano did make a high-profile and highly remunerated trip to St Andrews in Scotland to attend to the Archbishop, but this was not until the early 1550s. At that point, he stayed with John Cheke, who features in his autobiography, so they may have already been correspondents.[77] If that was the case, then Cardano's presence on the syllabus is explained, if apparently unheeded.

That the visitors should allow Cuthbert Tunstall's *De arte supputandi* is surprising for another reason. He was appointed a bishop in 1522 before Henry VIII split from Rome. Tunstall was deprived by Edward VI's government but not until 1551, so the visitors were not actually suggesting a book by a *persona non grata*, even if they must have known his views. Restored by Mary, he was still in the job at

[74] Heywood, ed., *Collection of Statutes*. pp. 6 – 8; Strickland Gibson, ed., *Statuta antiqua universitatis oxoniensis* (Oxford, 1931). pp. 343 – 4.
[75] Anthony Grafton, *Cardano's Cosmos* (Cambridge: MA, 1999). p. 79.
[76] Leedham-Green, *BCI.* v. 1, p. 366.
[77] Girolamo Cardano, *De vita propria liber*, Jean Storer trans. (London, 1931). p. 63.

the start of Elizabeth's reign when he was deprived again and died in custody. He was a moderate Catholic who could bend with the wind as need be. Henry's Anglo-Catholicism was acceptable to him even if Edward's outright Protestantism was not.[78]

Tunstall was a member of the same circle as Sir Thomas More and they paid fulsome compliments to each other in print.[79] Educated at both Oxford and Cambridge he actually received his LLD at Padua in canon law. He followed the usual progression of public offices, becoming Master of the Rolls. As is typical of Italian educated humanists, he wrote on a very wide variety of subjects including Aristotle's ethics as well as the arithmetic textbook. This was published in 1522 before he turned his back on secular learning when he gained a bishop's mitre. As Bishop of London, he is best known for joining More's campaign against the Lutherans and buying up all the available copies of William Tyndale's (1494 – 1536) English New Testament in order to burn them himself.[80]

Cuthbert Tunstall took the view, unusual for a humanist, that mathematics was a useful and positive skill that had both religious and practical uses. Although he gave up mathematics as unseemly when he became a bishop, he nevertheless saw it as an undertaking that can lead to knowledge of God. He tells us, in his section on proportion:

> God, architect of all things gave their form to the fabric of the world and every created things in it so that all would reveal symmetry among themselves: you see this, which it is right to discern in each thing, whether heaven or earth. Wherefore it says on the sacred page: 'by measure, number and weight'. The power of proportions greatly stands out in this matter: it witnesses that God had arranged all things.[81]

Thus, the importance of ratios was affirmed by King Solomon himself.[82] Robert Recorde placed the same biblical quotation, Wisdom 11:21, on a flyleaf of *Ground of Arts*.[83]

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[78] Charles Sturge, *Cuthbert Tunstal, Churchman, Scholar, Statesman, Administrator* (London, 1938).
[79] Thomas More, *Utopia*, Paul Turner trans. (Harmondsworth, 1965). p. 37.
[80] Sturge, *Cuthbert Tunstal*. pp. 8f.
[81] Cuthbert Tunstall, *De arte supputandi* (Strasbourg, 1538). p. 178. "Denique omnium opifex deus & mundi fabricate & rebus in ea creatis universis eam formam dedit, ut cuncta inter se symmetriam tenerent: id quod in singulis licet cernere, sive caelum, sive terram spectes. Quocirca sacrae literae, mensura, numero, et pondere, quibus in rebus maxime vis proportionum eminet: Deum omnia disposuisse testantur."
[82] Wisdom, 11:20.
[83] Robert Recorde, *Ground of Artes* (London, 1561). Frontspiece.

De Arte Supputandi ("The Art of Counting") had much success in England, featuring seventeen times in Cambridge probate lists and four times in the Oxford lists. The quarto *editio princeps* was published by Robert Pynson (1449 – 1529) of London in 1522, the year of Tunstall's elevation to the bishopric. This was the only edition from England although three others followed in Paris from Robert Estienne and then four more, in octavo, from Strasbourg.[84] The average price of nine pence hides some wide variations. Some of the first edition was printed on vellum as gift copies, which might explain why the book could be valued up to twenty pence. The later octavo editions went for as little as two pence.[85]

The work begins with a dedicatory epistle to More in which Tunstall explained his purposes in writing the book. He says that a few years before, he had been defrauded by a merchant and, having no wish to repeat the experience, set about relearning the arithmetic of his youth. This may be a reference to More and Tunstall's shared experiences of moneychangers during an embassy to the Netherlands in 1515.[86] Gathering together a collection of mathematical texts in every language, he found many of them were not much good. Thus, he set out to write his own so that anyone able to read Latin will find all he needs to know about the art of counting. The project was now wrapped up as he felt, as a bishop, that it would be more fitting that he turned his mind to sacred subjects.[87]

The work is arranged into four books. The first book starts by explaining very large numbers, simple operations, long multiplication and division and how to find square and cube roots. The second book is all about fractions and its preface apologetically explains that they are not easy to master. "Neither the lazy nor stupid" student will get any change from them, nor those who let their minds wander.[88] Tunstall then runs through adding, subtracting, dividing and multiplying fractions before briefly discussing higher roots. The book ends with some exercises. The third book covers what is effectively algebra. He describes the golden rule, which states that from two known quantities one can always find a related unknown (which is only

[84] Sturge, *Cuthbert Tunstal*. p. 75.
[85] Leedham-Green, *BCI*. v. 2, p. 760.
[86] Peter Ackroyd, *The Life of Thomas More* (London, 1999). p. 164.
[87] Tunstall, *De arte supputandi*. p. 4. "Prophana omnia scripta longa releganda putari."
[88] Ibid. p. 73. "Ita poscunt hominem nec dormitantitem, nec stupidum & cuius animus inter legendum peregrinetur."

true in limited linear circumstances but suits Tunstall's purposes well enough).[89] The preface and first few chapters cover this while the remainder of the book is about ratios. He covers these by setting out solutions to forty-six practical questions involving merchants, their money, inheritance and architecture. The fourth book's preface explains why ratios are so very important in painting, architecture, naval and military planning and medicine. The latter's relevance is due to the proportions of humours in the body being tied up to all sorts of question on health and illness under the Galenic system.[90] The rest of the book is made up of how to calculate different kinds of averages and some more introductory algebra.

There is little doubt as to the success of Tunstall's venture into the mathematical textbook market. His Latin is crisp, clear and generally accepted to be of the excellent quality we would expect from a Padua-trained humanist.[91] Even in 1558, the Protestant reformers who wrote the Elizabethan syllabuses included Tunstall's book, despite the fact that they had twice deprived him of his bishopric and recently he had died under confinement in Lambeth Palace. His book is detailed enough for students to work through it alone and contains many worked examples dealing with practical matters.

The Origins of the Quadrivium Syllabus in the 1549 Statutes

The imposition of a course of practical calculation on Oxford is unlikely to have been a home-grown initiative. Oxford's mathematical traditions were, as we have seen, theoretical and probably withering on the vine by 1549. Cambridge had always had a practical slant in its mathematical course and this continued through the first half of the sixteenth century, even if not all the lecturers were very keen. To understand why arithmetic was suddenly promoted ahead of the trivium in 1549, we need to look at the interests and identities of the visitors.

Two names stand out. The first is John Cheke. He was born in Cambridge and entered St John's College in 1524. He took his MA in 1533 and taught at the university until called to court in 1544 as tutor to Prince Edward. In 1548, he became provost of King's College and in 1549 Lady Margaret Professor of Divinity. He

[89] Ibid. p. 113. "Praecipua omnium regula est, quae de tribus notis quartum ignotum in notitiam educentibus, ab Arithmeticis traditur. Vulgus regulam auream vocat."
[90] Ibid. p. 177.
[91] Sturge, *Cuthbert Tunstal*. p. 74.

eventually rose to principal secretary to Edward VI and Regius Professor of Greek. However, his involvement with the plot around Lady Jane Grey ended his career and he died in the reign of Mary I after a spell in exile and a forced recantation of his protestant beliefs.[92]

We cannot say for sure that he drafted the quadrivial sections of the 1549 syllabus for Oxford and Cambridge, but the evidence in highly suggestive. Richard Mulcaster wrote in his *Positions Concerning the Training Up of Children* (1581) that Cheke, "feared the blame of a mathematicall head so litle himselfe and thought the profession to be so farre from any such taint, being sadly and soundly studied by others, as he betraid his great affection towards them most evidently in his doing."[93] In 1545, Cheke revised John Fisher's statutes of St John's College. Before this reform, John Dee described his course at St John's, which began in 1542, "to begin with logick, and so to proceed in the learning of good artes and sciences."[94] Despite his failure to mention any mathematical teaching, Dee was probably a beneficiary of Cheke's zeal for the subject.

Cheke kept all the provisions regarding the mathematical examiner in the statutes drawn up by John Fisher and furthermore added that new students should start their studies with six months of arithmetic and geometry.[95] Given this strong emphasis on mathematics, it comes as no surprise that half the university lecturers on the subject, from the foundation of St John's in 1516 until 1570, came from that college. Mulcaster reported that Cheke taught mathematics at St John's and he was indeed a college examiner for several years in the early 1530s, although the archival records do not say which subject he taught.[96] Mulcaster also tells us about his own experience of being taught by Cheke at King's College where he matriculated in 1548.

> Being himselfe provost of the kings colledge in Cambridge, in the time of his most honored prince, and his best hoped pupill, the good king Edward, brother to our gracious soveraine Queene Elizabeth, he sent downe from the court one maister

[92] Alan Bryson, "Cheke, Sir John (1514–1557)", *Oxford Dictionary of National Biography*, Oxford University Press, 2004 [http://www.oxforddnb.com/view/article/5211, accessed 5 Oct 2006]
[93] Mulcaster, *Positions Concerning the Training up of Children*. p. 243.
[94] John Dee, "Compendious Rehearsal," in *Johannis Glastoniensis Chronica*, ed. Thomas Hearne (Oxford, 1756). p. 500.
[95] J. E. B. Mayor, ed., *The Early Statutes of St John's College, Cambridge* (Cambridge, 1859). p. 107.
[96] Cambridge, St John's College Archives SB3.10

> Bukley somtime fellow of the saide colledge, and very well studyed in the mathematicalls to reade Arithmeticke, and Geometrie to the youth of the colledge: and for the better encouraging of them to that studie gave them a number of Euclides of his owne coast. Maister Bukley had drawne the rules of Arithmeticke into verses, and gave the copies abroad to his hearers. My selfe am to honour the memorie of that learned knight, being partaker my selfe of his liberall distribution of those Euclides, with whom he joyned Xenophon, which booke he wished, and caused to be red in the same house, and gave them to the studentes, to encourage them aswell to the greeke toungue, as he did to the mathematikes.[97]

Cheke's own copy of the first edition of Euclid in Greek shows heavier annotations than almost any other sixteenth-century Greek book that I have seen.[98] Clearly, Cheke had the skills necessary to interrogate this book further than most of his contemporaries. As for the version of Euclid that he handed to his students, this is unlikely to have been the entire work, but rather a summary of the propositions only.[99] William Buckley (MA 1545, King's College) was a royal tutor and also made instruments for the royal family.[100] The college accounts show that Buckley was a fellow in 1549 and 1551, but he was not one of the salaried lecturers.[101] His versified arithmetic was published as *Arithmetica memorativa* (1550). Cheke's influence as a teacher was noticed at the time. Writing to William Cecil in 1552, Roger Ascham praised the "goodly crop of Mr Cheke," including Cecil himself, that had now all been gathered from Cambridge.[102] As late as the 1590s, Thomas Nashe mentioned the tradition that it was John Cheke who had laid down a solid scholarly tradition at Cambridge.[103]

As well as revising St John's statutes, Cheke wrote the earliest surviving statutes for Trinity College, Cambridge. These date from 1552 and again state that geometry should be the first subject covered by new undergraduates.

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[97] Mulcaster, *Positions Concerning the Training up of Children*. p. 243.
[98] Oxford, Bodleian Library, shelf mark Savile W7.
[99] The manuscript Cambridge, University Library, Ff.vi.32 may be a surviving copy.
[100] Thompson Cooper, "Buckley, William (1518/19–1571)", rev. Anita McConnell, *Oxford Dictionary of National Biography*, Oxford University Press, 2004 [http://www.oxforddnb.com/view/article/3869, accessed 16 Aug 2006]
[101] Cambridge, King's College Archives, Mundum Book 12 1547 – 53, n.p.
[102] Ascham, *Whole Works of Roger Ascham*. v. 1, p. 351.
[103] Mordechai Feingold, "English Ramism: A Reinterpretation," in *The Influence of Petrus Ramus: Studies in Sixteenth and Seventeen-Century Philosophy and Science*, ed. Mordechai Feingold, Joseph S. Freedman, and W. Rother (Basel, 2001). p. 169.

> Euclid's *Elements* should be read in the first year, for it forms the way into the books of Plato and Aristotle with which it agrees very greatly, particularly since Plato wrote at the entrance of his school, 'let no one who is ignorant of geometry enter here' and logic repeats the subject anyway.[104]

The story about Plato's command is a commonplace in early-modern justifications for the study of geometry, although it is only first recorded by the Byzantine chronicler John Tzetzes in the twelfth century.[105] This trope also appears in Melanchthon's preface to Johann Vogelin's geometry textbook of 1536 and Mulcaster's *Positions.*[106]

Thus, it seems most likely that Cheke drafted the relevant sections of the 1549 university statutes. He certainly drafted similar provisions at St John's and Trinity, his interest in the quadrivium is extremely well documented and he was in an influential enough position to lead the drafters. Even if his rather quixotic promotion of arithmetic raised eyebrows among the other visitors, then he could count on support from Thomas Smith. Smith had joined the Queens' College in 1526 and taken his MA in 1533. He read natural philosophy in the schools and lectured on the same subject for his college.[107] He entered the court from 1547 but fell from grace with the Duke of Somerset in October 1549. His career revived under Elizabeth I when he became her secretary of state. He died in 1577.[108]

In 1573, Sir Thomas Smith endowed separate lectureships in arithmetic (paid £3 per annum to teach undergraduates) and geometry (paid £4 per annum to teach bachelors).[109] He set Tunstall's *De arte supputandi*, Oronce Fine's *Arithmetica practica* or Michael Stifelius for the former and the first six books of Euclid for the later. Smith saw the value of mathematical demonstration and insisted that it had a central part on the method of teaching. Payments to these lecturers appear in the

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[104] J.B. Mullinger, *The University of Cambridge* (Cambridge, 1873). v. 2, p. 614. "Primo anno Euclidis elementa, ita enim aditus fiet in Platonis et Aristotelis libros quibus maxime convenit ut legantur, cum praesertim in ingressu scholae Plato scripserit "*Μηδεὶς ἀγεωμέτρητος εἰσίτω*"et summam quam libet dialectices recitent."
[105] Olaf Pedersen, *The First Universities*, J. D. North trans. (Cambridge, 1997). p. 10.
[106] Melanchthon, *Orations*. p. 98; Mulcaster, *Positions Concerning the Training up of Children*. p. 242.
[107] M. Dewar, *Sir Thomas Smith: A Tudor Intellectual in Office* (1964). p. 13, and appendix three of this thesis.
[108] Ian W. Archer, "Smith, Sir Thomas (1513–1577)", *Oxford Dictionary of National Biography*, Oxford University Press, 2004 [http://www.oxforddnb.com/view/article/25906, accessed 5 Oct 2006]
[109] P. L. Rose, "Erasmians and Mathematicians at Cambridge in the Early Sixteenth Century," *Sixteenth Century Journal* 8 (1977). p. 55.

accounts from 1573 as expected.[110] He also gave the college a celestial globe that he had made himself and that remains in the Queens' College Old Library. When Smith died in 1577, he left whatever of his books that the fellows wanted to Queens' College. Smith's library list of 1566 contains many works of mathematics and astronomy.[111] This reflects the priority given to these subjects in the Edwardian statutes and Smith certainly would have supported Cheke's promotion of practical mathematics. However, while the fellows of Queens' College acquired plenty of his law books, of his collection of over twenty mathematical works, only two (a Tunstall and a Euclid) can be found in the college library today.[112] Despite the fact that Smith endowed the college with the lecturers in both arithmetic and geometry, it is doubtful the fellows even bothered to carry his mathematical books back to their library.

Smith's interest in mathematics was due to the practical applications that knowledge of the quadrivium opened up. For example, his library betrays his enthusiasm for astrology. He owned over a dozen books on the occult including Guido Bonato's classic manual of predestination.[113] During the reign of Elizabeth, Smith even tried to make astrological predictions regarding state business.[114] If Smith believed that astrology was a valid tool of government, he would have been happy to see astronomy taught better at the universities. Smith's astrological interests may have been controversial but they were certainly a practical application. Gabriel Harvey (1552 – 1631) later remembered that he was also interested in alchemy and Richard Eden corresponded with him about the matter.[115]

Another application of mathematics that he was interested in was horology. The Queens' College accounts reveal that Smith constructed a sundial although not the current one which dates from the seventeenth century.[116] His copy of Sebastian Münster's *Horologiographia* (1533) remains in Queens' College Library (though not annotated) and features five more times on the probate lists at Cambridge.[117] There was something of a vogue for monumental sundials in the late sixteenth century. The

[110] Cambridge, University Library, Queens' College Archives volume 4, "Journale 1560 – 87", fol. 97r.
[111] John Strype, *A Life of the Learned Thomas Smith, Kt* (Oxford, 1820). p. 279.
[112] Cambridge, Queens' College Old Library, shelf marks D.1.10 and D.1.38.
[113] Strype, *A Life of the Learned Thomas Smith, Kt.* p. 279.
[114] John Strype, *Annals of the Reformation and Establishment of Religion,* ed. S.R. Maitland, 4 vols. (Oxford, 1824). v. 2, p. 17.
[115] Dewar, *Sir Thomas Smith*, D. Gwyn, "Richard Eden, Cosmographer and Alchemist," *Sixteenth Century Journal* 15 (1984). p. 32.
[116] W. G. Searle, *The History of the Queens College, 1446 - 1662* (Cambridge, 1867). v. 1, p. 241.
[117] Leedham-Green, *BCI.* v. 2, p. 559.

magnificent monument in the front quad of Corpus Christi College, Oxford dates from 1589 but Nicolaus Kratzer built one for the college orchard earlier that century. He constructed another outside St Mary's Church. All these dials were painted on free-standing columns rather than mounted on walls.[118] At Cambridge, King's College Chapel has a small dial low on its south wall dated 1573 and mysteriously initialled JC. However, the manufacture of dials was not something that university educated gentlemen would have been involved in, except by way of a hobby. The London instrument makers dominated this growing trade and it is unlikely that a gentleman would need to know more than how to use one. Even the Royal Family needed to know how to do that. William Buckley, whom we met teaching mathematics at King's College in 1549, was tutor to Prince Edward in 1546. During this time, Buckley produced a ring dial for Princess Elizabeth together with instructions on how to use it.[119] Likewise, Ottiwell Holinshed (d. 1568) who was a Cambridge university mathematics lecturer in 1547, presented Edward VI with his own treatise on the ring dial in 1552 (his sister, presumably still had hers). In it, he sets out the five functions of the dial, including determining the time, which sign of the zodiac the sun is in and the hour of high tide at London Bridge. [120]

Both Buckley and Holinshed were looking for patronage and favour from the King. However, in order to earn this they had to show that their skills were useful to the Christian republic and telling the time was a simple but essential skill. Cheke and Smith's promotion of the subject probably had very similar motivations. They wanted their country to have men armed with the skills needed to defend it and rule it. The same motivation informed the abortive attempts to set up special colleges for law and medicine. The syllabus has no time at all for the theoretical aspects of mathematics, what Mulcaster calls "the degenerate and sophisticall partes of them, applyed by vaine heads to meere collusions".[121] Horology and astrology were two possible practical applications but there were certainly others.

The English tradition of civic humanism, typified by Thomas Elyot,[122] must certainly have affected Cheke. However, we do not find an emphasis on practical mathematics in Elyot or any other works in the genre, apart from Cheke's circle. It

[118] Information derived from: Phillip Pattenden, *The Sundials of an Oxford College* (Oxford, 1979).
[119] London, British Library, MS Royal 12.A.xxv.
[120] London, British Library, MS Royal 17A xxxiii. fols. 2r, 1v and 3v.
[121] Mulcaster, *Positions Concerning the Training up of Children*. p. 242.
[122] Thomas Elyot, *The Boke Named the Governor* (London, 1531).

therefore appears that mathematics was something that Cheke had to bolt onto his humanism rather than being an integral part of it. The problem then arose of how to sell his project to Ascham and the other humanists whom we saw in chapter three were suspicious of mathematics. Luckily, theological and classical justifications for mathematics existed which he could exploit. The alleged aphorism of Plato about geometry and the quotation from Wisdom 11:21 used by Record and Tunstall that we discussed above both provided justifications for the study of practical mathematics which were in the literary framework that humanists respected. These tropes allowed mathematics to be integrated into the humanist vision of useful knowledge. Thus, when Cheke made his move to promote arithmetic to first place in the syllabus, he had all the necessary bases covered.

If Cheke and Smith were responsible for the syllabus, this means that it was framed by Cambridge men and then imposed on Oxford. This is consistent with the practical emphasis of the 1549 syllabus being congruent with Cambridge rather than Oxford traditions. Furthermore, we know that the Cambridge visitors were appointed on 12th November 1548 giving them a good six months to draw up the statutes before they were issued in King's College Chapel in mid May 1549.[123] The Oxford visitors were not even appointed until 8th May 1549.[124] Of the Oxford visitors, we have no evidence that any of them had much interest in mathematics and one of them, Simon Haynes, was actually master of the Queens' College Cambridge for much of the time that Smith was a fellow there.

Geography in the 1549 syllabus

The most radical element of the 1549 syllabus was the introduction of a new subject – geography. There had been a little geography teaching prior to the visitation. In 1532 – 3, Cambridge University's Grace Book contains the following notice: "Item: it is allowed for Master [William] Paynell to profess the geography of Pomponius Mela or some other suitable author for the mathematics lecture [during your life]."[125] William Buckmaster, who was vice-chancellor in 1529 and 1538, may

[123] Knighton, ed., *State Papers 1547 - 1553.* 164.
[124] Ibid. 218.
[125] Searle, ed., *Grace Book G.* p. 272. "Item conceditur magistro Paynell ut Pomponii Melae aut alterius cuiusdem approbati authoris geographiam viventibus vestris profiteatur vice lecturae mathematices."

have supported this change. He bought two geography books from Garrett Godfrey who also sold five copies of Pomponius Mela to other individuals.[126]

This grace may have continued to be applicable for the next mathematics lecturer, Edward More. More's probate list survives and he did indeed have a copy of Pomponius Mela as well as Ptolemy's *Geographia*, Peter Apian's *Introductio cosmographiae* and the Elder Pliny's *Naturalis historia*. Pliny, Ptolemy and Mela, as well as Strabo, were the authors allowed as the subject of the geography lecture in the 1549 statutes.[127] These statutes presumably obviated the necessity for a specific grace as no more appear.

There was also some geography at Oxford before 1549. At Merton in 1536, Peter Burrow was appointed to lecture on the cosmography of Glareanus in the year of his regency and in 1539, Robert Warde was assigned the same author. Later, he became university lecturer in philosophy (1547 – 58) but resigned on the ascension of Elizabeth due to his Catholicism.[128] The book they were lecturing on was actually called *De geographia liber unus* (1527), which packs a great deal of information into its thirty-five pages. At Magdalen College, the subject did not become compulsory until 1591 following a presidential decree but the records of the college show that a geography lecturer was appointed for 1540/41. Baldwin Norton, about whom nothing else is known, was paid 39s to lecture to the college.[129] Richard Vernan (MA 1531), a master at Brasenose College, appears to have even written a lost Latin monograph called *Methodo Geographica* quoted by Nicholas Carr in his *De scriptorum Britannicorum paucitate* (1576). [130]

The rediscovery of Ptolemy's *Geographia* at the start of the fifteenth century as well as the voyages that began a generation, initially piqued interest in the new subject. Some of the early English attempts at exploration were disastrous. John Cabot (c. 1450 – 1498), sailing out of Bristol in 1498 on his first voyage after discovering Newfoundland, was lost with most of his fleet. In 1556, Richard Chancellor's successful attempts to find a passage around Scandinavia to trade with the Russians

[126] Leedham-Green, Rhodes, and Stubbings, *Garrett Godfrey*. pp. 26 and 149.
[127] Heywood, ed., *Collection of Statutes*. p. 7 and Gibson, ed., *Statuta*. p. 344.
[128] J. M. Fletcher, ed., *Registrum annalium Collegii Mertonensis, 1521 - 1567* (Oxford, 1974). pp. 68 and 77.
[129] William Dunn Macray, *A Register of the Members of St Mary Magdalen College, Oxford* (London, 1894). p. 69.
[130] Nicholas Carr, *De scriptorum britannicorum paucitate* (London, 1576). fol. 16v.

ended with his death in a wreck off Aberdeenshire. The Russian ambassador, who was also on board on the doomed ship, claimed that Chancellor had drowned saving his life.[131] A far safer way to be involved in the discovery of new lands and trade routes was to provide the necessary training in navigation while staying at home. Some learned men did travel with the sailors, most famously Thomas Harriot (c. 1560 – 1621). He was fresh from Oxford when he was employed to teach Sir Walter Raleigh and his captains the details of navigation, before also taking part in an attempt to colonise Virginia.[132] Richard Eden made his living translating geographical works into English for the Duke of Northumberland and any other patron he could get.[133] He later attached himself to the Muscovy Company, which also counted John Dee and Robert Recorde among its learned consultants.[134]

While the Edwardian visitors to the universities were preparing for their work, Sebastian Cabot was very much on the minds of the Privy Council. The Spanish were demanding his return home in no uncertain terms and the English were just as keen that he remained. The Privy Council authorised payments to him so that he would stay in London drumming up interest in ventures to the Far East.[135]

Sir Thomas Smith had been made secretary to the Council in 1547 and the next year became secretary of state. His duties included negotiating trade privileges and he would have had frequent contact with the merchants who were trying to launch further ventures. He may well have been in close contact with Cabot and the prospective backers of the Muscovy Company. There is good evidence of his interest in geography. His own book collection included Ptolemy and Strabo, Sebastian Münster's *Cosmographia*, and Richard Eden's English translation of Martin Cortes's *Art of Navigation*.[136] Eden, who took his MA in 1544, had been a student of Smith's at the Queens' College where he moved after he had started his Cambridge career at Christ's. In 1552, after an abortive career as an alchemist, Eden became the secretary

[131] James McDermott, "Chancellor, Richard (*d.* 1556)", *Oxford Dictionary of National Biography*, Oxford University Press, 2004 [http://www.oxforddnb.com/view/article/5099, accessed 29 April 2007]
[132] J. J. Roche, "Harriot, Thomas (*c.*1560–1621)", *Oxford Dictionary of National Biography*, Oxford University Press, Sept 2004; online edn, Oct 2006 [http://www.oxforddnb.com/view/article/12379, accessed 14 Dec 2006]
[133] Gwyn, "Richard Eden." p. 23.
[134] Ibid. p. 26.
[135] David Loades, "Cabot, Sebastian (*c.*1481/2–1557)", *Oxford Dictionary of National Biography*, Oxford University Press, 2004 [http://www.oxforddnb.com/view/article/4290, accessed 20 Dec 2006]
[136] Strype, *A Life of the Learned Thomas Smith, Kt.* Appendix, p. 141.

to Sir William Cecil[137] before embarking on a varied career as courtier and translator. He is most renowned for his edition of part of Peter Martyr's *Decades* (1555), which covered the new discoveries in more detail than any previous English work. He also translated John Taisnier's *De natura magnetis*, a medieval treatise on the magnet, which was published in 1579.[138] It is not clear whether Eden encouraged Smith to invest some time in geography of the other way around, but we can see that Smith and the other privy councillors had good reason to be interested in geography before the 1549 visitations.

Other humanists, writing on government, agreed that geography was an important subject. In *The Boke named the Governour* (1531), Sir Thomas Elyot, who otherwise betrayed little interest in mathematics, wrote:

> Also to prepare the childe to understandynge of histories, whiche, beinge replenished with the names of countrayes and townes unknowen to the reder, do make the historie tedious or els the lasse pleasant, so if they be in any wyse knowen, it encreaseth an inexplicable delectation. It shall be therfore, and also for refreshing the witte, a conuenient lesson to beholde the olde tables of Ptholomee, where in all the worlde is paynted, hauynge firste some introduction in to the sphere, wherof nowe of late be made very good treatises, and more playne and easie to lerne than was wonte to be.[139]

He went on to explain the importance of cosmography for rulers wanting to know about the regions in which they intend to wage war before recommending some authors:

> In the parte of cosmographie wherwith historie is mingled Strabo reigneth: whiche toke his argument of the diuine poete Homere. Also Strabo hym selfe, (as he saithe) laboured a great part of Africa and Egypte, where undoubtedly be many thinges to be maruailed at. Solinus writeth almost in like forme, and is more brefe, and hath moche more varietie of thinges and maters, and is therfore maruailous delectable: yet Mela is moche shorter, and his stile, (by reason that it is of a more antiquitie) is also more clene and facile. Wherfore he, or Dionisius, shall be sufficient.[140]

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[137] Gwyn, "Richard Eden." p. 20.
[138] Andrew Hadfield, "Eden, Richard (*c.*1520–1576)", *Oxford Dictionary of National Biography*, Oxford University Press, 2004; online ed., May 2005 [http://www.oxforddnb.com/view/article/8454, accessed 6 July 2006]
[139] Elyot, *The Boke Named the Governor.* fol. 37r.
[140] Ibid. fol. 38r.

He also suggested that 'All be it there is none so good lernynge as the demonstration of cosmographie by materiall figures and instrumentes, hauynge a good instructour'[141] rather than just getting what is needed out of books.

The Scope and Purpose of Geography

Today, the seminal event in the history of geography is the discovery of the New World in 1492. This event was, however, slow to percolate into the consciousnesses of many Europeans. While the ancient textbooks naturally had nothing to say on the New World, it did feature, if rather briefly, in early-sixteenth-century books. Peter Apian's *Cosmographicus Liber* in 1524 provided a description of America[142] and this section was much expanded by Gemma Frisius in later editions. Glareanus in his *De geographia liber unus*, which we saw was used as a textbook at Merton College in the 1530s, writes in his last chapter:

> Moreover, there is a land nearly eighty degrees to the west, which they call America. Two islands, Spagnella and Isabella, whose shores are land ruled by Spain, are known from the voyage of the captains Columbus of Genoa and Amerigo Vesputio.[143]

However, in the same passage, Glareanus also maintains that the ancients had known about America after all, when he refers to the passage that concludes act two of Seneca's Medea:

> The Age shall come, in fine, Of many years, wherein the Main may unloose the universal Chain; And mighty Tracts of Land be shown, To Search of Elder Days unknown. New Worlds by some new pilot found, Nor Thule be Earth's farthest Bound.[144]

The most practical application of geography was the growing professions of surveyor and cartographer. Many surveyors in England in the sixteenth century appear to have been Italians in royal service.[145] With the Reformation, it was essential to the

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[141] Ibid. fol. 37v.
[142] John Alden, *European Americana: A Chronological Guide to Works Printed in Europe Relating to the Americas*, vol. 1 (New York, 1980). p. 27.
[143] Henry Glarænus, *De geographia liber unus* (Basel, 1527). fol. 35r. "Porro, ad occidentem terra est, quam Americam vocant, longitudine octoginta ferme graduum. Duae insulae Spagnolla et Isabella: quae quidem regiones secundum littora ab Hispanis lustratae sunt, Columbo Genuensi, et Americo [sic] Vesputio eius navigationes ducibus."
[144] Seneca, *Medea*, ed. John Fitch (Cambridge MA, 2002). p. 377.
[145] Sarah Bendall, *Dictionary of Land Surveyors and local Map Makers 1530 - 1850*, 2 vols. (London, 1997). See her chronological list of surveyors in volume one and corresponding entries in volume two.

Protestant Commonwealth that this vital skill could be found at home and it provided another reason for adding geography to the university syllabus.

The necessary textbooks were readily available. Gemma Frisius, Peter Apian's editor, was also a noted surveyor. It was not unusual for writers like Oronce Fine, Apian and Gemma to be also involved in practical work to a much greater extent than in earlier centuries.[146] Gemma's *Libellus de locorum describendorum ratione* (1533), which explains how to carry out triangulations using a staff, was appended to Apian's *Cosmographia* together with a short treatise on how to use an astronomer's ring.[147] The method of surveying by triangulation invented by Gemma only required a single length to be measured to provide an absolute scale making it a great deal more practical than traditional methods. English tracts also began to appear, such as Leonard Digges *Tectonicon* (1556), which occasionally turn up on the later probate lists. It is likely that Digges was at Oxford in the early 1530s but no evidence from the university itself survives.[148]

One of the Cambridge University mathematics lecturers, John Rudd (MA 1520), appears to have enjoyed a career as cartographer upon leaving the university.[149] His son, Edmund, died in 1576 while at Clare College and his probate list consists of a number of maps and a drawing table.[150] He may have been following in his father's footsteps. Another of Rudd Senior's apprentices was the more famous Christopher Saxton who may have made use of some of Rudd's work in his own maps. Both men worked primarily for the crown.[151] Clement Adams (c. 1519 – 1587) of King's Hall, Cambridge was a protégé of John Cheke to whom he owed his appointment as royal tutor. He is credited with a map of the voyages of Sebastian Cabot in 1547[152] and an account of Richard Chancellor's voyage to Moscow.[153] As it turned out, surveyors did not tend to be university educated. However, it remains likely that a need for surveyors and cartographers was one of the reasons that Cheke saw fit to promote geography.

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[146] Jim Bennett, "Practical Geometry and Operative Knowledge," *Configurations* 6 (1998). p. 199.
[147] See for instance, Cambridge, University Library, shelf mark Hanson c.213.
[148] Stephen Johnston, "Digges, Leonard (*c.*1515–*c.*1559)", *Oxford Dictionary of National Biography*, Oxford University Press, 2004 [http://www.oxforddnb.com/view/article/7637, accessed 13 July 2006]
[149] Bendall, *Dictionary of Land Surveyors and local Map Makers 1530 - 1850*. v. 2, p. 444.
[150] Leedham-Green, *BCI*. v. 1, pp. 322 – 5.
[151] David Marcombe, "Rudd, John (*c.*1498–1579)", rev., *Oxford Dictionary of National Biography*, Oxford University Press, 2004 [http://www.oxforddnb.com/view/article/37921, accessed 13 July 2006]
[152] E. G. R. Taylor, *Tudor Geography 1485 - 1558* (London, 1933). p. 17.
[153] Gwyn, "Richard Eden." p. 26.

The 1549 syllabus allows Pomponius Mela's *De situ orbis*; Pliny the Elder's *Historia naturalis*; Strabo's *Geographia* or Ptolemy's *Geographia*.[154] All of these books are expensive. Mela averaged over a shilling while the others reached prices of five shillings or more.[155] Despite these high prices, they appear many times in the probate lists of Cambridge. If we assume that the price means that students were not the ones buying them, it seems likely that there was a significant group of masters studying geography and cartography to quite an advanced level. The probate lists suggest that interest in geography, especially the mathematical sort, was much greater at Cambridge than Oxford. At the former, geographical books are more popular than the rest of the quadrivium put together and of the 125 geography books, there are at least twenty-one copies of Ptolemy's *Geographia* and another ten early-modern books that could be described as heavily mathematical in emphasis. The complicated analysis of the Ptolemy entries in *Books in Cambridge Inventories* has been carried out by Catherine Delano Smith who realised that some copies, such as the Greek edition of 1533, lacked maps, and that these were sometimes listed separately.[156] The number of copies of Ptolemy is even more significant given the high prices that this book commanded. At Oxford, on the other hand, geography makes up only half the total of the other quadrivium books, and cartography is represented only by four copies of Ptolemy. Even the parity between the universities in the popularity of Pliny's *Historia Naturalis* is no evidence for geography being of interest at Oxford as it is far more a literary than a geographical work.

It is not impossible that there was a 'school' of Cambridge geographers active in the mid-sixteenth century whose activities have since become completely obscure. Examination of the many surviving copies of their books in the college libraries (they were big and impressive and so more likely to be preserved) may shed light on what they were doing. Their existence might also provide another explanation as to why Cheke and Smith, educated in this milieu, made the subject an official addition to the syllabus in 1549.

Cheap copies of Pomponius Mela were to be had if students wanted them. It is occasionally found in the hands of students. Peter Williamsom died in 1546 while

[154] Heywood, ed., *Collection of Statutes*. p. 290.
[155] See appendix one.
[156] C. Delano Smith, "Map Ownership in Sixteenth-Century Cambridge: The Evidence of Probate Inventories," *Imago Mundi* 47 (1995). p. 82.

studying for his MA and Peter Bullar in 1540 just after completing it. Both owned Mela.[157] Furthermore, Peter Apian's textbook could be had for sixpence. It is a reasonably comprehensive introduction and is the most likely textbook for the subject. William Johnson and Henry Hawes, who died around 1560 before or just after receiving their MAs, each owned a copy.[158]

The 1549 syllabus is repeated in the 1570 statutes at Cambridge but not in the 1564/5 prescriptions at Oxford, which do not contain any geography. It is not clear whether this continuing emphasis on the subject at Cambridge is anything more than accidental. After all, the 1570 statutes simply carry over the provisions of 1549 wholesale while Oxford saw fit for a complete rewrite in 1564/5.

The enormous popularity of Pomponius Mela at Cambridge shows us that a desire to acquire practical skills was not the only reason that sixteenth-century students studied geography. Many probably took their lead from Erasmus. In *De ratione studii* (1511), he was clear about why he found the subject useful:

> A knowledge of Geography is of prime importance, for the study both of ancient poets and of historians. Pomponius Mela makes a useful compendium; Pliny and Ptolemy are learned and elaborate writers; Strabo is something more than a geographer. This subject includes two parts, a knowledge, first, of the names, ancient and modern, of mountains, rivers, cities; secondly, of names of trees, plants, animals, of dress appliances, precious stones, in which the average writer of today shows a strange ignorance.[159]

He adds that Pliny is also to be valued for his stock of unusual words and Latin usages. By providing a conservative list of classical authorities as textbooks, Cheke allowed his practical aims to be subverted by more scholarly concerns. At Oxford, especially, that is exactly what happened. When the *nova statuta* came to be drafted in 1564/5, no room was found for geography, which was, by then, just an adjunct to classical studies.

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[157] Leedham-Green, *BCI*. v. 1, pp. 17 and 91.
[158] Ibid. v. 1, pp. 230 and 225. Johnson's copy, identified as "Appianus", may be doubtful but is placed among other quadrivium texts.
[159] D. Erasmus, "De ratione studii," in *The Collected Works of Erasmus*, ed. Wallace K. Ferguson (Toronto, 1978). p. 673.

Natural Philosophy in the 1549 syllabus

In contrast to the full list of mathematical books to be used, the syllabus provided very little guidance on studying natural philosophy. It required students to spend their third and fourth years studying philosophy and bachelors to further their studies in the subject.[160] However, the reading list given is extremely limited, being made up only of Aristotle's *Problemata*, *Moralia* and *Politica*, Pliny or Plato.[161] The *Problemata* is the only work of Aristotelian natural philosophy included. As for Plato, his single attempt at natural philosophy is the *Timaeus*, which treats the creation of the world by the demiurge and a few details on its constituents. This was the only serious work on the subject available in Latin in the early Middle Ages but was swept aside during the excitement of the twelfth century rediscovery of Aristotle.[162]

The Edwardian visitors' snub of Aristotle's natural philosophy echoed Melanchthon's own early effort at Wittenberg to construct a syllabus without using it. Luther himself had had little time for Aristotle and initially, Melanchthon had agreed with this stance.[163] He soon relented but concentrated, as we have seen, on *De anima* rather than the *Physica*. When considering the uses of natural philosophy, Melanchthon was most concerned with the light it could shed on law and moral philosophy. Speaking to his university in 1542, he said, "A great part of the ethical disputations spreads from [natural philosophy] because the causes of the virtues are to be sought in the nature of man."[164] Judging by their choices of books to be lectured on, the Edwardian visitors shared this typical humanist concern with practical ethics.[165] Indeed Leonardo Bruni's (1370 – 1444) version of the *Ethica Nicomachea*, published at Oxford in 1489, is one of the few versions of Aristotle to be printed in England before 1600.[166] It is unlikely that the Edwardian reformers attached any importance to natural philosophy at all and it was probably Plato's moral and political works that interested them rather than the *Timaeus*. One reason for this lack of attention to natural philosophy from the visitors was that there was not a natural philosopher among their number. Despite his having taught natural philosophy as a

[160] Heywood, ed., *Collection of Statutes*. p. 8.
[161] Ibid. p. 7.
[162] Edward Grant, *The Foundations of Modern Science in the Middle Ages* (Cambridge, 1996). p. 20.
[163] Kusukawa, *Transformation of Natural Philosophy*. p. 40.
[164] Melanchthon, *Orations*. p. 136.
[165] Charles Nauert, *Humanism and the Culture of Renaissance Europe* (1995). p. 13.
[166] Charles Schmitt, *John Case and Aristotelianism in Renaissance England* (Toronto, 1983). p. 26.

young regent master, Smith's library list of 1566 actually contains no early-modern natural philosophy at all.[167]

The Aristotelian *Problemata* were extremely popular during the sixteenth century. It appears to be a collection of teaching materials from the Lyceum not directly attributable to Aristotle and perhaps not reaching their final form until the sixth century AD. It contains 900 problems in thirty-eight books but the organisation is not completely consistent. There are about 200 repetitions in the text and fifty or so outright contradictions.[168] There is no doubt that it is intended as a pedagogical text. It contains no new basic principles of philosophy but is rather concerned with demonstrating how known principles can be applied to specific problems. The questions are mainly on natural history or medicine although there are also sections on other topics like mathematics and astronomy. The original Greek was translated into Latin about 1450 by Theodore of Gaza, who succeeded in eclipsing earlier medieval versions. He made a large number of silent emendations to his text which have served to confuse textual scholars ever since.[169] The *editio princeps* was printed in 1472 and there were about twenty Latin editions in all.[170] Circulating in parallel to the scholarly *Problemata* was a shorter and completely different Latin lay version.[171] This was the work that made it into the vernacular and was printed many more times than the scholarly version. There were twenty-three incunabula editions alone, including all the Cologne printings, compared to just five for the Greek.[172] It is probable that some of the copies of the *Problemata* shown in the booklists represent the lay version even though it was of no academic value to university masters.

Our first scrap of evidence that the *Problemata* was used for teaching at the universities is simply that it was unlikely to be much use for anything else. It was a popular work, appearing ten times in the Oxford booklists and seventeen times at Cambridge (although, as mentioned, some of these may be the lay version). This is in

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[167] Strype, *A Life of the Learned Thomas Smith, Kt.* p. 279.
[168] Ann Blair, "The 'Problemata' as a Natural Philosophical Genre," in *Natural Particulars: Nature and the Disciplines in Renaissance Europe*, ed. Anthony Grafton and Nancy Siraisi (Cambridge, MA, 1999). p. 174.
[169] John Monfasani, "The Pseudo-Aristotelian 'Problemata' and Aristotle's 'De animalibus' in the Renaissance," in *Natural Particulars: Nature and the Disciplines in Renaissance Europe*, ed. Anthony Grafton and Nancy Siraisi (Cambridge, MA, 1999). p. 207.
[170] Ibid. p. 189.
[171] Blair, "The 'Problemata' as a Natural Philosophical Genre." p. 181.
[172] Jill Kraye, "The Printing History of Aristotle in the Fifteenth Century: A Bibliographical Approach to Renaissance Philosophy," *Renaissance Studies* 9 (1995). p. 209.

addition to the various collected works of Aristotle and makes the *Problemata* one of the most popular single Aristotelian works in the book lists. It is consistent with it being a textbook that so many people should own it as an individual work. Furthermore, its elementary character and organisation into a series of questions made it particularly appropriate for student use. As shown in appendix five, the *Problemata* was allocated as a textbook to four masters in Merton College in 1541 and another one in 1546. It may be the fact that it was already in use that earned it a place in the 1549 syllabuses (retained by Cambridge in 1558 and 1570) although it is unlikely that Cheke would have been influenced by the example of Merton.[173] Its appearance in the English universities' statutes is the only time it is set as a teaching text although it was well regarded throughout Europe.[174] We will examine some of the *Problemata* in more detail in chapter eight.

The inclusion of Pliny's *Historia Naturalis* as a philosophical work appears, at first, rather surprising. However, its great size and breadth of coverage meant that it could perform many different functions. This makes it difficult to ascertain exactly what the 1549 visitors thought that it should be used for. It is included in the syllabus (and hence both the 1558 syllabuses and the 1570 syllabus at Cambridge) as a book to be lectured on by both the geography and philosophy reader.[175]

Pliny's great work is arranged into thirty-seven books of which book two is about astronomy and books three to six deal explicitly with geography. The remaining books cover what we call natural history as well as medicine and a fair amount on art and culture. It has to be admitted that the section on astronomy is one of the weakest and it is no surprise that one rarely sees Pliny quoted as an authority on the subject.

The second book of *Historia Naturalis* was stipulated as the introductory text in Melanchthon's 1545 statutes at Wittenberg.[176] It is entirely possible that the 1549 visitors had envisaged it performing a similar role at Oxford and Cambridge, although students who have mastered Sacrobosco would learn nothing new. But Pliny had other uses. Richard Fox's statutes for Corpus Christi College, Oxford also include Pliny as a set text, but this time it is for the humanities lectures. Pliny's enormous

[173] Heywood, ed., *Collection of Statutes*. pp. 7, 290 and appendix.
[174] Blair, "The 'Problemata' as a Natural Philosophical Genre." p. 179.
[175] Heywood, ed., *Collection of Statutes*. pp. 7, 290 and appendix.
[176] Kusukawa, *Transformation of Natural Philosophy*. p. 175.

vocabulary of obscure words coupled with the innate difficulties of the text made him irresistible to humanist philologists.

The fellow of Corpus with the greatest interest in Pliny was John Claymond. He was the author of one of the most remarkable and certainly longest pieces of humanist scholarship to be produced in England – his commentary on the *Naturalis historia*. Richard Fox picked him to be the first President of Corpus Christi whilst he was already President of Magdalen College. As no humanities lecturer was actually appointed until 1538, after his death, we can assume that Claymond also filled that post and may have actually lectured on Pliny.[177] Again, we see how Pliny was treated more as a literary than as a geographical author and it was primarily as a philologist and textual critic that John Claymond approached his work.[178] Indeed, only rough notes exist for the *Naturalis historia*'s books two and three in his commentary and nothing at all for the remaining geographical books.[179] His great commentary, never published, was mentioned by Conrad Gesner (1516 – 1565) (who admitted he had never seen it)[180] and cited by Claymond's pupil Edward Wotton (1492 – 1555).[181] Nevertheless, it was not completely unknown and the English intelligentsia knew what he was up to. As late as 1570, John Caius explains why Claymond could not get his work published (it was too long).[182] We cannot use Claymond's commentary as evidence for any sort of interest in geography or natural history at Corpus Christi College, Oxford. Indeed, of Claymond's gifts to the library, these subjects were represented only by a Latin Strabo and Theophrastus among twelve other books of medicine and natural philosophy.[183]

Given all the uses that could be found for Pliny – astronomy, natural history, philology and medicine – it is hardly a surprise that the book was enormously popular. There were at least fifty complete Latin editions prior to 1570 and this does not include the numerous subsidiary works that it spawned. There were also editions of individual books, vernacular translations (although no complete English edition in our period) and various indices and epitomes. We find over fifty copies in the

[177] Jonathan Woolfson, "John Claymond, Pliny the Elder and the Early History of Corpus Christi College, Oxford," *English Historical Review* 112 (1997). p. 898 – 9.
[178] Ibid. p. 885.
[179] Ibid. p. 882.
[180] Ibid. p. 895.
[181] Charles Raven, *English Naturalists from Neckham to Ray* (Cambridge, 1947). p. 41.
[182] John Caius, *De libris propriis* (London, 1570). fol. 13r.
[183] R. Liddell, "The Library of Corpus Christi College Oxford" (University of Oxford, 1938). p. 34.

Cambridge booklists. Cambridge bookseller, Garrett Godfrey, sold two copies in the period around 1530 covered by the surviving fragment of his account book.[184] John Dorne, bookseller at Oxford, sold no less than ten copies in his daybook from the 1520s.[185] It was also a popular gift to colleges and many remain in their libraries to this day. Thomas Wendy, the 1549 visitor, gave the 1525 edition to Caius College[186] who also received an incunabula version from Hugh Glyn, another medical doctor.[187] The most impressive collection of *Plinicana* that I have come across belonged to William Cecil who was a student at St John's College, Cambridge from 1535 – 1541. His library contained the criticisms of Leonicino and Barbaro, not to mention Pliny himself and a separate index volume.[188]

The size of Pliny's work meant that it was rarely available cheaply. The average price at both Oxford and Cambridge was over four shillings and with a fine binding it could fetch much more.[189] The most precious edition in the probate lists belonged to Andrew Perne and was appraised at no less than ten shillings. On the other hand, there were copies to be had for just four pence.[190] These would have been in smaller formats that became increasingly available later in the century. Nonetheless, this was a book that students would have found hard to afford and if they needed to consult a copy they would probably have had to ask a master or visit the college library. The *Problemata*, on the other hand, was much cheaper. It averaged seven pence and was available from Nicholas Pilgrim's Cambridge shop in a handy octavo format before 1546.[191] Better off students would have been able to afford their own copies and the early move to a small format suggests that they were a primary market for the book.

A subject for which either Pliny or the *Problemata* would have been useful preparation was medicine. Cheke's pupil, Mulcaster, certainly thought so when he wrote,

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[184] Leedham-Green, Rhodes, and Stubbings, *Garrett Godfrey*. p. 155.
[185] F. Madan, "The Daybook of John Dorne, bookseller in Oxford AD1520," in *Collectanea I*, ed. J.R.L. Fletcher (Oxford, 1885). p. 168.
[186] Cambridge, Caius College Library, shelf mark G.8.21
[187] G.A. Schneider, *Incunabula in the Library of the Gonville and Caius College* (Cambridge, 1928). no. 47.
[188] W. H. Herendeen and K. Bartlett, "The Library of Cuthbert Tunstall, Bishop of Durham," *Papers of the Bibliographical Society of America* 85 (1991). p. 279 – 80.
[189] See appendix one.
[190] Leedham-Green, *BCI*. v. 2, p. 628.
[191] Ibid. v. 2, p. 50.

> If Philosophie with her three kindes had the third colledge, were it thinke you unproper? Then the naturall might afterward proceede to Physcik, whom she fitteth: the Politicke to Lawe, whom she groundeth: the morall to Divinitie, whom she helpeth in discourse.[192]

Melanchthon also believed that, "the starting point of medicine is natural philosophy."[193] In the 1520s, he had wanted medical writers to replace Aristotle in the syllabus.[194] Aristotle himself had pointed out in *De sensu et sensato* 1 that physicians should "base their medical theories on the principles of natural science." It was generally assumed in the Italian medical schools that natural philosophy, as well as logic, was an important propaedeutic to medicine, even if the philosophy masters themselves thought of their subject as an independent discipline.[195] Medicine also enjoyed an Erasmian imprimatur as he praised the subject, if not its practitioners, in his early work *Encomium medicinae* (1499).[196] We have seen that the visitors had considered setting up medical colleges and the presence of these two books on the syllabus might represent a part of the plan to promote medicine that came to fruition. They may have considered that natural philosophy's most practical purpose was to introduce students to medical thinking and it was that which determined their unusual choice of texts to set for the subject.

Conclusion

The two visitations of 1535 and 1549 occurred for reasons of state. The former was intended to bring the universities around to the royal supremacy and the latter to Protestantism. However, the reason for its radical syllabus reforms was Cromwell's wish to install a course based on Christian humanism. He replaced scholastic theology with study of the Bible in its original languages. However, he did force Oxford to change over the natural philosophy syllabus anyway when he prohibited Scotus. Cambridge was less affected because its arts faculty was already using humanist textbooks. To a great extent, then, the changes to the natural philosophy syllabus were an incidental effect of the divorce crisis and probably represented only an acceleration

[192] Mulcaster, *Positions Concerning the Training up of Children*. p. 246.
[193] Melanchthon, *Orations*. p. 134.
[194] Kusukawa, *Transformation of Natural Philosophy*. p. 50.
[195] Charles Schmitt, "Aristotle among the Physicians," in *The Medical Renaissance of the Sixteenth Century*, ed. Andrew Wear, Roger French, and I. M. Lonie (Cambridge, 1985). p. 14.
[196] D. Erasmus, "Encomium medicinae," in *The Collected Works of Erasmus*, ed. Wallace K. Ferguson (Toronto, 1989).

of what was happening anyway. In contrast, the abolition of canon law was a direct consequence of Henry VIII declaring himself supreme governor.

Likewise, syllabus reform was not the major aim of the 1549 visitation. Instead, Cheke took advantage of the opportunity to act on his own pedagogical agendas. This was to use the universities as academies to produce the men with the skills the country needed. His book, *The Hurte of Sedicion: howe Greveous it is to a Commune Welth*, published in the same year as the visitations,[197] is a plea that the Protestant Commonwealth not be harmed by internal friction when there were so many threats from outside. It is as an earnest desire to protect of the Commonwealth that the reforms of the 1549 syllabus most make sense. The country needed men who could practice mathematics and geography. It also needed physicians. Even though the plans for a medical college at each university never got off the ground, the arts syllabus still featured the natural philosophy texts that would most benefit fledgling physicians. The universities were now uncompromisingly national and served the interests of a single country rather than a trans-national Church. And when the country was in as much danger as Cheke perceived England to be, then learning for learning's sake was a luxury it could ill afford.

[197] John Cheke, *The Hurte of Sedicion: Howe Greveous it is to a Commune Welth* (London, 1549).

Chapter Five: College and University Libraries

"More men will be drawn to Oxford by the spectacle of that library rich in the three tongues than were ever attracted to Rome in the olden days."[1]

Erasmus to Richard Fox, 1519

One important aspect of the visitors work was their purging of the universities of unapproved books. To Cromwell's visitors in 1535, this meant scholastic texts; to the Edwardian visitors of 1549, the targets were missals and Catholic liturgy. The Marian visitors of 1556 sought to root out books containing Protestant heresy. Overall, this led to the destruction of a large number of books. The dissolution of the monasteries during the 1530s had already led to the dispersal of many of the greatest libraries in England.[2] Although huge amounts have been lost, these monastic libraries attracted some attention from contemporaries such as John Bale, John Leland and Cromwell's visitor John ap Rice. The libraries of the universities and colleges of Oxford and Cambridge also suffered from extensive damage during the mid-sixteenth century. Furthermore, it has often been alleged that mathematical books were especially vulnerable to the depredations of the reformers. Several modern authors, such as Frances Yates and Antonia McLean, whose readership stretched beyond academia, have blamed the visitors for deliberately destroying mathematical works in Oxford's university and college libraries.[3] The allegations that the fate of these books was destruction rather than dispersal was first put forward by Anthony à Wood. In a typically fine turn of phrase, he referred to the 'funeral of Scotus' when the Subtle Doctor was eliminated from Oxford.[4]

If there was a deliberate policy to suppress or destroy books of mathematics or natural philosophy, that would be highly relevant to this thesis. Therefore, we must investigate this matter to determine if such a deliberate policy was in operation and the extent of the damage to Oxford and Cambridge libraries.

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[1] D. Erasmus, *The Correspondence of Erasmus*, ed. Peter Bietenholz, D. F. S. Thomson and Sir Roger Mynors trans., vol. 6 (Toronto, 1974 -). p. 406.
[2] Nigel Ramsey, "'The Manuscripts flew about like Butterflies': The Break-Up of English Libraries in the Sixteenth Century," in *Lost Libraries*, ed. James Raven (London, 2004).
[3] For example, Antonia McLean, *Humanism and the Rise of Science in Tudor England* (London, 1972). pp. 88 – 103 and Frances Yates, *Giordano Bruno and the Hermetic Tradition*, *Routledge Classics* (London, 2002). p. 186.
[4] Anthony à Wood, *The History and Antiquities of the University of Oxford: Annals of the University of Oxford*, ed. J. Gutch, vol. 1:2 (London, 1796). p. 108.

We shall find that what damage did take place was, in large part, due to a rapidly changing attitude towards books. Books began to be seen as commodities to be consumed and disposed of once they had become obsolescent. For a dangerous period in the sixteenth century, medieval manuscripts were included within the category of general books that had to justify their existence by their current usefulness. Inevitably, many failed this test and were lost. Many others survived due to benign neglect by the colleges that owned them.

This change of attitude towards books fed into the way that the new syllabuses were interpreted. Now books were expected to be up to date and were cheap enough to replace every few years rather than every few centuries, it was inevitable that the syllabuses would be read in the light of the latest textbooks. No longer was it assumed that the same sources should be used decade after decade. Instead, new books penetrated the student market, were adopted, became the standard text and then dropped out of circulation again as they were superseded. As we will see at the end of this chapter, the college libraries contain very few of the books that were used day by day by students, both because they hardly catered for the arts faculty and because the shelf life of any particular textbook was very short compared to the purchasing cycle of the libraries.

The Loss of Books at Oxford and Cambridge

As the tables in appendix six show (especially the comparisons between All Souls, Oxford in 1505 and 1548/56 and St John's, Cambridge between 1544 and 1556) the time of greatest danger to books was the first half of the sixteenth century. The booklists from 1556 are likely to have been assembled for Mary I's visitors (for which see chapter seven). Those from Cambridge contain a total of 602 books. Of these, 309 survive *in situ*. However, of the 582 books recorded in catalogues at Cambridge for the forty years before 1556, only 140 still remain in the college library in question. For Oxford, over half the books in the 1556 lists still survive but barely one in seven for the catalogues from the earlier sixteenth century.

Even more pronounced than this general trend are the differences that can be observed between colleges. Some, like Balliol and Merton at Oxford and Pembroke or Peterhouse at Cambridge have managed to preserve large numbers of manuscripts from their medieval collections. Others, such as Worcester (the successor college to

Canterbury) and Queen's College, Cambridge have not managed to hang onto anything at all. Aside from isolated events such as the fire at Clare College in 1521,[5] the visitations of the Reformation appear to have been responsible for a good deal of these losses.

Book Losses due to the 1535 Visitations

The most famous case of manuscript destruction during the 1535 visitation happened at New College, Oxford. As explained in the previous chapter, Cromwell's agents, Leighton and Tregonwell had turned up and ordered that the teaching of the schoolmen and especially Duns Scotus be abolished forthwith. The colleges were quick to oblige.

After an initial round of the colleges to explain to them the necessary changes, Leighton and Tregonwell returned to New College on 12th September. They were pleased by what they discovered. "We found the quadrant full of leaves of Dunce," they told Cromwell, "and Mr Grenefelde, a gentleman of Buckinghamshire, gathering them up for swelles or blawnsheres to keep deer within the wood and thereby have the better cry with his hounds." There were even worse indignities that the Subtle Doctor could suffer. He was also "made a common servant to every man fast nailed up upon the posts in all common houses of easement."[6]

Clearly, the fellows of New College, probably not uniquely, had thrown out their manuscript tomes of the Duns Scotus in order to make way for printed copies of the new books required by the injunctions. The only odd thing is that the College's library actually had only one book by Scotus,[7] so presumably the fellows were disposing of their own copies. This does not mean that the college library was spared. It suffered enormous loses during the sixteenth century. Of the 246 manuscripts given by the founder, William of Wykeham (ca 1320 – 1404), only twenty-seven remain on site.[8] We do not know when these manuscripts were lost, if not in 1535, but the new humanistic syllabus would have made them appear obsolete. In the words of N.R. Ker, "Shelves became overcrowded and new printed books pushed out the old

[5] Peter Clarke, *University and College Libraries of Cambridge*, vol. 10, *Corpus of British Medieval Libraries* (London, 2002). p. 151. The fire appears to have destroyed the archives but spared the library.
[6] *Letters and Papers, Foreign and Domestic, of the Reign of Henry VIII*, vol. 9 (London, 1862 - 1910). 350.
[7] Oxford, New College, Benefactions Book p. 30.
[8] Paul Morgan, *Oxford Libraries outside the Bodleian: A Guide* (Oxford, 1980). p. 90.

manuscripts."[9] It was not until the late sixteenth century that antiquaries began to value manuscripts for their own sake regardless of content. The probate values assigned to manuscripts, which were not even worth individually listing, show they were much less valued than printed books.[10] By the late sixteenth century, however, some manuscripts at least were accounted very valuable. In 1591, Merton College paid over four pounds sterling for Greek manuscripts of Euclid, Alexander's commentary on the *Metaphysica* and Sextus Empiricus.[11]

Book Losses due to the 1549 Visitations

The next event for which we have sources extant is the 1549 visitation at both universities. Evidence for the visitation at Oxford is very scant. This is very unfortunate because it is alleged to have been the occasion of one of the most notorious episodes of the English reformation: the 'funeral of Scotus'[12] when most of the libraries, including all of the university's, were destroyed or dispersed.

After the events of 1535, the study of Duns Scotus was already dead so a funeral may have seemed the next logical step. The equally subtle works of William of Ockham were also out of favour having been banned before 1546 when Leighton returned to try to root out any stray copies.[13] However, it is Richard Cox who is the traditional villain of the piece. Even before the visitors arrived there had been some iconoclasm at Magdalen, but the most serious damage to libraries was committed by them. Wood tells us of their activities:

> The ancient libraries, a glory of the university, as containing among them many rarities, the works of our own country men, besides many matters obtained from remote places, were by them or their appointment rifled. Many MSS, guilty of no other superstition than red letters in their fronts or titles were either condemned to fire or jakes. Others also that treated of controversial or scholastical divinity were let loose from their chains, and given away or sold to Mechanicks for servile uses.

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[9] N. R. Ker, *Medieval Libraries of Great Britain, a List of Surviving Books* (London Royal Historical Society, 1964). p. xv.
[10] See for instance E. S. Leedham-Green and R. J. Fehrenbach, *Private Libraries in Renaissance England: a Collection and Catalogue of Tudor and Early Stuart book-lists* (Marlborough, 1993). v. 1. PLR 47 shows six manuscripts for a penny in 1529 and PLR 15 shows ten 'old parchment books' for 16d.
[11] J. M. Fletcher, ed., *Registrum annalium Collegii Mertonensis, 1567 - 1603* (Oxford, 1974). p. 274.
[12] Wood, *History and Antiquities.* p. 108.
[13] Ibid. p. 81.

> Sure am I that such books wherein appeared Angles or Mathematical diagrams were thought sufficient to be destroyed, because accounted Popish, diabolical or both.[14]

Wood continues by saying he has heard that even some Greek New Testaments were destroyed by the over-zealous reformers. The fact that rubrication could be construed as sufficient reason to destroy a manuscript has been held up as a particular sin and the statement is often repeated. The reference to anything with a diagram on it being destroyed has been held up as evidence that the reformers were against such liberal knowledge, or else highly credulous about magic. There does seem to have been some confusion between mathematics and witchcraft.[15] However, Wood probably wants us to believe that it was books like Euclid's *Elementa*, commonly found in impressive folios with plenty of diagrams in evidence, which were the victims of this misplaced zeal.

In his *Brief Lives*, John Aubrey (1626 – 1697) claims Thomas Allen (1540 – 1632) was accounted a conjuror by the vulgar on account of his mathematical learning and collection of instruments.[16] John Dee was also accounted a wizard and accused of witchcraft during the reign of Mary I.[17] In his case, the accusation was probably fair.

Despite these contemporary accusations against mathematicians, serious doubt is cast on the story of the destruction at Oxford when we find it is probably derived from a recollection of John Aubrey, who is quoted as writing:

> My old cosen Parson Whitney told me that in the Visitation of Oxford in Edward VI's time they burned Mathematical books for conjuring books and if the Greeke Professor had not accidently come along, the Greeke New Testament had been thrown into the fire for a Conjuring booke too.[18]

The Greek professor at the time was George Etheridge (1519 – 1588) whom the visitors would deprive of his job on account of his Catholicism.[19] It is as difficult to imagine the visitors taking orders from Etheridge as it is to imagine them not

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[14] Ibid. pp. 106 – 7.
[15] See J. P. Zetterberg, "The Mistaking of "the Mathematicks" for Magic and Tudor and Stuart England," *Sixteenth Century Journal* 11 (1980).
[16] John Aubrey, *Brief Lives*, ed. John Buchanan-Brown (Harmondsworth, 2000). p. 370.
[17] R. Julian Roberts, "Dee, John (1527–1609)", *Oxford Dictionary of National Biography*, Oxford University Press, Sept 2004; online ed, May 2006 [http://www.oxforddnb.com/view/article/7418, accessed 8 June 2006]
[18] John Aubrey, *Brief Lives*, ed. Oliver Lawson Dick (London, 1949). p. xxxvii.
[19] Colin Matthew, Brian Harrison, and Lawrence Goldman, eds., *Oxford Dictionary of National Biography* (Oxford, 2004). "George Etheridge".

recognising a Greek New Testament in the first place. Nor can we rely on Aubrey's cousin to relate something that happened long before he was born.

Nevertheless, the university library with Duke Humphrey's collection of manuscripts did disappear. Even the desks that the books had been chained to were sold off during the reign of Mary I, which strongly suggests the library had already been emptied.[20] N.R. Ker quotes Edward Weston (c. 1565 – 1635), writing in 1602, as evidence that Duke Humphrey's books were burnt on the orders of Richard Cox:

> But he [Cox] recently destroyed many writings of various men in the Oxford Library, packed together as if by envy in a common treasury, to the fire as rude and barbaric heresy, the most serious burning since Diocletian.[21]

Weston, however, was a Roman Catholic exile and hardly likely to give Cox a good press.[22] Ker also quotes Gerald Langbaine's (1608/9 – 1658) biography of John Cheke from 1641:

> What other effect the visitiation had, does not well appear, but (tis said) Richard Coxe who was one of them, did so clearely purge the Vniuersitie – Librarie of the Monumenta of superstition, that he left not one booke in it of all those goodly manuscripts, of which by the munificence of several benefactors, that place was amply furnished.[23]

This seems to be the source that Thomas Fuller (1607/8 – 1661) was using in his *Church History* when he unwillingly blames Cox for the deed, noting also:

> The effects of this visitation do not occur, save only that they so clearly purged the university from all the monuments of superstition that they left not one book of many goodly manuscripts.[24]

Richard Cox was an evangelical clergyman of formidable reputation but hardly a complete philistine. As well as Dean of Christ Church, he was a tutor to Edward VI. He had a library of nearly 200 volumes of his own[25] and his draft statutes

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[20] N. R. Ker, "The Provision of Books," in *A History of the University of Oxford: The Collegiate University*, ed. J. K. McConica (1986). p. 466.
[21] Ibid. p. 466, n. 3. "Illorum autem et aliorum multorum scripta in Bibliothecam Oxoniensem, veluti in communem thesaurum congesta invidiosa, rudis ac barbara haeresis nupero incendio, at post illud Diocletiani gravissimo devastavit."
[22] Peter Milward, "Weston, Edward (1565?–1635)", *Oxford Dictionary of National Biography*, Oxford University Press, 2004 [http://www.oxforddnb.com/view/article/29118, accessed 24 May 2006]
[23] Ker, "The Provision of Books." p. 466. n. 3.
[24] Thomas Fuller, *The Church History of Britain*, 3rd ed., 3 vols., vol. 2 (London, 1842). p. 317.
[25] Leedham-Green and Fehrenbach, *PLRE*. v. 1, PLRE 1.

for Christ Church, Oxford included a new mathematics lecturer which is hardly consistent with the man supposedly responsible for denuding Oxford's libraries of mathematical texts.[26]

Nevertheless, only ten books survive of the original donation of almost 300 made to Oxford by Duke Humphrey, although another thirty of his manuscripts not given to Oxford are also extant.[27] Ker notes that a lack of pastedowns from the Oxford University library dating from before the 1540s suggests that the books really were burnt rather than being sold on to booksellers.[28] However, the evidence from the pastedowns is ambiguous. Ker lists 819 of them dating from 1515 – 74 of which only two can be traced to Merton and none to New College. Yet, we know that hundreds of manuscripts were lost from both these colleges. We are told by Wood that Merton sold a whole cartload of manuscripts to a bookseller:

> From Merton Coll. Library a cartload of MSS and above were taken away, such that contained the Lucubrations (chiefly Divinity, Astronomy and Mathematicks) of divers of the learned fellows thereof, in which studies they of the two last centuries obtained great renown.[29]

Wood tells us this story comes from a second hand recollection of the above-mentioned Thomas Allen although he would have been under ten at the time and not yet up at Oxford. Allen was an assiduous collector of scientific manuscripts, many of which are now preserved in the Bodleian Library.[30] Perhaps Wood meant an earlier Thomas Allen (d. 1561)[31] but this makes the information third or fourth hand rather than just second hand as Wood claims. Wood goes on to relate how some of these discarded manuscripts ended up in the new Bodleian Library and sure enough twenty-five medieval manuscripts from Merton, including six that could be described as mathematical, are now found there.[32] It has been suggested that the books discarded by the college were the circulating library (of which there are only four survivals out

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[26] J. K. McConica, "The Rise of the Undergraduate College," in *A History of the University of Oxford: The Collegiate University*, ed. J. K. McConica (Oxford, 1986). p. 37.
[27] David Rundle, "The Dispersals of the Library of Humfrey, Duke of Gloucester," in *Lost Libraries*, ed. James Raven (London, 2004). p. 114.
[28] Quoted in Ramsey, "The Break-Up of English Libraries." p. 134.
[29] Wood, *History and Antiquities.* p. 107.
[30] Andrew G. Watson, "Thomas Allen of Oxford and his Manuscripts," in *Medieval Scribes, Manuscripts and Libraries: essays presented to N.R. Ker*, ed. M. B. Parkes and A. G. Watson (London, 1978).
[31] Leedham-Green and Fehrenbach, *PLRE*. v. 3, p. 45.
[32] Ker, *Medieval Libraries of Great Britain, a List of Surviving Books*. p. 147.

of a total of 164) rather than the chained library although the manuscripts held by the Bodleian feature in Merton's medieval catalogue so this does seem rather unlikely.[33] In fact, we know of 1,200 manuscripts from Merton's medieval library, of which 320 survive *in situ*,[34] but many of the losses can be accounted for by natural wastage. It is more probable that the books were discarded to make way for the £68 of new books required to reflect the humanist and Protestant emphasis of the reformed syllabus.[35] Other colleges also invested in their libraries at this time. All Souls had spent at least £46 in the previous few years and no doubt some of the manuscripts looked very scruffy next to a spanking new copy of the Aldine Aristotle.[36] Even Oriel College spent £30.[37] All would have needed to free up some desk space for the new purchases.

The losses may not have all taken place at the time of the visitation. An "Acte for the abolishinge and putting away of diverse Bookes and Images" was passed in the parliament of 1549/50. Its provisions ordered:

> …all Bookes called Antyphones, Myssales, Scrayles, Precessionalles, Manuelles, Legends, Pyes, Portuyses, Prymers in Lattyn or Inglishe, Cowchers, Journales, Ordinales or other bookes or writings whatsoever heretofore used for service of the church, wrytten or prynted in the Inglishe or Lattyn tongue… cause them ymmediately eyther to be openlye brent or otherways defaced and destroyed.[38]

Obedience to these instructions could very easily spill over into a wider sphere and involve the destruction of other sorts of books as well. John Bale is quoted by Wood regarding the loss of manuscripts in the Reformation, "Yea, the unyversyties of thys realme are not all clere in this detestable fact."[39]

At Cambridge, the libraries were being neglected even before the reign of Edward. We know that in the early 1540s, Roger Ascham and John Cheke borrowed four manuscripts from the university library, none of which were ever returned.[40] In 1546, the situation had got so bad that the university closed down one of the two

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[33] Edmund Craster, *History of All Souls College Library* (London, 1971). p. 19.
[34] G. H. Martin and J. R. L. Highfield, *A History of Merton College* (Oxford, 1997). p. 79.
[35] Ibid. p. 152.
[36] Ker, "The Provision of Books." p. 448.
[37] H. E. Salter and G. C. Richards, eds., *The Dean's Register of Oriel 1446 - 1661* (Oxford, 1926). p. 124.
[38] *Statutes of the Realm*, (London, 1963). v. 4, pt. 1, p. 101.
[39] Wood, *History and Antiquities.* p. 109.
[40] J.C.T. Oates, *Cambridge University Library: A History. From the Beginnings to the Copyright Act of Queen Anne*, 2 vols., vol. 1 (Cambridge, 1986). p. 83.

library rooms on account of lack of use.[41] In 1535, John Leland visited Clare Hall and found eleven manuscripts of interest to him, including plenty of natural philosophy. By the time the library was catalogued in 1556, at most two on these manuscripts survived *in situ*.[42]

Book Losses due to the 1556 Visitations

No sooner had the Edwardian visitors purified the universities of papist superstition, than the Marian visitors arrived in search of Protestant heresy. The visitors demanded that everyone produce a list of their books that could be vetted for heretical titles. As John Foxe notes with regard to Cambridge, "This commandment some executed exactly and diligently; other some, forasmuch as they deemed it wrongful, executed it slack enough."[43] When the visitors arrived in late 1556, the city stationers were also searched and catalogues made of the contents of the college and university libraries (some of which survive and are included in appendix six). John Mere tells us that on 11th February 1557 "A great basket full of bookes [brought] unto the Visitors which they perused and some they abled and many appointed to be brent." Then on the 16th February, "Bucer and Fagius were taken up owt of their graves and about ix of the clock brent in the marketplace and a cart load of Bookes with them."[44] Foxe agrees about the books being burnt with Fagius and Bucer: "Fire being forthwith put to, as soon as it began to flame around about, a great sort of bookes that were condemned with them, were cast into the same."[45] Wood tells us that at Oxford, "All the English Bibles also that they could find and all Commentators on it in the same language, which were for their number almost infinite, they burnt in the common marketplace."[46] The surviving library lists suggest that Protestant books were carefully targeted as the tables above show there was nothing like the loss of books there had been in previous visitations. We should note, however, that the lists' compilers would be unwilling to include books of which the visitors were known to disapprove, hiding them or handing them over instead.

[41] J. Venn, ed., *Grace Book Δ* (Cambridge, 1910). p. 47.
[42] Clarke, *University and College Libraries of Cambridge*. UC14.
[43] John Foxe, *Acts and Monuments*, ed. S. R. Cattley, 8 vols., vol. 8 (London, 1837 - 41). p. 274.
[44] John Lamb, ed., *A Collection of Letters, Statutes, and other Documents, from the Manuscript Library of Corpus Christi College: Illustrative of the History of the University of Cambridge, during the Period of the Reformation* (London, 1838). pp. 215 – 7.
[45] Foxe, *Acts and Monuments.* p. 283.
[46] Wood, *History and Antiquities*. p. 136.

It is unlikely that deliberate destruction extended beyond books considered actively heretical. Aside from the single third-hand reference in Wood, which appears to be part of the general regret for the passing of Oxford's mathematical pre-eminence in the days of the Merton calculators, there is no good evidence that quadrivium subjects were specifically targeted. Yates and McLean perhaps take Wood a little too literally. It was certainly the case that a vast number of manuscripts ended up as binding for new books. For example, the Queens' College, Cambridge lost a substantial library of manuscripts in the early sixteenth century but we can be sure that some of it has ended up forming the binding of the college's early accounts books.[47] The sheer quantity of medieval manuscript to be found inside the covers of sixteenth-century books shows that there was a considerable industry devoted to recycling this material.[48] Even notebooks and commonplace books were bound with manuscript pastedowns.[49] Between the advent of printing and the early antiquarians like William Camden (1551 – 1623), there was a deadly period in which most manuscripts were not valued as anything except binding and wastepaper. Were it not for the work of collectors like Matthew Parker (1504 – 1575) and Andrew Perne, the situation would have been even worse. The drop in the price of printed books through the sixteenth century served to render manuscripts almost worthless. Combined with the dispersal of the monastic libraries, the losses have been catastrophic and not less so because nobody was actively trying to destroy mathematical books.

The Contents of College Libraries after 1535

Besides the loss of old books and manuscripts, the libraries of the colleges were subject to overhaul as a result of changes in religious and educational regime set in train by the Tudor university visitations. Unfortunately, the rather *ad hoc* way that colleges accumulated books means that we cannot draw many hard and fast conclusions from what they had in their libraries at a given date. Benefactions and books owned for a long time need have had no relevance to the current subjects being studied. However, we saw above that spending on new books was quite marked in the mid-sixteenth century and the newer colleges like Corpus Christi College, Oxford must have acquired all their books in the recent past.

[47] Cambridge, University Library, Queens' College Archives volumes 1 – 4ff.
[48] For the period 1515 – 74, Ker found 819 at Oxford for N. R. Ker, *Pastedowns in Oxford Bindings*, *Oxford Bibliographical Society New Series* (Oxford, 1951).
[49] See, for example, the notebooks of Sir Henry Savile, Oxford, Bodleian Library, MSS Savile 26 – 32.

The extant library catalogues are summarised in appendix six. There are rather fewer for Oxford than for Cambridge.[50] It is immediately clear from appendix six that mathematics and natural philosophy were not priorities in the purchase or giving of books. Rather, as expected, theological and law books were by far the most commonly owned. The reason for this was that most colleges were intended as places to support those enduring the long years of study for divinity or law degrees. Although a few fellows might have had other interests, we should not expect these to be reflected in institutional libraries. An extreme example comes from the catalogues of St John's College, Cambridge from 1544 and 1556. Despite what we know about the teaching of John Cheke, the promotion of the quadrivium in the college statutes that he drafted, neither catalogue contains any mathematics at all.[51] On some occasions, the buying policy probably did have one eye on the syllabus so that masters would have the books they needed for lectures available. We saw in chapter two how All Souls library provided a full set of books for the quadrivium in 1505.

The 1549 syllabus gave more attention to the quadrivium than natural philosophy and this is reflected in many of the college library catalogues. Of the four Oxford colleges for which we have catalogues from the second half of the sixteenth century, three show a much higher proportion of mathematics than natural philosophy. All Souls is the exception. The texts from the syllabus – Euclid and Ptolemy were found in all four libraries and Corpus Christi also had two copies of Tunstall's *De arte supputandi*. Of the natural philosophy texts stipulated in 1549, Pliny is omnipresent and the *Timaeus* doubtless found in the many *Opera* of Plato. The natural philosophy in the All Souls and Corpus Christi libraries was made up of various texts, but the Greek commentators such as Simplicius and John Philoponus are well represented. This is in contrast to the probate lists where we have rarely encountered these authors. The basis of the library of Corpus Christi College, Oxford was bequests from the founder, Richard Fox,[52] the first master John Claymond[53] and

[50] Thanks to the kindness of its editor, Rod Thomson, I have seen the draft of the *Corpus of Medieval Library Catalogues* project volume for Oxford and included the relevant lists from therein.
[51] D. McKitterick, "Two Sixteenth Century Catalogues of St John's College Library," *Transactions of the Cambridge Bibliographical Society* 7 (1978).
[52] R. Liddell, "The Library of Corpus Christi College Oxford" (University of Oxford, 1938). pp. 18 – 23.
[53] Ibid. p. 34.

books from the library of the humanist, William Grocyn.[54] As with all college libraries, it reflected the interests of its benefactors, which were, in this case, primarily humanist. There was an unrivalled collection of Greek, which sent Erasmus into heights of hyperbole,[55] plenty of natural philosophy (in large part due to Claymond) and a few books intended for students like the Latin Euclid from Claymond, specifically for the clerks. But, just having a library full of new books does not mean anyone will read them. Leader notes that while the medieval commentators have done 'sterling service' both at Corpus Christi and Balliol, classical and humanist works seem little read.[56]

At Cambridge, very few books relevant to the quadrivium or natural philosophy were to be found in the libraries. This extends even to those that were prescribed by the syllabuses during the period. A copy of Tunstall's *De arte supputandi* in the University Library (where it remains) is a signed vellum version presented by the author.[57] Tunstall was not ungenerous about handing these out and one of the copies at Corpus Christi College, Oxford is also an inscribed edition presented to Richard Fox.[58] Caius College owned this book too. Pliny can be found in many of the Cambridge libraries but, surprisingly, there is no Euclid. We noted earlier that mathematics did not gain much of a following at Cambridge before 1549 and the college libraries seem to confirm this. The natural philosophy books at Cambridge are almost entirely made up of editions of Aristotle and a few commentaries thereon. Donors seemed keen on presenting the *Opera* of Aristotle, especially if it was in Greek. John Fisher gave a set to Christ's College and Tunstall to the University Library. [59] There was probably an element of showing off when someone presents an expensive set of Greek texts – it showed the donor was both rich and learned.

The number of early mathematics and natural philosophy rare books in Oxford and Cambridge libraries today easily exceeds the measly return from the sixteenth-

[54] M Burrows, "Linacre's Catalogue of Grocyn's Books followed by a Memoir of Grocyn," in *Collectanea 2nd series* (Oxford, 1890).
[55] Erasmus, *Correspondence 6*. p. 406.
[56] D. R. Leader, *The University to 1546*, vol. 1, *A History of the University of Cambridge* (Cambridge, 1989). p 237.
[57] Cambridge, University Library, shelf mark Sel.3.262.
[58] Liddell, "The Library of Corpus Christi College Oxford". p. 39.
[59] Cambridge, Christ's College Library, MS 22 "Donations book". p. 6 and J. C. T. Oates and H. L. Pink, "Three Sixteenth Century Catalogues of the University Library," *Transactions of the Cambridge Bibliographical Society* 1 (1952). p. 332.

century catalogues.[60] My non-exhaustive survey of surviving works suggests the great majority of these books arrived in the college libraries much later than the sixteenth century. We can speculate that many of the books found in the probate lists later ended up in college or university libraries, as we know happened in the cases of Thomas Lorkin,[61] Andrew Perne,[62] Thomas Paynell and Reginald Pole.[63] Overall, then, the college library catalogues tell us little about the sixteenth-century intellectual environment outside theology and law.

[60] See H. M. Adams, *Catalogue of Books Printed on the Continent of Europe 1501 - 1600 and in Cambridge Libraries*, 2 vols. (Cambridge University Press, 1967). While there are many copies of Gemma and Sacrobosco, sixteenth century natural philosophy such as Lefèvre is much less well represented.
[61] Charles Sayle, "The Library of Thomas Lorkin," *Annals of Medical History* 3 (1921).
[62] D. McKitterick, "Andrew Perne and his Books," in *Andrew Perne*, ed. D. McKitterick (Cambridge, 1991).
[63] A. B. Emden, *A Biographical Register of the University of Oxford from AD 1501 to 1540* (Oxford, 1974). pp. 728 – 730 and 733 – 735.

Chapter Six: The Evolving Market for Textbooks

"There is always the carelessness of printers to contend with." [1]

Erasmus, Introduction to Pliny's *Naturalis historia* (1525)

The textbook market became increasingly advanced through the sixteenth century. Almost all of those used at the English universities had to be imported. England, it seemed, simply lacked the expertise to produce the technical volumes being printed in the rest of Europe. A few textbooks had been produced in England at the end of the fifteenth century, but the printers who issued them tended to be from the continent.

This chapter will argue that one of the major reasons for textbooks being much more frequently replaced than they were in the era of manuscripts was competition and new developments in the market for books. Obviously, the cheaper price of a printed volume and the further drop in the cost of books as printing became established was a major factor. A related economic reason was the development of a large second-hand market, which enabled students to get hold of texts even more cheaply than printers were willing to sell them for. However, it was not just cheaper prices that persuaded students to change their books much more often. As competition heated up, printers offered their customers a greater variety of reader's aids, handier formats and even colour. The trend towards producing translations and original vernacular compositions on academic subjects is, this chapter argues, another facet of printers trying to develop new markets. To do so, they had to provide readers with the knowledge they required in the most convenient package possible.

The change of attitude towards books, treating them as consumables, fed into the way that the new syllabuses at Oxford and Cambridge were interpreted. Now books were expected to be up to date and were cheap enough to replace every few years rather than every few centuries, it was inevitable that the syllabuses would be read in the light of the latest textbooks. No longer was it assumed that the same sources should be used decade after decade. Instead, new books penetrated the student market, were adopted, became the standard text and then dropped out of circulation again as they were superseded. Thus the college libraries contain very few of the

[1] D. Erasmus, *The Correspondence of Erasmus*, ed. Wallace K. Ferguson, D. F. S. Thomson and Sir Roger Mynors trans., vol. 11 (Toronto, 1974 -). p. 27, letter 1544.

books that were used day to day by students, both because they hardly catered for the arts faculty and because the shelf life of any particular textbook was very short compared to the purchasing cycle of the libraries.

The market in books

The most obvious point to make about the market in Latin mathematical and natural philosophical books is that they were almost never printed in England. There are only three exceptions during our period (as well as a few books written in English): John Canonicus's *Questiones super octo libros Physicorum Aristotelis* (St Albans, 1481), Alexander ab Alexandria's *Exposito super libros Aristotelis de anima* (Oxford, 1481) and Cuthbert Tunstall's *De arte supputandi* (London, 1522). However, the printers of these works had travelled from the continent and set up shop in England. There was no native talent able to produce titles such as these at all.[2] There are also several textbooks on logic, moral philosophy and one edition of Antonius Andreae's *Questiones super duodecim libros metaphysicae Aristotelis* (London, 1490). That both the Andreae and John Canonicus were published in England and appear on the short list of books to be lectured on at Oriel College up until 1535 may not be entirely coincidental.[3] This lack of native printers equipped to deal with philosophical treatises did not go unnoticed by English scholars and was one of the reasons identified in the 1550s by the Cambridge Regius Professor of Greek, Nicholas Carr, for the lack of English scholarship.[4] This could be a cause for serious embarrassment as the multitude of errata to Billingsley's translation of Euclid shows. The list is headed with a brief explanation blaming the in-house corrector for having problems with a technical work "for that the matter in it contayned is straunge to our Printers here in England, not having bene accustomed to Print many, or rather any, bookes contayning such matter."[5] Mistakes by compositors subverted the tendency for a printed copy to enjoy greater authority than the manuscript and some humanists felt that print was only introducing yet more corruptions. Further editions

[2] Theodoric Rood of Oxford was from Cologne and Richard Pynson of London from Normandy. See the relevant entries in Lotte Hellinga and George C. Painter, *Catalogue of books printed in the XVth century now in the British Library. Part 11, England* ('t Goy-Houten, 2007). p. 17 and p. 236.
[3] H. E. Salter and G. C. Richards, eds., *The Dean's Register of Oriel 1446 - 1661* (Oxford, 1926). p. 26ff.
[4] Nicholas Carr, *De scriptorum britannicorum paucitate* (London, 1576). fol. 16v.
[5] Quoted in D. McKitterick, *Print, Manuscript and the Search for Order, 1450 - 1830* (Cambridge, 2003). p. 120.

based on the original erroneous one meant some mistakes enjoyed very long shelf lives.[6]

If we assume that the two universities were the primary consumers of Latin textbooks above an elementary level, it would also follow that they were the main market for English printers of such texts. For such a market to be worth supplying, it would have to stay above of a certain size. As such, the rapid fall in the universities' populations during the Reformation, primarily caused by the suppression of the regular clergy, would have made them an unappealing prospect for book printers. Oxford dropped from some 1,700 members in 1500 to only about 1,000 in 1552.[7] More seriously, only a hundred new students a year were matriculating at Oxford through the 1540s which was an inadequate base upon which to build a printing shop.[8] Print runs were frequently in the thousands by the sixteenth century so a maximum potential domestic market of a few hundred a year would not have been economical.[9] It was not until the 1570s, when up to a thousand new students per annum entered the gates of the universities, that a sustained market for anything but the most basic textbooks existed.[10] In 1588, Johann Velcurio's *Epitomae physicae libri IV*, the first Latin natural philosophy book to be printed in England for a century, came off the press of Christopher Barker in London.[11]

The university booksellers whom we know from their account books and probate lists were commonly foreigners. John Dorne was from Brunswick,[12] while Garrett Godfrey and Nicholas Pilgrim were Dutch.[13] It is likely that their contacts with overseas printers were as good as with the London book trade. Even when a London printing was available, the Cambridge booksellers preferred to use their

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[6] Paul Grendler, "Printing and Censorship," in *Cambridge History of the Renaissance Philosophy*, ed. Charles Schmitt and Quentin Skinner (New York, 1983). p. 36.
[7] J. K. McConica, "Studies and Faculties: Introduction," in *A History of the University of Oxford: The Collegiate University*, ed. J.K. McConica (Oxford, 1986). p. 152.
[8] Lawrence Stone, "The Size and Composition of the Oxford Student Body 1580 - 1909," in *The University in Society*, ed. Lawrence Stone (Princeton, 1974). p. 16.
[9] Rudolf Hirsch, *Printing, Selling and Reading 1450 - 1550* (Wiesbaden, 1967). p. 67.
[10] Stone, "The Size and Composition of the Oxford Student Body 1580 - 1909." p. 6.
[11] STC 24632. A. W. Pollard et al., *A Short-title Catalogue of Books Printed in England, Scotland, & Ireland and of English Books Printed Abroad, 1475-1640*, 2nd ed., 3 vols. (London, 1976 - 1991).
[12] E. S. Leedham-Green, "University Libraries and Booksellers," in *The Cambridge History of the Book in Britain: 1400 - 1557*, ed. J.B. Trapp and Lotte Hellinga (Cambridge, 1999). p. 350.
[13] E. S. Leedham-Green, *Books in Cambridge Inventories: Books from the Vice-Chancellor's Court Probate Inventories in the Tudor and Stuart Periods*, 2 vols. (Cambridge, 1986). v. 1, p. 61.

overseas suppliers.[14] They could order more unusual books from abroad if they were especially requested by a buyer as well as purchasing more common texts if no London edition was available.[15]

The mere fact that so many books from Germany, Italy and France were common in England shows the rude health of the international book trade. By 1545, books were common enough imports to be included in the Book of Rates which laid down valuations for many types of cargo.[16] Books were assessed as £4 per basket, which corresponds to roughly one penny an octavo book. Although this is low, we should remember that the books were unbound and this was a wholesale, not retail price. The importer had to pay import duty of 6¼ per cent on the valuation of one penny, which was clearly not a significant cost once passed on to the final customer.[17] The cost of carriage would have been a more important cost but it was obviously not so great that it made foreign books prohibitively expensive.

The individuals who taught mathematics and natural philosophy furnish plenty of examples of travel to practically every foreign publishing centre. They had plenty of opportunity to see which books were popular at overseas universities. We cannot say that Roger Collingwood's two sojourns at Paris to read canon law in the early sixteenth century are related to the popularity of textbooks by Lefèvre back at Cambridge. Nor can we point to a specific individual among the large number of Englishmen exiled to Germany during the reign of Mary I who brought back a copy of Velcurio's textbook on natural philosophy. Rather, it is the sheer density of cross-channel connections that means we should not be surprised that so many foreign books ended up in England. The trade was not entirely one way, however. The first edition of Cuthbert Tunstall's *De arte supputandi* (London, 1522) exists in a contemporary and very handsome French binding.[18] Of course, Tunstall was a fully paid up member of the international humanist intelligentsia who was also the subject of the dedication by Simon Grynaeus to the Greek Euclid (Basel, 1533). Besides,

[14] D. McKitterick, *A History of Cambridge University Press: Printing and the Book Trade in Cambridge 1534 - 1698* (Cambridge, 1992). p. 41.
[15] Leedham-Green, "University Libraries and Booksellers." p. 351.
[16] Paul Needham, "The Customs Rolls as Documents for the Printed-Book Trade in England," in *The Cambridge History of the Book in Britain: 1400 - 1557*, ed. J.B. Trapp and Lotte Hellinga (Cambridge, 1999). p. 159.
[17] Ibid. p. 160.
[18] Cambridge, Corpus Christi College, shelf mark SP 296.

Robert Estienne of Paris was reprinting Tunstall's *De arte* in 1529 for which there was presumably considerable demand among French students.

Incunabula editions of mathematics and natural philosophy are weighted heavily towards Venice. The city enjoyed sixty per cent of the English trade in science books during the fifteenth century.[19] By the 1520s, Paris had muscled into half this market. Early-modern writers tended to see their works printed in fewer locations than Euclid or Aristotle. Of the popular textbooks, Peter Apian's *Cosmographia* comes mainly from Antwerp, Gemma's *Arithmeticæ practicæ methodus* from Antwerp and Lyon, Tunstall's *De arte supputandi* from Paris and Strasbourg, Lefèvre from Paris, Velcurio from Tübingen and Titelman from Antwerp, Paris and Lyon. Much of the reason that the centre of gravity shifted to the north must be that many booksellers in England, such as John Dorne and Garrett Godfrey, were from Holland or Germany. They used their own connections rather than relying on the existing Italian trade.

Although we tend to think of print and manuscript as two radically different mediums, this point of view took a while to emerge. In the sixteenth century, there was no reason not to bind printed and handwritten material together[20] and we would probably see many more examples of this if not for the wish of later librarians to have all their manuscripts in one place. The catalogue of Syon monastery certainly treated the two mediums as one and the same, noting the first words of the second folio as an identifier for both.[21] This is not to say that the effects of print culture were anything short of revolutionary or did not make themselves felt almost immediately. In the case of Hyginus' *Astronomica* we can trace the journey from manuscript to print over a period of less than fifteen years. In about 1470 a beautiful manuscript was produced in northern Italy where Hyginus' brief description of each constellation was accompanied by an illustration showing a picture of the figure with stars shining through.[22] In 1475, a printed edition of the same work was prepared but in an identical format. The printer left the half pages blank so as to allow an illustrator to fill in the

[19] Margaret Lane Ford, "Importation of Printed Books into England and Scotland," in *The Cambridge History of the Book in Britain: 1400 - 1557*, ed. J.B. Trapp and Lotte Hellinga (Cambridge, 1999). p. 190.
[20] For example Cambridge, Corpus Christi College Library, MS 420 where a guide to astrology in English is bound with Latin technical astronomical treatises.
[21] McKitterick, *Print, Manuscript and the Search for Order, 1450 - 1830*. p. 52.
[22] Cambridge, Fitzwilliam Museum, MS 260.

pictures by hand. By the 1482 edition, the process was complete and woodcuts had been printed as well as the text.[23] Another hangover from manuscripts that lasted well into the sixteenth century was the habit of leaving capitals out of the print edition so that they could be inserted later by a rubricator.[24] As it turned out most copies were never so decorated but one does occasionally see very attractive examples.[25]

The Evolution of the Printing Industry

Over the first century of the printing era, publishers found many ways of harnessing the new technology to meet the needs of their customers. They needed to offer readers more than raw knowledge, in large part because there was no such thing as copyright. Although printing privileges existed, these could be enforced only locally.[26] Textbooks had been a staple of the printing industry from its earliest days because there was a guaranteed local market of masters and students. The first press in Paris was set up at the Sorbonne for precisely this purpose. Like books aimed at the university market in Cologne, the earliest Parisian books were issued in quarto rather than folio format, presumably with an eye on attracting the student market.[27]

For a book without a certain market, the author would usually have had to make a substantial contribution to printing costs. In return they might receive copies of the work that they could try to sell on their own account.[28] It is likely, for example, that Cuthbert Tunstall paid Richard Pynson to print the quarto first edition of *De arte supputandi* (which cannot be considered a student textbook) and received some vellum copies to distribute among his friends. Erasmus promptly gave his copy away to a Polish bishop.[29] As we saw in the last chapter, Richard Fox and the University of Cambridge received vellum copies inscribed by the author.

The whole exercise was simply one of self-promotion and the hope for some reciprocation of the gifts. The fact that he had written rather a good textbook entirely secondary. Neither Tunstall nor Pynson would have seen any of the proceeds from

[23] McKitterick, *Print, Manuscript and the Search for Order, 1450 - 1830*. p. 76.
[24] The Aldine press was particularly prone to this. It is present until at least 1518. See their Pomponius Mela, *De situ orbis* (Venice, 1518).
[25] For example, Cambridge, King's College Library, shelf mark XV.6.8, Suiset [Richard Swineshead], *Liber de calculatione* (Padua, n.d.)
[26] Grendler, "Printing and Censorship." p. 33.
[27] Hirsch, *Printing, Selling and Reading 1450 - 1550*. pp. 19 and 50.
[28] Grendler, "Printing and Censorship." p. 31.
[29] Erasmus, *Correspondence 11*. p. 319.

Robert Estienne's subsequent octavo Parisian editions, intended for the student market and to make money. Another tactic adopted by printers was to trump their rivals with marginally different new editions, preferably with the name of a famous scholar on the cover. Thus we see terms like "freshly amended" or "now recently amended by the author and increased significantly in many places".[30] Erasmus milked this system to his advantage by dashing off dedicatory epistles to prefix works he had nothing much to do with.[31] We can imagine he supplied a dedication to Gryaenus' 1531 edition of Aristotle in Greek because he thought it was a worthwhile project. But his introduction to Pliny's *Naturalis historia* (Basel, 1525) was just a favour, whether remunerated or not, to the printer Jerome Froben and he was not responsible for much of the textual work.[32] Authors also hoped for material gain from offering dedications or gifts of books to rich individuals. Erasmus accused Tunstall of just this ploy and joked he made more by giving his books away than he could ever hope to by selling them.[33]

The best way, however, to sell a book was to ensure that buyers would appreciate it. Printers would add value for their customers in many ways. Lacking a new translation or even a new commentator, John Grieninger of Strasbourg used Jacopo Angelo's text, with Regiomontanus' annotations, for a large format edition of Ptolemy's *Geographia*. This includes specially cut decorated capitals featuring various surveying instruments as well as intricate borders on each page.[34] Few students would have been able to afford this, but a wealthy doctor like the 1549 visitor Thomas Wendy could. He gave his copy to Caius College where it remains.[35] Such deluxe editions of learned texts made ideal gifts to educational institutions.

It was also common to print standard texts like Aristotle with a commentary or to print the commentary with the text appended. Reader aids like pagination, indexes (found in the Ptolemy referred to above) and more readable fonts were all the product of printers in a fiercely competitive environment trying to give their customers what

[30] "Denuo emandata" from cover of ; "iam recens ab ipso authore emendata, & multis in locis insigniter aucta" from cover of Gemma Frisius, *Arithmeticæ practicæ methodus facilis* (Paris, 1556).
[31] Grendler, "Printing and Censorship." p. 35.
[32] Erasmus, *Correspondence 11*. p. 26.
[33] Natalie Zemon Davis, "Beyond the Market: Books as Gift in Sixteenth-Century France," *Transactions of the Royal Historical Society* 33 (1983). p. 69.
[34] Claudius Ptolemy, *Geographia*, ed. Johannes Regiomontanus (Strasbourg, 1525).
[35] E. S. Leedham-Green, "A Catalogue of Caius College Library, 1569," *Transactions of the Cambridge Bibliographical Society* 8 (1981). p. 30.

they wanted.[36] In his survey of animal books, Laurent Pinon found that no incunabula had indexes. About a third of the books he examined which were printed in the first half of the sixteenth century were equipped with them. In contrast, two thirds of books from the second half of the century have them.[37]

Another way that printers sought to please students was in the production of omnibus editions. For example, the *Opera* of Joachim Fortius Ringelbergius was a compendium of a large number of short educational tracts, some of which had previously appeared separately, covering the seven liberal arts. Unlike the *Margarita philosophica*, Ringelbergius' work was published in a handy octavo format without any pictures. At an average of nine pence in the probate lists, this was not a cheap book, but the wide coverage meant that it could work out more economical for a student in the long run.

Let us take John Sacrobosco's *De sphera* as an example of how printers worked hard to recycle popular books and encourage students to buy new copies. Between the *editio princeps* of 1472 and 1570 there were at least forty-five editions of this common and essential work printed, some of which are listed in table 6.1.

We will recall from chapter two that *De sphera* is not very long with an un-annotated printed version taking up a mere eighteen quartos.[38] Clearly, there was not much money to be made from this and so, almost immediately after the *editio princeps* of 1472, printers started to add other works to the basic text. In this, they were imitating the owners of manuscripts who had bound their copies of Sacrobosco's three treatises together with astronomical tables and other aids.[39] The 1478 edition from Venetian Francis Renner came with the medieval *Theorica planetarum* (usually attributed to Gerard of Cremona) and thus provided both of the main works required for an astronomy course between one pair of covers. The 1482 edition from local rival Erhard Ratdolt included both the old *Theorica planetarum* and the *Theoricae novae planetarum* by Puerbach as well as some commentary from Regiomontanus. The trend of including extra works was continued in the 1488 and 1490 editions and the second of these introduced a new innovation – colour printing.

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[36] Grendler, "Printing and Censorship." p. 27.
[37] Ann Blair, "Annotating and Indexing Natural Philosophy," in *Books and the Sciences in History*, ed. Marina Frasca-Spada and Nicholas Jardine (Cambridge, 2000). p. 81.
[38] Paris, 1538.
[39] Olaf Pedersen, "The Corpus Astronomicum and the Traditions of Medieval Latin Astronomy," *Studia Copernicana* 13 (1975). p. 74.

Title of coverpage	Format	Date	City	Printer	Commentators	Location and shelfmark[40]
Johannis de sacrobusto ... spera mundi feliciter incipit	4º	1478	Venice	Francis Renner	Gerard of Cremona, *Theorica planetarum.*	BL, IA.19869
Joannis de sacro busto sphearicu~ opusculu~.	4º	1482	Venice	Erhard Ratdolt	Gerard of Cremona, *Theorica planetarum*. Peurbach, *Theoricae novae planetarum* and Regiomontanus, *Contra Gerardum.*	CUL
SPHAERA/MUNDI	4º	1488	Venice		Gerard of Cremona, *Theorica planetarum*. Peurbach, *Theoricae novae planetarum* and Regiomontanus, *Contra Gerardum.*	CUL, Waddleton. d.2.1
SPHAERA/MUNDI	4º	1490	Venice	Octavian Scot	Gerard of Cremona, *Theorica planetarum*. Peurbach, *Theoricae novae planetarum* and Regiomontanus, *Contra Gerardum.*	CUL, SSS.15.7
TEX/tus De Sphe/ra Johannis de Sa-/crobosco OPUSCULÛ JOÂ/NIS DE SACRO BUSTO	2º	1494	Paris	Wolfgang Hopyl	Lefèvre and Clichtove.	BL, IB.40135
SPE/RICUM	4º	1495	Leipzig	Martin Landsberg	Wenceslas Faber	BL, IA.11977
Opus sphericum magistri Joãnis de Sacrobustho natione Anglici	4º	1501	Cologne	Heinrich Quentel	Wenceslas Faber	Cantab, Pembroke Col., C35
TEX/tus De Sphe/ra Johannis de Sa-/crobosco OPUSCULÛ JOÂ/NIS DE SACRO BUSTO	2º	1507	Paris	Henri Etienne	Lefèvre and Clichtove with Bonetus on the *Astronomer's Ring* and a summary of Euclid.	CUL, Tb.54.3
SPE/RICUM	4º	1510	Leipzig		Wenceslas Faber	CUL, Adams.7.51.4
Sphera/cum commentis in hoc volumine/contentis videlicet	2º	1518	Venice	Octavian Scot	Cecco D'Ascoli, Capuanus, Lefèvre, Theodosius, Michael Scot, Pierre d'Ailly, Robert Grosseteste, Campanus, Regiomontanus and Peurbach.	CUL, F151.b.2.10
Spheræ tractatus Joannis de Sacro Busto	2º	1531	Venice	L.A. Junte	Gerard of Cremona, Puerbach, Campanus, Regiomontanus, Michael Scot, Lefèvre, Pierre d'Ailly, Vesputius, Robert Grosseteste, Campanus and Alpedragius, Gauricus	CUL, M.8.35
LIBER/IOANNIS DE SACRO BU-/STO DE SPHAERA	8º	1534	Venice		Preface by Philipp Melanchthon	CUL, Hanson.d.17
Ioannis de Sacro/BOSCO SPHAERA MUNDIALIS	4º	1538	Paris		None	CUL, M.10.57(2)
Ioannis de Sacrobusto libellus de sphæra	8º	1545	Wittenburg	Vitum Creutzer	Preface by Philipp Melanchthon and Ecclesiatical Computus.	Cantab, Trinity Col., T.19.2

Table 6.1

[40] BL – British Library, London; CUL – Cambridge University Library;

The printer, Octavian Scot, has enhanced his woodcuts by printing them in up to four different colours as well as marking out headings with different inks.[41] This trumped the printed rubrication that Ratdolt had been using since 1482. Adding pictures also helped to sell books and astronomy textbooks lent themselves to this treatment. Although there was considerable capital cost attached to producing the woodcuts in the first place, they were largely immune to piracy and could be reused in later editions. The fine woodcuts that decorate Gregor Reisch's *Margarita Philosophica* were used over and again.

Meanwhile, in Paris, printers had their eyes on the local market of students and brought out textbooks that advertised their suitability as learning aids. "New commentary recently added for the use of students at the University of Paris", announced one of the first of their editions of Sacrobosco.[42] This is also the first edition to be prepared under the auspices of Lefèvre who supplied the commentary advertised by the cover. Leipzig and Cologne printers instead added the notes of Wenceslas Faber.[43] The Venetians responded by adding more and more additional works until there were no less than eleven packaged together in 1518, including Cecco D'Ascoli, Michael Scot, Pierre D'Ailly and Robert Grosseteste, to make a big book.[44] The title page of this edition makes it the most likely candidate for the pair of *De sphera* in John Dorne's stock priced at a hefty 8d each (probably unbound).[45] How much use all these subsidiary titles actually received is another question. Edmund Shether, who incepted at All Souls in 1529, owned the 1518 Paris edition but he has only annotated the first two texts – the *Theorica planetarum* and Cecco's commentary on Sacrobosco. The remaining 500 or so pages are unmarked, as is the 1515 Venetian *Almagest* with which the volume is bound.[46] The 1531 edition from Venice went even further, packing in an impressive eighteen works in its two volumes.[47] By now it is unlikely that students would have been interested, but all this learning in a handsome package could attract professors and anyone with wealth and intellectual pretensions.

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[41] Venice, 1490.
[42] "Nouo cōmentario nuper edito Ad vtilitatem studentiu ̄Philosophice Parisien. ̄Academie." Paris, 1494.
[43] Leipzig, 1495; Cologne, 1501.
[44] Venice, 1518.
[45] Compare Dorne's "Sphera Fabri cum commento" to the titlepage of Venice, 1518 "Sphera cum commentis" including a commentary by Lefèvre.
[46] Oxford, All Souls College, shelf mark SR.59.b.6.
[47] Venice, 1531.

The Parisian printers took a different tack and packaged Sacrobosco with the first few books of Euclid so that more of the university syllabus could be covered in one volume.[48] This was a package that would have appealed to the wealthier student. The price was not necessarily prohibitive. It is probably one of these folio editions, entitled *Textus de sphera*, which was valued at 2d in the belongings of Edmund Burton of Oxford in 1529.[49] It was also helpful to have a few famous names on the cover. Jacques Lefévre D'Etaples was already a well-regarded textbook author when a Parisian printer appended an introductory epistle and commentary from him in 1494. The astrologer, Cecco D'Ascoli who was notorious for being burnt on the orders of the inquisitor of Florence in 1327, was a risqué addition by Venetian printers given that his book had been declared heretical.[50] Finally, an obvious strategy to sell more copies would have been to produce an edition that was as cheap and handy as possible. This idea came later than one might expect. Octavo editions were rare in the first few years of printing. In Italy, only eight were released before 1470. In contrast, 449 appeared in the last decade of the fifteenth century.[51] The earliest octavo *Sphera* appeared in Wittenberg in 1531, aimed squarely at the student market. Another famous name, Philipp Melanchthon, supplied the introductory epistle to Simon Grynaeus that then appears in almost every ultramontane edition.[52] Furthermore, the new compact edition contained useful didactic illustrations, which, in 1538 were enhanced further with volvelles.[53] Octavo editions, together with pirated versions of Melanchthon's introduction quickly crossed the Alps to Venice.[54]

By allowing purchasers to decide how much they were willing to pay, either for a cheap copy or a deluxe version, sellers can maximise their profits. Ensuring that products are available at a wide range of prices means that sellers can supply similar products to different markets. The wide variety of formats used for Sacrobosco's work means that we see them valued anywhere between a penny and a shilling in the

[48] Paris, 1507.
[49] E. S. Leedham-Green and R. J. Fehrenbach, *Private Libraries in Renaissance England: a Collection and Catalogue of Tudor and Early Stuart book-lists* (Marlborough, 1993). v. 2, p. 117.
[50] James Hannam, "Cecco D'Ascoli and Church Discipline of Natural Philosophers in the Middle Ages " (MA Dissertation, Birkbeck College, University of London, 2003). p. 3.
[51] Brian Richardson, *Printing, Writers and Readers in Renaissance Italy* (Cambridge, 1999). p. 127.
[52] Venice, 1534, Wittenburg, 1545.
[53] Owen Gingerich, "Sacrobosco as a Textbook," *Journal for the History of Astronomy* 19 (1988). p. 269.
[54] Venice, 1534.

Cambridge probate lists.[55] Christopher Walker, who died before he incepted for his MA, owned a Sacrobosco valued at two pence in his modest collection of books. Andrew Perne, Christopher Brown and Thomas Lorkin, senior members of the university, owned copies valued at a full shilling.[56] A book as central as Sacrobosco was demanded both from students on tight budgets and professors with fatter purses. Maximising the number of versions available allowed publishers to sell expensive versions to the people who could afford them without having to forego sales to those who could not.

It is clear from the foregoing that printers were innovating to sell more books. As their new ideas came onto the market, coupled with the driving down of prices, the turnover of textbooks inevitably increased. Bringing out new texts, especially if the author bore much of the financial risk, was obviously another way to attract new customers. With existing standard texts like Sacrobosco, it was even more necessary to innovate. Taken together, these characteristics of the book market had a major effect on the modernisation of the syllabus by encouraging the adoption of new books, both for what they contained, their low price and their ease of use.

Vernacular Publishing

Printing a Latin book had the advantage that it could be sold all over Europe. Conversely, the proportion of people who could read only in their native languages was increasing all the time. Catering for these monoglots was something that publishers could make money from, especially if, like in England, the Latin market was saturated by foreign competition.

In the sixteenth century, Latin ceased to be a language even the intellectual elite used to communicate with each other. Letters between Richard Fox and John Claymond were in English.[57] The audit books of Cambridge University switch to English in the reign of Edward VI, back to Latin for Mary and decisively to English after her death.[58] English books become increasingly common in the probate inventories after 1560. By 1570, the increased popularity of English, no doubt

[55] Leedham-Green, *BCI.* v. 2, pp. 431 – 2.
[56] Ibid.
[57] See examples in P. S. Allen and H. M. Allen, eds., *Letters of Richard Fox 1486 - 1527* (Oxford, 1929).
[58] See accounts from first 200 pages of CUA, U.Ac.2(1).

coupled to falling standards of Latin, was even reflected in the Cambridge statutes framed by John Whitgift (c. 1530 – 1604). These state that, if necessary, the lecturer "will explain all books in the common language for the comprehension and understanding of listeners."[59] This is coupled with an increased use of English in students' commonplace books, which almost certainly reflects the language being used in lectures.[60]

Original works of science began to appear in English from 1537[61] with Robert Recorde's *Ground of Artes* and sequels, Anthony Ascham's (c. 1517 – 1559) *A Lytel Treatise on Astronomy* (1555), dedicated to Cheke, William Cunningham's (1531 – 1586) *Cosmographical Glasse* (1559) and Henry Billingsley's (d. 1606) English Euclid (1570).[62] However, using English was not uncontroversial. Thomas Elyot felt he had to defend his use of English as a scholarly language in the preface to his *Castle of Health*, paraphrasing Chaucer's *Treatise on the Astrolabe*, when he wrote,

> But if physicions be angry that I have wryten physike in Engliyshe, let theym remembre that the grekes wrate in greke, the Romanes in Latyne, Auicena and the other in Arabike which were their owne propre and maternal tonges.[63]

To Frank Johnson the rise of the English language mathematical textbook is a decisive innovation.[64] Christopher Hill went further and claimed "England seems to have been unique in its vernacular scientific literature and in its level of popular scientific understanding."[65] However, Charles Schmitt, more familiar with the European context, has poured cold water on the idea that there was anything special about the use of English for science.[66] Indeed, glancing at the lists of translations that were being made into other European languages during the sixteenth century, it is clear that England was in danger of being left behind. For example, translations of

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[59] James Heywood and Thomas Wright, eds., *Cambridge University Transactions during the Puritan Controversies of the 16th and 17th Centuries* (London, 1854). p. 5. "Quos omnes libros vulgari lingua pro captu et intelligentia auditorium explicabit."
[60] See, for instance London, British Library, MS Harley 4048 and Cambridge, Pembroke College, MS LC II 164.
[61] Edward Kaplan, "Robert Recorde (c.1510 – 1558): Studies in the Life and Works of a Tudor Scientist " (New York University, 1960). p. 53.
[62] Francis R. Johnson, "Astronomical Textbooks in the Sixteenth Century," in *Science, Medicine and History*, ed. E. Underwood (London, 1953). Appendix.
[63] Thomas Elyot, *Castel of Helth* (London, 1541). sig. A. iiii. v.
[64] Francis R. Johnson, *Astronomical Thought in Renaissance England: a Study of the English Scientific Writings from 1500 to 1645* (New York, 1968). p.290.
[65] Christopher Hill, *The Intellectual Origins of the English Revolution - Revisited*, Revised ed. (Oxford, 1997). p. 16.
[66] Charles Schmitt, *John Case and Aristotelianism in Renaissance England* (Toronto, 1983). p. 32.

Euclid before it was rendered into English included the Italian by Angelo Canjani (Rome, 1545), the German by Johann Scheybl (Augsberg, 1555) and the French by Pierre Forcadel (Paris, 1564). Pliny's *Historia naturalis* made it into the French of Antoine du Pinet (Lyons, 1562), the German of Johann Heyden (Frankfurt, 1565) and the Italian of Cristoforo Landino (Venice, 1476) and Antonio Brucioli (Venice, 1534). A complete English edition did not appear until the seventeenth century. Sacrobosco's *De sphera* was published in German by Conran Heynfogel (Nuremberg, 1516), Italian by Fiorentino Mauro (Venice, 1537) and Spanish by Hieronymo de Chaves (Seville, 1545). An English translation by William Thomas (d. 1554) exists in only manuscript.[67] Turning to early-modern textbooks, Peter Apian's *Cosmographia* also appeared in Dutch (Antwerp, 1537), French (Antwerp, 1544) and Spanish (Antwerp, 1548).[68] Gemma Frisius's *Arithmeticae practicæ methodus facilis*, first published in 1540, was translated into Italian, Dutch, Spanish and French.[69] There was a market here waiting for English printers to exploit it.

The motives of authors and translators were less likely to be entirely pecuniary. Robert Recorde is explicit about his concerns in the preface to the *Ground of Artes* where he decries the state of English learning. "Sore oftentimes," he says, "I have lamented with myselfe the infortunate condition of Englande, feeling so many great Clerkes arise in sundrie other partes of the world, and so few to appear in our nation."[70] Recorde's collection of manuscripts demonstrates that he had a considerable interest in medieval English mathematicians and natural philosophers such as Richard of Wallingford and Simon Bredon.[71] He refers to, "Groteshead, Michell Scot, Batecombe and Baconthorpe" as well as Roger Bacon in his works.[72] The desire to revive this great tradition may have been one of the central motivations for his work.

Recorde's first experience of mathematics was likely to have been in the years after he took his BA from Oxford in 1531. There is no trace of his having incepted as

[67] London, British Library, MS Egerton 837.
[68] Robert Karrow, *Mapmakers of the Sixteenth Century* (Chicago, 1993). p. 52.
[69] N. D. Haasbroek, *Gemma Frisius, Tycho Brahe and Snellius and their Triangulations* (Delft, 1968). p. 10.
[70] Robert Recorde, *Ground of Artes* (London, 1561). Preface.
[71] A. B. Emden, *A Biographical Register of the University of Oxford from AD 1501 to 1540* (Oxford, 1974). p. 735.
[72] Robert Recorde, *Castle of Knowledge*, Facsimile ed. (Amsterdam, 1975). p. 98 and Robert Recorde, *Pathway to Knowledge*, Facsimile ed. (Amsterdam, 1974). Preface.

a Master although he did become a fellow of All Souls. The next mention of him we find is his receiving an MD at Cambridge in 1545 but he is stated to have been licensed to practice at Oxford twelve years before.[73] The *Grounde of Artes*, which was published in London in 1543, was his first book. Hence, it seems to have been written while he was still studying medicine at Cambridge. Sadly, there is no information about his college, the duration of his studies or if he was a lecturer in the quadrivium. He was certainly not in a position to finance the printing himself and so his publisher, Reynold Wolff, must have hoped to find a ready market. He was not mistaken. *Ground of Artes* was a huge success and the *English Short Title Catalogue* lists forty-five editions continuing up until 1699.

Recorde's *Ground of Artes* was cheap and simple enough to be available and understood by a literate artisan. A master carpenter could expect to earn about £5 per year in the late-sixteenth century,[74] comparable to the Rede lecturers' salary of £4, while *Ground of Artes* averages just four pence in the booklists. These factors must have contributed to its enormous commercial success. This is more than can be said for Henry Billingsley's lavish folio of Euclid in English. It was beyond the pecuniary resources of Recorde's most likely market of literate craftsmen.[75] However, it is the Euclid that contains a spirited defence of using English, especially when other languages already have a thriving mathematical literature. Billingsley wrote,

> Wherefore considering the want & lacke of such goode authors hitherto in our Englishe tounge, lamenting also the negligence and lacke of zeale to their countrey in those of our nation, to whom God hath geven both knowledge and also abilitie to translate into our tounge, and to publishe abroad such good authors and bookes (the chief instrumentes of all learninges): seing moreouer than many good wittes both of gentlemen and others of all degrees, much desirous and studious of these artes, and seeking for them as much as they can and sparing no paines, and yet frustrate in thier intent, by no means attaining to that which they seek: I have for their sakes, with

[73] Stephen Johnston, "Recorde, Robert (*c.*1512–1558)", *Oxford Dictionary of National Biography*, Oxford University Press, 2004 [http://www.oxforddnb.com/view/article/23241, accessed 29 June 2006]
[74] D. M. Palliser, *The Age of Elizabeth: England under the Later Tudors*, ed. Asa Briggs, vol. 6, Social and Economic History of England (London, 1983). p. 151.
[75] John Dee, W. Shumaker, and J. L. Heilbron, *John Dee on Astronomy: Propaedeumata Aphoristica 1558 and 1568*, ed. J.L. Heilbron, Wayne Shumaker trans. (1978). p. 12.

> some charge and great trauaile, faithfully translated into our vulgar tounge & set abroad in print this booke of Euclide.[76]

Appealing to the patriotism of the upper classes perhaps helped to loosen their purse strings. The book is best known for its *Mathematical Preface* written by John Dee. In his preface to Euclid, Dee defends writing in English and provides six reasons for the use of the vulgar tongue for Euclid.[77] Firstly, he claims the exercise will honour the universities by lauding the achievements of their alumni. Then he notes that Italian and other languages already have science in the vulgar tongue, of which he provides an extensive list. He also expects the English Euclid to help young scholars who do not yet know enough Latin or Greek, as well as gentlefolk who want a liberal education. Fired by such learning he thinks that reading Euclid will encourage people to attend university to learn further arts. Finally, putting Euclid into English will further the education of common artisans and the good of the Commonwealth.

Given the probable cost of the book, it is his fourth reason, educating gentlemen, that most likely supplied the economic rationale with some hint of the second to encourage political interest. It is unlikely that Dee's reasons were compatible, as a gentleman would not want to be getting his education from the same book that a common craftsman was using. Therefore, this English Euclid does not provide much evidence for advanced mathematics reaching an artisan audience but rather that it was becoming a fashionable item to have on the desks of the gentry. The fact that it was not reprinted for a century suggests that, despite its fame, Billingley's English Euclid was not a great success.

Another advocate for education in English was William Thomas, one time tutor to Edward VI and executed for treason under Mary I.[78] He translated *De sphera* of Sacrobosco into English for the Duke of Suffolk in 1551, observing in his preface "the childe have no sooner learned his ABC but straight waies his maister putteth the Latin grammer in his hande".[79] After spending some time at Padua, Thomas was concerned that foreigners would gain an advantage from having the "grounded

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[76] Euclid, *The Elements of Geometrie of the Most Auncient Philosopher Euclide of Megara*, Henry Billingsley trans. (London, 1570). sig. ☞.ij. v.
[77] John Dee, *The Mathematical Praeface to the Elements of Geometry*, ed. Alan G. Debus, Facsimile ed. (New York, 1975). sig. A. iii v.
[78] Dakota L. Hamilton, "Thomas, William (*d.* 1554)", *Oxford Dictionary of National Biography*, Oxford University Press, 2004; online ed., May 2005 [http://www.oxforddnb.com/view/article/27242, accessed 1 June 2006]
[79] London, British Library, MS Egerton 837, fol. 3r. Recorde, *Ground of Artes.*

science" of astronomy in their own language because "each man first covett to florishe in his owne tongue."[80] His translation even provides a glossary of astronomical terms not found in English. Thomas's failure to find a publisher for his book, assuming he ever looked for one, is quite surprising given Recorde's success. A translation of Sacrobosco was an obvious follow up to the English arithmetic. In 1569, Henry Howard (1540 – 1614), son of the disgraced Earl of Surrey, wrote an English language treatise on natural philosophy. Howard took his MA at King's College in 1566 before he moved to Trinity Hall to study civil law. He was the Rede lecturer in rhetoric about this time.[81] Howard addressed his treatise to his sister but actually intended it for public consumption, noting that no guide to natural philosophy in English existed.[82] Given Howard's stated aim to communicate to a wide audience, it would again be interesting to know why he failed to find a publisher.

However, further English textbooks, such as Recorde's *Castle of Knowledge* (1556) continued to appear as publishers sought to sell their wares to as wide an audience as possible. It was their desire to make money, rather then authors' disinterested wish to educate their countrymen, that caused the diffusion of mathematical knowledge to readers who lacked Latin. The existence and frequent updating of vernacular textbooks was yet another reason to dispose of the old medieval works.

Greek at the Universities

Greek publishing effectively began with the commencement of trade by Aldus Manutius (1449 – 1515) in Venice in 1494. Before that date, very few Greek texts had been published, but such was the increase in popularity in the subject, the Aldine press could make money despite the high initial cost of creating a Greek font.[83] The language began to be taught in England at roughly the same time. Cornelius Vitelli (d. c. 1554) taught Greek at Oxford around 1485.[84] William Grocyn (c. 1449 – 1519)

[80] Jonathan Woolfson, *Padua and the Tudors* (Toronto, 1998). p. 126.
[81] Pauline Croft, "Howard, Henry, Earl of Northampton (1540–1614)", *Oxford Dictionary of National Biography*, Oxford University Press, 2004 [http://www.oxforddnb.com/view/article/13906, accessed 1 June 2006]
[82] Oxford, Bodleian Library, MS Bodley 616, fols. 1r and 3r.
[83] L. D. Reynolds and N. G. Wilson, *Scribes and Scholars: A Guide to the Transmission of Greek and Latin Literature*, Third ed. (Oxford, 1991). p. 155.
[84] Cecil H. Clough, "Thomas Linacre, Cornelio Vitelli and Humanistic Studies at Oxford," in *Linacre Studies: Essays on the Life and Work of Thomas Linacre c. 1460 - 1524*, ed. Francis Maddison, Margaret Pelling, and Charles Webster (Oxford, 1977). p. 10.

spent three years touring Padua and Florence. He may have learnt Greek before he left but on his return certainly started to teach it to students at Exeter College.[85] In the early-sixteenth century, Greek enjoyed an increasingly high profile at the English universities. In 1516, John Fisher himself appointed Richard Croke (1489 – 1558) who had studied under Grocyn as well as abroad, to be the first university lecturer at Cambridge in Greek.[86] In the following year, a public lecture in Greek was also included in the statutes of Richard Fox's foundation of Corpus Christi College, Oxford.[87] Regius chairs were endowed under Henry VIII at both universities. Greek, together with Hebrew, featured in all the university statutes and ordinances from 1535 onwards. Both languages appeared in popular contexts too. Henry VIII also issued a medal to commemorate the royal supremacy in 1545 that featured Latin on one side and the same message creatively rendered in Greek and Hebrew on the other.[88] Students studying theology gained a good grounding in the biblical languages from their textbooks. The Greek Grammar of Theodore of Gaza appears twenty times in the Cambridge probate lists.[89] A notebook belonging to a late sixteenth century Cambridge theology student actually contains Latin, Greek, Hebrew and English writing.[90]

The well documented rise in Greek studies at the universities appears to have had less impact in philosophy or the quadrivium. In an ambitious move, Edward IV's visitors to both universities had insisted that the original language be used in the study of all authors, which meant Aristotle, Ptolemy and Euclid in Greek.[91] This was no empty gesture and may reflect the practice of the visitors, like John Cheke, who had taught at the university. Roger Ascham boasted in 1542 that "Aristotle and Plato are read by the young men in the original but this has been done among us at St John's for

[85] J. B. Trapp, 'Grocyn, William (1449?–1519)', *Oxford Dictionary of National Biography*, Oxford University Press, Sept 2004; online edn, Oct 2005 [http://www.oxforddnb.com/view/article/11650, accessed 17 March 2006]
[86] D. R. Leader, "Professorships and Academic Reform at Cambridge: 1488 - 1520," *Sixteenth Century Journal* 14 (1983). p. 225.
[87] *Statutes of the Colleges of Oxford: with Royal Patents of Foundation, Injunctions of Visitors and Catalogues of Documents Relating to the University Preserved in the Public Record Office*, 3 vols. (Oxford, 1853). v. 2, p. 48.
[88] London, National Maritime Museum, E3327.
[89] Leedham-Green, *BCI.* v. 2, p. 743.
[90] Cambridge, Pembroke College, MS LCII 164.
[91] James Heywood, ed., *Collection of Statutes for the University and Colleges of Cambridge* (London, 1840). p. 38.

the last five years".[92] Cheke is also said to have handed out copies of the propositions of Euclid in Greek (first published in Basel in 1544) to his students.[93] His own copy of the complete Greek Euclid, published eleven years earlier also at Basel and dedicated to Cuthbert Tunstall, includes plenty of annotation in Cheke's hand so at least he knew what he was talking about.[94] This is unusual, as most of the Greek scientific texts that I have seen remain pristine and apparently unread. John ab Ulmis wrote from Oxford in 1550 saying that he has lectures on Aristotle's *Politics* at six in the morning which, he assures his correspondent, is terribly good for his Greek.[95] By the time Elizabeth's visitors reinstated and revised these statutes, however, it was realised that insisting on the use of original languages was impractical and the stipulation was weakened to their being used "as far as convenience may allow".[96]

There are few Greek texts of natural philosophy or mathematics in the probate lists. Edward More's copy of Euclid in Greek was exceptional and formed part of a substantial collection of texts in that language.[97] We do see many copies of Aristotle's Opera in Greek at Cambridge, although far fewer at Oxford. The price of these, however, was often around ten shillings which almost certainly meant they were possessed by masters rather than students.[98] The only Greek natural philosophy text that appears to have been commonly used by students was *De anima*. The bookseller, Nicholas Pilgrim, had no less than five copies in stock when he died in 1545. It appears another seven times in the probate lists, twice in the hands of men who had recently incepted.[99] At an average of only three pence, the book was also cheap. It is most likely to have been the short octavo edited by Jacques Lefèvre D'Etaples. There are not many Greek editions of *De anima* and this one, published at Basel in 1538, is the only version that was cheap and intended for students. The existence of the bulk order might mean that Pilgrim was interacting with the university lecturers to ensure the texts their students needed were in stock. It therefore seems fair to assume that *De anima* was being used as a class reader for students improving their Greek by tackling a more challenging text. This may be related to Melanchthon's commentaries on *De*

[92] Alvin Vos, ed., *The Letters of Roger Ascham* (New York, 1989). p. 32.
[93] Richard Mulcaster, *Positions Concerning the Training up of Children*, ed. William Barker (Toronto, 1994). p. 239.
[94] Oxford, Bodleian Library, shelf mark Savile W7.
[95] C. H. Williams, ed., *English Historical Documents 1485 - 1558*, vol. 5 (London, 1967). p. 1070.
[96] Heywood, ed., *Collection of Statutes*. p. 329.
[97] Leedham-Green, *BCI.* v. 1, p. 12.
[98] See appendix one.
[99] Anthony Hall (1551) and Thomas Hartley (1557) Leedham-Green, *BCI.* v. 1, pp. 118 and 167.

anima, the earliest of which appeared in 1540 and appears twelve times on the Cambridge probate lists.[100] Unlike most Aristotelian commentaries, this works from and frequently quotes the Greek text.[101] If it were being closely studied, then it would be helpful to have a copy of the Greek at hand, which may account for the numbers that appear in the Cambridge booklists. A copy belonging to Christopher Rookes (d. 1587), which he used as a bachelor at King's College, is preserved in the University Library.[102] The weakness of this thesis is that only William Robinson and Andrew Perne owned both of them. The fact that none of Aristotle's other books of natural philosophy are commonly found in Greek suggests that they were not taught in their original language, despite the stipulation of the 1549 statutes.

Conclusion

This chapter has argued that the interests and motivations of scholars and visitors were certainly not the only driver of change in the syllabus taught at the universities. Commercial reality drove printers to encourage frequent turnover of textbooks so they could sell new ones. They did their best to provide the products that would facilitate this and thus helped ensure that students were taught from up-to-date sources. We will see this happening in practice in the next chapter.

[100] Ibid. v. 2, p. 538.
[101] Charles Schmitt, "The Rise of the Philosophical Textbook," in *Cambridge History of the Renaissance Philosophy*, ed. Charles Schmitt and Quentin Skinner (Cambridge, 1988). p. 797.
[102] Sachiko Kusukawa, "The Reception of Melanchthon in Sixteenth-Century Cambridge and Oxford," in *Melanchthon - Schriften der Stadt Bretten*, ed. G. Frank and K Meerhoff (Stuttgart, 2002). p. 252.

Chapter Seven: Reaction and Consolidation

"Naturall Philosophy dryveth us violently to knowe god."[1]

Henry Howard, Earl of Northampton, 1569.

After the 1549 visitation, syllabus reform did not completely stop but the main planks of the new dispensation were, by then, in place. In theory, the reign of Mary saw the reintroduction of the ancient statutes but it is difficult to find evidence of what effect this had in practice. With the ascent of Elizabeth in 1558, the Edwardian syllabus was again installed. At Cambridge, a further round of statutory reform in 1570 made few changes to what was supposed to be taught. On the other hand, Oxford did launch yet another major change in the syllabus with the *nova statuta* of 1564/5. This by no means did away with the course already used. The emphasis on practical mathematics remained. However, the continuing importance of natural philosophy was made explicit with the re-introduction of Aristotle's natural philosophy books. Thus, the new syllabus allowed Oxford to partly reassert its traditional conception of the MA course. However, when we look behind the enactments, we will find that the effect of the 1564/5 reforms was not great and the old textbooks, now once again permitted, did not enjoy any surge in readership.

In this chapter we will see how the new syllabuses, coupled with the effects of the book market discussed in the last chapter, led to a comparatively rapid turnover in books. New authors were introduced, became dominant and then were, themselves, superseded by their successors. This process of renewal meant that the universities were able to provide a contemporary education that included new discoveries and ways of thinking. The work of Copernicus was already having an impact, in that students were exposed to it, in the 1560s. Even though the teaching methods of lecture and disputation remained much the same, the material that was covered could rapidly evolve.

[1] Oxford, Bodleian Library, MS Bodley 616, fol. 5r.

Reactions to the Edwardian Visitation

Natural Philosophy after 1549

The syllabus that the Edwardian visitors imposed on the universities was resolutely practical. It gave no space to Aristotle's books on physical science because they were not deemed useful enough to the Commonwealth. This presented a problem for the university masters who wanted to continue to teach these works. Their religious utility alone was too great for them to be abandoned. Thus, the universities had to find a way of keeping within the spirit of the statutes while continuing to teach a subject they deemed essential. Even the visitors themselves belatedly realised the importance of Aristotle's natural books. When they presented Clare College with its new statutes in 1551, John Cheke, William May and Thomas Wendy stipulated the traditional natural philosophy texts of Aristotle.[2] So did Cheke's statutes for Trinity College in 1552.[3]

We know that the university masters were determined to continue teaching Aristotelian natural philosophy because of the number of textbooks in the subject that we find in the booklists, especially in those of individuals whom we know taught it to students. At Oxford, there was no question of returning to the medieval works popular before 1535, whatever the preferences of the masters themselves. However, as we saw in chapter four, the books specified in the 1549 syllabus, the *Problemata* and Pliny's *Historia naturalis*, were simply inadequate for the task of teaching natural philosophy. So, the main instruction in the subject at both Oxford and Cambridge came from a new breed of textbook.

As we have seen, Philipp Melanchthon probably inspired the visitors with his project of reform at Wittenberg. He had rejected Aristotle's natural philosophy in the early 1520s.[4] Later, however, he found that he could not do without it. The masters at Oxford and Cambridge appear to have found likewise. The reason for Melanchthon's reacceptance of natural philosophy was its utility as a signpost towards God. He noted in an oration at Wittenberg in 1542 that, "natural philosophy also strengthens the

[2] James Heywood, ed., *Early Cambridge University and College Statutes* (London, 1855). pt. 2, pp. 162 and 178.
[3] J.B. Mullinger, *The University of Cambridge* (Cambridge, 1873). v. 2, p. 614
[4] Sachiko Kusukawa, *The Transformation of Natural Philosophy: The Case of Philip Melanchthon, Ideas in Context* (Cambridge, 1995). p. 43.

worthy sentiments on God and on providence."[5] His favourite topic was the soul and, as we have seen, he wrote two textbooks on *De anima*. Melanchthon had two central points to make in this work. The first, related closely to the possible Cambridge interest in *De animalibus,* was the intricate construction of the human body.[6] To illustrate this he enthusiastically embraced the work of Andreas Vesalius. His second point was that rational man can only be the product of a rational creator. In the speech in 1542, he explained, "We learn from natural philosophers that nature that has understanding cannot originate from the irrational or be the product of chance."[7] Thus, as he writes in his textbook, "therefore the soul of man teaches that God is the maker of things and that there is an intelligent being."[8] This is quite different from the way *De anima* was treated by the Scotists such as Alexander ab Alexandria. For them, the attraction of natural philosophy was that it provided certain knowledge through demonstration. Very little of Aristotle's *De anima* is about the soul in the Christian sense and most of it applies to animals as well as humans. It is worth noting that influential churchmen like John Calvin (1509 – 64) also had a great deal to say about how God's glory is reflected in the order of nature.[9] In England, Henry Howard also insisted natural philosophy proved God's existence,

> For when we se the causes of thinges one soe orderly dependinge of another we cannot but at the lengthe have recourse unto that principalle and especiall cause from whence all other as from theyre hedd and fountayne doe flowe.[10]

In their choice of textbooks to use after 1549, the masters of Oxford and Cambridge suggest that they too saw natural philosophy as a subject that illustrated the creative work of God. The textbooks that became popular in the 1550s made it very clear that natural philosophy demonstrated providential power. Lefèvre began to fall out of favour at Cambridge, probably because his methodology of analogy and mysticism was simply too opaque. His eye was certainly on God but he sought a non-literal interpretation of Aristotle at a time that such figurative readings were falling out of favour. They smelt too much of scholastic hermeneutics. Besides, his verbose style was probably more than many young students could bear. By 1545, the

[5] Philipp Melanchthon, *Orations on Philosophy and Education*, ed. Sachiko Kusukawa, Christine F. Salazar trans., Cambridge Texts in the History of Philosophy (Cambridge, 1999). p. 136.
[6] Ibid. p. 156.
[7] Ibid. p. 136.
[8] Ibid. p. 154.
[9] Reijer Hooykaas, *Religion and the Rise of Modern Science* (Edinburgh, 1972). p. 106.
[10] Oxford, MS Bodley 616, fol. 5r.

bookseller Nicholas Pilgrim had no copies of Lefèvre in stock and was instead offering two other natural philosophy textbooks written by Francis Titelman (1502 – 1537) and Johannes Velcurio (d. 1534).[11]

Titelman and Velcurio

Titelman came from Hasselt in the Low Countries and was educated at the Univeristy of Louvain where he received his MA in 1521. He then taught philosophy in the arts faculty before joining the Franciscans in 1523.[12] Initially, he also taught the arts for his order but later moved on to theology. Titelman was involved in some controversy with Erasmus against whom he defended the Vulgate version of the Bible.[13] In 1536, the Franciscans ordered him to Italy where he died the next year.

Titelman wrote many textbooks, which he called *Compendia*, intended to act as ready references to his brother friars so as to give them more time for their religious duties.[14] There is little doubt that religion is central to Titelman's concerns. Each of the twelve books of his *Compendium naturalis philosophica*, first published in 1530, is prefaced with a psalm and cross references to the scriptures litter his text. Only Aristotle enjoys anything like as many citations although there are also a few other authors like Boethius and even Virgil. He explains in the introduction that his book should not been seen purely as a matter of philosophy but also partly theological because God had created the heavens and earth.[15] In this, Titelman sounds quite like Lefèvre in his insistence that you can find God in Aristotle if only you know where to look. However, the friar wrote a very different kind of text. The first four books cover the material found in the *Physica* and the remaining eight all the other natural books (but not the natural history). Titelman is Aristotelian in his subject matter, for instance rejecting the vacuum.[16] However, he does take material from other sources. He gives both the contemporary estimates for the size of the Earth[17] and avers that there are

[11] E. S. Leedham-Green, *Books in Cambridge Inventories: Books from the Vice-Chancellor's Court Probate Inventories in the Tudor and Stuart Periods*, 2 vols. (Cambridge, 1986). pp. 61 – 70.
[12] Charles Lohr, *Latin Aristotle Commentaries: Aristotle in the Renaissance* (Florence, 1988). pp. 456 – 8.
[13] Peter Bietenholz, ed., *Contemporaries of Erasmus* (London, 1985 - 7). v. 3, p. 326.
[14] Lynn Thorndike, *History of Magic and Experimental Science*, 8 vols. (New York, 1923 - 58). v. 5, p. 148.
[15] Ibid. p. 150.
[16] Francis Titelman, *Naturalis philosophiae compendium* (Paris, 1545). fol.. 55r. "Vacuum iuxta naturam non posse existere pluribus probatur experimentiis"
[17] That is, both Eratosthene's figure of 252,000 stadia and Ptolemy's 180,000 stadia. Ibid. fol. 91v.

eleven heavenly spheres.[18] On the habitability of the torrid zone, he accepts that there are people living their although they are small, burned black and short-lived on the account of the heat of the sun.[19]

However conservative his science, there is no doubt that Titelman's *Compendia* was something new pedagogically. It differed from Lefèvre's *Paraphrases* in a number of important respects, all of which were to the advantage of the student. Firstly, all the editions were cheap octavo formats rather than the expensive folios of Lefèvre. Titelman's books had been written with the intention that each student should have one and hence they must be marketed directly to them. Lefèvre's publishers still seemed to think that their smart folios would more likely be found on the master's lectern or the college library than in every student's satchel. Secondly, while Lefèvre is supplying a substitute for Aristotle, Titelman has replaced the Philosopher's works altogether with a book that no longer seeks to simply restate the original. While the material in Titelman is solidly Aristotelian, the presentation and the language are not. This is a true textbook intended to communicate the subject matter of natural philosophy to students without ever thinking that they need to be familiar with the actual text. This gives Titelman the freedom to bring in all his biblical and literary references in a way that Lefèvre cannot do even though his introduction strongly suggests that he would like to. In fact, Titelman was a political opponent of Erasmus and Lefèvre, whom he accused of being partial to novelty and pandering after new things.[20] The irony is, of course, that Titelman himself wrote as a humanist, despite his being a religious conservative, even when attacking Erasmus.[21] The reformers of England must have known very little about his religious beliefs and found his work on natural philosophy to be conducive to their own Christian humanism. They liked his dialectical textbook and commentary on the Psalms too.[22]

Whatever Titelman's virtues, after the 1540s his work was never as popular as that of Johannes Velcurio. Johannes Bernhardi or Velcurio (after his home town) was a master at Wittenberg who received his MA in 1519 and then studied theology under

[18] Ibid. fol 95r. "Sunt igitur coeli undecim hoc ordine siti, coelum empyrean, primum mobile, coelum crystallinium, firmamentum, coelum Saturni, Iovis, Martis, Solis, Veneris, Mercurii & Lunae."
[19] Ibid. fol. 108r. "Homines enim locorum illorum nigerrimi, sunt & brevis vitae ac paruae staturae, quod procedit ab excessu caloris."
[20] Erika Rummel, *The Humanist-Scholatic Debate in the Renaissance and Reformation* (Cambridge: MA, 1995). p. 98.
[21] Ibid. pp. 151 – 2.
[22] Leedham-Green, *BCI.* v. 2, p. 750 – 1.

Melanchthon.[23] He also taught natural philosophy at Wittenberg before he died in 1534.[24] Velcurio was a staunch supporter of both Luther and Melanchthon, the latter of whom returned the affection.[25] Given this pedigree, it is no surprise to find that he appealed to English Protestants.

Velcurio's *Epitomae physicae libri IV* was first published at Basel in 1537 but it is the 1539 Tübingen edition that enjoyed subsequent success by going through nineteen editions up to 1595. The London edition of 1588 is based on this latter version. The *Epitomae* is a true textbook produced in the small octavo format and within reach of students who want to have their own copies. Like many popular textbooks it is reasonably rare today despite its sixteenth-century popularity and those copies that do survive tend to be heavily annotated.[26] It was popular at both English universities featuring twenty-six times in the Cambridge probate lists and eight times at Oxford. One of the individuals who we find with a copy is James Powell who actually taught natural philosophy at Oxford as a new regent master in 1569.[27] The account book of John Whitgift from 1567 – 77 shows the books that he bought for his students at Trinity College, Cambridge where he was Master. Although he purchased four copies of Velcurio for his students, [28] the vast majority of the books he bought for them relate to the trivium. It is probable that older students, after they had received their BA degree and were studying the quadrivium, bought their books for themselves. Under Trinity College's 1560 statutes, philosophy was studied by undergraduates, which might explain why Whitgift sometimes bought them natural philosophy.[29]

From the booklist evidence, it is clear that from the mid-1540s, Velcurio was the leading natural philosophy textbook at both universities. The reasons for his popularity and especially his eclipsing the textbooks of Lefèvre, Titelman and Bricot are not just down to the quality of writing. First, the close relationship between

[23] Lohr, *Aristotle in the Renaissance.* p. 474.
[24] Johannes Velcurio, *Epitomae physicae libri IV* (London, 1588). sig. *3r. "Vuittemberge praeceptor meus fuit".
[25] Kusukawa, *Transformation of Natural Philosophy*. p. 110.
[26] See for example, all four copies held by the British Library in London.
[27] Andrew Clark, ed., *Register of the University of Oxford (1571 - 1622),* vol. 1, *Oxford Historical Society Publications* (Oxford, 1887). p. 99.
[28] P. Gaskell, "Books Bought by Whitgift's Pupils in the 1570s," *Transactions of the Cambridge Bibliographical Society* 7 (1979). p. 289. The vast majority of the books bought by Whitgift for his pupils relate to the trivium. It is probably that older students, after they receive their BA degree, bought their books for themselves.
[29] Mullinger, *The University of Cambridge*. v. 2, p. 621.

Velcurio and Melanchthon meant that the Protestants were going to be more comfortable with Velcurio that the Franciscan Titelman. Velcurio was even within the spirit of Cromwell's 1535 injunctions, which specifically recommended Melanchthon.[30] Some students found it best to have a copy of both. Alexander Nowell owned both before passing them on to his brother Lawrence studying at Christ Church (where he became lecturer in mathematics).[31] Likewise, Reuban Shirwood at Cambridge had both these books, Melanchthon's *De anima* and completed his collection by owning Lefèvre's *Paraphrases* as well.[32]

Variously called an epitome and commentary on Aristotle's *Physics*, Velcurio's work is neither of these things. Instead, it is the most complete textbook on the entire sweep of sixteenth-century natural knowledge. Like Titelman, Velcurio deals with the whole of natural philosophy as delineated by the works of Aristotle, but he goes even further and includes a large amount of material on natural history and metaphysics as well. He organises his material into chapters divided up into numbered sections with plenty of marginal glosses to help the reader. Another area where he scores highly is the range of his references. Titelman, as we have seen, does not extend his inquiry much further than Aristotle and the Bible. Velcurio makes use of a far wider circle of classical material that includes Pliny, Cicero and the other major Latin authors.

The work itself is arranged into four books. The first covers metaphysics and physics, the second deals with the heavens and corruptible earth, the third is a compendium of natural history while the fourth encompasses psychology and human nature. This made the book extremely wide ranging and although the basis of each subject was the work of Aristotle, Velcurio did not restrict himself to the Philosopher. Book three, in particular, was probably more based on Pliny the Elder. On the other hand, Velcurio cannot be accused of being an original thinker and rarely allowed his own ideas to intrude into his presentation.

[30] James Heywood, ed., *Collection of Statutes for the University and Colleges of Cambridge* (London, 1840). p. 201.
[31] Oxford, Bodleian Library, MS Brasenose College 31, p. 65/fol. 47r.
[32] James Hannam, "The Library of Reuban Shirwoode," *Transactions of the Cambridge Bibliographical Society* XIII:2 (2005). 275 – 86.

In a similar fashion to Lefèvre and Titelman, Velcurio's 'Preface of the Author' was insistent on the essential utility of natural philosophy for theology. As he said:

> No sane person is so negligent and unskilled in the sacred scriptures, I think, that he would not see in these holy books much which requires a knowledge of nature if anyone wishes to understand or comprehend them with certainty. For when disputes occur about fate, or on the necessity or contingency of facts, causes and effects, or on freewill, fortune, the soul and nature, and the characters of men, those unskilled in Physics are more silent than fishes or the [dumb] Seriphian frogs. From the knowledge of such things, everything may be sought after.[33]

He also insisted that physics was required not just for the study of medicine, but also for understanding poetry and philosophy.

On the vacuum, Velcurio first presented the opinions of Lucretius and the Epicureans before siding firmly with Aristotle. Otherwise, his treatment was not very detailed although he did add a new example of nature abhorring a vacuum. Pointing to the operation of a cannon, he added "fire and air, by a very violent motion, expel a stone or iron ball of huge weight lest a vacuum arise, that is, lest each body should not occupy its own place."[34] This is noteworthy as a contemporary and new example of Aristotle's idea that motion is allowed by materials expanding and contracting rather than moving through a void. In his discussion of the number of heavenly spheres, Velcurio settled on nine while admitting that theologians, (like Titelman), add two more. He also made a rare reference to a medieval author, here Albertus Magnus on *De Caelo*.[35] On the subject of the tropics, Velcurio was the earliest author to ignore questions about habitability completely. Indeed, as far as he was concerned, the climatic zones exist only as a projection of the imaginary circles of astronomers.[36]

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[33] Velcurio, *Epitomae Physicae*. sig. *4r. "Et nemo sanus tam est sacrae Scripturae negligens & imperitus, ut arbitror, quin videat in ipsis quoque Bibliis sacris plurima esse, quae naturae cognitionem plane desiderent, si modo quis ea certo cognoscere & intelligere velit. Ubi enim disputationes incidunt de fato, de rerum, causarum, effectuumque necessitate & consequentia, de libero arbitrio, de fortuna, de anima & natura, viribusque hominis, isti Physices imperiti, magis sunt muti, quam pisces & ranae seriphiae, a qua talium rerum notitia omnino est petenda."

[34] Ibid. p. 145. "Cui respondeo, quod hoc fieri no possit, arguere experimentiam in bombardis, ubi ignis & aër vehementissimo motu ejaculantur globum lapideum aut ferreum ingentis ponderis, ne admittatur vacuum, hoc est, ne non suum locum quodque corpus occupet."

[35] Ibid. p. 170.

[36] Ibid. p. 204. "Sicut imaginantur mathematici quinque zonas in caelo secundum quattour circulos, ita partiuntur terram in quinque zonas, quae ab Arctico in Antarcticum polum recta, definiunt terrae diametrum."

It is in natural philosophy that we first see the rapid turnover of textbooks that enabled the universities to keep the education they offered abreast of current developments. Nowhere is this progress through the different natural philosophy textbooks that we have examined better illustrated than among the college lecturers of the Queens' College, Cambridge. With almost complete financial accounts from the end of the fifteenth century,[37] we have a full list of the lecturers from this college, given in appendix three, including such luminaries as Andrew Perne and Thomas Smith. We focus on three of them who died in Cambridge and whose probate lists are preserved. First, we examine William Framyngton, who taught philosophy at Queens' in 1533, the year before he incepted as MA. He was a writer, a friend of John Caius and died in 1537.[38] His inventory of over 100 books includes Lefèvre's textbooks on arithmetic and metaphysics as well as Aristotle's *Opera* in Greek.[39] Edward Raymand was the Queens' philosophy lecturer in 1559 and died in 1562. His inventory includes Titelman's textbook on natural philosophy and Aristotle's *Parva naturalia*.[40] Finally, John Wells was the lecturer in 1562 and passed on in 1570. His probate list features Velcurio's textbook as well as arithmetics by Gemma and Recorde.[41] Thus, we see exactly the progression of authors that we might expect from other evidence: at the start of the sixteenth century Lefèvre and Bricot held the fort at Cambridge and Oxford respectively; they are themselves superseded by Titelman and then Velcurio in the 1540s. We also have booklists for the two most famous names on the list of Queens' College philosophy lecturers, Sir Thomas Smith and Andrew Perne. We have already noted that Smith's library contained plenty of mathematics but no early-modern natural philosophy.[42] If he still owned the books he taught from in 1533 when the library list was compiled in 1566, then he must have been using Plato's *Timaeus*, *De animalibus* or Aristotle's *Opera* in Greek. Perne, on the other hand, had plenty of natural philosophy although not so many that could be called textbooks. If we want to assume that he never disposed of any of his books, then his copy of Velcurio, sadly not preserved in Peterhouse, is a likely text for his lectures of 1540 – 2.[43]

[37] Cambridge, University Library, Queen's College Archives 1 – 4.
[38] Cathy Shrank, "Framyngham, William (1512–1537)", *Oxford Dictionary of National Biography*, Oxford University Press, 2004 [http://www.oxforddnb.com/view/article/10063, accessed 29 June 2006]
[39] Leedham-Green, *BCI.* v. 1, pp. 6 – 9.
[40] Ibid. v. 1, pp. 270 – 272.
[41] Ibid. v. 1, pp. 311 – 313.
[42] John Strype, *A Life of the Learned Thomas Smith, Kt* (Oxford, 1820). p. 279.
[43] Leedham-Green, *BCI.* v. 1, pp. 326 – 340.

Natural History after 1549

Neither Lefèvre nor Titelman has anything to say on natural history, as we would now call the subject. Velcurio, however, devotes most of book three to animals, vegetables and minerals. He is as terse and exhaustive as usual, giving us four chapters on minerals (largely drawn from Pliny), eight chapters on plants (from Pliny, Dioscorides and Theophrastus) and eight more on animals (with Aristotle his main source). Also Aristotelian are the eight chapters that conclude book three on human biology and physiology.[44] Aristotelian natural history texts were not included in the 1549 syllabuses at Cambridge even though we have already seen that they were popular.[45] However, the *Problemata* does cover some of the same ground as Aristotle's books on animals. At Oxford the situation is slightly more complicated. Although missing from the 1549 statutes, Aristotle's *De animalibus* was added to the syllabus when the visitors made their clarifications to the statutes.[46] Thus, it seems clear that natural history was seen as a branch of natural philosophy.

The English universities produced several important pioneers of natural history in the sixteenth century. Thomas Penney, William Turner and Thomas Mouffet collected information on plants, insects and birds.[47] John Caius produced a short treatise *De canibus britannici* and a slightly more substantial *De rariorum animalium atque stirpium historia* (London, 1570). Most of the material in the latter work first saw the light of day as part of the *Historia Animalium* of Conrad Gesner (1516 – 1565).[48] Both works are presented as letters to Gesner to whom Caius sent the descriptions and pictures shortly before the former's death in 1565.[49] By attending to nature rather than their books, these early naturalists helped with the creation of a new subject that has recently been called 'the science of describing'. Thus natural history, which was simply the title of Pliny's book in 1500, had become a discipline in its own right by 1600.[50]

This development of a new subject has overshadowed one of the great achievements in the old subject of animals within the tradition of natural philosophy.

[44] Velcurio, *Epitomae Physicae*. l. 3.
[45] Heywood, ed., *Collection of Statutes*. pp. 7, 290 and appendix.
[46] Strickland Gibson, ed., *Statuta antiqua universitatis oxoniensis* (Oxford, 1931). p. 358.
[47] The life and works of these pioneers is detailed in Charles Raven, *English Naturalists from Neckham to Ray* (Cambridge, 1947).
[48] Ibid. p. 141.
[49] John Caius, *De libris propriis* (London, 1570). fol. 21r.
[50] Brian Ogilivie, *The Science of Describing* (Chicago, 2006). p. 87.

Edward Wotton's interest in humanistic natural philosophy is demonstrated by his *De differentiis animalium*, published in Paris in 1552 through the good offices of Sir John Mason, chancellor of Oxford University.[51] Mason himself gave All Souls College, Oxford the subtly decorated copy that it still possesses[52] but Wotton did not donate a copy to Magdalen who got theirs from another fellow, Nicholas Gibbard (MA 1566).[53] Had it been published a few years earlier, this excellent work of humanism might have been a commercial success. As it is, the single edition attests to it being a vanity publication dedicated to Edward VI and probably paid for by Wotton himself. It is a big folio volume of over four hundred pages, with large type, but no illustrations.[54] Wotton has distilled all the classical natural philosophy on animals into a single work that might have acted as a useful textbook. His main sources are Pliny and Aristotle, but he has plundered many other ancient authorities such as Galen, Dioscorides, Celsus and Aetius. The more contemporary authors that he cites are usually textual scholars, such as Theodore of Gaza and Ermolao Barbaro, whom he has used to untangle Pliny's names of animals. He has also occasionally used John Claymond's commentary. The bilingual index impressively includes both Greek and Latin names. Wotton already had experience of publishing in Greek. He had been involved with the Aldine *editio princeps* of the Greek text of Galen, published in 1525. He had been joined by the English physicians John Clement (d. 1572) and William Rose (d. 1525) as well as Thomas Lupset and the German, Georg Agricola (1494 – 1555).[55] *De differentiis animalium* may have been damned with faint praise by Gesner[56] and never penetrated the book market (Andrew Perne owns the only copy in the booklists),[57] but it is a fine monument to a fine scholar.

Overall, the responses of university masters to the new syllabuses were extremely varied. Scholasticism was ruled out but plenty of options remained. For the majority of masters who did not wish to follow the restricted choices of the syllabus itself, the new breed of humanist textbooks made an ideal alternative. They taught Aristotle but in a way that was acceptable to an Erasmian. For others, the inclusion of

[51] Raven, *English Naturalists from Neckham to Ray*. p. 40.
[52] Oxford, All Souls College Library, shelf mark vv.infra.2.3.
[53] Oxford, Magdalen College Old Library, shelf mark R13.5(1).
[54] Edward Wotton, *De differentiis animalium libri decem* (Paris, 1552).
[55] Vivian Nutton, *John Caius and the Manuscripts of Galen*, vol. 13, *Proceedings of the Cambridge Philological Society Supplementary Volumes* (Cambridge, 1987). p. 38.
[56] Raven, *English Naturalists from Neckham to Ray*. p. 41.
[57] Leedham-Green, *BCI.* v. 1, p. 457.

Pliny and the *Problemata* on the syllabus was an invitation to take up what would soon be called natural history. This variety, together with the ability of new books to enter the market, meant that the old hegemony, where every student learnt much the same thing in much the same way for centuries, could no longer be maintained even if anybody had wanted to.

The 1559, 1564/5 and 1570 Statutes

On 20th August, 1553, almost as soon as she had ascended the throne, Mary I ordered the universities to drop the Edwardian reforms and return immediately to their ancient statutes until she had time to visit them herself.[58] Both John Cheke and Thomas Smith lost influence under Mary. Cheke was imprisoned and forced into a degrading public recantation of his Protestantism.[59] The alternative was the stake. I cannot find any evidence that scholasticism made a comeback in the arts faculties during the late 1550s. It is likely, therefore, that the arts masters were allowed to carry on what they were doing while official attention was focused on the theology faculty. When Cardinal Pole's visitors did lay down new ordinances in 1557, these made no mention of the syllabus and concerned themselves exclusively with religion and discipline.[60]

The only evidence that we have for the promotion of mathematics during Mary's reign concerns John Dee. In 1554, Oxford invited Dee to lecture on mathematics (or so he claimed) but he declined.[61] No one else seems to have been approached and the initiative was dropped.

At the start of her reign, Elizabeth's visitors issued another set of statures that signalled a return to something very like the Edwardian syllabus at both universities, except that rhetoric replaced arithmetic in the first year. Also in 1558, the Rede lectureship in grammar was renamed the lectureship in rhetoric, presumably to echo the promotion of rhetoric in the statutes.[62] The demotion of mathematics has been

[58] C.S. Knighton, ed., *Calendar of State Papers, Domestic Series of the Reign of Mary I, 1553 - 1558* (London, 1998). 12 and 13.
[59] J. D. Mackie, *The Early Tudors, The Oxford History of England* (Oxford, 1952). p. 552.
[60] Heywood, ed., *Collection of Statutes*. p 230.
[61] John Dee, "Compendious Rehearsal," in *Johannis Glastoniensis Chronica*, ed. Thomas Hearne (Oxford, 1756). p. 507.
[62] Cambridge, Jesus College Archives, Audit Book for 1558, n.p.

examined in depth by Mordechai Feingold and we need not repeat his research here.[63] However, he concludes persuasively that mathematics continued to hold an important place in the curriculum. The reason that arithmetic was no longer the first subject taught had, he argues, to do with the need for the universities to attract well-to-do students looking for a couple of years of education before moving to the Inns of Court or political careers. Their primary interest was rhetoric and so that is the subject that was covered first.[64] Those undergraduates who remained to take BA or MA degrees continued to cover as much mathematics as before. One might only add to Feingold's analysis by noting that if the mathematical emphasis of the 1549 syllabus was as dependent on John Cheke as we have seen, then his absence in 1558 would itself lead to a resurgence of the trivium.

Later in Elizabeth's reign, Oxford and Cambridge once more diverged and each adopted their own sets of statutes rather than using an essentially identical shared set. We can see this as a return to the situation before 1535, when both universities could reflect their own personalities before uniformity was enforced for the next thirty years. However, neither university could entirely shake off the previous reforms. The rejection of scholasticism and the adoption of early-modern textbooks could not be reversed, even at Oxford.

The Nova Statuta of Oxford

Oxford decisively abandoned the Edwardian system in 1564/5 for what looks, at first sight, like a return to the medieval syllabus. This reform was the brainchild of the Earl of Leicester, the chancellor of Oxford who issued a new set of statutes, called the *nova statuta*, in 1564/5.[65] They laid down the mathematical works that regent masters had to expound in their ordinary lectures. Boethius, Witelo and Sacrobosco return as required for lecturing in the subjects of arithmetic, geometry and astronomy respectively. The *Theorica planetarum*, the *Almagest* or another book by Ptolemy are also listed for astronomy. Euclid, of course, is ever-present as the primary author for geometry.[66] Later in the statutes, there is another list of books which are to be

[63] Mordechai Feingold, *The Mathematicians Apprenticeship: Science, Universities and Society in England, 1560 - 1640* (Cambridge, 1984). p. 24ff.
[64] Ibid. p. 29.
[65] Penry Williams, "State, Church and University 1558 - 1603," in *A History of the University of Oxford: The Collegiate University*, ed. J. K. McConica (Oxford, 1986). p. 425.
[66] Gibson, ed., *Statuta*. p. 378. "In ordinariis suis lectionibus hos explicabunt autores... Arithmeticam vel Boetii vel Tunstalli vel Gemmephrisii. Geometricam vel Euclidis vel Vitellionis perspectivam.

explicated to the students in each faculty. Lectures on arithmetic and music were to be heard by undergraduates for three and two terms respectively. Bachelors had to become thoroughly acquainted with geometry and astronomy over two terms each, and with natural over three.[67] This statute allows Boethius for arithmetic or music, Euclid for geometry and Sacrobosco for astronomy.[68] So far, so medieval, even though we know that the music lectures were often abandoned due to lack of interest.[69] However, the victory for the conservatives was nothing like complete. For a start, the statutes had a split personality. Cuthbert Tunstall and Gemma Frisius were also allowed as arithmetic texts for the regent masters to lecture on, while Gemma also featured in the authors for undergraduates studying arithmetic. These early-modern authors represent not just a change of style from Boethius, but, as we have seen, a completely different subject. Furthermore, the booklists show no evidence that in reality Boethius made any sort of comeback at Oxford after 1565.

Gemma was a Dutch physician and instrument maker of lowly birth who built up a business of manufacturing and selling globes, quadrants and astronomical equipment. He even invented his own instruments such as the ring described in his 1533 pamphlet (bound with Peter Apian's *Cosmographia*). His son Cornelius followed his father to become a professor at the University of Louvain and his apprentice, Gerard Mercator, was later famous for his map projection. Most of all, Gemma was a consummate businessman who knew how to make things sell. He took Apian's book, languishing and unknown, and turned it into a bestseller by adding illustrations, updates and appendices of his own. He also had immense self-belief, taking as a Latin name his place of birth, and added a poem to the back of his treatise on the astronomical ring that starts "Gemma is my author. Who does not know Gemma? How strong is he in wisdom and skill?"[70] Even by sixteenth-century

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Astronomiam vel Iohannis de Sacro Bosco vel Theoricam Planetarum vel Ptolomei Almogestam, vel quemlibet alium librum Ptolomei."

[67] Ibid. p. 390. "A primo uniuscuiusque Oxonium adventu quatuor annos quisque completo antequam ad bacchalaureatus gradum aditus patefiat, quos his audiendis artibus ad hunc modum singuli insumunto. Duos terminos ediscendae grammaticae danto...tres arithmeticae, duos demum musicae. A tempore suscepti bachalaureatus, tres annos in caeteris pernoscendis quisque ponito; duos scilecit terminos in geometria, itidem in astronomia duos, in naturae philosophia tres."

[68] Ibid. p. 389. "In quaque facultate, hos potissimum ad explicandum scriptores adhibento..., Boetium vel Gemmam Frisium in arithmetica; in musica Boetium; in geometria Euclidem; Orontium de Sphera vel Iohannem de Sacrobosco in astronomia."

[69] Clark, ed., *Register 1571 - 1622.* p. 100.

[70] Gemma Frisius, *Arithmeticæ practicæ methodus facilis* (Antwerp, 1540). Back cover. "Gemma mihi est auctor, quis nescit nomina Gemma? Quantus is ingenio, quantus & arte valet?"

standards this seems to be laying it on a bit thick. However, as esteemed a figure as Andreas Vesalius (1514 – 1564) called him "Famous as a physician and as a mathematician, comparable to but a few."[71]

His *Arithmeticæ practicæ methodus facilis* was a popular textbook represented twenty-two times on the Cambridge probate lists – more than any other mathematical work. The reason for its popularity is likely to be the book's brevity rather than any virtues of clarity or style. Being compact, it was also cheap enough for students' purses at just four pence on average a copy.[72] On the other hand, it is found only four times at Oxford, all after 1566, having featured in the 1564/5 statutes. Its addition to the syllabus at this time accounts for this late surge in appearances in Oxford booklists, but it was probably in use earlier than 1564 as well. John Badger of Christ Church was Oxford's regent master for arithmetic in 1555.[73] When he died in 1577, his books included Gemma's *Arithmeticæ methodus* as well as Petrus Ramus' *Arithmetices libri duo* (which had not been published by 1555).[74] Badger also owned an unidentified work of Cardano, which might just be the arithmetic textbook allowed by the 1549 statutes.

In all, Gemma's *Arithmeticæ methodus* went through over seventy editions. The *editio princeps* was printed at Antwerp in 1540 and is dedicated to William Rhetius whom Gemma thanks for certain sums of money.[75] This may mean that the book was commissioned by Rhetius or that having his name immortalised in this way was the reward for being one of Gemma's better customers. Gemma is writing, he claims, due to the pleas of his friends and promises to be neither too longwinded and verbose nor too laconic, but clear.[76] He succeeds only with the first two of these.

This is not a book that you could have given to a student who had never done any maths and expected them to wade through it. They could have done this with Tunstall's *De arte supputandi*, which took matters at a much slower pace and included sufficient worked examples to clear up any misunderstandings. Not so Gemma, who had only one example of how to extract square roots and two for cube

[71] G. Kish, *Medicina, mensura, mathematica: The Life and Works of Gemma Frisius, 1508 - 1555* (Minneapolis, 1967). p. 7.
[72] See appendix one.
[73] See appendix four.
[74] E. S. Leedham-Green and R. J. Fehrenbach, *Private Libraries in Renaissance England: a Collection and Catalogue of Tudor and Early Stuart book-lists* (Marlborough, 1993). v. 5, p. 13.
[75] Cambridge, University Library, Hanson c.213.
[76] Frisius, *Arithmeticæ methodus*. Preface.

roots. Neither explains quite what is going on and there is confusion due to his not pointing out which figure we are supposed to be manipulating at a given moment. Part one deals with numbers and basic arithmetic. We are informed that Arabic numerals are to be read from right to left as this is what the ancient Chaldians did[77] and how to read a large number. We then move to the four arithmetic operations, which Gemma compares to the four standard methods of logic: deduction, induction, contradiction and imitation.[78] He then briefly covers arithmetic and geometrical progressions and the 'golden rule', also present in Tunstall, whereby one unknown can be found from two knowns. Part two deals with fractions, again too rapidly for the beginner. Part three is the most interesting. First, there are ten practical examples of the golden rule and two, involving a wine merchant and spice dealer, on calculated results with a single constraint. Then Gemma claims to be presenting something new in his *regula falsi*. This is not, he is keen to make clear, a case of his giving us a false rule but rather what seems to be the method of trial and error. For simple first order algebra his method only involves guessing an answer, comparing it to the desired quantity and changing it by the necessary amount. Hence, $3x + 7 = 22$. Guess $x = 7$. This gives you $21 + 7 = 28$, which is 6 more than 22. So the actual number is 6/3 less than our guess. So $x = 5$. There is nothing original or clever here and it is hard to see how Gemma can claim his method is an original idea never before set out in works of algebra.[79] As a recent authority noted, "Gemma's method … has no practical value at all,"[80] although it seems to have impressed John Dee.[81] We then move on to the extraction of square and cube roots by the same algorithm as Tunstall, but less clearly explained. Then a return to the *regula falsi* to see if it works with quadratics (Latin for square roots as Gemma mentions) as well.[82] Although he gives us seven examples he does not seem to be doing more than a method of trial and error. He has certainly not started to use Cardano's quadratic solutions. The brief part four covers ratios and the treatise ends with some unanswered mathematical puzzles.

[77] Ibid. fol. 2r.
[78] Ibid. fol. 3r.
[79] Ibid. fol. 23r.
[80] A. J. E. M. Smeur, "The "rule of false" Applied to the Quadratic Equation in Three 16th-century Arithmetics," *Archives Internationale d'Histoire des Sciences* 28 (1978). p. 76.
[81] John Dee, *The Mathematical Praeface to the Elements of Geometry*, ed. Alan G. Debus, Facsimile ed. (New York, 1975). sig. *iii r.
[82] Frisius, *Arithmeticæ methodus*. fol. 30r.

Gemma's textbook was succinct and covered the basics. But he was far more interested in showing off his own cleverness than helping students struggling with their arithmetic. They would actually need to be taught and this book may have served as a ready reference but no more.

The 1564/5 statutes also allowed bachelors to hear lectures on a contemporary author to be used in astronomy.[83] This is Oronce Fine (1494 – 1555) or Orontius whose *De mundi sphaera sive cosmographia libri V* was first published in 1532 as part of a compendium of textbooks. Five editions also appeared subsequently as a separate title.[84] This was one of the books recommended by Robert Recorde in his *Castle of Knowledge*[85] as well as one of the books he imagined a student starting out with.[86] It appears in the Oxford probate lists only once,[87] belonging to William Kettelby (d. 1573) of Christ Church.[88] However, this is an interesting find because he was an astronomy regent in 1562. He also owned Peter Apian's *Cosmography* and an astrology text by Alcabitus. Although he was teaching before the 1564/5 statutes came into effect, Fine could well have been used before that date. After all, the book must already be well known and approved of to make it onto the statutes. Falling just outside my sample, the same book was owned by Henry Hutchinson (d. 1573) who was probably about to take his MA when he died.[89] He also owned Gemma's arithmetic and surely had both books as part of his ongoing MA studies. At Cambridge, Fine's *De mundi sphaera* is found only with the physician John Perman in 1545 before it appears in both the huge collections of Thomas Lorkin and Andrew Perne around 1590.[90] Fine's textbook is similar to Apian's *Cosmographia* in that it covers geography as well as cosmology. Fine was also the author (with Tunstall) from whom Walter Mildmay (1521/2 – 1589) chose to educate himself on the quadrivium when, like many of Edward IV's courtiers, found himself with rather more free time

[83] Gibson, ed., *Statuta*. p. 389.
[84] S. K. Heninger, "Oronce Finé and English Textbooks for the Mathematical Sciences," in *Studies in the Continental Background of Renaissance English Literature: Essays Presented to John L. Lievsay*, ed. D.B.J. Randall and G.W. Williams (1977). p. 175.
[85] Robert Recorde, *Castle of Knowledge*, Facsimile ed. (Amsterdam, 1975). p. 98.
[86] Ibid. p. 2.
[87] A 'probable' identification in the books of Thomas Griffith seems too uncertain to me. See Leedham-Green and Fehrenbach, *PLRE*. v. 3, p. 67.
[88] Ibid. v. 4, p. 149.
[89] Ibid. v. 4, p. 133.
[90] Leedham-Green, *BCI*. v. 2, p. 345.

after the accession of Mary I.[91] Mildmay had only attended Christ's College, Cambridge for a couple of years, not long enough to have covered the quadrivium, before moving to the Inns of Court. He plainly felt the lack, despite his considerable financial acumen, because he decided to work through several mathematical textbooks. These, all dated 1555 and with his autograph, are preserved in the library of Emmanuel College, which he founded.[92]

The new statutes of 1564/5 also returned to Aristotle where, for the three philosophies, the books from the ancient statutes are stipulated.[93] Later in the statutes, each faculty was ordered to lay on lectures in the *Physica*, *De caelo* and *De mundo*, *Meteorologia* and either *De anima* or the *Parva naturalia*.[94] Comparing this list to the earlier one from the fifteenth century syllabus in chapter two, it is interesting to note that many of the Aristotelian works now considered to be spurious have been excluded. Only *De mundo* remains. This winnowing of spurious texts might reflect the activities of humanists trying to restrict the Aristotelian corpus to the pure original Aristotle.[95] *De mundo* is allowed to stay because it was translated by the notable humanists Giorgio Valla (d. 1500) and Guillaume Budé (1467–1540). Books which are probably one of these versions appear eleven times in the Cambridge booklists and twice at Oxford.[96] In 1566, almost immediately after these statutes were promulgated, James Whitehead of Merton College was twice told to lecture on natural philosophy, specifically on the *Parva naturalia*, *De anima* and the *Meteorologia*.[97] It is only in this later period that *De anima* and the *Parva naturalia* start to make common appearances in the Oxford booklists. This would suggest that the new statutes did lead to an emphasis on the original texts that was probably lacking at the start of the sixteenth century, notwithstanding the demands of the medieval statutes. This impression is confirmed by the probate list of James Powell, who was a natural

[91] L. L. Ford, "Mildmay, Sir Walter (1520/21–1589)", *Oxford Dictionary of National Biography*, Oxford University Press, 2004 [http://www.oxforddnb.com/view/article/18696, accessed 28 July 2006]
[92] Bound together at Cambridge, Emmanuel College, shelf mark FB5.
[93] Gibson, ed., *Statuta*. p. 378. "Quod vero attinet ad tria philosophorum genera, in illis explicandis ordem illum quem statuta vetera praescribunt retineri volumus."
[94] Ibid. p. 390. "In quaque facultate, hos potissimum ad explicandum scriptores adhibento... Aristotelem aut de Phisicis, aut de Coelo et mundo, aut de Meteoris, aut de Parvis naturalibus, aut de Anima in naturae philosophia."
[95] Jill Kraye, "Philologists and Philosophers," in *The Cambridge Companion to Renaissance Humanism*, ed. Jill Kraye (Cambridge, 1996). p. 147.
[96] Leedham-Green, *BCI*. v. 2, p. 44; Leedham-Green and Fehrenbach, *PLRE*. v. 2, p. 185 and v. 3, p. 112.
[97] J. M. Fletcher, ed., *Registrum annalium Collegii Mertonensis, 1521 - 1567* (Oxford, 1974). pp. 264 and 270.

philosophy regent master in 1569. When he died in 1575, he left behind a copy of the *Physica* and Velcurio's textbook in his modest library of thirty or so books.[98] He also owned a copy of Scotus on *Metaphysica*, which, like other scholastic works, do start to appear in the probate lists of the 1560s and 1570s.

Charles Schmitt sees a "serious revival of interest in scholasticism" in England at the end of the sixteenth century, probably as a result of European influence.[99] The booklists go some way towards supporting this contention. At Oxford, there is no medieval natural philosophy at all in the probate lists between 1534 and 1570. Thereafter there is a cluster of books by Albertus Magnus, William of Ockham and, of course, John Canonicus.[100] The collection of Robert Barnes, which passed to Merton College at the end of the sixteenth century, is also strong in scholastic natural philosophy.[101] Despite all the efforts of the Christian humanist reformers, it appears Oxford had reverted to type. However, as Barnes's books survive, we can see that he has had to hunt for second-hand copies with none of the scholastic titles dating from after 1505. We saw in chapter two how his copy of John Canonicus had had three or four owners before Barnes got his hands on it. Of course, this is hardly surprising because few scholastic books were printed after 1520 anywhere. A similar picture emerges from the benefactions to Christ Church, which also received several old scholastic tomes.[102] This interest in scholastic books seems unrelated to the university's teaching activities and could be antiquarian rather than pedagogical.

The *nova statuta* then, do not represent a return to the situation current before 1535. Rather they show Oxford reasserting its independence from a set of statutes that had originally been written by Cambridge men with their own university very much in mind. While the new syllabus included some of the older books, it also stipulates early-modern authorities for the quadrivium. The drafters must also have realised that reinstating the natural books of Aristotle was merely recognising the practice that

[98] Leedham-Green and Fehrenbach, *PLRE*. v. 4, p. 205.
[99] Charles Schmitt, *John Case and Aristotelianism in Renaissance England* (Toronto, 1983). pp. 66 and 75.
[100] See especially the collections of William Stocker (1570) and John Tathan (1576) in Leedham-Green and Fehrenbach, *PLRE*. v. 4, pp 4 – 5 and v. 5, pp. 259 – 264.
[101] A. B. Emden, *A Biographical Register of the University of Oxford from AD 1501 to 1540* (Oxford, 1974). pp. 714 – 5.
[102] N. R. Ker, "Books at Christ Church 1562 - 1602," in *A History of the University of Oxford: The Collegiate University*, ed. James McConica (Oxford, 1986). pp. 502 – 513.

already prevailed on the ground. It had no effect on the textbooks used and the ability of masters to adopt new ones when it suited them.

The Statutes of 1570 at Cambridge

Unlike Oxford, Cambridge did not revise the syllabus in its next set of statutes issued in 1570. These were the last revision before the nineteenth century, required the same books as 1549 and much the same teaching framework.[103] Of course, the 1549 statutes upon which those of 1570 were based were already well attuned to the Cambridge milieu. That the opportunity to revise the course was not taken, even after Oxford had completely rewritten its syllabus, suggests that teaching continued much as it had before in the Christian humanist framework. Certainly there is no sign of a scholastic revival.

Rather, we must assume that because the syllabus was not changed, the current situation was felt to be quite adequate. No matter that what was taught could diverge quite markedly from what was ordained. To issue a new set of books would be more prescriptive than continuing to interpret the syllabus in the broadest way imaginable. Thus Cambridge retained a maximum degree of flexibility by not changing a list of set books that could already been seen as thirty years out of date. This came into its own as the pedagogical method of Petrus Ramus enjoyed an enormous surge in popularity in the last quarter of the sixteenth century. Even if Ramus' influence was not philosophically very great, large numbers of his textbooks and those of his followers were consumed by eager students.[104]

Teaching at Oxford and Cambridge in the Reign of Elizabeth

First-hand evidence of the teaching at the universities is quite rare, although we do find more of it as the sixteenth century rolled on. From what we can tell, the old system of lectures and disputations continued to hold up quite well. We have seen how lectures were increasingly given by salaried masters or professors. It was also the case that the colleges took on an increasing amount of the teaching burden for their own students.

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[103] James Heywood and Thomas Wright, eds., *Cambridge University Transactions during the Puritan Controversies of the 16th and 17th Centuries* (London, 1854). p. 1ff.
[104] Mordechai Feingold, "English Ramism: A Reinterpretation," in *The Influence of Petrus Ramus: Studies in Sixteenth and Seventeen-Century Philosophy and Science*, ed. Mordechai Feingold, Joseph S. Freedman, and W. Rother (Basel, 2001). p. 128.

Rather than concentrate on the mechanics of teaching, which have been closely examined in the relevant volumes of the histories of the universities,[105] we shall try and discern some of the subject matter of the lectures and disputations to see if they reinforce what we have discovered about the syllabuses being flexible and allowing the introduction of new material and textbooks.

Disputations

Disputations were formal events where one individual took on the role of the *opponens* and the other of *respondens*,[106] usually with a student having to dispute with a master in order to pass the examination. This was not so much a real dispute but a formula by which the student could demonstrate their familiarity with the arguments and counter arguments before reaching the foreordained conclusion. However, we do hear of occasions when a disputation had been in danger of veering off in an unexpected direction, especially when it was a public event between masters rather than of pedagogical intent.[107]

There are many references to disputations in the statutes that make clear these were highly formalised events. Cambridge masters were ordered to arrive from their colleges or halls, and not direct from the pub.[108] Colleges also held their own disputations. For example, Richard Fox ordered a philosophy disputation to take place in Balliol on Saturday from 1506[109] and the dean was to lead disputations on the *Problemata* at Jesus College Cambridge according to the 1515 statutes.[110] Mathematical and logical disputations took place at Christ Church under Richard Cox.[111] In 1550, John ab Ulmis, studying medicine at Oxford, attended disputations in natural and moral philosophy at 12pm each day.[112] There is much more in the statutes

[105] See especially: G. D. Duncan, "Public Lectures and Professorial Chairs," in *A History of the University of Oxford: The Collegiate University*, ed. J.K. McConica (Oxford, 1986). and D. R. Leader, *The University to 1546*, vol. 1, *A History of the University of Cambridge* (Cambridge, 1989). c. 11.
[106] J. M. Fletcher, "The Faculty of the Arts," in *A History of the University of Oxford: The Collegiate University*, ed. J.K. McConica (Oxford, 1986). p. 168.
[107] Claire Cross, "Oxford and the Tudor State 1509 - 1558," in *A History of the University of Oxford: The Collegiate University*, ed. J.K. McConica (Oxford, 1986).: p. 136 recounts how Bishop Ridley had to intervene to ensure a victory for those refuting the sacrificial nature of the Eucharist in 1549.
[108] Heywood, ed., *Collection of Statutes*. pp. 155 – 6.
[109] *Statutes of the Colleges of Oxford: with Royal Patents of Foundation, Injunctions of Visitors and Catalogues of Documents Relating to the University Preserved in the Public Record Office*, 3 vols. (Oxford, 1853). v. 1, "Balliol"
[110] Arthur Gray, ed., *The Earliest Statutes of Jesus College, Cambridge* (Cambridge, 1935). p. 15.
[111] J. K. McConica, "The Rise of the Undergraduate College," in *A History of the University of Oxford: The Collegiate University*, ed. J. K. McConica (Oxford, 1986). p. 41.
[112] C. H. Williams, ed., *English Historical Documents 1485 - 1558*, vol. 5 (London, 1967). p. 1071.

and other sources to convince us that disputations remained central to the life of the universities throughout the sixteenth century.

In August 1564, the Queen came to Cambridge and was entertained with a round of disputations and speeches. Perne received royal applause for his Latin sermon and Elizabeth herself was persuaded to say a few words in the ancient language.[113] Two years later, it was the turn of the masters of Oxford. They laid on a similar programme, which also included philosophy disputations.[114] One of the respondents before the Queen was Edmund Campion, the future Jesuit martyr who asked, "Whether inferior bodies are ruled by superior ones."[115] This sounds like a reference to the efficacy or otherwise of astrology. The other natural philosophy question that day was whether the tides are caused by the moon. Sixty years later, Galileo was answering the same question in the negative.

The questions asked at the university disputations are only preserved from the 1570s onwards. However, I believe it is reasonable to briefly examine them because it is likely that they are a fair reflection of the sorts of questions being asked in disputations during the 1560s as well. The *Variationes* from Merton College, which do run through all the sixteenth century and we will look at in the next chapter, show little difference between the 1560s and the 1570s. Despite this, the following discussion of disputation questions can only indirectly illuminate what the situation may have been in the earlier decade.

The questions for Oxford have been printed while the Cambridge questions remain largely in manuscript. This latter set of questions was collated by Weeden Butler (1740 – 1823), headmaster of the Cheyne Walk School in Chelsea.[116] He explains that the manuscript contains those "Cambridge Tripos in my possession" in both manuscript and printed form.[117] As some of the questions date back to the sixteenth century, this description is anachronistic. The Butler collection also includes versified answers. Most of these extend only for a page or two and contain little by way of substance, citations or discussions of contrary positions. It is likely this

[113] John Nichols, *The Progresses and Public Processions of Queen Elizabeth*, vol. 1 (London, 1823). pp. 166 and 170.
[114] Ibid. p. 211.
[115] Ibid. p. 211. "Corpora inferiora reguntur a superioribus"
[116] Thompson Cooper, "Butler, Weeden (1742–1823)", rev. Philip Carter, *Oxford Dictionary of National Biography*, Oxford University Press, 2004 [http://www.oxforddnb.com/view/article/4214, accessed 22 Aug 2006]
[117] London, British Library, Add MS 15343, fol. 1r.

collection is based on the printed broadsides produced from the late sixteenth century that featured answers to disputation questions presented in verse. One of the earliest surviving such broadsides is by Henry Hawkins of Peterhouse dating from 1577.[118] Butler duly transcribed it into his collection.[119]

The status of the questions and answers in Butler's manuscript is consequently unclear. They may include broadsides published for reasons other than academic advertisement and they certainly do not contain verbatim records of disputations. The questions cover many subjects, including theology, magic, politics and all branches of philosophy. One question on natural philosophy is "There are not many worlds." After mentioning Democritus, the answer continues,

> Doubtless the excellent of mind, who by a heaving chest fearing to be enclosed by the narrow confines of heaven, gives birth to innumerable worlds and he will cross the hated boundary joined at the pole which surrounds the last circle and embraces the sphere of the fixed stars. Doubtless of an excellent mind which exits the door of highest ether, he sees news agreements of laws and other circuits of stars, backwards eternal elements and other natures.[120]

As philosophy, this leaves plenty to be desired although I will not pass judgement on it as poetry. The author finally concludes that "it is allowed that our world has everything."[121]

The earliest extant Oxford disputation questions date from 1576, 1581 and then in continuous series from 1583.[122] We know these were the questions approved by congregation. Not all of them were entirely serious in intent. In 1595, a question was asked, "Whether dunces are more obscure than illuminating." Apparently, they

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[118] STC 4474.97
[119] London, British Library, Add MS 15343, fols. 25r - 30v.
[120] Ibid. fol. 12(2)v.
"Scilicet egregius mentis, qui pectore anhelo
Concludi metuens angusto limite coeli
Parturit innumeros mundos finemque perosus
Transabit connexa poli, quem circulus ambit
Ultimus, infixisque orbem complectitur astris.
Scilicet egregius mentis, qui claustra supremi
Aetheris egressus, vidit nova foedera legum
Atque alios cursus astrorum elementaque rursus
Aeterna, naturasque alias."

[121] Ibid. "Licet omnia mundus noster habet."
[122] Clark, ed., *Register 1571 - 1622.* v. 1, p. 170ff.

are indeed.[123] This might reflect official disapproval with the revived interest in scholasticism, especially Duns Scotus, in which case it was a witty way to show it. In 1600, it was asked, "Whether wandering around is conducive to philosophy." Again, the question looks like a satirical dig at Aristotle even if the disputants did affirm that peregrination is good for the mind.[124]

The issue of many worlds came up in 1581 and 1588. The inhabitants of the antipodes arose in 1584 and the tides in 1587.[125] Of most interest is the question from 1576, "Whether the earth rests in the centre of the world."[126] There is no doubt that this does refer to the Copernican controversy. John Chamber and Henry Savile, who had both been astronomy regent masters in the previous few years presumably mentioned Copernicus. Savile certainly approved of Pole's ability if not fully crediting his originality.[127]

This was the state of play when Giordano Bruno (1548 – 1600) turned up at Oxford in 1583 to dispute on the matter of the heliocentric hypothesis. He criticised Oxford in the fourth dialogue of the *Ash Wednesday Supper*. Bruno claimed he was barred from finishing his public disputation before the Polish prince, Laski, in 1583 by the pedantic and ignorant doctors of grammar. His lectures on the soul and sphere were also forestalled.[128] In reply to Bruno's complaints, the doctors replied, "they were companions of Aristotle, of Ptolemy, and of many other most learned philosophers; and the Nolan remarked that there are innumerable imbecile, senseless, stupid and ignorant persons."[129] Bruno then claimed he was urged "that he should have compassion over the poverty of this country, which was left a widow by good letters concerning philosophy and real mathematics (in which they are now all like blind men)."[130] There have been many efforts to read something into this beyond the fact that the Oxford doctors rejected Bruno's Copernicanism and doubtless found him a complete bore. The foregoing analysis makes clear that the doctors of Oxford were not ignorant of Copernicus. Nor were they ignorant of neo-Platonism, as Robert

[123] Ibid. p. 173. "An dunsi magis obscurent quam illustrent? – Aff."
[124] Ibid. p. 174. "An peregrinatio conducat ad philosophandum. – Aff."
[125] Ibid. pp. 170 – 171.
[126] Ibid. p. 170. "An terra quiescat in medio mundi."
[127] Robert Goulding, "Testamonia humanitatis: the Early Lectures of Henry Savile," in *Sir Thomas Gresham and Gresham College: studies in the intellectual history of London in the sixteenth and seventeenth centuries*, ed. Francis Ames Lewis (Aldershot, 1999). pp. 137 and 143.
[128] Giordano Bruno, *The Ash Wednesday Supper*, Stanley Jaki trans. (The Hague, 1975). p. 136.
[129] Ibid. p. 138.
[130] Ibid. p. 142.

McNulty revealed in 1960.[131] Bruno was caught red-handed by one of the masters plagiarising Marsilio Ficino, which was apparently the cause of his disputation being curtailed.[132] I find myself in full agreement with Charles Schmitt when he writes, "Bruno was a self-centred bigot who was obviously piqued because the men of Oxford did not consider him to be as brilliant as he considered himself to be".[133]

Towards the end of the sixteenth century, manuscript sources become more plentiful. John Day, the close contemporary of John Case who prepared the commentary on Aristotle's *Physica*, also set out a list of disputation topics.[134] These covered the whole field of philosophy and followed the text of Aristotle's treatises closely. Day presented the questions in a scholastic fashion with a series of objections, each of which he coupled with a solution. For readers who lacked Day's intimate knowledge of Aristotle's philosophy, he helpfully provided references for most questions. For example, this is how we know the question "Whether the Earth should move." relates to earthquakes and refers to *Meteorologica* 2.7.[135] The presence of perennially popular questions such as "Whether the elements remain in mixtures" (which we will meet at Merton in the next chapter as well), suggest that there was some central corpus of disputations.[136] Charles Schmitt dated the collection to around 1592 – 1606, on the basis of citations to contemporary authors.[137] However, despite this late date, it does shed light on the earlier disputations discussed above.

Lecturers

It is clear from the appendices to this thesis that we have more information on the identities of lecturers for the 1560s than we enjoy for earlier periods. We are also lucky that Henry Savile left behind voluminous notes for his lectures on the *Almagest*, delivered in 1570. Of course, Savile was not in any way representative of a regent master. He admitted that, although lecturing on the quadrivium was not a very popular task with his colleagues, he was very happy to be doing it himself.[138] His lectures were at a higher level and covered far more material than we would expect. The notes have

[131] Robert McNulty, "Bruno at Oxford," *Renaissance News* XIII (1960). p. 302.
[132] Frances Yates, *Giordano Bruno and the Hermetic Tradition, Routledge Classics* (London, 2002). p. 229.
[133] Schmitt, *John Case*. p. 58.
[134] Oxford, Bodleian Library, MS Rawl. D. 274, fols. 127r – 259v.
[135] Ibid. fol. 237r, "An sit terrae motus. Meteor 2.7."
[136] Ibid. fol. 164r, "An elementa maneant in mixtis. de Gen 1.10."
[137] Schmitt, *John Case*. p. 57.
[138] Goulding, "Testamonia humanitatis." p. 127.

been estimated to have contained enough material to keep his students occupied for four and a half years although it is doubtful that any students would have stayed for more than a fraction of the course.[139] As well as being overlong, the lectures were highly detailed, demanding and mathematical. It is very hard to believe they provide an accurate picture of what was really being taught at Oxford in the sixteenth century when the *Almagest* is so rarely found in the book lists. Savile's lecturers were, at least, recycled to some extent by John Chamber (1546 – 1604) who lectured on Ptolemy in 1573.[140]

Savile said that he expected his students to have studied the first six books of Euclid as well as some of books 11 and 13 before they took his class on Ptolemy's *Almagest*.[141] This is a rather optimistic estimate of a typical student's geometrical prowess. He began his lectures with some general remarks on astronomy and astronomers, before expounding in enormous detail on the text itself.[142] In his lectures, he came out strongly against the practical techniques of tradesmen and insists that mathematics is a "testimony of humanity".[143] He was not sympathetic to the practical skills of artisans and craftsmen.[144] Following Ramus, Savile cited the myth of Aristippus finding geometrical figures on the beach after a shipwreck, which led him to believe he has been cast onto the shore of a civilised country.[145] This is the Boethian tradition of mathematics as the first step to philosophy rather than as a useful skill for getting on in the world.

Savile certainly took great enjoyment from Euclid but probably found geometrical demonstrations as tedious as Roger Ascham. A story was related by John Aubrey of when Savile was interviewing candidates for his newly endowed chair in geometry:

> Bishop Ward, of Salisbury, has told me that he first sent for Mr Gunter, from London, (being of Oxford University) to have been his professor of Geometry: so he came and brought with him his sector and quadrant, and fell to resolving of triangles and doing

[139] Ibid. p. 127.
[140] Ibid. p. 143.
[141] Robert Goulding, Studies on the mathematical and astronomical papers of Sir Henry Savile, PhD, Warburg Institute, (1999). p. 76.
[142] Goulding, "Testamonia humanitatis." p. 128.
[143] Robert Goulding, "Studies on the Mathematical and Astronomical Papers of Sir Henry Savile " (Warburg Institute, University of London, 1999). p. 56. 'testamonium humanatitis'.
[144] Ibid. p. 54.
[145] Goulding, "Testamonia humanitatis." p. 131.

> a great many fine things. Said the grave knight, 'Do you call this reading of Geometry? This is showing of tricks, man!' and so dismissed him with scorn, and sent for Briggs from Cambridge.[146]

Tempting though it is to declare this story apocryphal, it rings true with what Savile himself had to say as early as 1570.

There exist a few textbooks and treatises written by Oxford and Cambridge masters at the end of the sixteenth century. John Case, the foremost philosopher in this period wrote his *Ancilla philosophiae, seu Epitome in octo libros physicorum Aristotelis* published in 1599 as an introductory textbook for students. Nowhere in it did he refer to any medieval author, although he surely knew of them. He did find space for Rudolf Agricola whom he described as a "man most learned in the thought of Aristotle."[147] Cromwell's visitors could not have agreed more. In 1589, John Day (1566 – 1628) wrote a lengthy commentary on the *Physica* at the request of his colleagues at Oriel College.[148] He was one of the foremost Aristotelian scholars of his day and cannot be taken as representative of the typical state of Oxford learning.[149] He frequently cites Thomas Aquinas (c. 1225 – 1274), but otherwise sticks to referring to a whole host of early-modern writers.[150] At Cambridge, Henry Howard, in his 1569 manuscript introduction to natural philosophy that we have met before, is typical in his use only of ancient authorities with the occasional early-modern one. He mentions the Spanish philosopher, Sebastian Fox Morillo (1528 – 1568) on Plato's *Timaeus* and Lefèvre's *Paraphrasis.*[151] Fox Morillo's treatise comparing Plato with Aristotle's natural philosophy, published in 1554, was known in Cambridge as it appears a couple of times in the probate lists.[152]

Our brief review of the material covered in lectures and disputations shows age-old concerns from the *Physica* and *Problemata* jostling with questions about the movement of the earth, the cause of the tides and the existence of other worlds. Many different viewpoints, scholastic and humanist, philosophical and practical, were

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[146] John Aubrey, *Brief Lives* (Harmondsworth, 2000). p. 281.
[147] John Case, *Ancilla philosophiae, seu Epitome in octo libros physicorum Aristotelis* (Oxford, 1599). p. 34.
[148] Oxford, Bodleian Library, MS Rawlinson D 274, fols 1 – 125.
[149] Jeremy Catto, "Day, John (1566–1628)", *Oxford Dictionary of National Biography*, Oxford University Press, 2004 [http://www.oxforddnb.com/view/article/7369, accessed 23 Aug 2006]
[150] Schmitt, *John Case*. p. 57.
[151] Oxford, Bodleian Library, Bodley 616, fol. 55v.
[152] Leedham-Green, *BCI.* v. 2, p. 354.

represented among the regent masters. Both of the universities then exposed their students to new ideas and would continue to do so.

Chapter Eight: The *Variationes* of Merton College

"*Do fish breathe?*"[1]

Asked of Herman Bilson, fellow of Merton College, 1540

The evidence presented so far in this thesis has been made up of a large number of fragments. Even the coverage of the booklists is extremely uneven and we have much less information from before the 1550s than we would like. Likewise, the lists of lecturers depend largely on whether the accounting clerks deigned to note down their names or not. However, there is one source of evidence that we have, so far, not drawn upon: the lists of questions asked at *Variationes* at Merton College, Oxford. We will examine these as an independent strand of evidence to see if they support the arguments advanced in the rest of the thesis. Thus, we are expecting to find that the questions posed before 1535 reflect those found in scholastic commentaries. After that date, we should see more natural history, references to the *Problemata* and other texts favoured by humanists. Towards the end of the period examined, an increasing number of questions should be concerned with current issues of concern found in the new textbooks then used. Finally, after 1549, we would expect to see that ethics and politics made up a greater proportion of the questions as these subjects displaced natural history from the syllabus.

Clearly, the Merton *variationes* can only be used to support our hypotheses about the situation at Oxford. No set of questions survive from Cambridge, as far as I am aware, and consequently we do not possess the kind of independent correlation there that Merton provides us with for Oxford.

Merton College *Variationes*

When Merton College elected a new fellow, he was expected to take part in a public exercise of determining six questions in two groups of three. He might invite his friends along as well.[2] There is no evidence that the occasion was one when the new fellow was being accessed, so it was more like an inaugural lecture. Nor is it clear whether the exercise was a disputation involving more than one party.[3] The

[1] J. M. Fletcher, ed., *Registrum annalium Collegii Mertonensis, 1521 - 1567* (Oxford, 1974). p. 82. "Utrum pisces respirant."
[2] H. E. Salter, ed., *Registrum annalium Collegii Mertonensis, 1483 - 1521* (Oxford, 1923). p. xxiv.
[3] Ibid. p. xxiv.

questions posed seem to have been chosen, if not by the fellow himself, then with his academic interests firmly in mind. Several fellows received a dispensation to drop the second set of three *variationes*, usually because they were lecturing or away.

The questions asked are recorded in the Merton registers published by the Oxford Historical Society. The earliest recorded *variationes* date from 1511 and they continue to the end of the published registers in 1603. Not all the questions are recorded in the register, but a total of 319 are extant. These give us a very useful guide to the topics that exercised new masters through the sixteenth century.

The records of the *variationes* can be used in two ways. We will examine the whole list of questions for evidence of changing interests and priorities over the entire period. At the same time, I want to look at what they tell us about Merton fellows of whom we already know from their lecturing or the book lists.

Table 8.1 summarises the subject matter of the *variationes* recorded in the Merton registers. The headings used may seem slightly anachronistic, but they do reflect categories that would be recognised in the sixteenth century. The heading 'physical science' refers to the subject matter of Aristotle's *Physica* and *De generatione et corruptione*. 'Natural history' includes the *Parva naturalia*, *De animalibus* and *Problemata*. 'Psychology' means questions related to *De Anima*. The remaining categories are self-explanatory. Questions are allocated according to where they fit best although this can sometimes be somewhat arbitrary. However, overall the general trends are clear and accurate.

It is unfortunate that relatively few questions are preserved from the period of greatest change, that is 1535 to 1558. Essentially, we can examine the situation before and after the Reformation, but can make out little of what was happening during it. Another obvious point is that towards the end of the century, questions of ethics and politics came to dominate the *Variationes*. The Philosopher himself also came into question when, in 1594, Richard Trafford (MA 1590) was asked, "Whether the obscurity of Aristotle in received natural philosophy is reprehensible."[4] Even Aristotle, although by now purified of medieval detritus, was no longer above criticism.

[4] J. M. Fletcher, ed., *Registrum annalium Collegii Mertonensis, 1567 - 1603* (Oxford, 1974). p. 304. "Aristotelis obscuritas in philosophia naturali tradenda reprehendenda est."

	Natural Philosophy						
Dates	Physical science	Natural history	Psychology	Astronomy	Ethics and politics	Metaphysics	Total
1511 - 1530	30	14	25	15	8	27	119
1540 - 1559	5	17	5	6	3	0	36
1565 - 1580	16	17	14	12	19	0	78
1584 - 1600	9	8	9	2	47	0	75
1511 - 1530	25%	12%	21%	13%	7%	23%	
1540 - 1559	14%	47%	14%	17%	8%	0%	
1565 - 1580	21%	22%	18%	15%	24%	0%	
1584 - 1600	12%	11%	12%	3%	62%	0%	

Table 8.1

Variations 1511 - 1530

In the period before 1535, there were plenty of questions on *Physica*, *De generatione*, *Parva naturalia*, *De anima* and *Metaphysica*. The spread of questions related closely to the natural philosophy texts that we know were assigned to regent masters in the period up to 1517.[5] Of the 21 regents, eight were allocated *De anima*, four *De generatione* and six read one or more of the *Parva naturalia*.

A typical question on *De generatione*, asked of John Pollen (MA 1512) in 1513, was "Whether the substantial forms of the elements remain distinct in a mixture."[6] A very similar question was put to John Master (MA 1525) in 1526, John Marlowe (MA 1527) in 1529 and John Denis (MA 1541) in 1543.[7] The text this question is based on is *De generatione* 1:10, where Aristotle appears to argue in the negative. The problem of the state of elements in a mixture was of constant concern to scholastic philosophers because they were unable to reconcile Aristotle's thought on this question with the concepts of substance and form. Elements (that is, earth, water, fire and air) supposedly combined in a mixture to produce a new substance. At the same time, the elements' old forms were destroyed to make way for the form of the

[5] See table 2.1 in chapter two.
[6] Salter, ed., *Registrum 1483 - 1521*. p. 442, "Utrum forme substantiales elementorum manent formaliter in mixto."
[7] Fletcher, ed., *Registrum 1521 - 1567*. pp. 24, 43 and 91.

new substance. Understanding this twin process proved beyond scholastic thinkers and no satisfactory solution was ever found.[8]

Variationes on the *Physica* are similar to the questions found in John Canonicus' *Questiones super VIII libros Physicorum* discussed in chapter two. For example, in 1513, John Pollen was asked, "Whether in the same composite there are [different] substantial forms,"[9] and similarly, in 1524, Simon Ball (MA 1520) was asked, "Whether in the same composite of substance there are many substantial forms."[10] This is the flipside of the problem of the elements in mixtures and much of the difficulty is due to Aristotle having dealt with the two issues in different places and apparently overlooked the need to reconcile them. Other questions that seem to be related to Canonicus are "Whether the first cause is acting naturally," asked of Masters Davis and Pedyll in 1527 and 1528.[11] However, these questions are not identical to those found in Canonicus, or in similar works like Walter Burley's (owned by three masters whose probate lists survive from before 1530).[12] Several questions of metaphysics about existence and essence were also asked. These reflect the concerns of Antonius Andreae whose book we saw in chapter two was often associated with Canonicus. It comes as no surprise that the questions found in the medieval treatises used as textbooks should also form the basis of the *Variationes*. However, the lack of any exact agreement with the questions in the texts means that there was probably a corpus of Oxford questions that could be drawn upon. Further evidence for this conjecture is the way that we see several questions, like the one on mixtures, being asked more than once and in different places. We saw the same question on mixtures come up in the university disputations in the last chapter.

Given the celebrated works of the Merton calculators, such as Richard Swineshead's *Liber calculatorem*, it is pleasing to see a few questions relating to the intention and remission of forms.[13] For example, John Davis (d. 1536) was asked

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[8] Anneliese Maier, *On the Threshold of Exact Science*, ed. Steven D. Sargent (Philadelphia, 1982). pp. 125 – 142.
[9] Salter, ed., *Registrum 1483 - 1521*. p. 442. "Utrum in eodem composito sunt forme substantiales."
[10] Fletcher, ed., *Registrum 1521 - 1567*. p. 7. "Utrum in eodem composito substanciali sint plures forme substanciales"
[11] Ibid. pp. 30 and 41. "Utrum prima causa sit agens naturale."
[12] E. S. Leedham-Green and R. J. Fehrenbach, *Private Libraries in Renaissance England: a Collection and Catalogue of Tudor and Early Stuart book-lists* (Marlborough, 1993). v. 1, pp. 13, 68, 105. The edition of Burley examined is *Expositio super librum Physicorum* (Venice, 1501), which includes a list of questions.
[13] Edward Grant, *The Foundations of Modern Science in the Middle Ages* (Cambridge, 1996). p. 100.

"Whether the intension and remission of forms should be the same in number."[14] Questions on the latitude of forms are often related to rates of generation and corruption. We know that in 1483, Richard Fitzjames (d. 1522), the Warden of Merton, had a copy of Swineshead's book in his chamber although overall the Merton Calculators' works are not much found in the College's book lists.[15]

Fitzjames also possessed Witelo's *Perspectiva*.[16] We recall this was on Oxford's medieval syllabus, which still applied up until 1549. In 1525, Humphrey Bluet (MA 1523) was asked a tranche of three questions on eyesight beginning with "Whether vision is caused by rays emitted by the eye."[17] Bluet later became a physician and lectured on Galen. His interests included astronomy (not unusual for a medical man) and he borrowed a book on the subject from Merton's library.[18] He also had care of the college's collection of astronomical instruments for a period.[19] The questions on the physiology of sight are classified as natural history rather than hived off to a separate category because vision is discussed by Aristotle in *De sensu et sensibilibus* 2 and 3. These questions do not appear to have much in common with the applied geometrical aspects of *perspectiva* that led to this subject being included within the quadrivium.

The other questions categorised under 'Natural History' for this earlier period were also mainly derived from the *Parva naturalia*. For example, Richard Ewer (d. 1558) was asked in 1527, "Whether men living in hot regions should live longer."[20] This is based on *De longitudine et brevitate vitae* 5.

Of the fifteen questions on astronomy prior to 1530, the most interesting was addressed to Henry Tyndall (MA 1517) in 1519. One of his questions was "Whether it is necessary to posit epicycles and eccentrics to save the appearances of the motions of the planets."[21] This shows that Tyndall must at least have been familiar with *Theoricum planetarum* and perhaps other works of astronomy. The question is exactly

[14] Fletcher, ed., *Registrum 1521 - 1567*. p. 30. "Utrum forma intensa et remissa sint idem numero."
[15] F.M. Powicke, *The Medieval Books of Merton College* (Oxford, 1931). p. 214.
[16] Ibid. p. 214.
[17] Fletcher, ed., *Registrum 1521 - 1567*. p. 20. "Utrum visio fiat per radios ab oculo emissos"
[18] A. B. Emden, *A Biographical Register of the University of Oxford from AD 1501 to 1540* (Oxford, 1974). p. 52.
[19] Fletcher, ed., *Registrum 1521 - 1567*. p. 42.
[20] Ibid. p. 30. "Utrum homines habitantes in regionibus calidis sint longismme vite."
[21] Salter, ed., *Registrum 1483 - 1521*. p. 481. "Utrum necesse sit ponere ecentricos & epiciclos ad saluandum apparencia sive apparenciam in motibus planetarum."

the one that Copernicus posed in the preface to *De revolutionibus* when he accused astronomers of deviating from constant circular motion in their descriptions of the heavens.[22] Other astronomy questions are more closely related to the subject matter of *De caelo* in that they raise issues like the substance of the planets and stars.

Looking at questions asked of particular individuals, it is clear that they could expect something related to their own interests. John Blysse (d. 1530), 'medical doctor and astronomer' became a fellow of the College of Physicians as well as Merton.[23] He was said to be a skilled disputant and learned in philosophy. Although married at one point, he died a member of the Dominican order.[24] In 1513, his second set of *Variationes* were all medical, although they are classified under 'natural history' because the *Problemata* contains several similar questions. Blysse was asked, "That medical science is not beneficially split into the theoretical and practical." and "That the choleric complexion is the most noble."[25] George Owen (c. 1499 – 1558), an even more distinguished doctor who was physician to a succession of Tudor monarchs, answered his variations in 1523.[26] These were not all specifically medical but he was asked, "Whether a young man is 'hotter' than a boy." and "Whether the period of everyone's life is fixed."[27]

Variations 1540 - 1559

During the period of greatest reform, questions from the *Problemata* became much more popular. We know that the text was lectured on at Merton from 1541[28] and we have seen how after 1549 it was actually the only work of Aristotelian natural philosophy on the syllabus. Thomas Symonds was the college lecturer on the *Problemata* in 1546 and the previous year had been asked at his variations "Whether semen flows out of the whole body."[29] This refers to *Problemata* 4:6. Symonds was

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[22] Nicolaus Copernicus, *On the Revolutions of the Heavenly Spheres*, Charles Glenn Wallis trans. (Amherst, 1995). p. 5.
[23] Emden, *Oxford 1501 to 1540*. p. 98, "medicus et astronomus quam doctus".
[24] Anon., "Blysse, John (*d.* 1530)", rev. Patrick Wallis, *Oxford Dictionary of National Biography*, Oxford University Press, 2004 [http://www.oxforddnb.com/view/article/2723, accessed 22 Aug 2006]
[25] Salter, ed., *Registrum 1483 - 1521*. p. 441. "Quod scientia medicinalis non bene dividitur in spectulativan & practicam." "Quod colerica complexio sit nobilissima."
[26] Sidney Lee, "Owen, George (*c.*1499–1558)", rev. Patrick Wallis, *Oxford Dictionary of National Biography*, Oxford University Press, 2004 [http://www.oxforddnb.com/view/article/20998, accessed 22 Aug 2006]
[27] Fletcher, ed., *Registrum 1521 - 1567*. p. 4 "Utrum iuvenis sit calidor puero." and "Utrum omnium viventium sit determinata periodus."
[28] Ibid. p. 86.
[29] Ibid. p. 86. "An semen profluat ex omni parte corporis."

also asked, "Whether the heart lives first and dies last."[30] The medical aspects of these problems are not surprising as Symonds was studying for the BMed he received in 1547. He became the first junior Linacre lecturer in 1550[31] and died in 1553. His probate list is extant. Of his 140 books, very many are medical or herbal. However, he owned Tunstall, Sacrobosco and Lefevre's natural philosophy, as well as rather more scholastic texts than we might expect at this date. He has a collection of Aristotle's works but no stand-alone edition of the *Problemata*.[32]

In 1546, Edmund Daniel (d. 1576), exiled to Rome under Elizabeth, was asked, "Whether the north wind is the healthiest."[33] This refers to *Problemata* 26:17 and 26:42. There is a substantial overlap between the *Problemata* and the *Parva naturalia*. Thomas Carter, another college lecturer in the *Problemata*, was asked in 1543, "Whether man lives longer than other animals."[34] This has clear reference to *De longitudine et brevitate vitae*. Although the sample is small, we can see from table 9.1 that the proportion of questions relating to 'natural history' has increased to almost half. We can connect this to the syllabuses' promotion of the subject through Pliny and the *Problemata* that we saw in chapter four.

Thomas Symonds was also asked if the southern hemisphere was inhabited.[35] It would be interesting to know if Symonds would have answered this by bringing up the voyages of discovery or used the traditional method of comparing texts to achieve the synthesis he required. We have seen how the question of the antipodes was one touched on in almost all the new generation of textbooks on astronomy and natural philosophy. It appeared as a question several more times at Merton and in the university disputations discussed in the last chapter.

If the antipodes was a matter of frequent concern, metallurgy certainly was not. The question "Whether metals are generated in the guts of the earth." was asked uniquely of Edward Bell (d. 1577) in 1545.[36] This reflected the theory explained by Aristotle in *Meteorologica* 3:6 that metals were a product of wetness trapped and dried beneath the earth.

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[30] Ibid. p. 86. "An cor primum vivat et ultimum moriatur."
[31] Gillian Lewis, "The Faculty of Medicine," in *A History of the University of Oxford: The Collegiate University*, ed. J.K. McConica (Oxford, 1986). p. 221n.
[32] Leedham-Green and Fehrenbach, *PLRE*. v. 2, pp. 223 – 226.
[33] Fletcher, ed., *Registrum 1521 - 1567*. p. 129. "An boria sit ventus saluberrimus."
[34] Ibid. p. 96. "Utrum homo diutius vivat ceteris animalibus."
[35] Ibid. p. 115. "An sub aequatore sit habitatio."
[36] Ibid. p. 108. "An metalla generantur in visceribus terre."

Variations after 1565

In the fifteen years from 1565, after the *Nova statuta* had been implemented for the University, the *Variationes* are spread fairly evenly across all allowable topics. Note that metaphysics has not featured since the 1530s. This is despite Aristotle's *Metaphysica* being included in the *Nova statuta*.[37] Also, the questions on the *Physica* that emphasised relations between substance and form have fallen away. They now seem to concentrate on slightly less esoteric topics: "Whether the speed of light in air is infinite," "Whether the stars take light from the sun," "Whether anything happens by chance and not by a cause," and still of interest, "Whether the Earth is inhabited under the equator."[38] This last question was asked of John Chamber (1546 – 1604), the astronomy regent and friend of Henry Savile.[39] He was also asked, "Whether the tides of the sea are affected by the moon."[40] This was, of course, also debated by Edmund Campion before Queen Elizabeth.[41]

Savile himself was asked, "Whether the Earth is moved in a circle," showing that Copernicus was at least under discussion.[42] We need to be careful, though, not to interpret these questions wrongly due to anachronistic assumptions. In 1569, John Tatham (d. 1576) was asked, "Exhalation would be the cause of the motion of the Earth."[43] We might link this with Copernicanism as well, except that it actually refers to Aristotle's ideas about earthquakes. The passage under discussion is *Meteorologica* 2:7. Tatham was also asked, "There would be one soul for all men," and two questions relating to the creation and eternity of the world.[44] The former question relates to controversies regarding the Averröist ideas on the unity of the intellect, which Pietro Pomponazzi revived at Padua in 1516.[45] The question arose again in

[37] Strickland Gibson, ed., *Statuta antiqua universitatis oxoniensis* (Oxford, 1931). p. 390.
[38] Fletcher, ed., *Registrum 1567 - 1603*. pp. 25, 51, 71 and 72. "Dissipatio luminis per totum aera non fit ad punctum temporis."; "Astra non capiunt lumen a sole."; "Nihil fit fortuna neque casu."; "Terra est habitabilis sub aequatore.",
[39] Adam Mosley, "Chamber, John (1546–1604)", *Oxford Dictionary of National Biography*, Oxford University Press, Sept 2004; online edn, May 2006 [http://www.oxforddnb.com/view/article/5044, accessed 1 Aug 2006]
[40] Fletcher, ed., *Registrum 1567 - 1603*. p. 72, "Maris aestus non efficitur a luna."
[41] John Nichols, *The Progresses and Public Processions of Queen Elizabeth*, vol. 1 (London, 1823). p. 211.
[42] Fletcher, ed., *Registrum 1567 - 1603*. p. 50, "Terra movetur circulariter."
[43] Ibid. p. 32. "Exhalatio sit causa terrae motus."
[44] Ibid. p. 32. "Unus sit numero animus omnium hominum."
[45] Brian Copenhaver and Charles Schmitt, *Renaissance Philosophy* (Oxford, 1992). p. 107.

1586 when Thomas Master (d. 1628) was asked, "Reason does not confirm the immortality of the soul."[46]

Tatham himself was Merton's rhetoric lecturer and briefly rector of Lincoln College before he died. His probate list is extant and contains the largest private collection of natural philosophy in the Oxford booklists. His collection contains plenty of medieval scholasticism as well as contemporary Aristotelian authors. He has Ockham and Averröes on the *Physica*, two copies of John Canonicus, Joannes Garcaeus (1530 – 1574) on *Meteorologia* and Francisus Vicomercatus (c. 1512 – 1571) on *De anima*.[47] It is impossible to say how many of these he owned in his Merton days, but he appears to have been one of the foremost authorities on natural philosophy at the time at Oxford.

Conclusions

The concerns of the Merton *Variationes* were similar to those we saw illustrated by the Oxford University disputations discussed in chapter seven. There is, unsurprisingly, a sizeable overlap of questions. With the university disputations, politics and ethics dominate the questions, just like they do at Merton at the same time. Thus, while we have no record of university disputations before the 1570s, it is not unreasonable to assume that the topics under discussion at Merton in the early-sixteenth century were similar to those elsewhere at the university.

Overall, the *Variationes* illustrate many of the trends discovered in the earlier chapters of this thesis. The early questions were based around the late scholastic texts used up until 1535 as well as the works of Aristotle. After 1535, the *Problemata* became far more prominent and questions related to metaphysics disappear. During the reign of Elizabeth, there was a decisive swing towards ethics and politics. Natural philosophy lost its pre-eminent place, although it still accounted for thirty-eight per cent of questions from 1584 to 1600. In the later period we also saw more questions on contemporary concerns in natural philosophy such as the movement of the earth, the immortality of the soul and the cause of the tides.

[46] Fletcher, ed., *Registrum 1567 - 1603*. p. 178, "Ratio non convincit animae immortalitatem."
[47] Leedham-Green and Fehrenbach, *PLRE*. v. 4, pp. 256 – 294.

Chapter Nine: Conclusions

"I know the universities were instituted only that the realm may be served with preachers, lawyers and physicians"[1]

Roger Ascham to William Cecil, 1553

The Reform of the Syllabuses

If we wanted to ask who were the two men most responsible for the state of teaching in the quadrivium and natural philosophy at Oxford and Cambridge in 1570, we should have to answer John Fisher and John Cheke. Fisher led the changeover from the scholastic to humanist syllabus in natural philosophy at Cambridge after 1500. His position as agent of Lady Margaret provided him with both the royal authority and the money to put in train wide-ranging reforms. His motivation was the programme of Christian humanism represented by his friend Erasmus. Both men believed that scholasticism had grown stale and should be replaced by a course based on the classics, ancient languages and the Bible. The new natural philosophy syllabus was still to be based on Aristotle, but shorn of his medieval commentators. The textbooks of Lefèvre, easily available in printed editions, met this requirement as well as being specifically written for students. He was quickly adopted. Although the textbooks changed each generation, the central idea that only classical or biblical sources should be referred to remained in place.

Thomas Cromwell's role was essentially destructive – to clear the ground of scholasticism. He launched his visitations so that the royal supremacy should be accepted at the universities. He also took the opportunity to outlaw scholastic theology and replace it with an Erasmian alternative. The demise of the philosophy course was a direct consequence of this, but probably not strictly intentional. Oxford masters had little choice but to import the existing Cambridge syllabus into Oxford after 1535 because it fell within the spirit of Cromwell's injunctions. Despite not featuring in the 1549 statutes, humanist natural philosophy remained in place at both universities thereafter. Masters found the subject was too useful to dispense with altogether. We have seen evidence that it provided evidence of Providence's creative

[1] Roger Ascham, *The Whole Works of Roger Ascham: Now First Collected and Revised, with a Life of the Author*, ed. J. A. Giles, 4 vols. (London, 1865). v. 1, p. 353.

work and that natural history became increasingly popular because it fulfilled this role even better than traditional physics.

Before the 1549 statutes were in place, mathematics was the poor relation at both universities. At Oxford, it was intended as a theoretical prolegomena to Scotist theology, based on the work of Boethius. The 1535 reforms left it as an orphan. Cambridge mathematics had always been of a more practical bent but based on very terse medieval textbooks and usually taught by whoever was willing to take it on. Cheke changed that with his 1549 statutes. His natural aptitude for the subject had taken him further than the meagre teaching at Cambridge allowed for. After a spell at court on the Privy Council, he wanted to ensure students learned practical skills and so gave pride of place to arithmetic. He also added geography, partly because he saw the need for native surveyors and partly as a result of exposure to navigators like Chancellor and Cabot. The discovery of the New World and the possibility of new trade routes made exploration an exciting and potentially profitable venture. The attempt to widen the practical remit of the universities still further by dedicating special medical and law colleges was abortive. However, the natural philosophy syllabus installed in 1549 probably was intended to form an introduction to the medical course.

Despite being downgraded in later statutes, the practical mathematics syllabus survived, although Oxford lost geography. This was because Cheke had provided that classical gazetteers like Pliny, Strabo and above all Pomponius Mela could be used for geography lectures. Oxford masters took advantage of this chance to avoid difficult mathematics and no geographical tradition arose. When the *nova statuta* were issued in 1564/5, this sort of geography served no purpose.

Of equal importance to the fact that the syllabuses underwent radical change, is the way that textbooks began to be replaced regularly. This meant that it was no longer necessary to have periodic bouts of radical reform to keep the syllabus up to date. By changing the textbooks used every few years (in practice, it seems, about once every generation), gradual evolution became automatic. The comparatively rapid turnover of textbooks was made possible by printing. This had a number of complementary effects. Firstly, by reducing the value and also the production values of books, people were more willing to abandon something quickly if a better or more recent alternative came along. Secondly, new texts could reproduce very quickly and

be present in new markets in sufficient numbers to challenge the incumbents. Thirdly, as printing technology improved over the sixteenth century, new aids for readers were developed. These made it even more attractive to purchase new books and handed a further advantage to the latest versions. We should not forget, however, that this climate contributed to the disastrous losses of medieval manuscripts which, temporarily, were prized far less than the new printed books. As book prices fell, the value of manuscripts fell even lower so that for a time they were worth less than a blank sheet of vellum that would have made a cleaner binding.

There are signs that the switch to using early-modern textbooks would have happened anyway. This is no surprise as the factors driving it were independent of other reasons for reform. At Oxford, Bricot's *Textus abbreviatus philosophiae naturalis*, which was a summary of scholastic thinking, was already popular in the early sixteenth century. However, after 1520, scholasticism underwent a Europe-wide decline and all the factors that helped to encourage the use of new books indirectly supported humanism and succeeding intellectual trends.

The Effects of the Reformation

This scope of this thesis was deliberately set to extend well prior to the Reformation so that it could try to differentiate the effects of Catholic humanism from England's break with Rome and establishment of a Reformed Church. As it turns out, it is extremely hard to distinguish differences between Catholics and Protestants. There is a temptation to associate humanism with Protestantism, but this should be resisted. For example, both John Fisher and John Cheke were humanists who made important contributions to syllabus reform at Cambridge. However, the former died for his Catholicism and the latter only repented his Protestant beliefs in the shadow of the stake.

The lists of lecturers are no more revealing of differences. The mathematics lecturers included, in John Young and Thomas Lever, zealots of both stripes.[2] Likewise, the lists of lecturers in natural philosophy at the Queens' College, Cambridge and Magdalen College, Oxford reveal no bias in religious belief.[3]

[2] See appendix two.
[3] See appendices three and five.

Suggestions that Protestant reformers deliberately destroyed a sizable chunk of England's scientific legacy also appear to be groundless.

In one sense, though, we can detect a slight bias towards philosophy and the quadrivium by Catholics. In the late sixteenth century, Catholics were becoming slowly less common and hence they do tend to stand out. Of the men who are specifically famed as mathematicians or natural philosophers in this period, there does appear to be a preponderance of Catholics. Among those whom we have met in this thesis are the mathematician Thomas Allen, the writer on natural philosophy and later courtier Henry Howard, the philosopher John Case, the doctor and naturalist John Caius and the translator of Simplicius, John Harpysfeld. In seeking to explain the reasons for these Catholics interesting themselves in art subjects, we should seek an explanation in their place in society. As Catholics, any sort of clerical career was closed to them, but they were scholars who felt at home in the university. Consequently, they devoted themselves to philosophy or mathematics as a way of remaining within the bounds of academia. For Allen and Case, we know that they did have to make compromises due to their religion to remain at Oxford. It is easy to imagine that Howard, before his rehabilitation, and Harpysfeld, before his imprisonment, felt similarly. However, the extent of Caius' Catholicism is debatable even today and did not appear to have hindered his career.[4]

The major effect of the Reformation in the teaching of the subjects we have been reviewing was to provide an opportunity for reform. The primary aims of all the visitations were religious and political, but when the statutes were rewritten, it was easy to reform other areas as well. If England had remained Catholic and the universities had not been subject to radical changes, we would expect that the trends at work prior to 1535 would have continued over the following half century. The only exception to this was the mathematical syllabus of 1549. This had little by way of precursors and it is very possible that reformation provided an occasion for the promotion of practical mathematics that may not have occurred otherwise.

[4] Vivian Nutton, "Caius, John (1510–1573)", *Oxford Dictionary of National Biography*, Oxford University Press, 2004 [http://www.oxforddnb.com/view/article/4351, accessed 3 May 2007]

Oxford and Cambridge in a European Context

Many Englishmen travelled in continental Europe and studied at the universities there. As well as travelling specifically to study, the changes in religious regime in England meant that there was a constant flow of exiles back and forth from the 1530s onwards. As they tended to be educated men, it was natural for them to gravitate towards the universities, both for employment and further education. The most common destination was Padua where the university was under Venetian control. This meant that even after the Reformation, English Protestants could continue to study there despite papal restrictions on admitting heretics.

The Italian universities had employed a succession of esteemed natural philosophers during the fifteenth and sixteenth centuries. Padua in particular could boast of Paul of Venice, Cajetan de Thiene, Agostino Nifo(c. 1473 – c. 1538), Niccolò Leonico Tomeo (1456 – 1531) and Pietro Pomponazzi among others. With such illustrious names, it is hardly surprising that natural philosophy enjoyed a high reputation there as well as being a subject for which professors were well paid.[5] In addition, the medical school at Padua demanded that arts students be better versed in natural philosophy than the theologians at Oxford or Cambridge felt necessary. These factors meant that Padua employed four professors of natural philosophy in 1500.[6]

All these professors were producing important original work as well as teaching a great number of students. Their numerous publications are the main reason their fame lasts to this day. But beyond the calibre of the teaching faculty, how different were Oxford and Cambridge from the Italian universities? Charles Schmitt recognised five major changes in the way that natural philosophy was studied in Italy after 1500.[7] Of these, three certainly had a profound effect in England: scholastic logic and natural philosophy died out; new translations won the day and Greek learning increased. The booklists also show that the Greek commentators were occasionally owned in England.[8] Of Schmitt's factors, only the last, the publication of

[5] Paul Grendler, *The Universities of the Italian Renaissance* (Baltimore, 2004). p. 269.
[6] Ibid. p. 29.
[7] Charles Schmitt, "Aristotelianism in the Veneto and the Origins of Modern Science," in *The Aristotelian Tradition and Renaissance Universities* (Aldershot, 1984). p. 112.
[8] E. S. Leedham-Green, *Books in Cambridge Inventories: Books from the Vice-Chancellor's Court Probate Inventories in the Tudor and Stuart Periods*, 2 vols. (Cambridge, 1986). v. 2, pp. 16, 617 and 706. and John Clement in A. W. Reed, "John Clement and his Books," *The Library* 6 4th series (1926). p. 337.

the entire Arabic corpus of natural philosophy, appears to have had no significant effect at Oxford or Cambridge. There is little doubt that one could get a better education in Italy than in England in the sixteenth century, especially in medicine, but the difference was one in degree. Both countries remained solidly Aristotelian and both absorbed humanism to an extent not always recognised by scholars who associate Aristotle with scholastics.

In mathematics, at least in the period under review, the situation may have been slightly different. Until the late sixteenth century, when the reputation of Jesuit mathematicians adorned the subject, mathematics was seen as a second-class subject on the continent, much as it had been in England before 1549.[9] In 1500, Padua had only one mathematics lecturer who had many more students than Roger Collingwood at Cambridge.[10] The syllabus looked similar to Cambridge (being more practical than theoretical) but the close relationship with the medical faculty meant that, unlike in England, astrology was taught.[11] Without the weight of large medical faculties, for which astrology was an essential subject, the English universities never accepted that this was a subject that deserved space in the curriculum.

With the 1549 syllabus and the promotion of all branches of mathematics, the subject officially received the same status as in England as the other arts. The increase in the quantity of mathematical books in the probate lists and other sources shows that this enhanced status was real and lasting. Thus, this thesis would argue that an Elizabethan wanting a mathematic education was better off staying in England and approaching Thomas Allen at Oxford or entering St John's College, Cambridge.

The University of Paris, pre-eminent in theology, had little reputation in natural philosophy or mathematics. The Royal Chair, occupied by Oronce Fine from 1530 until his death in 1555 provoked Petrus Ramus to deplore the lack of a Regius Professor of Mathematics at Oxford or Cambridge.[12] However, the hostility of the theology faculty to the Collège Royal meant that it was not officially attached to the university and does not appear to have significantly influenced the teaching of most

[9] James Lattis, *Between Copernicus and Galileo: Christoph Clavius and the Collapse of Ptolemaic Cosmology* (Chicago, 1995). p. 32.
[10] Grendler, *The Universities of the Italian Renaissance*. p. 29.
[11] Ibid. p. 412.
[12] Robert Goulding, "Testamonia humanitatis: the Early Lectures of Henry Savile," in *Sir Thomas Gresham and Gresham College: studies in the intellectual history of London in the sixteenth and seventeenth centuries*, ed. Francis Ames Lewis (Aldershot, 1999). p. 134.

students.[13] Lefèvre, whose natural philosophy textbooks were so popular at Cambridge, was more interested in theology. Besides, his textbooks were superseded in the 1540s by the desire for practical mathematics and a less convoluted reading of Aristotle.

Finally, we must compare Oxford and Cambridge to Melanchthon's academy at Wittenberg. The differences were considerable. At Wittenberg, the university was very much under the control of one man, Philipp Melanchthon, and the syllabus developed with his thought. Kusukawa has shown how his Lutheran faith was reflected in the syllabus and that he believed philosophy fed into law much more easily than into theology.[14] In this thesis, we have found some quite similar courses of study in England where the religious milieu was different and constantly changing. However, there are clear commonalities between Melanchthon's desire for good governance and Cheke's concern to protect the Protestant Commonwealth. Both men promoted mathematics, but Melanchthon's primary interest in the subject was astrological. This was not for the medical reasons that the subject was promoted in Italy. For Melanchthon, the efficaciousness of astrology was because God's providential care controlled the heavens. The creator ensured that the movements of the stars accurately reflected events on Earth and hence one could read the sky to find God's messages about what was happening below.[15] For this reason, Melanchthon himself lectured on Ptolemy's astrological *Tetrabiblos* for many years.[16] In England, mathematics was aimed at ends other than astrology, at least officially. We have seen that Sir Thomas Smith and John Dee were committed astrologers and doubtless there were many others. But the subject never penetrated the core syllabus which meant that mathematics was not constrained by having to lead to this single end. Melanchthon's conception of natural philosophy was also, as we have seen, delineated by the wish to glorify God's work. English arts masters would have been perfectly comfortable with this conception. Although, they rejected Pliny as an adequate natural philosophy textbook, it was a Wittenberg textbook by Velcurio that proved most popular in England in the mid-sixteenth century. Melanchthon's

[13] Anthony Levi, *Renaissance and Reformation: the Intellectual Genesis* (New Haven, 2002). p. 332.
[14] Sachiko Kusukawa, *The Transformation of Natural Philosophy: The Case of Philip Melanchthon, Ideas in Context* (Cambridge, 1995). p. 202.
[15] Ibid. p. 141.
[16] Kusukawa, *Transformation of Natural Philosophy*. p. 135.

writings were extremely popular in England (they fill six pages in the index volume of *Books in Cambridge Inventories*, almost twice as much as Luther himself).[17]

Overall, Oxford and Cambridge offered only a slightly lower standard of education to their continental competitors in the fields of natural philosophy and mathematics. In the latter, they probably enjoyed parity. However, neither English university was pre-eminent in any subject. As for medicine, in 1550, one Christopher Hales wrote to Heinrich Bullinger (1504 – 1575), saying that as far as the medical faculty was concerned,

> Oxford is not to be compared with Paris or the schools of Italy. But still, it is one in which studious youth may be occupied with great advantage. The same is said of Cambridge.[18]

Some of the students at the time lauded the medical teaching. John ab Ulmis wrote in 1550, "The professors of medicine lecture very learnedly, accurately and intelligently; they are also very courteous and take very great pleasure in the progress of their pupils."[19] Still, one would be best advised to join William Harvey in travelling to Italy to take a degree. In theology, Catholics began to set up their own schools in Europe, most famously at Douai. In law, the Inns of Court never surrendered their supremacy to the universities. However, in this thesis, we have found that the early-modern textbooks used by the English universities were popular and informative. New subjects such as geography and natural history were studied. No one needed to travel to Italy for a good education, even though the Italian universities were certainly producing more lasting scholarship at this time than the English ones did. The reality was that the teaching and syllabus at the English universities were generally up to date by contemporary standards. More importantly, they had the capacity to stay that way.

The Effects of the Universities on English Science

One of the reasons that sixteenth-century science in England has suffered from a poor reputation was the apparent lack of books on the subject published by English authors. Only in the field of vernacular textbooks, it was said, could England claim to enjoy parity with Europe. We have seen in this thesis that both of these beliefs are

[17] Leedham-Green, *BCI.* v. 2, pp. 537 – 542.
[18] C. H. Williams, ed., *English Historical Documents 1485 - 1558*, vol. 5 (London, 1967). p. 1071.
[19] Hastings Robinson, ed., *Original Letters Relative to the English Reformation* (Cambridge, 1846). p. 424.

misleading. The lack of English books on science and mathematics was the fault of publishers not writers. Once we factor in books printed abroad, we find there was quite a respectable amount of relevant work by English authors, from the Greek edition of Galen, through Tunstall's *De arte supputandi* and Wotton's *De differentiis animalium*, and on to William Turner's *Herbal*. Conversely, in chapter six, we found that there were plenty of vernacular textbooks and far more translations out of Latin in other European countries.

The overall picture is of scholarship as a predominantly Latin venture closely tied to Europe through personal, educational and business links. There was nothing exceptional, in either a positive or negative sense, about England's intellectual culture in the sixteenth century. We do not need to assume that the universities were unable to offer a sufficient scientific education for the pioneers of the new philosophy and hence forced them to look elsewhere (for instance, Gresham College). Oxford and Cambridge were quite capable of providing it. Indeed, that is what they did.

Natural philosophy commanded less time in the syllabus in 1570 than it had enjoyed at the start of the sixteenth century. This was due to the increased amount of time spent on ethics and politics. This, we found, reflected the concerns of the visitors for students to learn civic skills useful for careers in the service of the state. We also saw how the *Variationes* showed us the nature of natural philosophy changed over the period, with the evidence of the booklists and lectures bearing this out. Students went from concentrating on a few texts of Aristotle, studied through the medium of in-depth Scotist commentaries, to covering the entire range of natural books through dedicated textbooks. This meant that the course was both broader and shallower, especially as less time was spent on it. It was intended to function as a survey of the subject rather than drilling students with the knowledge and techniques that they would need later on for theological studies. In this way, the natural philosophy course entered the tradition of learning for its own sake so as to give students a rounded education. While it was excellent as a way of illustrating God's goodness in creating the world, it did not actually lead to anything specific, in the way that the medieval syllabus had led to scholastic theology. For those who wanted to carry out their own research into the state of nature, such a broad education was ideal in allowing them to identify areas they wished to follow up and not forcing them into any particular ideological mould.

The flexibility of the course allowed contemporary intellectual trends to quickly make themselves felt in the years after 1570. Ramism arrived from France and Ramus's follower, Johannes Thomas Fregius (1543 – 1583) enjoyed a brief period when his encyclopaedic natural philosophy textbook, *Questiones physicae* (1579) was quite common at Cambridge.[20] Then, it was the turn of Gulielmus Adolphus Scribonius (1550 – 1600) in the 1590s.[21] His *Rerum physicorum explicatio* (1581) was even translated into English in 1621.[22] At Oxford, Henry Savile could slot the stipulations for his new professorships, famously including coverage of Copernicus, into the existing course.[23]

Mathematics did enjoy more space in the syllabus in 1570 than it had at the start of the century. Mathematical skills were now more obviously useful than natural philosophical knowledge (a reversal of the state of affairs in 1500). This thesis began with William Harrison's assertion that mathematics was "now smallie regarded" in 1577. This is misleading. It is true that the quadrivium did not enjoy parity of esteem with the trivium or with moral philosophy, but it was in a better state than it had been fifty years previously. Besides, the famous literary sources, like Ascham, Vives and Erasmus, which disparage mathematics, were written by literary men with no empathy for the subject. We simply cannot trust someone, for whom the minimum amount of mathematical education was too much, to give us an accurate picture. It is possible that William Harrison, like Robert Recorde and other English patriots, was calling to mind the glorious period of the fourteenth century rather than the immediate past when he denigrated the state of learning in his own time. He was, after all, a historian and a topographer. Nevertheless, his statement is not entirely fair. While the sixteenth century could not hold a candle to the achievements of the Merton calculators, Duns Scotus and William of Ockham, few periods in the history of Oxford or Cambridge can.

[20] Leedham-Green, *BCI.* v. 2, pp. 357 – 8. Charles Schmitt, "The Rise of the Philosophical Textbook," in *Cambridge History of the Renaissance Philosophy*, ed. Charles Schmitt and Quentin Skinner (Cambridge, 1988). p. 800.
[21] Ibid. p. 695.
[22] Wilhelm Adolph Scribonius, *Naturall Philosophy, or, A Description of the World* (London, 1621).
[23] Stricklan Gibson, ed. *Statuta antiqua Universitatis Oxoniensis* (Oxford, 1931). p. 529.

Appendix One

Analysis of booklists relating to before 1535

Book title	Author	Publication date	Oxford copies	Cambridge copies
Astronomy:				
Tractatus de sphera	John Sacrobosco	1488	11	2
Almagest	Ptolemy	1515	0	1
Sphera	Proclus	1499	0	1
Computus	na	1488	3	0
Intitutiones Astronomicae	Joachim Ringelbergius	1531	0	4
Other astronomy	Various	na	4	4
			14	8
Arithmetic and geometry:				
De arte supputandi	Cuthbert Tunstall	1522	1	1
Arithmeticae methodum	Gemma Frisius	1540	0	1
Grounde of the Artes etc	Robert Recorde	1543	0	0
Epitome in duos libros Arithmeticos	Jacques Lefèvre d'Etaples	1495	4	1
De musica	Boethius	1488	0	0
Arithmetica decem libris demonstrata	Jordanus Nemorarius	1488	4	1
Elementa	Euclid	1482	5	1
Algorimus	Sacrobosco	1488	7	0
Other arithmetic	Various	na	2	1
			23	6
Natural philosophy				
Natural books	Aristotle	na	11	13
De animalibus	Aristotle	na	3	6
De plantis	Theophrastus	1498	1	5
Paraphrases	Themistius	1481	0	1
Historia naturalis	Pliny the Elder	1469	16	9
Totius philosophiae naturalis paraphrases	Jacques Lefèvre d'Etaples	1492	2	5
Dialogi physicae	Jacques Lefèvre d'Etaples	1492	0	3
Compendium naturalis philosophicae	Franz Titelman	1530	0	0
Epitomae physicae libri IV	John Velcurio	1537	0	0
Questiones super VIII libros Physicorum	John Canonicus	1475	4	0
Textus abbreviatus philosophiae naturalis	John Bricot	1495	6	0
Expositio super librum Physicorum	Walter Burley	1476	3	0
Expositio in libros de caelo et mundo	Gaetano de Thiene	1476	3	0
Other ancient natural philosophy	Various	na	3	0
Other Arab natural philosophy	Various	na	0	1
Other medeival natural philosophy	Various	na	12	1
Other modern natural philosophy	Various	na	0	0
			64	44
Total number of books on the quadrivium			**37**	**14**
Total number of books on natural philosophy			**64**	**44**
Total number of books in booklists			**4,075**	**3,611**

Analysis of complete booklists

Book title	Author	Publication date	Oxford copies	Cambridge copies	Oxford prices	Cambridge prices
					pence	*pence*
Compendiums:						
Margarita philosophica	Gregor Reisch	1499	3	3	*23*	*6*
Opera	Joachim Ringelbergius	1531	3	6	*16*	*9*
			6	9		
Astronomy:						
Tractatus de sphera	John Sacrobosco	1488	18	19	*5*	*6*
Almagest	Ptolemy	1515	0	2		*20*
Sphera	Proclus	1499	2	9	*3*	*4*
Phenomena	Aratus	1499	0	6		*3*
Intitutiones Astronomicae	Joachim Ringelbergius	1531	0	5		*3*
Computus		1488	4	1	*2*	
Other astronomy	Various	na	14	22		
			38	64		
Geography:						
De situ orbis	Pomponius Mela	1471	1	26		*11*
Geographia	Ptolemy	1475	3	21		*42*
De cosmographia	Peter Apian	1524/1533	4	9	*6*	*9*
Historia naturalis	Pliny the Elder	1469	17	35	*39*	*43*
Geographia	Strabo	1516	4	8	*17*	*33*
Epitome trium terræ partium	Joachim von Watt (Vadianus)	1531	1	8		*12*
Other geography	Various	na	7	18		
			37	125		
Arithmetic and geometry:						
De arte supputandi	Cuthbert Tunstall	1522	5	17	*8*	*9*
Arithmeticae methodum	Gemma Frisius	1540	4	22	*4*	*5*
Grounde of the Artes etc	Robert Recorde	1543	1	9		*4*
Commentary on Arithmetic	Jacques Lefèvre d'Etaples	1495	3	6	*15*	*5*
De musica	Boethius	1488	4	0		
De institutione arithmeticae	Boethius	1488	1	1		
Elementa	Euclid	1482	6	19	*37*	*20*
Algorimus	Sacrobosco	1488	10	0	*2*	
Other arithmetic	Various	na	8	25		
			42	99		
Natural philosophy						
Natural books	Aristotle	na	44	124		*5*
De plantis	Theophrastus	1498	8	10	*8*	*9*
Paraphrases	Themistius	1481	3	6	*14*	*16*
De rerum natura	Lucretius	1473	3	3	*8*	*4*
Commentary on the Dream of Scipio	Macrobius	1472	6	13	*7*	*10*
Totius philosophiae naturalis paraphrases	Jacques Lefèvre d'Etaples	1492	5	23	*12*	*10*
Compendium naturalis philosophicae	Franz Titelman	1530	3	16	*4*	*8*
Epitomae physicae libri IV	Johan Velcurio	1537	10	26	*9*	*9*
Commentarius de anima	Philipp Melenchthon	1540	0	12		*5*
Questiones super VIII libros Physicorum	John Canonicus	1475	8	0	*12*	
Textus abbreviatus philosophiae naturalis	Thomas Bricot	1495	9	4	*6*	*6*
Expositio super librum Physicorum	Walter Burley	1476	4	1	*22*	*16*
Other natural philosophy	Various	na	27	33		
			130	271		
Total number of books on the quadrivium (excluding geography)			**38**	**64**		
Total number of books on natural philosophy			**130**	**271**		
Total number of books in booklists			**7,246**	**15,632**		

Analysis of Aristotelian texts in complete booklists

Book title	Author	Oxford copies	Cambridge copies	Oxford prices	Cambridge prices
				pence	*pence*
Unspecified natural philosophy	Aristotle	2	7	*32*	*6*
On animals	Aristotle	4	19	*33*	*18*
Opera	Aristotle	4	15	*64*	*96*
Opera (Greek)	Aristotle	2	22	*40*	*109*
De mundo	Pseudo-Aristotle	2	11	*4*	*5*
Physics	Aristotle	13	17	*13*	*9*
Physics (Greek)	Aristotle	0	1		*12*
De anima	Aristotle	4	2	*7*	*6*
De anima (Greek)	Aristotle	0	12		*3*
Parva naturalia	Aristotle	2	1	*13*	*2*
Meteorology	Aristotle	1	0	*6*	
Problemata	Pseudo-Aristotle	10	17	*7*	*7*
Total Aristotelian texts		**44**	**124**		
Total Greek Aristotelian texts		**2**	**34**		

Appendices Two – Five

Notes and abbreviations used in references

1 and 2 Reg. Con. (1998): Mitchell, W.T., ed. *Register of Congregations 1505 - 17*. 2 vols. Oxford: Oxford Historical Society, 1998.

All Souls: Oxford, Bodleian Library, All Souls College Archives, Box D.D.c.283.

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CUA: Cambridge, University library, University Archives U.A.c.2.(1): Audit books.

Dean's Reg.: Salter, H. E., and G. C. Richards, eds. *The Dean's Register of Oriel 1446 - 1661*. Oxford: Oxford Historical Society, 1926.

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Foster I, II, III and IV: Foster, Joseph. *Alumni Oxonienses: The Members of the University of Oxford, 1500-1714*. 4 vols. Oxford: Parker & Co, 1891 - 2.

GBB1 and 2: Bateson, M., ed. *Grace Book B, Parts I and II*. 2 vols. Cambridge: Cambridge University Press, 1903.

GBD: Venn, J., ed. *Grace Book Δ*. Cambridge: Cambridge University Press, 1910.

Goulding: Goulding, Robert. "Testamonia Humanitatis: The Early Lectures of Henry Savile." In *Sir Thomas Gresham and Gresham College: Studies in the Intellectual History of London in the Sixteenth and Seventeenth Centuries*, edited by Francis Ames Lewis, 125 - 45. Aldershot: Ashgate, 1999.

Green: Communication with Adam C. Green, Archivist, Trinity College, Cambridge.

Heberden: Heberden, Charles Buller. *Brasenose College Register 1509 - 1909*. Vol. 2. Oxford: Oxford Historical Society, 1909.

Janus: "Physic, Regius Professor of", *University of Cambridge Officers, Academic Officers, Professors*, 2000 [http://www.cus.cam.ac.uk/~jld1/lists/, accessed 23rd December 2006].

JCA: Cambridge, Jesus College Archives, Audit Book and Rolls.

Lewis: Lewis, Gillian. "The Faculty of Medicine." In *A History of the University of Oxford: The Collegiate University,* edited by J.K. McConica, 213 - 56. Oxford: Oxford University Press, 1986.

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Mulcaster: Mulcaster, Richard. *Positions Concerning the Training up of Children*. London, 1581.

ODNB: Matthew, Colin, Brian Harrison, and Lawrence Goldman, eds. *Oxford Dictionary of National Biography*. Oxford: Oxford University Press, 2004.

QCA: Cambridge, University Library, Queens' College Archives, QCA volumes 1 – 4.

Reg. Exon.: Boase, C. W., ed. *Registrum Collegii Exoniensis*. Oxford: Oxford Historical Society, 1894.

Reg. Mer. (1923): Salter, H. E., ed. *Registrum Annalium Collegii Mertonensis, 1483 - 1521*. Oxford: Oxford Historical Society, 1923.

Reg. Mer. (1974): Fletcher, J. M., ed. *Registrum Annalium Collegii Mertonensis, 1521 - 1567*. Oxford: Oxford Historical Society, 1974.

Reg. Oxon. (1887): Clark, Andrew, ed. *Register of the University of Oxford (1571 - 1622)*. Vol. 1, *Oxford Historical Society Publications*. Oxford: Clarendon Press, 1887.

SJC: Cambridge, St John's College Archives.

SJCR: Cambridge, St John's College Archives, Register of Fellows and Officers 1.

Venn I, II, III and IV: Venn, J., and J. A. Venn. *Alumni Cantabrigienses. Part One: From the Earliest Times to 1751*. 4 vols. Cambridge, 1922.

Appendix Two

Cambridge University Lecturers

Mathematics Lecturers

Name	College	Dates in Office	MA date	Career	Higher Degree	Death	Archive reference	Reference
Collingwood, Roger	Queens’	1500 - 01	1499	Lawyer	BCL		GBB1 p. 171	ODNB
Anon.		1502						
Collingwood, Roger	Queens’	1503 - 06	1499	Lawyer	BCL		GBB1 p. 195, 203, 212, 218	ODNB
Peyto(n), William	Queens’	1507	1505	Cleric		c. 1558	GBB1 p. 230	ODNB
Grindall, John	St. Catherine’s	1508 – 10	1506			1510	GBB1 p. 236, 244, 251	Venn II, p. 270
Bullock, Henry	Queens’	1510 – 13	1507	Cleric	DD 1510	1526	GBB1 p. 251; GBB2 p. 2, 10	ODNB
Walkden, Humphrey	Queens’	1512 – 14	1507	Cleric	DD 1520	1523	GBB2 p. 10, 25	Venn IV, p. 315
Collingwood, Roger	Queens’	1514 - 16	1499	Lawyer	BCL		GBB2 p. 34, 45, 53	ODNB
Pindar, William	Clare	1517 – 22	1514				GBB2 p. 61, 70, 82, 89, 101	Venn III, p. 367
Kingston, Christopher	Peterhouse	1521 – 24	1518			c. 1528	GBB2 p. 101, 106, 115	Venn III, p. 22
King, John	Peterhouse	1524 – 25	1523			1565	GBB2 p. 123	Venn III, p. 19
Rudd, John	St John’s	1525 – 30	1520	Surveyor		1578	GBB2, p. 125, 128, 135, 141, 149, 152, 155, 157	ODNB
Blythe, John	King’s	1530 – 31	1528	Physician	MD 1543		GBB2 p. 161	Venn I, p. 171
Paynell, William	Michaelhouse	1530 – 34	1527			1537	GBB2 p. 162, 167, 174, 181	Venn III, p. 303
More, Edward	St. Catherine’s	1535 – 38	1532			1539	GBB2 p. 190, 197, 206, 215	Venn III, p. 204
Ascham, Roger	St John’s	1539 – 41	1537	Courtier		1568	GBB2 p. 226, 232	ODNB
Young, John	St John’s	1541 – 43	1539	Cleric	DD	1580	GBB2 p. 238, 241	ODNB
Barker, William	St John’s	1543 – 46	1540	Courtier		c. 1576	GBB2 p. 245	ODNB
Holinshed, Ottiwell	Trinity	1547 - 48	1544	Cleric		1568	CUA p. 26, 37 – 8	ODNB
Lever, Thomas	St John’s	1549	1545	Cleric		1577	CUA p. 52 - 3	ODNB
Cooke, John		1550	1541			1573	CUA p. 65	Venn I, p. 384
Pilkington, Leonard	St John’s	1551	1547	Cleric	DD	1599	CUA p. 77	ODNB
Taylor, William	Christ’s	1552	1548	Cleric		after 1558	CUA p. 82, 93	Venn IV, p. 210
Gwynne, John	St John’s	1553	1551	Lawyer	LLD	1574	CUA p. 92 - 3	Venn II, p. 277
Anon.		1554						
Barley, Henry	Trinity	1555	1550				CUA p. 109	Venn I, p. 89
Anon.		1556						
Abithell, Nicholas	Trinity	1557	1556	Cleric		1586	CUA p. 126 - 7	Venn I, p. 2
Curteys, Richard	St John’s	1558	1556	Cleric	DD 1569	1582	CUA p. 134 - 5	ODNB
Lee, Roger	Trinity	1559	1555	Physician	MD		CUA p. 145	Venn III, p. 65
Coldwell, John	St John’s	1560	1558	Physician	MD	1596	CUA p. 153	ODNB
Smith, Richard	St John’s	1561	1560	Physician			CUA p. 163	Venn IV, p. 106
Shacklock, Richard	Trinity	1562	1559	Lawyer	BCL		CUA p. 174	ODNB
Anon.		1563 - 67						
Browne, Lancelot	St John’s	1568 - 9	1566	Physician	MD	1605	CUA p. 231, 235	ODNB

Philosophy Rede Lecturers

Name	College	Dates in Office	MA date	Career	Higher Degree	Death	Archive reference	Reference
Stokes, John	King’s	1557	1554	Physician	Med Lic	1559	JCA Bur Acc 1557	Venn IV, p. 166
Hutton, Matthew	Trinity	1558	1555	Cleric	BD 1562	1605	JCA Audit Book 1	ODNB
Longworth, Richard	St John’s	1559	1556	Cleric	DD 1567	1579	JCA Audit Book 1	Venn III, p. 104
Byng, Thomas	Peterhouse	1560	1559	Lawyer	LLD	1599	JCA Audit Book 1	ODNB
Curtis, Richard	St John’s	1561	1556	Cleric	DD 1569	1582	JCA Audit Book 1	ODNB
Hughes, William	Christ's	1562	1560	Cleric	DD 1575	1600	JCA Audit Book 1	ODNB
Matthew, Mathias	Clare	1563	1563				JCA Audit Book 1	Venn III, p. 161
Walker, George	St Catherine's	1563	1557	Physician	MD 1563	1597	JCA Audit Book 1	Venn IV, p. 316
Anon.		1564						
Powell, David	Trinity	1565	1563			1601	JCA Audit Book 1	Venn III, p. 387
Anon.		1566 - 1572						
Whitaker, William	Trinity	1573	1571	Cleric	DD 1587	1595	GBD p. 274	ODNB

Regius Professors of Physic

Name	College	Dates in Office	MA date	Career	Higher Degree	Death	Archive reference	Reference
Blythe, John	King’s	1540 - 54	1528	Physician			Janus	Venn I, p. 171
Hatcher, John	St John’s	1555	1535	Physician	MD	1587	Janus	Venn II, p. 329
Walker, Henry	Caius	1555 - 64	1528	Physician	MD	1564	Janus	Venn IV, p. 316
Lorkyn, Thomas	Queens’	1564 -91	1555	Physician	MD	1591	Janus	ODNB

The Queens' College

Name	Subject	Dates in Office	MA date	Career	Higher Degree	Death	Archive reference	Reference
Bond, William	Philosophy	1504	1504	Cleric	BD	1530	QCA1 f. 173r	Emden, p. 72
Gough, John	Natural Philosophy	1529 - 30	1528	Cleric	DD 1537	1544	QCA2 f. 122r, 135r	Venn II, p. 244
Glyn, William	Philosophy	1531	1530	Cleric	DD	1558	QCA2 f. 150r	ODNB
Wilks, Richard	Philosophy	1532	1527	Cleric	BD	1556	QCA2 f. 173r	Venn IV, p. 409
Smith, Thomas	Philosophy	1533	1533	Lawyer	LLD	1566	QCA2 f. 173r, 190r	ODNB
Framington, William	Philosophy	1534	1533			1537	QCA2 f. 190r, 204r	ODNB
Stokes, Robert	Philosophy	1535	1534	Cleric	BD	1570	QCA3 f. 1r	Venn IV, p. 166
Ponet, John	Philosophy	1536	1535	Cleric	BD	1556	QCA3 f. 21r	ODNB
Hodgeson, Gavin	Philosophy	1537	1538				QCA3 f. 21r, 32r	Venn II, p. 385
Wilshaw, Henry	Philosophy	1538	1539		BD 1546	1591	QCA3 f. 44r	Venn IV, p. 426
Ashton, John	Philosophy	1539	1540	Cleric		1568	QCA3 f. 59r	Venn I, p. 46
Perne, Andrew	Philosophy	1540 - 42	1540	Cleric	DD	1589	QCA3 f. 72r, 84r, 96r	ODNB
Dickenson, Richard	Philosophy	1543	1544	Cleric	BD	1551	QCA3 f. 113r	Venn II, p. 40
Anon.	Philosophy	1544						
Robinson, Edward	Philosophy	1545	1544	Cleric			QCA3 f. 128r	Venn III, p. 468
Yale, Thomas	Philosophy	1546	1546	Lawyer	LLD	1577	QCA3 f. 142r	ODNB
Stoke Jr, John	Philosophy	1547	1544	Cleric	DD	1568	QCA3 f. 151r	Venn IV, p. 166
Yale, Thomas	Philosophy	1548	1546	Lawyer	LLD	1577	QCA3 f. 162r	ODNB
Raymond, Thomas	Philosophy	1549	1549				QCA3 f. 178r	Venn III, p. 429
Robinson, Nicholas	Philosophy	1550 - 51	1551	Cleric	DD	1584	QCA3 f. 191r, 200r	ODNB
Joselyn, John	Philosophy	1552	1552	Cleric		1603	QCA3 f. 210r	ODNB
Mey, John	Philosophy	1553	1553	Cleric	DD		QCA3 f. 217r	ODNB
Thorpe, Richard	Philosophy	1554	1553				QCA3 f. 223r	Venn IV, p. 236
Robinson, Nicholas	Philosophy	1555	1551	Cleric	DD	1584	QCA3 f. 234r	ODNB
Harward, William	Philosophy	1556	1553	Cleric		1589	QCA3 f. 241r	Venn II, p. 326
Alsopp, George	Philosophy	1557	1554				QCA3 f. 241r	Venn II, p. 338
Igleden, John	Philosophy	1558	1557	Cleric	BD 1564		QCA3 f. 255r	Venn II, p. 446
Anon.	Philosophy	1559						
Raymand, Edward	Philosophy	1560	1558	Cleric		1562	QCA4 f. 2r	Venn III, p. 428
Wells, John	Philosophy	1561 - 62	1562	Cleric	BD	1570	QCA4 f. 10r, 21r	Venn IV, p. 362
Rockrey, Edmund	Philosophy	1563	1564	Cleric	BD	1597	QCA4 f. 33r	ODNB
Lyndforde, Robert	Philosophy	1564	1564	Cleric	BD	1619	QCA4 f. 46r	Venn III, p. 87
Tower, Robert	Philosophy	1565	1564	Cleric	BD	1585	QCA4 f. 50r	Venn IV, p. 256
Some, Robert	Philosophy	1566	1565		DD	1609	QCA4 f. 56r, 67r	ODNB
Garrett, Robert	Philosophy	1567	1565	Cleric	BD	1576	QCA4 f. 62r	Venn II, p. 197
Some, Robert	Philosophy	1568	1565		DD	1609	QCA4 f. 67r	ODNB
Yalle, David	Philosophy	1569	1564	Cleric	LLD	1626	QCA4 f. 73r	Venn IV, p. 486
Percival, John	Philosophy	1570	1569	Cleric	BD		QCA4 f. 79r	Venn III, p. 345

St John's College

Name	Subject	Dates in Office	MA date	Career	Higher Degree	Death	Archive reference	Reference
Fitzherbert, Hugh	Mathematics	1529				1537	SJC D.106.6 f. 45r	
Anon.	Mathematics	1530 - 45						
Wilson, Miles	Mathematics	1545	1545				SJC D.106.18	Venn IV, p. 430
Leaper, William	Mathematics	1546 - 47	1541	Cleric			SJC D.106.18	Venn III, p. 75
Pilkington, Leonard	Mathematics	1548	1547	Cleric	DD	1599	SJCA p. 93	ODNB
Thexton, Lancelot	Mathematics	1549	1548	Cleric	BD	1588	SJCA p. 94	Venn IV, p. 218
Pilkington, Leonard	Mathematics	1550	1547	Cleric	DD	1599	SJCA p. 94	ODNB
Gwynne, John	Mathematics	1551	1551	Lawyer	LLD	1574	SJCA p. 94	Venn II, p. 277
Keching, Thomas	Mathematics	1552 - 59	1551	Cleric			SJCA p. 95	Venn III, p. 26
Longworth, Richard	Mathematics	1560	1556	Cleric	DD 1567	1579	SJCA p. 96	Venn III, p. 104
Smith, Richard	Mathematics	1561 - 62	1560	Physician			SJCA p. 96	Venn IV, p. 106
Daubney, John	Mathematics	1563	1561	Cleric	BD 1569		SJCA p. 97	Venn II, p. 11
Dakins, John	Mathematics	1564	1563			1566	SJCA p. 97	Venn II, p. 3
Gilbert, William	Mathematics	1565 - 66	1564	Physician	MD	1603	SJCA p. 98	ODNB
Randall, Thomas	Mathematics	1567	1567	Physician	MD	1595	SJCA p. 99	Venn III, p. 419
Joye, George	Mathematics	1568 - 69	1567	Cleric	BD	1600	SJCA p. 100	ODNB
Lakin, William	Mathematics	1570	1568	Physician	MD		SJCA p. 100	Venn III, p. 35

Name	Subject	Dates in Office	MA date	Career	Higher Degree	Death	Archive reference	Reference
Barton, Leonard	Philosophy	1529	1529			1531	SJC D.106.6 f. 45r	Venn I, p. 100
Anon.	Philosophy	1530 - 45						
Hutchinson, Roger	Philosophy	1546	1544	Cleric		1555	SJCA p. 93	ODNB
Ayland, Henry	Philosophy	1547 - 48	1545			1551	SJCA p. 93	Venn I, p. 59
Pilkington, Leonard	Philosophy	1549	1547	Cleric	DD	1599	SJCA p. 94	ODNB
Raulyn, J	Philosophy	1549					SJCA p. 94	Unidentified
Thexton, Lancelot	Philosophy	1550	1548	Cleric	BD	1588	SJCA p. 94	Venn IV, p. 218
Raven, Edward	Philosophy	1551	1549	Physician		1558	SJCA p. 94	Venn III, p. 423.
Wilson, Thomas	Philosophy	1552	1549	Cleric	DD	1586	SJCA p. 95	Venn IV, p. 440
Lever, Ralph	Philosophy	1553 - 54	1551	Cleric	DD	1585	SJCA p. 95	ODNB
Foster, Peter	Philosophy	1555 - 58	1553	Physician			SJCA p. 95	Venn II, p. 163
Wibourn, Percival	Philosophy	1559 - 61	1559	Cleric		1606	SJCA p. 96	Venn IV, p. 481
Jeffrey, Thomas	Philosophy	1562	1553	Cleric	BD		SJCA p. 96	Venn II, p. 466
Winter, John	Philosophy	1563 - 64	1561	Cleric		1606	SJCA p. 97	Venn IV, p. 440
Drant, Thomas	Philosophy	1565	1564	Cleric	BD		SJCA p. 98	ODNB
Randall, Thomas	Philosophy	1566 - 67	1567	Physician	MD	1595	SJCA p. 99	Venn III, p. 419
Proctor, Thomas	Philosophy	1568	1567				SJCA p. 100	Venn III, p. 403
Barker, Walter	Philosophy	1569	1568	Cleric	BD 1575	1576	SJCA p. 100	Venn I, p. 87
Knewstub, John	Philosophy	1570	1568	Cleric	BD		SJCA p. 101	ODNB

St John's College

Name	Subject	Dates in Office	MA date	Career	Higher Degree	Death	Archive reference	Reference
Day, George	Linacre	1524 - 27	1524	Physician/Cleric		1556	SJC M3.4, SB3.1	ODNB
Jackson, Christopher	Linacre	1528	1527			1528		Venn II, p. 454
Ruttande, Paul	Linacre	1529 - 30	1528	Physician	MD		SJC SB3.3, SB3.4	Venn III, p. 502
Brandisby, Richard	Linacre	1530	1526				SJC SB3.5	Venn I, p. 205
Barton, Leonard	Linacre	1531	1529			1531	SJC SB3.5	Venn I, p. 100
Brandisby, Richard	Linacre	1532 - 35	1526				SJC SB3.7, SB3.9, SB3.10	Venn I, p. 205
Cheke, John	Linacre	1536 - 40	1533	Courtier		1557	SJC SB3.11. SB3.12, SB 3.13, D106.17 p. 49	ODNB
Anon.	Linacre	1541 - 44						
Bill, William	Linacre	1545 - 50	1536	Cleric	DD	1561	SJC D106.17 p. 249, 291; D106.18 p. 26	ODNB
Ayland, Henry	Linacre	1551	1545	Physician		1551	SJCA p. 94	Venn I, p. 59
Patrick, Richard	Linacre	1551 - 52	1546	Physician	MD		SJC SB3.22	Venn III, p. 318
Anon.	Linacre	1553 - 54						
Raven, Edward	Linacre	1555 - 57	1549	Physician		1558	SJCA p. 95	Venn III, p. 423.
Foster, Peter	Linacre	1557 - 60	1553	Physician				Venn II, p. 163
Baronsdale, William	Linacre	1560 - 68	1558	Physician	MD	1608	SJCA p. 96 - 7	ODNB
Randall, Thomas	Linacre	1568 - 76	1567	Physician	MD	1595	SJCA p. 100	Venn III, p. 419

Trinity College

Name	Subject	Dates in Office	MA date	Career	Higher Degree	Death	Archive reference	Reference
Penny, Thomas	Mathematics	1560	1559	Physician	MD	1589	Green	ODNB
Lacock, Richard	Mathematics	1561	1561				Green	Venn III, p. 57
Bingham, William	Mathematics	1562	1561	Lawyer	LLD 1572	1611	Green	Venn I, p. 153
Forde, Anthony	Mathematics	1563	1563	Cleric	BD 1570	1578	Green	Venn II, p. 157
Powell, David	Mathematics	1564	1563			1601	Green	Venn III, p. 387
Anon.	Mathematics							
Barrough, Isaac	Mathematics	1566	1564	Physician	MD 1570	1617	Green	Venn I, p. 97
Anon.	Mathematics							
Bill, James	Mathematics	1568	1566	Cleric	BD 1573		Green	Venn I, p. 150
Alephe, Giles	Mathematics	1569	1566			1629	Green	Venn I, p. 15

King's College

Name	Subject	Dates in Office	MA date	Career	Higher Degree	Death	Archive reference	Reference
Buckley, William	Mathematics	1549 - 51	1545	Teacher		1571	Mulcaster p. 239	ODNB

Appendix Four

Regent Masters

Name	College	Dates in Office	MA date	Career	Higher Degree	Death	Subject	Book specified	Archive reference	Reference
Davenport, John	Magdalen	1505	1505				Natural Philosophy	Physics, Canonicus (book 1), De generatione	1 Reg. Con. (1998) p. 352	Emden p. 161
Bowerman, John		1506	1506		BCL 1507		Natural Philosophy	De anima (1 book)	1 Reg. Con. (1998) p. 423	Foster I, p. 160
Peirson, Peter	University	1506	1506				Natural Philosophy	De anima (1 book)	1 Reg. Con. (1998) p. 361	Foster III, p. 1134
Wright, Thomas		1506	1506	Cleric			Natural Philosophy	De anima	1 Reg. Con. (1998) p. 401	Foster IV, p. 1688
Roswell, Thomas	All Souls	1508	1509	Cleric	DD 1532		Natural Philosophy	Natural Philosophy (1 book)	1 Reg. Con. (1998) p. 512	Emden III, p. 1602
Milling, Hugo	Exeter	1509		Cleric	DD 1512		Astronomy	Sacrobosco	2 Reg. Con. (1998) p. 65	Foster III, p. 1014
Colyar, George		1510	1510	Cleric		1557	Natural Philosophy	De anima (book 3)	2 Reg. Con. (1998) p. 97	Emden p. 132
Falowfelde, John	University	1511	1515	Cleric		1552	Natural Philosophy	De generatione (book 2)	2 Reg. Con. (1998) p. 143	Emden p. 199
Lorimer, William	Merton	1511	1512	Physician		1514	Natural Philosophy	Parva naturalia	2 Reg. Con. (1998) p. 149	Emden p. 362
Cuthbertson, John	Queens	1512	1512	Cleric	BTh 1525		Natural Philosophy	Parva naturalia	2 Reg. Con. (1998) p. 198	Emden p. 157
Moreman, John	Exeter	1512	1512	Cleric	DTh 1530	1554	Natural Philosophy	De sensu	2 Reg. Con. (1998) p. 215	Emden p. 400
Bartlett, Richard	All Souls	1513		Physician	DM 1518	1556	Medicine	Hippocrates	2 Reg. Con. (1998) p. 299	ODNB
Bentley, Thomas	New	1513		Physician	DM 1518		Medicine	Hippocrates	2 Reg. Con. (1998) p. 315	Foster I, p. 110
Fairwell, John		1513	1514	Cleric			Natural Philosophy	De anima	2 Reg. Con. (1998) p. 250	Emden p. 200
Connor, John	Exeter	1514	1514	Cleric	BTh 1524	1569	Natural Philosophy	De anima (book 3), Physics (3 books)	2 Reg. Con. (1998) p. 321	Emden p. 134
Mortimer, William		1514	1514	Cleric	DTh 1530		Natural Philosophy	De anima (book 3)	2 Reg. Con. (1998) p. 357	Emden p. 403
Shirwood, Richard	Brasenose	1514	1514	Cleric			Natural Philosophy	De anima (book 2)	2 Reg. Con. (1998) p. 368	Emden p. 515
Cobley, John	Oriel	1515	1515	Cleric			Natural Philosophy	Parva naturalia (1 book)	2 Reg. Con. (1998) p. 450	Emden p. 125
Collins, Robert		1515	1516	Cleric	BCnL 1524		Natural Philosophy	Parva naturalia (1 book)	2 Reg. Con. (1998) p. 449	Emden p. 132
Bothe, John	Brasenose	1516	1516	Cleric			Natural Philosophy	De generatione (1 book)	2 Reg. Con. (1998) p. 461	Emden p. 61
Havell, Edward		1516	1517	Cleric			Natural Philosophy	De generatione (1 book)	2 Reg. Con. (1998) p. 471	Emden p. 274
Iamys, William		1516	1516				Natural Philosophy	De anima (one book)	2 Reg. Con. (1998) p. 517	Emden p. 316
Marham, Robert		1516	1516	Cleric			Natural Philosophy	Parva naturalia (1 book)	2 Reg. Con. (1998) p. 475	Emden p. 378
Martin, John		1516	1516	Cleric	BCnL 1525		Natural Philosophy	De generatione (1 book)	2 Reg. Con. (1998) p. 470	Emden p. 383
Mosgrove, Thomas	Merton	1516	1514	Physician	DM 1523	1527	Medicine	Hippocrates	2 Reg. Con. (1998) p. 517	Foster III, p. 1040
Starkey, Thomas	Magdalen	1522	1520	Politician		1538	Natural Philosophy		ODNB	ODNB
Powle, John	All Souls	1537	1537	Cleric		1558	Music		1 Reg. Con. (1998), p. 189	Foster III, p. 1191
Ardener, Thomas	Lincoln	1539	1539	Cleric		1563	Geometry	Euclid	1 Reg. Con. (1998), p. 189	Foster I, p. 30
Norfolke, John	Lincoln	1539	1539	Cleric			Natural Philosophy	De animalibus	1 Reg. Con. (1998), p. 189	Foster III, p. 1074
Andleser, Edward	Christ Church	1555	1555	Cleric	BD 1565	1600	Geometry		Reg. Oxon. (1887), p. 96	Foster I, p. 24
Atkinson, Thomas	Lincoln	1555	1555	Cleric		1600	Natural Philosophy		Reg. Oxon. (1887), p. 96	Foster I, p. 42
Badger, John	Christ Church	1555	1555			1577	Arithmetic		Reg. Oxon. (1887), p. 96	Foster I, p. 54
Boughton, George	Christ Church	1555	1555				Natural Philosophy		Reg. Oxon. (1887), p. 96	Foster I, p. 154
Evans, John		1555	1555				Astronomy		Reg. Oxon. (1887), p. 96	Foster II, p. 470
Foux/Fooks, John	Christ Church	1555	1555				Music		Reg. Oxon. (1887), p. 96	Foster II, p. 513
Hill, John	Christ Church	1555	1555	Cleric	BD 1561		Arithmetic		Reg. Oxon. (1887) p. 96	Foster II, p. 710
Hughes, Robert	Oriel	1555	1555	Cleric			Geometry		Reg. Oxon. (1887) p. 96	Foster II, p. 763
Lawson, William	Christ Church	1555	1555	Cleric			Geometry		Reg. Oxon. (1887) p. 96	Foster III, p. 890
Lyche, Robert	Christ Church	1555	1555	Lawyer	DCL 1567	1587	Music		Reg. Oxon. (1887) p. 96	Foster III, p. 892
Morice, George		1555	1553				Arithmetic		Reg. Oxon. (1887) p. 96	Foster III, p. 1034
Nott, Thomas	Christ Church	1555	1555	Teacher			Astronomy		Reg. Oxon. (1887) p. 96	Foster III, p. 1080
Passey, John	Christ Church	1555	1555	Teacher			Natural Philosophy		Reg. Oxon. (1887) p. 96	Foster III, p. 1125
Payne, Robert	New	1555	1555	Cleric			Natural Philosophy		Reg. Oxon. (1887) p. 96	Foster III, p. 1129
Rastell, John	New	1555	1555	Cleric		1600	Astronomy		Reg. Oxon. (1887) p. 96	Foster III, p. 1234
Ryve, John	Corpus	1555	1555	Lawyer			Music		Reg. Oxon. (1887) p. 96	Foster III, p. 1295
Sudbury, Richard	Christ Church	1555	1555				Arithmetic		Reg. Oxon. (1887) p. 96	Foster IV, p. 1442
Perry, Thomas	Magdalen	1557	1557	Cleric	BD 1577	1612	Philosophy		Reg. Oxon. (1887), p. 98	Foster III, p. 1150

Regent Masters

Name	College	Dates in Office	MA date	Career	Higher Degree	Death	Subject	Book specified	Archive reference	Reference
Doting, Henry	Exeter	1560	1560	Cleric			Astronomy		Reg. Oxon. (1887), p. 96	Foster I, p. 416
Gressop, William	Corpus	1560	1559				Natural Philosophy		Reg. Oxon. (1887) p. 96	Foster II, p. 606
Weighman, Thomas		1564			BCL 1564		Music		Reg. Oxon. (1887), p. 100	Foster IV, p. 1593
Benbow, Robert	Christ Church	1567	1568	Cleric			Music		Reg. Oxon. (1887), p. 100	Foster I, p. 105
Roue, William	Magdalen	1568	1567	Cleric	BD 1572		Natural Philosophy		Reg. Oxon. (1887), p. 99	Foster III, p. 1285
Kettelby, William	Christ Church	1569	1569			1573	Astronomy		Reg. Oxon. (1887), p. 99	Foster II, p. 847
Powell, James	Oriel	1569	1569			1575	Natural Philosophy		Reg. Oxon. (1887), p. 99	PLRE 109
Wickam, John	Christ Church	1569	1569	Cleric		1591	Music		Reg. Oxon. (1887), p. 100	Foster IV, p. 1625
Savile, Henry	Merton	1570	1570	Politician		1622	Astronomy	Almagest	Goulding, p. 125	ODNB
Chamber, John	Merton	1573	1573		BM 1584	1604	Astronomy	Almagest	ODNB	ODNB

University lecturers

Name	College	Dates in Office	MA date	Career	Higher Degree	Death	Subject	Book specified	Archive reference	Reference
Lupset, Thomas	Corpus	1521	1521			1530	Philosophy	Linacre's Proclus	Duncan, p. 338	ODNB
Kratzer, Nicholas	Corpus	1522	1523			1550	Geography	Ptolemy and the Astrolabe	Duncan, p. 339	ODNB
Mosgrove, Thomas	Merton	1523	1514	Physician	DM 1523	1527	Medicine		Duncan, p. 339	Foster III, p. 1040
Etheridge, George	Corpus	1547	1543	Physician	BM 1545	1588	Philosophy		Duncan, p. 343	ODNB
Warde, Robert	Merton	1547 - 57	1539	Physician		1558	Philosophy		Duncan, p. 343	Foster IV, p. 1570

Regent Professors of Medicine

Name	College	Dates in Office	MA date	Career	Higher Degree	Death	Subject	Book specified	Archive reference	Reference
Warner, John	All Souls	1536 - 54	1525	Physician	DM 1535	1565	Medicine		Lewis (McConica), p. 224	ODNB
Francis, Thomas	Christ Church	1554 - 61	1544	Physician	DM 1554	1574	Medicine		Lewis (McConica), p. 232	ODNB
Bayley, Walter	New	1561 - 83	1556	Physician	DM 1563	1592	Medicine		Lewis (McConica), p. 234	ODNB

All Souls College

Name	Dates in Office	MA date	Career	Higher Degree	Death	Subject	Book specified	Archive reference	Reference
Hall, Humphrey	1560/62	1558	Physician	BM 1561		Philosophy		All Souls Rolls	Foster II, p. 632
Watkins, John	1561	1559	Cleric	BD 1569	1594	Philosophy		All Souls Rolls	Foster IV, p. 1580
Chetham, Henry	1563	1562				Philosophy		All Souls Rolls	Foster I, p. 268
Reynolds, John	1569	1566				Philosophy		All Souls Rolls	Foster III, p. 1248

Brasenose College

Name	Dates in Office	MA date	Career	Higher Degree	Death	Subject	Book specified	Archive reference	Reference
Barnes, Richard	1560	1556	Cleric	DD 1579	1587	Philosophy		Heberden II, p. 88.	ODNB
Leche, William	1561 - 63	1560				Philosophy		Heberden II, p. 88.	Foster III, p. 892
Parkinson, Edmund	1564	1558	Cleric	DCL 1566		Philosophy		Heberden II, p. 88.	Foster III, p. 1118
Smith, Robert	1565 - 67	1563	Physician	DM 1574		Philosophy		Heberden II, p. 88.	Foster IV, p. 1379
Charmocke, James	1568	1562	Cleric			Philosophy		Heberden II, p. 88.	Foster I, p. 264
Whitworth, Miles	1569 - 73	1567				Philosophy		Heberden II, p. 88.	Foster IV, p. 1624

Magdalen College

Name	Dates in Office	MA date	Career	Higher Degree	Death	Subject	Book specified	Archive reference	Reference
Webb, William	1501 - 04	1506	Cleric		1523	Natural Philosophy		Macray 1, 122	Emden III, p. 2004
Stubbs, Lawrence	1504 - 05	1500	Cleric	DD 1514	1548	Philosophy		Macray 1, 127	Foster IV, p. 1439
Molesworth, John	1505 - 08	1504	Cleric		1558	Natural Philosophy		Macray 1, 135	Emden II, p. 1289
Burges, John	1506 - 10	1505	Cleric	DD 1520	1536	Natural Philosophy		Macray 1, 137	Foster I, p. 212
Carter, Robert	1509 - 11	1506	Cleric	DD 1524		Philosophy		Macray 1, 142	Foster I, p. 244
Maring, John	1510 - 13	1508	Cleric	BD 1519	1549	Natural Philosophy		Macray 1, 143	Foster III, p. 870
Lee, Geoffrey	1514	1510				Natural Philosophy		Macray 1, 144	Foster III, p. 893
Cartwright, Nicholas	1517	1513		DD 1536	1558	Natural Philosophy		Macray 1, 146	Emden IV, p. 105.
Molyneaux, Anthony	1518 - 19	1515	Cleric	DD 1531	1558	Philosophy		Macray 1, 150	Foster III, p. 1019
Wotton, Edward	1518 - 19	1518	Physician	MD 1526	1555	Natural Philosophy		Bloxam, 48	ODNB
Gulston, John	1521 - 22	1516	Cleric	BD 1526		Natural Philosophy		Macray 1, 153	Foster II, p. 619
Starkey, Thomas	1521 - 22	1520	Politician		1538	Natural Philosophy		Macray 1, 156	ODNB
Burton, Thomas	1524 - 25	1521	Cleric	DD 1531	1535	Natural Philosophy		Macray 1,	Foster I, p. 227
Sutton, Anthony	1526	1520		DD 1535		Philosophy		Macray 1, 163	Foster IV, p. 1443
Anon.	1527 - 33								
Patmore, John	1534 - 35	1527		BD 1535		Natural Philosophy		Macray 2, 49	Foster III, p. 1136
Cotes, George	1536	1522	Cleric	DD 1536	1555	Philosophy		Macray 2, 63	Foster I, p. 332
Hooker, John	1537 - 40	1535	Cleric	BD 1540		Natural Philosophy		Macray 2, 71	ODNB
Norton, Baldwin	1540 - 41	1540	Cleric	BD 1558		Geography		Macray 2, 69	Foster III, p. 1078
Armstrong, John	1541	1537	Physician	BM 1538		Philosophy		Macray 2, 74	Foster I, p. 31
Dighton, Richard	1542 - 45	1540	Cleric		1546	Natural Philosophy		Macray 2, 82	Foster I, p. 404
Slithurst, Richard	1546 - 48	1543	Cleric	DD 1543	1586	Natural Philosophy		Bloxam, 77	Foster IV, p. 1366
Moleus, John	1549 - 50	1545	Cleric	DD 1565	1591	Natural Philosophy		Bloxam, 61	Foster III, p. 1018
Renniger, Michael	1551	1549	Cleric	DD 1573	1609	Natural Philosophy		Bloxam, 99	Foster III, p. 1245
Humphrey, Lawrence	1552	1552	Cleric	DD 1562	1589	Natural Philosophy		Bloxam, 104	ODNB
Piers, John	1553 - 54	1549	Cleric	DD 1565	1594	Natural Philosophy		Bloxam, 93	ODNB
Cope, Alan	1555 - 56	1552	Cleric	BCL 1560	1578	Natural Philosophy		Macray 2, 97	ODNB
Hawthorne, Adrian	1557	1556	Cleric	DD 1573	1576	Natural Philosophy		Bloxam, 134	Foster II, p. 679
Perry, Thomas	1558 - 62	1557	Cleric	BD 1577	1612	Natural Philosophy		Bloxam, 135	Foster III, p. 1150
Day, John	1562	1555	Lawyer	DCL 1579		Natural Philosophy		Bloxam, 102	Foster I, p. 387
Kingsmill, John	1562 - 65	1562	Lawyer			Philosophy		Macray 2,	Foster II, p. 856
Buste, Henry	1566 - 71	1564	Physician	MD 1578	1616	Philosophy		Macray 2,	Foster I, p. 221

Merton College

Name	Dates in Office	MA date	Career	Higher Degree	Death	Subject	Book specified	Archive reference	Reference
Holder, John	1515	1514	Cleric	DD 1515	1544	Geometry	Euclid	Reg. Mer. (1923), p. 466	Emden p. 293
Mosgrove, Thomas	1515	1514	Physician	DM 1523	1527	Astronomy	Sacrobosco	Reg. Mer. (1923), p. 466	Foster III, p. 1040
Hewlett, Lawrence	1535	1535	Teacher			Astronomy	Sacrobosco	Reg. Mer. (1974), p. 66	Foster II, p. 765
Borough, Peter	1536	1536	Cleric		1541	Geography	Glarianus - Cosmography	Reg. Mer. (1974), p. 68	Foster I, p. 216
Warde, Robert	1539	1539	Physician		1558	Geography	Glarianus - Cosmography	Reg. Mer. (1974), p. 77	Foster IV, p. 1570
Barnes, Robert	1541	1541	Physician	DM 1566	1604	Natural Philosophy	Problemata	Reg. Mer. (1974), p. 86	Foster I, p. 75
Carter, Thomas	1541	1541				Natural Philosophy	Problemata	Reg. Mer. (1974), p. 86	Foster I, p. 244
Dennis, John	1541	1541				Natural Philosophy	Problemata	Reg. Mer. (1974), p. 86	Foster I, p. 394
Wales, Giles	1541	1541	Physician	BM 1555	1558	Natural Philosophy	Problemata	Reg. Mer. (1974), p. 86	Foster IV, p. 1555
Symonds, Thomas	1546	1544	Physician	BM 1547	1553	Natural Philosophy	Problemata	Reg. Mer. (1974), p. 123	Foster IV, p. 1451
Whitehead, James	1566	1566	Physician	BM 1571	1576	Natural Philosophy		Reg. Mer. (1974), p. 264	Foster IV, p. 1619

Oriel College

Name	Dates in Office	MA date	Career	Higher Degree	Death	Subject	Book specified	Archive reference	Reference
Shoppe, Thomas	1515	1516				Natural Philosophy	De generatione	Dean's Reg p. 37	Foster IV, p. 1352
Freman, William	1515	1516	Physician	DM 1527	1550	Natural Philosophy	Canonicus	Dean's Reg p. 37	Foster II, p. 532
Croft, George	1517	1518			1538	Natural Philosophy	De generatione	Dean's Reg p. 40	Emden p. 150
Mawnfeld, Thomas	1517	1519		BD 1555		Natural Philosophy	Canonicus	Dean's Reg p. 40	Emden p. 377
May, Walter	1517	1514	Cleric	DD 1530	1558	Natural Philosophy	De anima	Dean's Reg p. 40	Foster III, p. 993
Freman, William	1518	1516	Physician	DM 1527	1550	Natural Philosophy	Canonicus	Dean's Reg p. 44	Foster II, p. 532
Crispen, Richard	1519	1519		DD 1531	1551	Natural Philosophy	De anima	Dean's Reg p. 49	Emden p. 156
Slade, Thomas	1519	1519	Cleric		1539	Natural Philosophy	De generatione	Dean's Reg p. 49	Foster IV, p. 1364
Upton, William	1519	1519	Cleric		1527	Natural Philosophy	Canonicus	Dean's Reg p. 49	Foster IV, p. 1531
Chard, Robert	1525	1525	Cleric		1559	Natural Philosophy	De sensu	Dean's Reg p. 65	Foster I, p. 262
Rixman, John	1525	1525	Cleric	BD 1532	1557	Natural Philosophy	De somno	Dean's Reg p. 65	Foster III, p. 1260
Gryffith, John	1527	1528	Cleric	BD 1541		Natural Philosophy	De anima	Dean's Reg p. 73	Foster II, p. 609
Hayn, William	1527	1528	Cleric	BD 1537	1550	Natural Philosophy	Canonicus books 4 and 5	Dean's Reg p. 73	Foster II, p. 682
Wodwall, John	1527	1528				Natural Philosophy	Parva naturalia	Dean's Reg p. 73	Emden p. 637
Jamys, Robert	1528	1529	Brewer			Natural Philosophy	Canonicus/De generatione	Dean's Reg p. 79	Emden p. 315
Winter, Roger	1528	1529			1582	Natural Philosophy	Canonicus/De generatione	Dean's Reg p. 79	Foster IV, p. 1662
Huys, Richard	1533	1533	Physician	LM 1534		Natural Philosophy	De anima books 1 and 2	Dean's Reg p. 94	Foster II, p. 762
Pye, William	1533	1533	Cleric	DD 1543	1557	Natural Philosophy	De anima book 3	Dean's Reg p. 94	Foster III, p. 1222
Smith, John	1533	1533	Cleric	BD 1545		Natural Philosophy	Canonicus	Dean's Reg p. 94	Foster IV, p. 1373
Yorke, Thomas	1534	1535				Natural Philosophy	Parva naturalia	Dean's Reg p. 101	Foster IV, p. 1703
Coxe, William	1536	1537			1544	Natural Philosophy	De anima	Dean's Reg p. 104	Foster I, p. 297
Huyck, William	1536	1537				Natural Philosophy	De partibus animalium	Dean's Reg p. 104	Foster II, p. 780
White, Peter	1555	1555	Teacher			Natural Philosophy	De generatione	Dean's Reg p. 140	ODNB

Other Colleges

Name	College	Dates in Office	MA date	Career	Higher Degree	Death	Subject	Book specified	Archive reference	Reference
Nowell, Laurence	Christ Church	1550	1550			1571	Mathematics		ODNB	ODNB
Mosgrove, Thomas	Corpus Christi	1522	1514	Physician	DM 1523	1527	Medicine		Lewis (McConica), p. 220	Foster III, p. 1040
Cocks, Urien	Exeter	1526	1527				Natural Philosophy	De generatione	Reg. Exoniensis, p. 58	Foster I, p. 296

Appendix Six: College Libraries

This appendix summarises the college library catalogues referred to in this thesis. A great deal more analysis of these lists would be possible, especially when the books can be identified with those that survive today. However, this survey is intended only to give a rough idea of what was available in the libraries. It shows that overall, there were few texts on the quadrivium or natural philosophy compared to the trivium, classical works and, above all, theology. In the lists of books relating to natural philosophy, I have not attempted to differentiate between the various kinds of commentaries and questions.

University of Oxford

All Souls College

Date	Number of titles	Number of survivals	Natural philosophy	Quadrivium
1505[1]	178	36	12	8
1548[2]	170	121	10	3
1576[3]	135	112	8	2

Natural philosophy titles

1505: Thomas Aquinas, Walter Burley and John Canonicus *Physica*; Giles of Rome *De caelo et de mundo* and *De anima*; Albertus Magnus *De anima*, *De animalibus* and *Textus naturalis philosophiae*; Paul of Venice *Textus naturalis philosophiae*; Anon *Textus naturalis philosophiae*, Questions on *Physica* and *Parva naturalia*.

1548/56: Walter Burley and John Sharpe *Physica*; John Philoponus *De anima*, *De generatione* and *Physica*; Simplicius *De caelo* and *De anima*; Aristotle *Opera* (Latin and Greek); Theophrastus *De plantis.*

1576: Paul of Venice *Textus naturalis philosophiae*; Simplicius *De caelo*, *Physica* and *De anima*; Averröes *Physica*; Aristotle *Opera* (Latin and Greek); Theophrastus *De plantis* (Greek).

Quadrivium titles

1505: Ptolemy *Almagest* (2); Boethius on music and arithmetic; an *Algorismus* and *Theorum planetarum*; an Arab *Perspectiva*, probably Alhazen; Campanus *Liber astronomiae.*

1548/56: Ptolemy *Almagest* and *Geographia*; Euclid *Elementa*; Pliny *Historia naturalis.*

1576: Euclid and *Liber musicae* (perhaps Boethius).

[1] N. R. Ker, *Records of All Souls College Library 1437 - 1600, Oxford Bibliographical Society New Series 16* (Oxford: 1971). List XIV.
[2] Ibid. List XVI.
[3] Ibid. List XVII.

Brasenose College

Date	Number of titles	Number of survivals	Natural philosophy	Quadrivium
1556[4]	78	39	1	6

Natural philosophy titles

Gaietanus de Thienis *Physica*;

Quadrivium titles

Pomponius Mela *De situ orbis*; Ptolemy *Geographia*; Euclid (2); Pierre D'Ailly *De sphera*; a treatise on the astrolabe.

Canterbury College

Date	Number of titles	Number of survivals	Natural philosophy	Quadrivium
1501[5]	336	-	21	-
1510[6]	218	-	8	-
1521[7]	323	-	16	-
1524[8]	292	-	14	-

Natural philosophy titles

1501: Michael Scot *De generatione*; Alexander and John Duns Scotus *De anima*; pseudo-Aristotle *Problemata*; Thomas Aquinas *De anima* and *Physica* (2); Giles of Rome, William of Ockham and John Sharpe *Physica*; Albertus Magnus *Textus naturalis philosophiae;* Richard Swineshead *De intensione et remissione*; Averröes *De caelo et de mundo*; Aristotle *De caelo et de mundo*, *Meteorologica* and *De generatione*; Anon *Physica*, *De anima* (2), *Parva naturalia*, *Naturalis philosophiae.*

1510: Alexander *De anima*; Thomas Aquinas *Physica*; Giles of Rome, William of Ockham and Averröes *Physica*; Anon *De caelo et de mundo* and *De anima*; Aristotle *Parva naturalia.*

1521: Alexander *De anima*; Thomas Aquinas, Giles of Rome, William of Ockham and Averröes *Physica*; Anon *De caelo et de mundo* and *De anima*; Aristotle *Parva naturalia*, Averröes *Physica*, Aristotle *De caelo et de mundo*(2), *Physica* and *De anima*; pseudo-Aristotle *Problemata* (2); Anon *De anima*.

1524: Alexander *De anima*; Thomas Aquinas, Giles of Rome, William of Ockham and Averröes *Physica*; Anon *De caelo et de mundo* and *De anima*; Aristotle *Parva naturalia*, Averröes *Physica*, Aristotle *De caelo et de mundo*(2), *Physica* and *De anima*; Anon *De anima*.

[4] Rod Thomson and Andrew G. Watson, *University and College Libraries of Oxford, Corpus of British Medieval Libraries* (London: British Library, Forthcoming). UO23.
[5] W. A. Pantin, *Canterbury College, Oxford,* 4 vols., vol. 1 (Oxford: Oxford Historical Society, 1947). List C.
[6] Ibid. List E.
[7] Ibid. List F.
[8] Ibid. List G.

Lincoln College

Date	Number of titles	Number of survivals	Natural philosophy	Quadrivium
1476[9]	135	45	4	-

Natural philosophy titles

Aristotle *Textus naturalis philosophiae* and *De anima* with commentary; Alexander ab Alexandria *De anima*; Albertus Magnus *Meteorologica*.

Merton College

Date	Number of titles	Number of survivals	Natural philosophy	Quadrivium
1556	163	104	7	10

Natural Philosophy titles

Aristotle *Physica* (2), *De animalibus* and *Parva naturalia*; Giles of Rome, Simplicius and Jakob Schegk *Physica*.

Quadrivium titles

Strabo *Geographia*; Euclid's *Elementa*; Pliny *Historia naturalis*; Proclus *De sphera*; Sacrobosco *De sphera*; Ptolemy *Geographia*; Regiomontanus *De sphera*; Dürer *Institutiones geometricae*; Boethius *Opera* (2).

University of Cambridge

Caius College

Date	Number of titles	Number of survivals	Natural philosophy	Quadrivium
1569[10]	150	123	3	5

Natural Philosophy titles

Aristotle *Opera* (Latin and Greek); Avicenna *De anima*

Quadrivium titles

Pliny *Historia naturalis* (2); Ptolemy *Geographia*; Tunstall *De arte supputandi*; MS on the astrolabe.

Clare College

Date	Number of titles	Number of survivals	Natural philosophy	Quadrivium
1496[11]	90	-	6	2
1556[12]	18	4	-	-
1560[13]	36	13	1	-

[9] Robert Weiss, "The Earliest Catalogues of the Library of Lincoln College," *Bodleian Quarterly Review* 8 (1937). 343 – 59.
[10] Elisabeth Somerville Leedham-Green, "A Catalogue of Caius College Library, 1569," *Transactions of the Cambridge Bibliographical Society* 8, no. 1 (1981). 29 – 41.
[11] R. W. Hunt, "Medieval Inventories of Clare College Library," *Transactions of the Cambridge Bibliographical Society* 1, no. 2 (1950). 105 – 125.
[12] Peter Clarke, *University and College Libraries of Cambridge*, vol. 10, *Corpus of British Medieval Libraries* (London: British Library, 2002). UC16.

Natural Philosophy titles

1496: Giles of Rome *De anima*; John Canonicus *Physica*; Averröes *De substantia orbis*; Anon *Physica* (3).

1560: Albertus Magnus *De anima*.

Quadrivium titles:

1496: Boathius *De musica*; Alhazan *Perspectiva*.

Corpus Christi College

Date	Number of titles	Number of survivals	Natural philosophy	Quadrivium
1525[14]	187	50	-	1
1544[15]	135	50	-	1
c. 1556[16]	137	55	-	2

Quadrivium titles

1525: Pliny *Historia naturalis.*

1544: Pliny *Historia naturalis.*

1556: Pliny *Historia naturalis*; Ptolemy *Geographia*.

Plus, Riesch *Margarita philosophica* in all catalogues.

King's College

Date	Number of titles	Number of survivals	Natural philosophy	Quadrivium
1556[17]	84	12	-	1

Quadrivium titles

MS on arithmetic.

Pembroke College

Date	Number of titles	Number of survivals	Natural philosophy	Quadrivium
c. 1500[18]	159	55	-	-
1556[19]	84	55	2	2

Natural philosophy titles

1556: Aristotle *Opera*; Albertus Magnus *De caelo*.

Quadrivium titles

1556: Pliny *Historia naturalis*; Münster *Cosmographia.*

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[13] Ibid. UC17.
[14] Ibid. UC22.
[15] J. M Fletcher and J. K. McConica, "A Sixteenth Century Inventory of the Library of Corpus Christi College, Cambridge," *Transactions of the Cambridge Bibliographical Society* 3, no. 3 (1961). 187 – 199.
[16] Clarke, *University and College Libraries of Cambridge*. UC25.
[17] W. D. J. Cargill-Thompson, "Notes on the King's College Library, 1500 - 1750," *Transactions of the Cambridge Bibliographical Society* 2 (1954). 38 – 54.
[18] Clarke, *University and College Libraries of Cambridge*. UC43.
[19] Ibid. UC45.

The Queens' College

Date	Number of titles	Number of survivals	Natural philosophy	Quadrivium
1472[20]	227	-	-	-
1580[21]	54	42	1	3

Natural philosophy titles

1580: Aristotle *Opera*.

Quadrivium titles

1580: Pliny *Historia naturalis*; Ptolemy *Geographia*; Münster *Cosmographia.*

St John's College

Date	Number of titles	Number of survivals	Natural philosophy	Quadrivium
1544[22]	92	36	3	-
1556[23]	78	38	3	-

Natural philosophy titles

1544: Aristotle *Opera* (Latin and Greek); Lefèvre *Philosophiae naturalis paraphrases*.

1556: Aristotle *Opera* (Latin and Greek); Lefèvre *Philosophiae naturalis paraphrases*.

University Library

Date	Number of titles	Number of survivals	Natural philosophy	Quadrivium
1473[24]	330	17	-	-
1556[25]	161	130	4	3
1574[26]	166	130	2	3

Natural philosophy titles

1556: Aristotle *Opera* (Latin with commentary by Averröes and Greek) and *Physica*, Theophrastus *De plantis*; Unidentified *Naturalia Aristotelis*.

1573: Aristotle *Opera* (Latin with commentary by Averröes) and *Physica*.

Quadrivium titles

1556 and 1574: Tunstall *De arte supputandi*, Strabo *Geographia*, pseudo-Boethius *Ars metrica*.

[20] Ibid. UC50.
[21] Clare Sargent, "Two Sixteenth-Century Book Lists from the Library of Queens' College, Cambridge," *Transactions of the Cambridge Bibliographical Society* 12, no. 2 (2001). 161 – 178.
[22] D. McKitterick, "Two Sixteenth Century Catalogues of St John's College Library," *Transactions of the Cambridge Bibliographical Society* 7, no. 2 (1978). 135 – 155.
[23] Ibid.
[24] Clarke, *University and College Libraries of Cambridge*. UC3.
[25] J. C. T. Oates and H. L. Pink, "Three Sixteenth Century Catalogues of the University Library," *Transactions of the Cambridge Bibliographical Society* 1, no. 4 (1952). 310 – 40.
[26] Ibid.

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Cambridge: Christ's College

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