

SCIENCE AND PATRONAGE IN ENGLAND, 1570–1625: A PRELIMINARY STUDY

Stephen Pumfrey and Frances Dawbarn
University of Lancaster

1. INTRODUCTION

Over the last fifteen years our understanding of the development of late Renaissance and early modern science has been transformed by the application of patronage studies. These studies have concentrated on Italy and Germany, and to a lesser extent on France, Denmark and the Imperial court in Prague.¹ England, which developed during this period from a cultural backwater to an international influence, has been neglected.

This article is the first systematic survey of England, the preliminary results of a three-year research project for the period commencing around 1570 (when Henry Billingsley's edition of Euclid symbolized the maturity and aspirations of mathematics in the reign of Elizabeth I, 1558–1603) and ending with the death in 1625 of Elizabeth's successor, James VI (of Scotland) and I (of England). We present some archival research but also rely at this stage upon published scholarship. Our intention is to share some of our research, and to offer some preliminary conclusions and hypotheses in which we already have confidence.

The first conclusion is that the patronage culture surrounding natural knowledge in England differed in important respects from what has effectively become a paradigm based on Italian and German courts. Secondly, a related hypothesis is that the forms of natural knowledge patronised differed from the Continental paradigm. We draw a distinction between what we call "ostentatious" and "utilitarian" forms. Before England's most famous courtier-philosopher, Francis Bacon, elevated what can be called utilitarianism to a natural philosophical aim, the English court consistently promoted useful over ostentatious work. Indeed, thirdly, we hypothesize that Bacon can be read in part as a codifier of these courtly values. Fourthly, as a more specific example of this distinctive culture of patronage, we believe that patronage considerations help to explain why none of the surprisingly numerous Copernicans in Elizabethan England went on to contribute significantly to the creation of physical astronomy. This new discipline was characterized by the ostentatious claims, practices, publications and self-images of grand clients such as Tycho Brahe, Johannes Kepler and Galileo Galilei. We present evidence that English clients were not able to fashion themselves and their work similarly. Finally, we develop a concept of a 'connectivity', or density of patronage opportunities, to account for some of these differences, in particular that low connectivity limited the capacity of English clients for self-fashioning.

A systematic application of patronage theory is new to English science, and relatively new to history of science generally. As historians of other forms of cultural production, from high art to popular theatre, from confessional apologetics to country houses, had long been aware, patronage was ubiquitous in sixteenth- and seventeenth-century Europe.² Courtly, aristocratic, ecclesiastical and, increasingly, mercantile patrons provided most of the positions for men (and some women) with intellectual and practical skills but limited socio-economic autonomy. These clients' careers, the cultural and material goods they produced, even the nature of the professions they pursued, depended upon the complex sets of interests that structured the field of patron–client relations. Such also was the dependence of most English makers of natural knowledge. It was especially true of those working outside Oxford and Cambridge, ranging from elevated court physicians and philosophers through projectors and private tutors to more humble mathematical and mechanical practitioners.

Our use in the previous paragraph of the term 'natural knowledge' signifies the usual, and more terminological problems associated with the history of Renaissance and early modern 'science'. Whilst natural philosophy was the closest thing to a forerunner of science, the clients we study were rarely natural philosophers in any significant sense. Some were artisans, some gentleman practitioners of mathematical and mechanical arts, others physicians with empirical or theoretical inclinations. Yet others were divines, professors of mathematics, translators or courtiers, with small or eclectic interests in nature. Our research has led us, like many others, to reconsider what counted as science, or what counts as the object of historical studies of science, in a period and (it seems) a country where material practices and disciplinary boundaries were especially contested and evolving. We are as yet unsure about exactly what to include and exclude, and what maps of knowledge were mobilized. For the moment, then, we are attempting to allow the clients and patrons to shape these categories within the umbrella term of 'natural knowledge'. We concede, however, that we are more interested in those aspects of its pursuit in Elizabethan and Jacobean England that might have longer-term significance.

The sociological and cultural turns in the history of science, broadly construed in this way, have transformed the significance of patronage. If the disciplinary frameworks, material and social practices, and intellectual content of forms of natural knowledge were strongly shaped by the institutional and cultural contexts in which they were developed, then, potentially, early modern systems of patronage not only sustained but also directed innovation. Recent studies of courtly astronomers such as those of Galileo by Westman, Biagioli and Freedberg, of Tycho by Thoren and Christiansen, and of della Porta, Aldrovandi and Kircher by Findlen, and studies of chemical philosophers like Hartmann by Moran, have actualized the potential.³

Of course, historians of English science knew from the biographies of celebrities like John Dee and William Harvey that they depended equally upon patronage, at least for their financial and material support.⁴ They also knew that, as in other countries, the universities of Oxford and Cambridge, the traditional sites of knowledge-making in natural philosophy and its related disciplines, were challenged, influenced and

often surpassed by new, primarily courtly sites where dependence upon patronage was more direct and personal.⁵

England did not produce ostentatiously successful individuals during the period, but it did foster a number with international reputations. The best known were John Dee, Thomas Digges, Thomas Harriot, William Gilbert, Edward Wright, Francis Bacon, William Harvey, Theodore Mayerne, Cornelis Drebbel, and the humanist scholar Isaac Casaubon. The last three names prove that leading foreign experts were once again accepting English patronage. It produced a clutch of ‘English Paracelsians’ and other proponents of heterodox medical philosophy and practice.⁶ Moreover, London, with its burgeoning international role as a trading and military centre, hosted a large community of practitioners of mathematical, mechanical and other ‘arts’, and a larger audience of private patrons and a paying public for their work. Gresham College, founded in 1597 but planned earlier, partially answered calls and proposals for new institutional initiatives, such as Humphrey Gilbert’s plan for “The Queen’s Academy”, which he presented to Elizabeth I in 1573.⁷

Besides this well-documented activity, a host of forgotten petitioners also put their talents at the disposal of English aristocrats and courtiers. Innovative private tutors served elite households. As Feingold and Cormack have argued, university professors, tutors and graduates, themselves part of intellectual and patronage networks, participated in studies that went beyond the formal curriculum. Moreover, as Bennett, Johnston and others have shown, humbler individuals such as Robert Norman, William Bedwell and Thomas Hood typified widespread instrumental and quantitative approaches that shaped England’s influential development of experimental mechanical philosophy.⁸

Johnston, however, is pessimistic about the value of studying English courtly patronage. Writing specifically of English mathematical practitioners, he asked where they could work. “On the Continent royal courts provided an important answer. But England did not have a court culture which could offer substantial support to the activities of a mathematician. There was no equivalent to the courts of William IV of Hesse-Cassel or Rudolph II of Prague...”⁹

Our research confirms that there was indeed “no equivalent” to such courts and that “substantial support” was lacking in England. Certainly there was no support for the spectacular new programmes of observational astronomy begun by Wilhelm IV and Tycho, who completed his career in Prague. The problem, we contend, is transformed if we recognize that courts like Hesse-Cassel and Prague promoted ostentatious science, whilst England promoted utilitarian science, and that the former has dominated patronage studies to the point of distortion.

1.1. *Ostentatious Science and Patronage*

In *Science and the secrets of nature*, William Eamon writes that:

The style of art or science that won favor in the courts was in large part conditioned by the replication of princely self-images. To be sure, science also served

practical needs. Astrologers, engineers, and mathematicians performed important practical services by casting horoscopes, designing bridges and fortifications, and providing expertise on matters such as ballistics. But if in retrospect the prince's primary needs were for technical assistance, from a contemporary perspective even more important was "reputation", since what others thought of him was an important determinant of what he actually was.¹⁰

It is true that all princes and nobles were preoccupied with reputation and honour. The ability to dispense ostentatious patronage, the quality of their clients, and the capacity of their clients' work to promote their self-image were primary ways to establish reputation. It is equally true that science functioned in this way. Just as an aristocrat's attire, retinue, manners and largesse signified his or her social wealth, so could the intellectual performances of their scientific clients. Natural philosophers often filled the same role as poets, musicians, writers and artists in providing works or entertainments that pleased courtly egos. There has, however, been a tendency in patronage histories to read science exclusively according to this art history model.

We believe that the model works better for some courts than others. It works well for courts that engaged in what Biagioli and Findlen call cultural competition, and best of all for Italian courts. Their pioneering studies show how patrons competed to increase their cultural eminence through clients like Galileo or Aldrovandi. Eamon describes how, in the geographical "honeycomb" of small Italian states, "[t]he luxurious ostentation of court culture was no mere show; it was a display of the prince's power".¹¹

Cultural competition was, in part, a surrogate for territorial or dynastic competition — like diplomacy, the conduct of war by other means. Most Italian and central European (especially German) princely courts were those of small client states. Their borders were fixed, and their territories mapped and defined. Political change was ultimately controlled by the dynastic powers of the Spanish and Austrian Hapsburgs, France, the Pope, the Holy Roman Emperor and, later, Sweden. With no realistic expansionist or imperial ambitions, courts such as Cosimo's in Florence, Alfonso II d'Este's in Ferrara or Wilhelm's in Hesse-Cassel signified their power, vitality and limited independence internally. Cultural production and competition were key signifiers.

We call ostentatious science those activities that, for the patron, had the primary, cultural function of glorifying his self-image, of showing [ostending] spectacularly [ostentatiously] his intellect, discernment and power, rather than a utilitarian function in the narrow sense. Several features distinguish ostentatious science, we think. First, it placed a premium, which was rare in Renaissance university culture, upon disciplinary transgression and radical innovation, if not heterodoxy. Neoplatonist philosophers, Copernican astronomers, chemical physicians and natural magicians, many of whom were distrusted by church, university or medical authorities, found protection in courts. Properly handled by the patron, brilliant young turks brought lustre to the court. It is radical natural philosophers such as Cornelius Agrippa, della Porta, Petrus Severinus and Galileo, and constructors of lavish 'big science' like

Tycho Brahe and Ulisse Aldrovandi, who have tended to dominate patronage studies at the expense of practical and more modest innovators.

Secondly, and in consequence, as Biagioli has emphasized, princely patrons generally preferred to keep a distance between themselves and their clients' intellectual commitments. As in politics, they liked to balance factions and to appear to stay above the fray of dispute, never to back a losing theory. By contrast, patrons of utility wanted proof.

Thirdly, if truth was not paramount in ostentatious science, pleasing edification was. The clients' work had to meet courtly ideals of impressive display. Thus, Biagioli has shown how some of Galileo's apparently combative and ill-considered writings (on the sublunary nature of comets, for example) were produced for set-piece debates.¹² Collections of natural magic such as Della Porta's had as one of their functions the elevated entertainment of élites. Museums and cabinets of natural history similarly allowed a patron to entertain and impress distinguished guests, as well as establishing his court as a site of scholarship.¹³

Fourthly, in terms of power over nature, it was sufficient for ostentatious science to increase the court's cultural hegemony, not its territorial reach or economic production. Through his telescopic discovery of Jupiter's moons or 'Medicean stars', Galileo could offer to extend Cosimo's possessions to include the heavens, but not neighbouring states, just as Cosimo's support for Galileo's Copernicanism signalled a cultural but not political independence from Rome.¹⁴ One might also suggest that the natural historical collections analysed in Findlen's *Possessing nature* showed ostentatiously what flora and fauna the prince did indeed possess, without being especially concerned with his utilitarian power to exploit them.

This is not to suggest, of course, that Galileo's astronomy or Croll's chemical philosophy¹⁵ were devoid of serious scientific endeavour, were mere display, or even that they consciously compromised sound work with rhetorical excess. Indeed, genuine intellectual novelty and persuasive argument were highly regarded by patrons of ostentatious science.

There are good reasons why patronage studies have concentrated on ostentatious science. Its practitioners were often the most original and interesting of their time. They therefore figure in both conventional and revisionist canons. There is ample evidence of their highly visible patronage relations. The patronage culture is readily analysed according to art historical models of image making. But ostentatious science has received such exclusive attention from historians that the patronage of 'practical' or utilitarian science has been neglected.

Our research suggests that, whilst honour and ostentation drove English patronage in many ways, it rarely drove it to back ostentatious science. But it did patronize science. Unlike the Italian courts described by Eamon, the "contemporary perspective" of English patrons seems to have emphasized solid utility over shows of reputation.

1.2. *Utilitarian Science and Patronage*

If we are right to associate ostentatious science with the political and cultural specificities of the honeycomb of small, client states of Italy and Germany, then the English context may be partially explained by a geopolitical difference. Bruce Moran has recently drawn attention to such a difference, which we also think is pertinent to England:

In northern Europe, where the consolidation of regional power gained new vigour in the sixteenth century, political and economic motives dominated in turning the attention of princes towards the patronage of practical mathematics and the mechanical arts. The identification of new sources of wealth required an exact knowledge of the prince's own sphere of political and economic influence. In this regard, map-making and the design of surveying instruments became important elements in defining the regional extent of the court's legal jurisdiction and economic privileges. Navigational instruments, proportional compasses, triangulation instruments, mining machinery and cartographic tools became instruments of state, and the manufacture of such instruments tended to become state of the art.¹⁶

These activities are good examples of what we call utilitarian science. It equally includes Eamon's 'practical' science of astrology, medical treatments, agriculture, [al-]chemical processes, and various magical arts such as music therapy. Whilst these were all utilitarian 'applied sciences' in their way, patrons had firmly in mind utility to the state, usually as a clear economic or military benefit. Gaukroger has recently drawn attention to Francis Bacon's aim of moving natural philosophy from the domain of *otium*, speculative (even idle) study, to that of *negotium*, the concrete business or affairs of state which, we suggest below, he derived from his knowledge of Elizabethan patronage.¹⁷

Utilitarian science was therefore shaped by something more than a prince's self-image or reputation, although his power was obviously enhanced by it. It aimed at the practical control of nature, and patrons expected results. Several aspects of ostentatious science did not apply. Practitioners were not advantaged by a reputation for intellectual heterodoxy. Indeed, they did not have to be learned humanists. They could come from lower social orders, and occupy less visible positions in patronage networks.

We may also assume that patrons were not so distanced from their clients' knowledge claims. Courts were not interested in fortifications that were easily breached, compass designs that led to shipwreck, the 'detection' of non-existent minerals, or manufacturing processes that swallowed their investment with no return, no matter how elegantly the claims were presented.

We do not offer utilitarian and ostentatious science as easily distinguished, mutually exclusive categories, but rather as ends of a spectrum. New instruments or maps could be purely functional or elaborate, slanted in design towards practical use or gentlemanly instruction.¹⁸ Claims of natural philosophical importance or classical precursors could be added to work that was primarily practical. The dependence of a flourishing high culture upon wealth and good governance could be emphasized by a

practical projector, just as natural philosophers appealed to the ethos of *vita activa*, *negotium* or ‘the common wealth’ by indicating practical applications of their work. Galileo presented the telescope to the Venetian oligarchs as a practical, commercial instrument and to Cosimo as a natural philosophical one.

If the example of the telescope shows that specific patronage cultures are important, these are no more mutually exclusive than the science they supported. Client states continued to have considerable interests in natural knowledge and practices that could improve their economic and administrative efficiency. A monarch like Elizabeth I was acutely aware of her self-image, and of how outstanding minds like John Dee could enhance (or damage) it. In any case, court culture everywhere was agonistic and competitive, governed by an aristocratic desire to gain and *display* power, including power over nature, in accordance with humanistic codes of etiquette.

Such considerations may begin to explain why Italian and German courts predominantly patronized ostentatious science, whilst utilitarian science was more important in a Northern European state like England. What they cannot explain is the almost total absence of ostentatious science in England, an absence not replicated in France, Denmark or the Dutch Republic, for example.

In our analysis, the remarkable career of John Dee turns out to exemplify the strongly utilitarian nature of English courtly science. Like Galileo, Dee aspired to patronage for more than utilitarian services. Indeed, he argued for the broader philosophical importance of mathematics in his extraordinary preface to Billingsley’s edition of Euclid’s *Elements*.¹⁹ By 1577 he had been patronized by several nobles for work in practical mathematics, but none had shown interest in his philosophical work. He appended an anonymous “Necessary Address” to one of his tracts on navigation. If, he wrote of himself, Dr Dee “had found a constant and assistant CHRISTIAN ALEXANDER, BRYTAN should not have now bin destitute of a CHRISTIAN ARISTOTLE”.²⁰ He wanted a grand patron for his grand projects, and he was disillusioned that the Queen of “Brytan” never made him “her philosopher”. In 1584 he emigrated, becoming a client of Prince Albrecht Laski of Poland, before moving on to the true Alexander of occultism, Emperor Rudolph II in Prague.²¹

2. ENGLAND AND RECENT PATRONAGE HISTORIES OF SCIENCE

The importance of courtly sites to the evolution of post-scholastic forms of natural knowledge during ‘the scientific revolution’ has been superbly established by several historians of Continental science. While the ubiquity and necessity of patronage in England will become evident, few of their conclusions transfer easily to the English context.

A powerful case for courtly patronage was first made in 1980 by Robert Westman.²² Westman proposed that courts became crucial alternative sites where traditional disciplinary boundaries could be challenged and transgressed, specifically in the creation of a new, physical astronomy. Universities maintained the traditional disciplinary divide between the high-status natural philosophical practice of cosmology, which dealt with causal explanations of the heavens, and the lower-status, non-causal

practice of mathematical astronomers. Such institutional divisions and values were less evident in courts. The system of court patronage brought clients from different disciplines into working relationships. It permitted clients to negotiate new roles. Some courts also encouraged innovative, even radical work, as demonstrations of their cultural independence and dynamism.

Consequently, some court astronomers, protected by their patrons, were able to fashion a new role that included making knowledge claims (even Copernican ones) about the physics of the heavens. In England, if F. R. Johnson exaggerated the number of Copernicans,²³ there was still a considerable number, disproportionate to its international standing. Among the handful of proponents of the Earth's motion before 1601 were Thomas Digges, Thomas Harriot, William Gilbert and Edward Wright, and dubious claims have also been made for others such as Leonard Digges, Robert Recorde and John Dee.²⁴ All worked outside Oxford and Cambridge ('Oxbridge') and depended upon patronage, yet none went on to contribute significantly to the new physical astronomy, despite a relative lack of religious opposition. As we shall see, the English court did not support disciplinary innovation in this case.²⁵

While Westman proposed a totalizing model of the role of court patronage in the emergence of physical astronomy, Biagioli provided a micrological account of the most famous new astronomer, Galileo. In *Galileo, courtier*, Biagioli interpreted both Galileo's career and work as the response of a client to the opportunities and constraints of his various patronage and court contexts. Even allowing for criticisms of reductionism, Biagioli conclusively demonstrated the explanatory power of patronage in the construction of early modern science.²⁶

The closest parallels to Galileo in England were Thomas Digges and Thomas Harriot. We shall see that Digges's and Harriot's careers and output are just as open as Galileo's to being read in terms of patronage culture. Yet neither they, nor any other Englishman, with the exception of Robert Fludd, a client of James I, succeeded in using the patronage system to create what we call ostentatious natural philosophy.²⁷ There was never any concerted courtly support for new philosophy of the kind that Shackelford has identified as crucial to the establishment of Paracelsians like Severinus in Denmark.²⁸ Nor is there any English equivalent to J. J. Becher who, as Pamela Smith has demonstrated for a slightly later period, succeeded in manipulating the patronage system to alter the Holy Roman Imperial Court's interest in alchemy from occultism to a 'modernized' business.²⁹

Another pioneer, Bruce Moran, has demonstrated the importance of "prince-practitioners" — hands-on patrons — to the development of new disciplines such as observational astronomy and chemical philosophy in German courts such as Hesse-Cassel.³⁰ In Hesse the early Copernican astronomer Christoph Rothmann worked alongside Wilhelm IV and the instrument maker Joost Burgi. The iatrochemist Georg Hartmann of Marburg was personally selected by Wilhelm's son Prince Maurice.³¹ Elizabethan England's closest approximation to a prince-practitioner was Henry Percy, ninth Earl of Northumberland (the "wizard earl"). We argue below that Northumberland was not only a rare exception, but a suspect and powerless patron.³²

Finally, Paula Findlen's *Possessing nature* explores the intimate connections between patronage and the new culture of natural history, of collecting, taxonomizing and richly displaying nature.³³ In the case of Aldrovandi, this natural history depended upon patrons' interests in the self-aggrandizing benefits, both political and scholarly, of possessing such collections, as well as the immense patronly resources and contacts necessary to assembling them. For English patrons, to possess nature primarily concerned the utilitarian concerns of mapping territory, making inventories of natural resources and exploiting them. Moreover, the English patronage system simply did not offer clients the richness of material and social resources to undertake projects such as Aldrovandi's. John Gerard's failure, despite the backing of his patron William Cecil, Lord Burghley, to create a physic garden for Cambridge University is one example.³⁴

2.1. *The Patronage of Natural Knowledge: Systems and Interests in Early Modern Europe*

2.1.1. *Patronage systems*

Patronage formed an elaborate network linking all social groups and levels. Like a successful bureaucrat, a successful practitioner of natural knowledge, especially one engaged in complex projects, was at the centre of a rich web of patron–client relations. This ensured that a variety of intellectual, social and material needs were continuously met despite the uncertain nature of patronage. Patronage was primarily a political system, and scientific patronage operated by similar rules. A client could increase his status and power either by acquiring a patron at the top of the hierarchy, or by building up a portfolio of lesser patrons. To be identified with a single, powerful patron brought great rewards, but also dangers. Francis Bacon was temporarily tainted by his association with Essex; his role in Essex's prosecution then made him suspect with King James. Harriot suffered from the successive disgraces of Raleigh and Northumberland. Multiple patrons allowed a client to survive such vicissitudes. The mathematician John Blagrave wisely cultivated several, whilst Harriot was thwarted by the death of his new cultivations.³⁵

Like other forms, scientific patronage also worked indirectly and discreetly, often through patronage brokers. A key broker in Elizabethan England was Michael Hicckes, secretary to Burghley. Gabriel Harvey, a client of Robert Dudley, Earl of Leicester, and briefly his secretary, had especially good contacts with London's mathematical practitioners.³⁶ In James's reign Adam Newton advanced many, especially himself, using the brokerage that flowed from his position as tutor to Henry, Prince of Wales. Casaubon's well-documented move to England was brokered at every turn.³⁷

It was therefore important for a client to have connections to as many sources of patronage as possible, even if one had few patrons at one time. The more connections, the better the client could actively manipulate his opportunities. Such active manipulation was basis of 'self-fashioning', the process by which a client constructed, evolved and improved his status and identity in relation to his patrons.

More connections allowed the scientific client to pursue more or different interests, to protect himself against the death of a patron or shifts of power at court, and to command more material and intellectual resources, including introductions to and leverage with other client practitioners.

The concept of self-fashioning is a necessary counterbalance to the apparent determinism of patronage systems. It can be too easy for the historian to present clients and their work as the ciphers of patronly interests. Indeed, the reader may judge that our analysis of England suffers from this erroneous denial of agency. In the concluding section we will return to self-fashioning, and link it more closely to our concept of connectivity. We will contend that English practitioners were poorly connected, and that their scope for active self-fashioning was consequently limited by comparison with Continental clients. For this reason, as well as for placing the English system in comparative context, we now review the kinds of patronage available to the well-connected client.

Possibly the most richly connected was the Bolognese naturalist Ulisse Aldrovandi studied by Findlen. He provides our benchmarks. The top tier consisted of court patronage proper. The most expansive geographically was imperial patronage, the classic example being that of the Holy Roman Imperial court at Prague which, as Evans showed, Rudolph II turned into a centre for occult philosophy and natural magic.³⁸ The others are the Papal and Spanish courts. Whilst Aldrovandi was connected to all of these imperial systems, residents of Anglican England were not.

Next comes princely patronage. As we have seen, the courts of monarchical nation states, such as France, England, and the Scandinavian countries, differed from the courts of the city states that made up much of Italy and Germany. England was not merely one cell in a honeycomb that allowed clients to hop across borders, or to combine positions with neighbouring princes as Aldrovandi and Galileo did. In England the monarchs' spheres of political and cultural control were geographically coincident, and their policies included territorial consolidation and expansion. England was especially concerned with repulsing the Spanish threat, expanding its American colonies, subjugating Ireland, increasing trade and, under the Stuarts, integrating England and Scotland. Cultural competition through science seems to have been a secondary, even unaffordable aim.

In no court was patronage monolithic. Indeed, there were several causes promoting diversity. First, patronage was the main tool rulers had for maintaining a balance of power and range of options. Aristocratic factionalism was inevitable, but if rival factions were balanced by shifting flows of largesse, it could be turned to advantage. Devolution of patronage to an inner circle of trusted advisors-cum-intermediaries also encouraged diversity. Rulers allowed different factions to promote different political, religious or cultural policies, thereby disguising their own allegiances, changes of mind or uncertainties. This was supposedly Elizabeth I's favourite strategy. Radical redistribution of patronage (often involving the 'fall of the favourite' which Biagioli considers was Galileo's fate — as it was certainly Raleigh's) satisfied frustrated ambitions and ensured the entry of new talent.

However, Elizabeth's court did not have the diversity afforded by satellite courts of family members. Simon Adams even judges that "[a]s the household of a virgin queen regnant, the Court of Elizabeth I was all but unique for the sixteenth century". As Leeds Barroll notes, James VI and I's marriage to Anna of Denmark brought on his accession in 1603 the first "bifurcated" English court for decades. Moreover, Anna brought from her Danish background a tradition of an intellectually and culturally vital court in which women played an independent and significant role. Barroll argues that Anna's court, and her entourage of learned noblewomen "without any intervention from James I — became a crucial center for early Stuart high culture".³⁹ Her court patronized literature and the fine arts, just as James's interest in learning was governed by theology. However, Barroll demonstrates Anna's considerable influence upon a third satellite court, Prince Henry's, which, as we shall see, had a keen interest in natural knowledge.

Of course, the oligarchs of political entities such as Venice, Bologna, German 'free cities' and Swiss cantons like Geneva, where there was often no court as such, had considerable powers of patronage, notably over the appointment of physicians and university faculty. As humanistic values spread through Europe, these regional élites extended their patronage to support small, informal academies and coteries of intellectuals, most of whom gained their primary income from other, more formal state positions. Court patronage thus shaded into aristocratic patronage. Once again, England's political structure precluded much of this diversity and reduced the number of connections open to clients. The Cecil and Sidney families operated important networks but, with the exception of the physician Thomas Moffet, these did not include clients who pursued natural philosophy. Northumberland was a rare, perhaps unique, nobleman in maintaining a quasi-autonomous natural philosophical circle.

A parallel, overlapping network of patronage was ecclesiastical. The Counter-Reformation Church continued to operate an extensive system. Indeed, as it lost territory, Rome increased resources in an effort to consolidate at least its ideological and cultural hegemony. The patronage of the Roman Church had the unusual feature that, when popes died or papal legates were replaced, their successors frequently sidelined incumbents, to whom they had few familial obligations. They promoted their own networks, creating new intellectual opportunities.⁴⁰ Obviously, practitioners in England had very limited access to the dense and diverse connections afforded by Catholic patronage.

The confessional divides between Catholic, Lutheran, Calvinist and Anglican states significantly disrupted the European-wide circulation of personnel, and to some extent practices and ideas, if not of artefacts such as books, instruments and specimens.⁴¹ The closer integration of church and state in countries like England tended to lessen the distinction between ecclesiastical and political patronage. More significant than explicitly ecclesiastical patronage was the rise of religious orthodoxy as a factor in patronage choices and networks.

Some connections were forged between Swiss and Dutch Calvinists and supportive English patrons and clients. It was as a result of such contacts that Lambert Daneau's

Physica Christiana was translated into English by a client of Francis Walsingham.⁴² However, English connections were relatively few and difficult, even after James sought to position Anglicanism, and himself, as a reconciling *via media* based on its supposed conformity with patristic tradition. Isaac Casaubon, whom James patronized to promote this position, ended up distrusted by Catholics and Calvinists alike.⁴³

Early modern practitioners had two relatively new sources of patronage, which were exemplified in England by new corporations such as the College of Physicians (founded in 1518 but now with more influence), the Muscovy and East India Companies of merchant adventurers, and Gresham College. These latter patronized lecturers in practical mathematics. The newest patron, in some scholars' interpretations, was 'the public'.⁴⁴ By the turn of the seventeenth century several countries, including England, had a flourishing commercial press and an audience willing to consume vernacular works. In England these were mainly of a practical or instructional nature; as such they seem to have reinforced the English predominance of utilitarian over ostentatious science.

Whilst public opinion, and the growth of corporate scientific academies,⁴⁵ increasingly supplanted elite patronage as the measure of scientific credibility during the seventeenth century, serious and innovative natural philosophers still required it for their livelihood and reputation in this period. We believe that, compared with Italians like Aldrovandi or Galileo, English practitioners depended upon limited networks centred on the royal court, with a concomitant limitation of connectivity, resources, interests and personnel. We present more evidence in Section 7.

2.1.2. *Patronly interests*

Continental patrons had a wide range of interests in natural knowledge. The purpose of this analysis is to show that in England it was the utilitarian ones that predominated.

We might begin with direct self-interest. The financial drains of patronage obligations and conspicuous consumption led some to back alchemical projects to make gold. Elizabeth's Privy Counsellors were no exception.⁴⁶ Princes and leading aristocrats routinely retained experts in medicine and astrology (frequently the same person), to advise on their personal health and fortune. The new star of 1572, apparently the first since the birth of Christ, caused predictable concern, as did the comet of 1577, and the conjunction of Jupiter and Saturn in 1583. These created some of the few opportunities for astronomers in Elizabeth's reign.⁴⁷

That rulers privately exposed to such clients their physical and mental worries explains why they often chose (or suspected) them to be special emissaries or spies. Elizabeth's physician-astrologers Elisha Bomelius and John Dee both came under suspicion, as did the Scottish follower of Bruno and sometime client of James VI, Alexander Dickson.⁴⁸ William Paddy, one of Robert Cecil's physicians, had the code name "No. 40" in the secret negotiations that secured James I's accession.⁴⁹ Cecil became James's first favourite and was made Earl of Salisbury, whilst Paddy was knighted and served James as a personal physician. Timothie Bright, a physician

in Philip Sidney's circle, accompanied him on a mission to Paris, when the St Bartholomew's Day Massacre forced them to join the refugees in Sir Francis Walsingham's embassy.⁵⁰

Courts patronized a more eclectic range of healers than medical establishments liked, and tended to erode the formal medical hierarchy. In James's court, for example, College Galenists were forced to minister alongside more heterodox favourites from Scotland and the provinces. Continental court patronage was vital to Gerhard Dorn's and Adam Bodenstein's work in the collation of Paracelsian texts, as it may well have been to the number of learned English Paracelsians whom Charles Webster has added to Debus's lower practitioners. Indeed, courts provided legitimation for innovative natural philosophies of court physicians of many kinds.⁵¹ The role of English court patronage in this regard needs more research, although very few royal physicians made novel interventions in natural philosophy. The most famous to do so before Harvey, William Gilbert, had a conspicuous lack of patronly support for his magnetic philosophy.

Courtly interests also underpinned the florescence of Renaissance occultism. Clients as diverse as Dee, della Porta, Brahe, Campanella and Fludd tended to ground their claims to a greater control over nature in eclectic, Neoplatonist or Paracelsian ontologies that placed greater emphasis than did Aristotelianism upon concepts of spirit, microcosm, sympathies and harmonies. The power, novelty and heterodoxy of their occult philosophies, especially where they threatened traditional theology and metaphysics, left the exponents in need of, and good candidates for, patronly protection. In England, James I's protection of the heterodox Robert Fludd stands out, certainly in comparison with the reluctance of Elizabethan patrons to support Dee's occult philosophy.

A few patrons had genuine intellectual interests in some aspects of science. These are Moran's prince-practitioners, who conducted their own research with the help of clients.⁵² Noble- or prince-practitioners were rare, however. Tycho's biography illustrates one of the obstacles. As a rich nobleman, he began by funding himself (he was a patron in his own right), but encountered resistance because mathematics was considered to be the work of non-noble professionals. The royal patronage of Frederick that Uraniborg relied upon was always contentious, and when Frederick died, Tycho was forced to become a client of Rudolph II (who was more interested in Tycho's alchemy than his observational astronomy).⁵³ Tycho's literal ennobling of astronomy explains why Edward Wright, for example, cited him in the first edition of his *Certain errors in navigation*. In his preface he expressed his "Hope (whether vaine or no I know not) of some Mecoenas" so that the poor relation of navigational science "may have some increase, like as Astronomie hath much advauncement by Tycho Brahe alone, who for his deserved renowne cannot be too oft named".⁵⁴

Nevertheless, our research so far suggests that English patrons had predominantly utilitarian interests. Elizabethan and, to a lesser extent, Jacobean courtiers and politicians were preoccupied with matters of defence and control at home, imperial expansion abroad, and economic self-sufficiency and prosperity. Catholic Ireland needed

subjugation through plantation and physical might, as well as political diplomacy. Some outlying English regions, notably the Catholic Northwest, were not reliably governed. Scotland also posed a threat until 1587 when Mary was executed and James VI's accession secured.

In the last half of Elizabeth's reign the perceived threat of Spanish invasion and destabilization was especially great. The survival of England as a Protestant state was held to depend upon its new and burgeoning naval prowess. If a defeat of Philip II's armada was expected, it was by no means certain. Coastal defences, like military organization in general, were considered to be inadequate. Expeditionary forces, which Leicester ingloriously commanded, were sent to Ireland and to the new Dutch Republic. Later, James I, plagued by fears of Catholic conspiracies before and after the Gunpowder Plot of 1605, actively sought a leading role in an alliance of Protestant rulers as Europe headed towards the Thirty Years War.

The economy was also poor: Elizabeth's and James's courts were in permanent financial crisis. Securing a sound and adequate money supply was perhaps the most pressing domestic problem after religion. Hence the concern with an expansion of overseas trade, improved land use, identification of natural resources, and increased production of raw materials. There were attempts to establish colonies in America. All these concerns also related to England's external security — not just defence but equally prosperity to wage war, and self-sufficiency in the event of war: this was Burghley's "most constant political preoccupation".⁵⁵ However, the conclusion that patrons could not afford ostentatious (and comparatively cheap) science is not supported by their extravagance in other areas of culture.

In short, England's position as a consolidating state fits our hypothesis that its patronage of natural knowledge differed in being less ostentatious and more utilitarian. Our initial findings confirm the hypothesis to a degree that has surprised us.

3. THE PATRONAGE OF NATURAL KNOWLEDGE IN EARLY MODERN ENGLAND

Although it was ubiquitous, English patronage was rarely as splendid as in Europe's richer or more culturally competitive courts. Henry VIII had used patronage self-consciously to begin an English Renaissance, but the ensuing decades of religious and political turmoil left Elizabeth's administration in straitened circumstances. Elizabeth herself acquired a contemporary reputation for "parsimony" in patronage,⁵⁶ but the justification remains uncertain, as does the extent to which she, as a female monarch (indeed a "virgin queen"), devolved it to her principal courtier-politicians such as the Earls of Leicester and Essex. Recent studies of Burghley, and his son Robert Cecil (later made Earl of Salisbury by James I), have demonstrated that "the Cecil family were not only politically dominant, but also formed the vital centre of a network of cultural, artistic, economic and intellectual patronage unequalled in England in the second half of the sixteenth and early seventeenth centuries". One client described his household as akin to a university. Burghley was an outstanding patron, especially in his costly programme of constructing grand houses and gardens that he undertook in order to secure his (and later his son's) status as Elizabeth's

chief minister.⁵⁷

Our study of Elizabethan patronage of natural knowledge shows that it was certainly distributed between the main administrators and courtiers: the Queen was rarely directly involved. Since her nobles had different interests and agendas, any Elizabethan ‘policy’ is not easily detectable. In some areas, Elizabeth emerged as a centralizing patron by the end of her reign: she amalgamated various companies of players into “The Queen’s Men”, probably the better to control the religio-political content of the theatre. We find no similar trend in natural knowledge. The personal policy of Elizabeth does not explain the ubiquity of utilitarianism.

The accession of James VI and I brought major changes to the nature of patronage, both generally and in natural knowledge. Together, they resulted in more direct royal control. First, as we noted above, the Jacobean period saw the return of satellite courts. The royal family now offered more, and more diverse opportunities, including natural philosophy.

Secondly, James was a strongly centralizing monarch, who sought an absolutist’s influence over England’s institutions and policies, through himself and his distrusted succession of favourites. Moreover James effected a clearout of Elizabethan personnel when he arrived in 1603 with his Scottish entourage.⁵⁸ Only Burghley’s son Robert continued to dominate, as James’s first favourite. Thirdly, James attempted to be a much more munificent patron than Elizabeth. He strongly cultivated the image of monarchy as a fountain, an endless dispenser of grace and favour, or (as critics saw it) profligacy and corruption.⁵⁹ Finally, James’s self image as a humanist scholar and theologian with an irenic mission ensured that, in these fields of learning at least, he was active as a kind of prince-practitioner — who even presented himself as the principal author of the “King James’ Bible”. For all of these reasons, there are important contrasts between Elizabethan and Jacobean systems of patronage of natural knowledge, as of other activities. However, our initial research has focused more on Elizabethan patronage, and it will form the basis of our report below.

In England as elsewhere, patronage of natural knowledge differed little from patronage of other forms of cultural production, except for its relative lack of importance. The same group of Elizabethan courtiers or Jacobean favourites dominated activities as diverse as the commissioning of works of art and architecture, supporting musicians, masques and companies of players, influencing fellowships at Oxford and Cambridge colleges or promoting the religious activities of doctrinal cliques.⁶⁰ For most of the patrons, the quantity of evidence of patronage in these areas, in the form of works dedicated, petitions received, correspondence exchanged and influence dispensed, swamps that for natural knowledge.

The extent and diversity of cultural patronage is becoming clearer. Burghley emerges as a significant backer of schemes to exploit England’s natural resources, but it scarcely matched his architectural, not to mention political patronage.⁶¹ Leicester, although another leading promoter of practical mathematics, was more concerned with advancing puritan theologians, more ensnared (as Chancellor of Oxford University) by academic disputes, and more financially burdened by “The

Earl of Leicester's Men".⁶²

Patrons also had obligations to their regional power bases, which bound them to a range of intellectual clients. Thus Thomas Egerton, Baron Ellesmere, advanced professionals of many kinds from his Shropshire homelands, through Brasenose College, Oxford, to positions of influence. His patronage extended to the recusant Aristotelian natural philosopher John Case, who dedicated his *Lapis philosophicus* to Egerton: Case was a Shropshire protégé — and private tutor to Egerton's son.⁶³

3.1. *Clients*

We began our research from a base of client practitioners who published works with letters of dedication to their patrons. This database of practitioners continues to undergo additions and subtractions. On the one hand, the claims of clientage made in dedications need to be confirmed. Conversely, there is, of course, substantial archival evidence of clients who published nothing. So far, we have identified some 140 practitioners for whom some evidence exists.

Dedications to his patron by an author were an important way of publicly signalling a connection. To honour one's patron, or patrons, was necessary, and not just because such public gratitude was the price of continued support. Given the inferior status and uncertain reputation of the typical author of a work of natural knowledge, it was the dedicatee who first guaranteed the authority of a work — who was, in the sense of authorization, the principal author; a serious work, especially a novel one, without an authoritative dedicatee risked lacking credibility. Thus in 1594 Hugh Platt dedicated to the Earl of Essex his *Jewell house of art and nature. Conteyning divers rare and profitable inventions, together with sundry new experiments in the art of husbandry, distillation and moulding...* He commended it to "rest secure under the shadow of so honourable a Patron" (as Essex still was) and believed that it would thereby avoid the "deepest censure, ech author of novelties ... is every way in danger of".⁶⁴

Successive editions allowed clients to advertise and repay debts to new patrons. The first, 1599 edition of Edward Wright's *Certain errors in navigation* was dedicated to George Clifford, third Earl of Cumberland, the privateer who inaugurated Wright's career as a navigation expert, but the second edition of 1610 boasted a dedication to Henry, Prince of Wales, in whose court Wright now worked. Wright no longer expressed his hope for a Maecenas, for Henry (briefly) seemed to be one.

Successive works can also reveal patronage problems. In John Blagrave's pro-Copernican *Astrolabium Uranicum generale* of 1596 he thanked the Lord High Admiral, Charles Howard, Baron of Effingham, for having been "pleased to take further notice of me by my personal preference". Blagrave, a gentleman of limited independent means, mentioned that he had "beene always exceedingly bounde, Next to the [ailing...] Lord Burleigh, Lord High treasurer of England, unto the late right Honorable Sir Francis Knolles". Blagrave had honoured his debt by dedicating previous works to both men, but he needed a new patron to continue to protect his family against "most injurious and wicked practices heretofore vehemently prosecuted against us". But when, two years before his death in 1611, he dedicated his *Art of*

dyalling to James I's privy counsellor Sir Thomas Parry, he complained that

alas, time hath bereft me of many my most Honorable Favourers. And only your Honour now succeeding your Honorable Father in place of honour, is the principall hope left unto me, who in my Mathematicke infantry [infancy] both favoured me, and furnished me out of your admirable and generall library, of such mathematickes books as in those daies were hardly, or not elsewhere to be gotten.

Blagrove's dedication to Parry probably owed more to legitimate hope based on past favour than to an established patronage connection.⁶⁵

Since practitioners' suggestions of clientage in dedications need confirmation, biographical studies of their careers are important. At this stage of the research we have mainly augmented existing biographies. Given the dearth of 'important' Englishmen in the period, and the lack of attention to patronage, a few works stand out as exemplars that expand upon the available biographical summaries. Most of these confirm the importance, but difficulty, of obtaining reliable and especially ostentatious patronage, especially under Elizabeth. Clulee's study illustrates why the ambitious John Dee left England.⁶⁶ Pattison's biography of Casaubon draws richly on Casaubon's letters and ephemerides to delineate a client in great demand.⁶⁷ Shirley's biography of Thomas Harriot illustrates, *en passant*, Harriot's appalling luck in moving from one disgraced patron, Raleigh, to another, Northumberland — the negative consequences for Harriot's domestic reputation and international renown as a potential "English Galileo" have recently been explored by Pumfrey.⁶⁸ Whilst there is evidence of Dr William Gilbert's medical patrons (who included Burghley, Walsingham and other privy counsellors), there is no sign of support for his magnetic philosophy.⁶⁹ Things improved under James for the likes of Harvey, Fludd and Casaubon, but the several recent biographies of Francis Bacon touch upon the lack of interest that this otherwise consummate courtier generated in his programme of natural philosophical reform.⁷⁰ We badly need more knowledge of the careers within patronage of many early modern practitioners, for most of whom the literary remains are sparse and scattered.

In fact, the convention that authors needed a consenting noble dedicatee was beginning to break down for certain genres.⁷¹ As 'the public' became a new kind of authority-conferring patron, writers of popular and practical works, including some of natural knowledge, began dedicating books "to all true students of Geography and Cosmography" as did the astrologer Simon Forman in his *Groundes of the longitude*, or even "to the courteous reader", to whom the abrasive Mark Ridley addressed his English version of William Gilbert's magnetic philosophy. In 1596 the prolific commercial writer and lecturer Thomas Hood barely apologised to Sir John Burrowes for his "bold attempt, that uppon so small acquaintance I should presume to dedicate this work [*The mariners guide*] unto you". The "sufficient excuse for my presumption" was that Burrowes bore "an Honorable regard" for navigation.⁷² Likewise, Antony Linton, the obscure Sussex parson who puffed a magnetic longitude scheme in his

Newes of the complement of the art of navigation (London, 1609), which he dedicated to James I, had no connections with the royal court. The magnetic experts patronized by Prince Henry moved immediately to destroy his credibility.⁷³

3.2. Patrons

It is obviously more difficult to establish the diverse interests of patrons. Franklin Williams's *Index of dedications and commendatory verses in English books before 1641* is invaluable (if occasionally unreliable) for identifying natural knowledge, though it was usually one interest among many.⁷⁴ The growth of transgressive and speculative dedications like Hood's is helpful. So too are dedications of foreign natural philosophical and related works translated into English, where the translator-author may not otherwise be known for works of natural knowledge. For example, we have stated that few patrons supported natural philosophers. Indeed, the only truly English works of natural philosophy were John Case's *Lapis philosophicus*, patronized by Egerton, and those of the royal client Fludd. But there were two translations. Daniel Widdowes's abridgement of Gulielmus Scribonius's 1583 *Rerum naturalium doctrina methodica* was published in 1621 by the soldier-surveyor John Wid[d]owes as *A description of the world*. He dedicated it to his master Sir William Parsons, Surveyor General of Ireland, cleverly noting that his work of natural philosophy also "represent[ed] most lively, vast countries within a small map".⁷⁵

More significantly, Thomas Twyne, the puritan translator and physician,⁷⁶ dedicated his 1578 edition of the Calvinist Lambert Daneau's *Physica Christiana*, a work that extracted a system of natural philosophy from the Bible, to Elizabeth's fervently Protestant secretary Francis Walsingham. As Twyne argued, Daneau's work formed a perfect counterpart to the translation of New Testament by Theodore Beza, Calvin's successor in Geneva, published two years earlier by Walsingham's under-secretary Lawrence Tomson, and which also claimed Walsingham's protection.⁷⁷

Twyne had earlier dedicated a translated collection of religious writings to Nicholas Bacon.⁷⁸ Bacon had contact with Beza, as did many courtiers and churchmen.⁷⁹ In 1583, during the siege of Geneva, a collection in English churches raised £5039, as well as gifts from leading Anglican clergy to counterparts like Heinrich Bullinger. Indeed, many British Protestants paid homage to the beleaguered Genevans on their foreign travels, and Casaubon met the patrons and brokers in his move to England this way. The most important, Richard Thomson, did so as tutor to a travelling English noble. Thomson brokered Casaubon's acquaintance with Sir Henry Wotton, who lodged with the scholar, and epistolary exchanges with William Camden, Sir Henry Savile and, more crucially for Casaubon's intellectual reputation, Joseph Scaliger in Leiden. Savile used Casaubon to get Genevan typeface for a publication in Greek; whilst in 1611 Thomson, now a Fellow of Clare Hall, Cambridge, asked him to help prevent his ejection. Likewise, the future Bishop of Glasgow sought out Casaubon in Paris in 1601, with an invitation to write to James. He did so, pleading for support for Beza and the Genevan academy.⁸⁰ In the light of such connections, we might see the Elizabethan edition of *Physica Christiana* more as support for beleaguered

Calvinist learning than for natural philosophy *per se*.

Of course, Elizabethan support for Calvinist states went beyond the republic of letters. The Earl of Leicester commanded an expeditionary force to the Dutch Republic. This made him an obvious patron of Cyprian Lucar's *Arte of shooting*, a translation of Niccolo Tartaglia with Lucar's own appendix on gunpowder.⁸¹ The dedication was provided by the publisher, John Harrison (himself a Leicester client and publisher of William Harrison's *Description of England*, likewise dedicated to Leicester). John Frampton's *Ioyfull newes out of the newfound world* (London, 1577), his version of Nicolas Monardes's celebrated *De simplicibus medicamentis ex occidentali India delatis quorum in medicina usus est*, was dedicated to Sir Edward Dyer.

A leading patron like Leicester received scores of dedications from clients.⁸² Those from client mathematicians like Lucar or Thomas Digges or from medical writers like William Cuninghame, William Gale and John Jones, are dwarfed by those from historians such as John Stow and William Grafton, Puritans like Robert Fills and John Harmer, and explicitly anti-Catholic propagandists such as John Feild and Anthony Munday. A host of lexicographies testify to literary patronage befitting Leicester's Chancellorship of Oxford University (and Elizabeth's undisguised disappointment with Leicester's linguistic skill).⁸³

As Lord High Admiral from 1586 to 1618, Charles Howard, Baron of Effingham was naturally associated with works like John Davis's *Seamans secrets*, Thomas Steward's *Pathwaie to martiall discipline*, Walter Raleigh's *Discoverie of the ... Empire of Guiana*, and Edward Wright's translation of the Dutchman Simon Stevin's important *Haven finding art by the latitude and variation*.⁸⁴ But even he received more of his fourteen dedications from religious and anti-Jesuit authors. Again, works of natural knowledge form only three of the scores of dedications to Egerton.⁸⁵

It is therefore not surprising that the majority of the twenty-five works dedicated to Francis Bacon were theological, with a few on law and one on a masque that Bacon was involved with at his Inn of Court. What is surprising is that Bacon's protection was not sought by any innovative natural philosophers or other practitioners, unless one includes the fifth, 1617 edition of William Vaughan's *Directions for health*, a conventional work he had previously dedicated to family members.⁸⁶ By contrast, two of only three works dedicated to Northumberland (on astrology and the golden ratio) reflected his interest in mathematical magic.⁸⁷ Although we are re-establishing the ubiquity of English scientific patronage, its extent must be kept in perspective.

As we move from published to archival evidence, the literary remains of the leading English patrons are invaluable. Patronage of natural knowledge was considerably deeper and more diverse than can be inferred from written works. Patrons like Lord Treasurer Burghley continued to commission or receive from clients many manuscript treatises, for their private edification or concerning specific questions. To be sure, most dealt with religion and politics, as did Francis Thynne's lavish manuscript "Lives and successions of the Treasurers of England".⁸⁸ But the notorious non-conformist Robert Browne, a kinsman whom Burghley assisted, offered him a treatise proving that Oxbridge taught the arts and sciences erroneously and laboriously.⁸⁹ William Bourne

compiled for Burghley a “Treatise on the property or qualities of glasses, according to the making, polishing and grinding of them”, and another on buoyancy.⁹⁰ John Montgomerie compiled a substantial “Treatise concerninge the mayntenance of the navie”, which he dedicated to Leicester “to signifie my loving affection”.⁹¹ Burghley received another on the discovery and utility of lands in the southern hemisphere.⁹² Valentine Russwarin, a foreign physician, dedicated a natural philosophy of urine to Burghley, together with a plea that he promote his “sute” and usefulness.⁹³ Thomas Digges also produced manuscripts for Burghley and Leicester.⁹⁴

As had been common in the early years of print culture, manuscripts were sometimes later printed. The Reverend William Barlow, chaplain to Prince Henry, wrote the first version of his *Magneticall advertisements* (1616) as a private 1609 manuscript dedicated to Sir Thomas Chaloner, controller of the prince’s court, and this he reworked and published after accusing Mark Ridley of plagiarizing it for his *Magneticall bodies and motions* of 1613.⁹⁵

By the late Elizabethan period, print culture was sufficiently established that clients writing on natural knowledge routinely sought a wider, more international audience than manuscript circulation easily allowed. However, publication, together, of course, with a dedication, had to bring mutual benefit to both patron and client. The lack of such benefit may explain why so few manuscripts of the famous clients of the infamous “wizard Earl” of Northumberland were published.⁹⁶ Conversely, Elizabeth I kept a public distance from her “wizard client” John Dee.

Of course, many unlearned practitioners, instrument makers and projectors whom the archives reveal as clients did not produce work that could be published with suitable encomia. In short, whilst any analysis must begin with written works, a full picture of English patronage depends upon a painstaking analysis of state papers, library and private archives, which we have only just begun.

From our preliminary examination of all these sources, we have compiled a database of no fewer than 60 patrons of natural knowledge, ranging from dominant figures such as James I to minor ones such as the navigator Thomas Cavendish, an early patron of Robert Hues. In Elizabeth’s reign, her senior ministers and favourites emerge as the central players. They are Lord Burghley, his son Robert Cecil (first Earl of Salisbury); the Earl of Leicester, his nephew Sir Philip Sidney, and his stepson Robert Devereux (second Earl of Essex); the ninth Earl of Northumberland; Sir Walter Raleigh; the third Earl of Cumberland; and Charles Howard of Effingham (Lord High Admiral). Although many clients lived to span both reigns, among the patrons only Robert Cecil remained to serve James VI and I.

Many of these patrons were closely linked by family, marriage or other courtly connections. In the sphere of politics, and of gaining more influence at court, they were themselves clients, who could gain favour, *inter alia*, by recommending trusted physicians or ingenious men in their entourage. The interconnections are very visible in the group of philosophers and physicians associated with Sir Philip Sidney, the poetic Platonist, major patron of the arts, and nephew of Leicester.⁹⁷

We can see these connections between circles in the case of Thomas Moffet. Moffet

was primarily a client of the Earl of Essex, who seems to have admired his unorthodox interests, which ranged from the natural history of insects to Paracelsian medical philosophy. Indeed Essex supported the irascible Moffet and forced a reluctant College of Physicians to accept him as a Fellow and to grant a license to Moffet's own client, the 'quack' healer Leonard Poe. (This was the breakthrough Poe needed, and he rose to become James I's royal physician.)⁹⁸ Moffet also advised Sidney on the "barrenness" of his wife Frances, Sir Francis Walsingham's daughter. When Sidney died, Frances married Moffet's patron Essex. Moffet maintained his links with the Sidney family through his association with Sir Philip's sister, Mary Herbert, Countess of Pembroke, to whom Moffet dedicated his treatise on silkworms. As children, Mary and Philip had both been tutored by John Dee, but Mary was reputed to have developed her interest in natural philosophy, even making alchemical experiments, medical preparations and raising silkworms, with Moffet's assistance. On Moffet's death in 1604 another of the circle, Matthew Lister, stepped into his place as her physician, and later served Robert Cecil and Anna of Denmark.⁹⁹

3.3. *The Elizabethan Patron: Burghley and Utilitarian Interests*

The single most complete, relevant and accessible archive is formed by the British Library Lansdowne Manuscripts. Thanks to Burghley's extraordinary longevity as Elizabeth's chief minister, and his obsessive bureaucracy, these papers have given us an unparalleled insight into the intellectual influence of a leading noble patron, just as they form the basis of Heal's and Holmes's recent study of Burghley's neglected patronage of 'economic' projects.¹⁰⁰

Burghley was Elizabeth's chief adviser from her accession almost until his death in 1598. She relied heavily upon his counsel in all matters, especially concerning the Catholic threat and her sister Mary.¹⁰¹ He presided quite successfully over the English economy and state finances during a period when military expenditure created constant crises. Between 1585 and 1603, more than 100,000 men were pressed into service abroad.¹⁰² Nevertheless, he maintained the stability of English coinage, following a successful recoinage in 1560. Even as Burghley's health failed in the 1590s Elizabeth refused to allow his son Robert to succeed him. Burghley responded by patronizing lavish entertainments for the Queen at his major residence, organized around a *Tempest*-like theme of rural retreat.¹⁰³

Burghley's great influence, underwritten by his annual income of around £4000, was rivalled only by Leicester's. The two are sometimes cast antagonistically as father figure and suitor, or 'moderate' and 'Protestant ideologue' respectively, but in important matters of policy including, it seems, utilitarian patronage, they and their circles co-operated pragmatically.¹⁰⁴ A rupture occurred when Leicester insisted upon the military campaign to support the Dutch Republic against Spain. Until Leicester's death in 1588 they had many clients in common, including Thomas Digges and Thomas Bedwell, Keeper of the Ordnance Stores and maker of military instruments.¹⁰⁵

Unlike Leicester, Burghley had a good humanist mind. Around 1550 he had been — along with fellow members of St John's College, Cambridge, John Cheke

(Elizabeth's tutor), his brother-in-law Sir Nicholas Bacon, and Sir Thomas Smith — one of the leading 'Athenians', advocating not just reformed religion but with it a return to a classical pronunciation of Greek. On Elizabeth's accession he secured positions for them. Smith especially, together with Bacon and the reforming merchant Sir Thomas Gresham, were also profound influences upon Burghley's 'economic policy'.¹⁰⁶ Smith's 1549 policy manuscript "Discourse of the Commonweal" (eventually published in 1581) coherently advocated government intervention in the economy as a solution to the legacy of a debased coinage.¹⁰⁷ "By allurements and rewards" entrepreneurs were to be encouraged to increase domestic production and manufactures. Thirsk has read Burghley's development of monopoly patents as his implementation of the policy, together with inducements for foreigners to settle and bring new processes to England. As Heal and Holmes observe, "Burghley employed agents to comb England and Europe for new processes of manufacture. And when projects seemed practicable Burghley was willing to invest in his entrepreneurs".¹⁰⁸

There seems little doubt that such a 'utilitarian' interest dominated Burghley's patronage of natural knowledge. This is despite the fact that Burghley's patronly responsibilities brought him into contact with a much broader range of intellectual concerns. In the first place, Burghley was Chancellor of Cambridge University from 1560 until his death, while Leicester was his counterpart at Oxford. Like the more Puritan Leicester, Burghley was active in ensuring that academic communities conformed to his version of Elizabethan policy, especially in religion. He attempted reforms and regulated frequent academic disputes.¹⁰⁹

Burghley was involved in university matters ranging from Walsingham's request that Magdalen College be reformed, through to the provision of a plague-free water supply, to granting leave for physicians to study abroad.¹¹⁰ The Archbishop of Canterbury asked him to prevent the university press printing "schismatical books".¹¹¹ He was petitioned by both sides in a controversial appointment to the readership of physic at Puritan-dominated St John's College.¹¹² He intervened from personal obligation too. Roger Ascham, Elizabeth's tutor, had been his client and friend, and Ascham's widow dedicated the first (1570) and subsequent editions of *The scholemaster* to Burghley.¹¹³ Burghley tried to get Ascham's impoverished son Giles a pension and a Fellowship at Oxford.¹¹⁴

Probably his most significant philosophical intervention was his protection of the Johnian Fellow Everard Digby, grandfather of the atomist Kenelm Digby. Everard was unpopular primarily for his religion but also for his immoderately anti-Ramist defence of *logica vetera*, and was deprived of his Fellowship in 1587. Burghley had Digby restored (against Leicester's wish), and later helped him to move on to a church living.¹¹⁵

Much more significant, from the standpoint of natural knowledge, was Burghley's apparent inability to get Cambridge University to plant a physic garden. Burghley's superintendent of gardens, and valued client, was John Gerard. Cambridge was petitioned in 1588 and a letter of recommendation, drawn up by Gerard on Burghley's behalf, remains in Burghley's papers.¹¹⁶ It proposed the "purchasing of publicke

gardens ... at the University of Cambridge ... whereby the noble science of physic is made absolute ...".¹¹⁷ When the proposal was rebuffed, Gerard expanded his physic garden at his London home in Fetter Lane. His famous *Herball or Generall historie of plants* of 1597 is, of course, dedicated to Burghley, and pays tribute to his patron's encouragement.¹¹⁸ The fine illustrations and extraordinary number of prefatory commendations, many in Latin, from men of state, learned physicians and others, established that, despite Gerard's lack of formal learning, this was a project to be taken seriously. Gerard noted that Montpellier and Padua universities had physic gardens, and that he had successfully grown many little known herbs in England.¹¹⁹ A physic garden fitted perfectly with Burghley's policy of encouraging self-sufficiency through copying foreign techniques, and with his family's fondness for gardens as political signifiers.

Like many courtiers, Burghley took a keen interest in physic and physicians. In 1576 he was informed about "disorders to be reformed" in the College of Physicians.¹²⁰ He was involved in the selection of royal physicians: in 1570 Elisha Bomelius, the royal physician cum astrologer, petitioned him to be released in order to serve the Czar.¹²¹ His own household was served by the best, including William Gilbert. Timothie Bright dedicated to him *Hygieina, id est de sanitate tuenda medicinae* in 1582.¹²² Burghley's ill health, especially his gout, provided entrées and suits for many aspiring healers.¹²³

Burghley, then, came into contact with a variety of practitioners of natural knowledge. But there is no evidence from the Lansdowne papers that he ever patronized natural philosophy or 'theoretical' mathematics. Indeed, only Gerard's *Herball*, with its illustrations and multiple encomia, can be termed 'ostentatious' natural knowledge. This is in marked contrast to his enthusiasm for utilitarian natural knowledge, including the numerous economic projects discussed by Heal and Holmes.

It was not just a Copernican astronomer like Digges whom Burghley seemingly rebuffed. Few of the hundreds of petitioners every week got past broker-gatekeepers, such as his secretary Michael Hicke, who exercised considerable power.¹²⁴ Burghley's known willingness to reward projectors meant that his office received hundreds of petitions. For dealings with projectors, Burghley used as intermediaries a number of clients, such as Armagil Waad. Peter Osborne of the Exchequer advised on metals and mining, whilst the Welsh official William Herle effectively became a permanent agent, with artisanal contacts in the Low Countries.¹²⁵

The "heady days" of projection analysed by Heal and Holmes ended around 1570. From our own survey of Lansdowne papers after this date, it is clear that the nature of the schemes did not change.¹²⁶ They fall into three broad classes of natural knowledge: agriculture, the mechanical arts, and (al-)chemical processes, primarily concerning metals. It is therefore not surprising that Burghley's circle welcomed approaches from alchemists. In the 1560s Waad had managed the experimental project of Burghley's client Cornelius de Lannoy, until de Lannoy was arrested for non-production.¹²⁷

This is the context in which we must place the most extraordinary of Burghley's projects, his involvement in 1579 with the ill-fated but royally approved "Society

for the New art of making Copper and Quicksilver by way of Transmutation”, built upon the claims of William Medley. Transmutation concerned Burghley because of its implications upon coinage.¹²⁸ Where some European courts had both practical and philosophical interests in alchemy, there is scant evidence that Elizabeth’s politicians had interests in its occultist theory. Thus, when Sir Edward Dyer contacted John Dee and Edward Kelly in Prague with Burghley’s “pray[er] to God to direct you to bestow the Gifts that God hath given you rather upon your own place, and Country, than upon strangers”, it was Kelly he wanted, most likely as a transmuter.¹²⁹

Burghley’s patronage of Medley and other alchemists has predictably been seen as rash credulity in occultism. But Heal and Holmes disagree, citing his empirical approach:

His meticulous attention to detail, his readiness to invest time to secure solutions, his refusal to take claims on trust, are characteristics that emerge in every aspect of his political engagements, not least in response to the economic projects. His response to the abstruse technical debates between native and Italian military architects concerning the structure for the new walls of Berwick — build test models of each and subject them to bombardment — typifies his response to arguments about lead-furnaces, drainage pumps, or rape-seed production.¹³⁰

We hypothesise that Burghley typified the English patron who, though patronizing ostentatious work in some areas, had a firmly utilitarian attitude to natural knowledge.

3.4. *The Elizabethan Client: Thomas Digges and Evolving Ambitions*

Thomas Digges (1545/6–1595) aspired to be a new astronomer in the realist tradition, advocated by Copernicus, practised in his time by Tycho Brahe, and developed further by Kepler and Galileo. His early work shows him to be convinced that observational and mathematical astronomers could intervene in cosmological debate, disproving conventional doctrines about the immutability and solidity of the heavens, and even establishing the truth of heliocentrism. His later work, however, conformed to English utilitarian interests, and was exclusively concerned with the military arts. The shift was, we believe, forced upon him by Elizabethan patronage culture.

Digges was the son of Leonard, a learned and wealthy gentleman mathematician from an established Kent family, who died c. 1559. However, his father was attainted because of the Wyatt Rebellion against Queen Mary and his estate was confiscated. He may have avoided execution through the intervention of Edward Clinton Fiennes, Lord Clinton and later first Earl of Lincoln. Leonard became a pioneering author of practical and popular vernacular works of mathematics, which possibly supplemented his reduced income.¹³¹ In 1553 he published the first of many editions of his *Prognostication*, an almanac including basic astronomical techniques, the 1555 edition of which he dedicated to Fiennes. *Tectonicon*, a work of surveying, followed in 1556, and he left unfinished works which Thomas completed and published as *Pantometria* (1571, on cartography) and *Stratoticos* (1579, on military engineering). Some time

after Elizabeth's accession, Thomas obtained some restitution of the estate, although the extent of his gentlemanly independence is at present unknown.

He did not attend university, but was tutored in mathematics by his father and by John Dee, a friend of Leonard. Thus Thomas was well-versed in practical mathematics but, like Dee and his father, he believed that mathematics and mathematicians had a higher calling.

After Leonard's death, Dee acted as a friend and patron to Thomas Digges. He permitted Digges's entrance onto the international Latin stage with an address to the "benevolo lectori" of Dee's *Parallacticae commentationis praxeos[ue] nucleus quidam* (London, 1573). At the same time Digges established himself as a leading observational astronomer with his work on the new star in Cassiopeia, an event that interested mathematicians, theologians and politicians alike. This, together with his reputation as the continuer of the *Prognostication*, seems to have brought him some patronage from Burghley. He provided Burghley with his manuscript observations and prognostications concerning the new star of 1572.¹³² He then dedicated to Burghley his astronomically ambitious *Alae seu Scalae mathematicae* of 1573. In this work Digges, like Tycho, concluded from observations of parallax that the star was a celestial and not a meteorological phenomenon, that there had been changes in the heavens, and that mathematical astronomy could therefore determine cosmological questions. Several European astronomers commented favourably upon it, including Tycho, and Digges may have cultivated Tycho as a potential patron.¹³³

In 1574 Digges presented Burghley with yet another astronomical treatise.¹³⁴ It may have been an early version of his extraordinary Copernican *Perfit description of the celestiaall orbes*. Whatever it was, Burghley's patronage of Digges seems to have ended and the *Perfit description* appeared in 1576, appended to another edition of the *Prognostication*. Digges dedicated it to his father's patron Fiennes, now Lord High Admiral and Earl of Lincoln, claiming that he still owed him a debt of gratitude.

From 1578 Digges became a highly favoured client of Leicester. Given the zealous Protestantism that Digges exhibited in the *Perfit description* and elsewhere, Leicester was an appropriate patron. But the switch signalled the end of Digges's attempts to establish himself as a radical new astronomer. Leicester patronized him exclusively as an expert on the military arts. Unlike John Dee, he accepted and made the most of these limited opportunities. The *Arithmaticall militare treatise, named stratoticos* of 1579 was to be his last new work. In the dedication to Leicester, Digges poignantly described his change of direction.¹³⁵ He had

spent his younger years, even from my cradle, in the sciences liberal, and especially in searching the most difficult and curious demonstrations mathematical ... yet finding none, or very few, with whom to confer and communicate those my delights (and remembering also that grave sentence of the divine Plato, that we are born not for ourselves, but also for our parents, country and friends), after I grew to years of riper judgement, I have wholly bent myself to reduce

those imaginative contemplations to sensible practical conclusions of those my delectable studies, as also to be able, when time is, to employ them to the service of my prince and country.¹³⁶

In 1581 Leicester employed him to survey Dover Castle and town, and in 1582 put him in charge of the huge project of redefending Dover Harbour. In 1586 he accompanied Leicester as muster-master-general of his patron's expeditionary force to the Netherlands, a post he held until shortly before his death. He defended Leicester's honour by writing a defence of his much-criticized relief of Sluse.¹³⁷ Reciprocally, as numerous papers show, Leicester remunerated Digges and protected him (as apparently did Burghley) in several litigious disputes.¹³⁸ Thus, even though Leicester seems to have been no more interested in Digges's innovative astronomy than was Burghley, he did provide a mathematician with courtly patronage of a very high order. Digges pragmatically chose to advance his country, not Copernicanism.

3.5. *Anomalous Networks: Northumberland and Thomas Harriot*

Any account of English patronage of natural knowledge, especially one that suggests a general ideology of utilitarianism, must address the patronage relationship between the Earl of Northumberland and Thomas Harriot together with the other scholars in his circle. If our preliminary research suggests that English patronage was utilitarian, and clients dissuaded from natural philosophy, then Northumberland and Harriot are significant exceptions. Harriot has been called "the English Galileo".¹³⁹ If we take seriously the importance of patronage in the construction of Galileo's intellectual identity and work, that would make Northumberland the English Cosimo de Medici.

Northumberland was no Cosimo. To be sure, he had genuine, wide ranging intellectual interests and patronized clients to advance them. In addition to occultism,¹⁴⁰ the "variety of studies [suited] to a young head" that he listed in his *Advice to his son* (1609) included "Arithmetic, Geometry, Logic, Grammar Universal, Metaphysics, the Doctrine of Motion, Astronomy, the Doctrine of Generation and Corruption, Cosmography, the Doctrine of *de Anima*, Moral, Politics, Economics, the Art Nautical and Military".¹⁴¹ It was written whilst Northumberland and his family were imprisoned in the Tower of London, accused of treasonous complicity in the Gunpowder Plot. He was in no position to advance anyone's career or protect any innovative or heterodox natural philosophy.

In fact, Harriot began as a client of Northumberland's friend Sir Walter Raleigh. He was a member of his London household by 1583. The mutual interests binding patron and client were navigation and exploration. In this high point of his popularity with Elizabeth, Raleigh used Harriot for his voyages to Virginia. Harriot trained his captains, mapped the new territories, and surveyed their economic resources, meanwhile living in Spartan conditions. Whilst Raleigh probably prevented Harriot from publishing commercially and militarily sensitive work such as his lost navigation manual *Arcticon*, he made sure that he published his *Breife and true report of the new found land of Virginia*. This was a cheap tract dedicated to Raleigh, and it functioned

in large part as propaganda, attracting support for a colony and countering hostile rumours about Raleigh's ambitions. It was Richard Hakluyt's brokerage of a Latin, illustrated Continental edition that brought Harriot fame.¹⁴²

In the event, it was Harriot's only published work, and it supports the Diggesian picture of patrons' bending bright mathematicians and philosophers to utilitarian work. At about the same time Harriot compiled for Raleigh a manuscript on projectile motion. Some have read it as the promising beginnings of a Galileo-style new theory of motion. The recent analysis by Walton persuasively recasts it as a pragmatic work of ballistics, commissioned by Raleigh as part of his thinking about naval gunnery.¹⁴³

The arriviste Raleigh's incautious use of his position as Elizabeth's favourite ensured his decline and fall. His and Harriot's growing friendship with Northumberland did not help. Northumberland was an outsider. From a Catholic family, his religion was suspect. His powerbase was on the Scottish border, though this allowed him to cultivate the future James I. Perhaps more damningly, he had a justified reputation as a contemplative, free-thinking scholar, who entertained atheistic ideas in philosophy and metaphysics. Raleigh shared his client Harriot with Northumberland and, as Raleigh's fortunes disappeared in the early 1590s, he became one of Northumberland's pensioners. When charges of atheism were made against the Raleigh-Northumberland circle, Harriot (whose own beliefs were certainly heterodox) was implicated.¹⁴⁴

In the late 1590s, Northumberland sought greater favour by entering the mainstream at court. He even volunteered for military service in the Low Countries. He attempted to learn some practical, military mathematics from Harriot, but his service was a fiasco — he was challenged to a duel by a seasoned commander outraged by the foppishness of his entourage. It was afterwards that Harriot's work for him moved more towards speculative mathematics, astronomy and matter theory.¹⁴⁵

The arrival of James I changed everything. Raleigh soon fell from favour, was formally tried for treason in November 1603, and finally executed in 1618. At the sensational trial Raleigh was warned not to heed Harriot's belief that there was no hell! Northumberland, who had accompanied James on his journey to London, retained favour for himself and Harriot until they were visited by his Catholic cousin and Gunpowder Plotter, Thomas Percy, on 4 November 1604. Northumberland thus joined Raleigh in the Tower. Harriot was imprisoned, his house sealed, his papers searched, and he was suspected of having cast James's horoscope for Northumberland. He was released, after addressing the Privy Council:

I was never any busy medler in matters of state. I was never ambitious for preferments. But contented with a private life for the love of learning that I might study freely.¹⁴⁶

Whether Harriot genuinely wanted "a private life for the love of learning", that was his lot after 1605.¹⁴⁷ He remained resident at Northumberland's Syon House, and received an annual pension of some £100 until he died in 1621. Apart from occasional communication and summonses to the Tower, Harriot had little contact with his patron.

After 1605 he was, perhaps at last, able to “study freely”. In the ensuing decade his intellectual trajectory overlapped with Galileo’s and Kepler’s. Besides composing reams of ingenious mathematics, he investigated refraction both geometrically and experimentally. He became a convinced Copernican, toying with elliptical orbits. He preceded Galileo in turning telescopes upon the heavens.¹⁴⁸ And he developed an atomic theory of matter.

But only the intellectual trajectory overlapped with Galileo’s. Unlike Galileo, Harriot was barely a public figure. He published nothing. He kept his Copernicanism, atomism, and theories of light that depended upon the existence of a vacuum, as private as possible. Despite this, Kepler heard of it and initiated a correspondence, to which Harriot responded with inappropriate and uncourtly dullness. Whilst it may be true that historians have only begun to appreciate the scientific fertility of Harriot’s copious manuscripts, the fact also remains that Harriot exerted almost no national, let alone international influence upon the development of natural knowledge in the early seventeenth century. Patronage considerations suggest that Harriot’s marginality arose directly from the marginality of his patrons, tainted with charges of treason and heterodoxy and unwilling or unable to launch Harriot into international orbit. In short, the philosophical circle of the “wizard earl” seems to have been powerless as a counterweight to the largely utilitarian style of English patronage. Considered similar to the powerful patronage of ostentatious Italian and German princes, Northumberland’s support has been treated as exemplary of English patrons too. On our reading, Northumberland was neither powerful nor exemplary in his patronage of natural philosophy.

4. PATRONAGE, ASTRONOMY AND NATURAL PHILOSOPHY IN ELIZABETHAN ENGLAND: A CASE STUDY IN THE CONSEQUENCES OF UTILITARIANISM

Consideration of Harriot and his reputation as an English Copernican returns us to the issue of how the new astronomy fared in England. Unlike Lutherans or Catholics, Anglican clerics rarely condemned Copernicanism. Advocates as diverse as the puritan Thomas Digges and the sceptical William Gilbert suffered no public opposition. To be sure, the Reverend William Barlow, chaplain to the late Prince Henry, condemned Mark Ridley’s magnetic Copernicanism as irreligious, but only after provocation, and he admitted that he had refrained from making the same criticisms of Gilbert out of respect. Harriot’s reticence is best read as arising out of the more general rumours of his circle’s atheism and his weak position as a Northumberland client.¹⁴⁹

Yet Westman and Biagioli have demonstrated the centrality of court culture and patronage to the development of Copernicanism in particular and of physical astronomy in general, and the number of Englishmen among the early Copernicans shows that London was in principle a congenial location. Like other European courts, London’s was full of humanist enthusiasts for the *vita activa*, such as Gabriel Harvey, and these were dismissive of traditional learning and disciplinary constraints. And, as in Galileo’s milieu, London hosted a mathematical community that melded ex-university lecturers with practical mathematicians and curious patrons, all with

interests in a higher status for mathematics. London replicates in many respects the factors that stimulated the new discipline of physical astronomy elsewhere. Yet significant evidence exists that English patronage worked against it.

We have already reviewed the considerable evidence that patronly interests deflected Thomas Digges from his desired career as a realist astronomer. Dee developed an innovative cosmology even if, despite claims such as French's, he was almost certainly not a Copernican.¹⁵⁰ He certainly argued that mathematics had cosmological significance. He left England in order to find more expansive patronage.

Another mathematician and Copernican was Edward Wright. Wright revealed his Copernican sympathies in the "Laudatory Address" that he penned for William Gilbert's *De magnete* of 1600. Wright had been a mathematical scholar and Fellow of Gonville and Caius College, Cambridge from 1587 until 1596. We do not know whether Wright, like Gabriel Harvey, resented the intellectual limitations of Cambridge but in 1596 he accepted the offer of patronage from Cumberland. Despite his lack of experience, he entered Cumberland's service specifically to observe and advise on navigational practice during a raiding voyage to the Azores. The commission changed Wright's career. Moving to London, and perforce resigning his fellowship, he published exclusively on navigation, and rose to serve Prince Henry as mathematics tutor, navigation expert and (had the prince not died) Royal Librarian.

Wright's first publication was his famous *Certaine errors in navigation* of 1599, the outcome of his work for Cumberland and dedicated to him. In terms reminiscent of Digges, Wright recorded how it was through Cumberland that he "was first moved, and received maintenance to divert my mathematical studies, from a theoricall speculation in the Universitie, to the practical demonstration of the use of Navigation". In the preface he wrote that he had concentrated on navigation "neglecting other studies and courses that might have beene more beneficiall to me".¹⁵¹

It is not inconceivable that Wright saw his considerable involvement with Gilbert's *De magnete*, clearly a work of natural philosophy, as a means of establishing his intellectual credentials as a speculative as well as a practical mathematician. In his "address" he presented himself as a mathematician (like Galileo and Kepler) with things to say about the cosmos and Biblical exegesis. Whatever his intention, Wright's patronage opportunities destined him to remain an expert in navigation.

This brings us to England's third early Copernican, William Gilbert himself. Like the numerous physicians mentioned in this paper, Gilbert's rise to prominence as a London doctor depended upon noble patrons. They included Gilbert Talbot, Earl of Shrewsbury, Sir Francis Walsingham, Burghley and Robert Cecil. Such excellent court connections smoothed the path to his appointment as one of Elizabeth's physicians in 1601.¹⁵² Moreover, courtly patronage gave him the credibility, wealth, leisure and intellectual independence to publish his iconoclastic, anti-Aristotelian work of magnetic philosophy.

De magnete is a remarkable work of natural philosophy in many ways. It demonstrated that the Earth was a magnet, it did so experimentally, it drew out navigational applications, it argued that terrestrial magnetism rotated the Earth in Copernican

orbits, and it attacked Aristotelian natural philosophy. Given the conventions of Elizabethan publishing, it is also remarkable in having no dedication — there is only the address by Wright, Gilbert’s inferior. Whilst Gilbert made characteristically iconoclastic remarks about philosophical authors who sought to dignify derivative work by “going abegging for some patron”, it is reasonable to conclude that Gilbert could find no patron for his work of magnetic and Copernican philosophy.

Given England’s utilitarian patronage system, it could be that *De magnete* became the most remarkable and influential work of Elizabethan natural philosophy precisely because it bypassed the system. Of course, *De magnete* did not lack utility. As Edward Wright emphasised in his “address”, it offered solutions to the navigational problems of both latitude- and longitude-finding. But *De magnete* was primarily, like Gilbert’s “Nova physiologia” (unpublished until 1651), a natural philosophy of the Earth’s magnetic soul and motions, and their incompatibility with Aristotelian cosmology and theories of matter. With the exception of Northumberland, we have not encountered an *Elizabethan* patron who might have been interested in the work.¹⁵³

In the light of Digges’s, Dee’s and Wright’s careers, and of the patronless *De magnete*, we suggest that Elizabethan court culture differed from the well-studied cultures of Florence, Prague, Hesse-Cassel, the Copenhagen of Tycho, and Tycho’s Uraniborg itself. With the exception of the marginal Northumberland, English patrons discouraged clients from exploring the integration of mathematics and natural philosophy into a new discipline of physical astronomy.

This is not to say that Elizabethan patronage was conservative. The high and exclusive value placed by noble patrons upon the utility of the mathematical and mechanical arts was surely a major factor in the creation of a large, vibrant, self-confident community. As Bennett has shown, that community matured to make its own claims about the relevance to natural philosophy of its aims and practices.¹⁵⁴ But English court culture did not, of itself, encourage the synthesis of mathematics and natural philosophy that existing patronage studies can suggest was the normal outcome.

5. PATRONAGE UNDER JAMES VI AND I

We noted above that James’s accession in 1603 considerably changed the nature of patronage. He brought in his own entourage at the expense of many Elizabethan clients, increased the amount of patronage, centralized it, established satellite courts for his wife and son, and set a more splendid and scholarly tone. The expansion of commercial publishing, lecturing and instrument making, of the ‘medical marketplace’, and of the concomitant role of ‘the public’ as patron, continued to reduce the role of the genuine patron-cum-dedicattee. Gresham College, finally founded in 1597 but only now hitting its stride, provided a new institutional focus. Our research on Jacobean patronage is at an earlier stage than for Elizabethan, but it seems clear that these changes provided different opportunities for client makers of natural knowledge.

As James VI of Scotland, the new James I of England arrived with considerable experience as a royal patron. There has been surprisingly little work on this earlier

patronage context, and even less that gives an insight into the attitude of James and his court to natural knowledge.¹⁵⁵

The young James was educated in Latin and Greek literature by George Buchanan and Peter Young. When leisure permitted, he also studied “arithmetic and cosmography”.¹⁵⁶ James’s rejection of Buchanan, especially his Protestant resistance theory of government, did not extend to astronomy. His *Daemonologie* declared it to be “most necessary and commendable”.¹⁵⁷ Astrology, certainly judicial astrology, was a different matter, as Harriot and Northumberland discovered.

Nevertheless, James’s Scottish court had patronized several influential defenders of astrology. Williamson has shown how magic, mathematics and prophecy “visibly flourished” in Edinburgh and James’s court itself.¹⁵⁸ Three leading clients in this movement were Robert Pont, a supporter of astrology, James Maxwell and John Napier. Napier, an affluent gentleman of Merchiston, is famous for his works on logarithms of 1614 and 1617, but he was already known, even in Denmark, as a mathematician (and devotee of astrology) in the early 1590s. Likewise, numerology was prominent in his friend Pont’s 1599 *Newe treatise of the right reckoning of yeares, and ages of the world*.¹⁵⁹

These scholars combined their interpretations with the long-standing Scottish belief in their ancient Egyptian ancestry. Hector Boece’s *Scotorum historiae* of 1527, for example, argued that hieroglyphic was the original Scottish script.¹⁶⁰ Thus, whilst much of Frances Yates’s so-called “Hermetic magic” of the late Renaissance has had to be reclassified as a more mainstream occultism, the real thing existed under James. Hermeticism combined with proto-freemasonry, architectural symbolism and especially the art of memory. One exponent was William Schaw, appointed Master of the Work and Warden General in 1583. Schaw, who was commissioned to reform Scottish masonry, held that Hermes “had played a major part in preserving the knowledge of the mason craft and transmitting it to mankind after the flood”. His statutes emphasized possession of “the art of memorie and the science thairof”.¹⁶¹ His idea of the art drew on Alexander Dickson, another court favourite once he renounced Catholicism and spying. His *De memoriae virtute* (1583) set the classical art of memory in a Hermetic Egyptian context “much more openly than Bruno had done”. Bruno honoured Dickson by making him an interlocutor in his dialogues. Dickson’s acquaintance, William Fowler, was another expert in the art of memory whose manuscripts include a treatise on it and a record of “teaching your maiestie the arte of me[m]orie”.¹⁶²

Although James changed his views on subjects such as witchcraft once in England, the Edinburgh ideology of Hermetic mysticism in the service of Reformed apologetics may go some way to explaining James’s later patronage and defence of Robert Fludd. Fludd dedicated several works to James, including the first volume of his *Utriusque cosmi* of 1617, in which James is accorded the Hermetic epithet “Ter Maximus”, and saluted as “the most potent and wise prince in the world”.¹⁶³

We know of no evidence that James endorsed the details of Fludd’s occult natural philosophy. As Biagioli reminds us, princes generally distanced themselves from

the contentious epistemological or ontological claims of their clients. It is worth remembering that it was James's other high-profile client-scholar Casaubon who exposed the pseudo-antiquity of the Hermetic corpus in his (admittedly little-read) *De rebus sacris et ecclesiasticis* of 1614.¹⁶⁴ It is safer to assume that James saw Fludd, like Casaubon, as part of his eirenic religious programme to find common ground between the confessions.¹⁶⁵

James was personally committed to Paracelsian or chemical medicine. This too probably originated in his Scottish court: many Protestants saw Paracelsism as a more godly and even a more ancient alternative to Galenism's "heathen" origins. John Craig, who became James's royal physician, seems to have been acquainted with chemical medicine before he (and Schaw) accompanied James on his visit to Denmark in 1589, made to bring his wife Anna back to Scotland.¹⁶⁶

The big impression made by Frederick II's and Sophia's lively court coupled with Anna's typically Danish expectation that she would influence the culture of James's own circle, probably deepened his interest in chemical medicine. The Copenhagen court, where James lingered well into 1590, was famous for its ostentatious patronage of natural knowledge, especially Paracelsism.

James and Anna actively advanced Paracelsian chemical medicine and philosophy in England. When James arrived with Craig as his physician, he insisted that the College of Physicians alter its statutes concerning foreigners in order to admit him. He intervened personally to protect heterodox and "unlearned" practitioners such as Leonard Poe and Francis Anthony. He and Anna also invited to court the Huguenot chemical physician Theodore Turquet de Mayerne when he, like Casaubon, needed sanctuary after the assassination of Henri IV. He found it as the personal physician first to Anna, and subsequently to James, Henry, and Charles. James also sanctioned his leading role in the desperate attempts to cure Prince Henry.¹⁶⁷

Jacobean court patronage seems, then, to have been a significant factor in the development of 'English Paracelsianism' in the face of opposition from the College of Physicians. It is important to recall Webster's correction of Debus's thesis: English Paracelsians included not only pragmatic empirics from the lower rungs of the medical hierarchy, but also men with sophisticated natural philosophies that drew on alchemical principles.¹⁶⁸ Further research must establish the full extent to which chemical philosophy in Jacobean England depended, as it did in Marburg and Copenhagen, upon the opportunities for disciplinary innovation provided by court culture.

There is also evidence that the Scottish court was influenced by Frederick II's interests in alchemy, astrology and astronomy. He and Sophia supported Tycho's extraordinary work at Uraniborg.¹⁶⁹ In fact, James had a personal interest in Brahe even before he visited Denmark. Stewart notes that both of James's tutors were correspondents of Tycho. Tycho sent Buchanan a copy of his *De stella nova* when he learned that Buchanan was writing a poem on the new star. Young met Brahe during an ambassadorial visit in 1586, and sent Brahe a portrait of Buchanan. Brahe recorded James's pleasure at seeing it in his library when the men met in 1589–90.¹⁷⁰

This background makes less surprising Johann Kepler's dedication of *Harmonice*

mundi to James in 1619. Kepler recalled that James “as a youth considered the astronomy of Tycho Brahe, upon which my work rests, worthy of his intellect”. But, as in all James’s intellectual patronage, religion was more important than science. James’s international fame as an irenicist and philosopher-king took off with the controversy over his Oath of Allegiance of 1606, which aimed to separate loyal Catholic subjects who rejected the Pope’s supreme temporal authority from hardliners. Since his own faith was neither Lutheran nor Calvinist enough to be acceptable to either confession, Kepler enjoyed the eclectic culture of Rudolph’s court, and he was drawn both to James’s religion and his learning. Kepler sent James a copy of his *De stella in pede Serpentarii* from Prague in 1607. His accompanying letter asked God to help James bring about “the pacification and improvement of the church reborn under most difficult circumstances” as well as to ensure that he would “never feel compelled to abandon philosophy because of excessive business”. In 1619, when James was helping to reconcile the forces of the Bohemian Protestants and Austrian Hapsburgs, Kepler hoped that his work on *celestial* harmony would appeal to a king seeking “harmony and unity in the ecclesiastical and political spheres”. However, he declined overtures to move to Britain.¹⁷¹

One international star who was persuaded to move was Isaac Casaubon. On his arrival in 1610 he was considered the world’s leading humanist scholar after Joseph Scaliger. The Jacobean court did not, of course, want Casaubon for his (limited) knowledge of natural philosophy.¹⁷² We noted above that James’s cultivation of Casaubon began in Scotland, in 1601. At that time Casaubon had moved from Geneva, via Montpellier, to Paris, where Henri IV had promised, but not delivered, a well-paid professorship. Throughout his Paris years, Casaubon’s extraordinary national and international value as a client rested in his ambiguous confessional status. A Calvinist, he was developing a position very close to James’s and which became that of the Laudian high church. This was that the patristic tradition offered a safe middle ground between the Catholic claim to have safeguarded the traditions of the church, and the radical Protestants’ rejection of all but the very early church. Europe held its breath as the Greek scholar studied the works of the Church Fathers. In Paris he was frustrated by his inability to publish freely, tired of meeting the Catholic *convertisseurs*, and rightly alarmed by Jesuit-fuelled fanaticism. When Henri IV was assassinated, he accepted Archbishop Bancroft’s offer, brokered by his one-time lodger Henry Wotton, of a position at James’s court, and joined the king’s numerous theologians and controversialists who promoted Anglicanism as the true church. James’s letter patent appealed to a somewhat invented tradition: “As our progenitors have heretofore been carefull to call into their realm persons of eminent learning, so have wee ... invited [Casaubon] out of France into this our realme.”¹⁷³

In 1601 he had flattered James VI as a philosopher-king “such as Plato had imagined but never seen”. The reality was different. True, he had cursed Henri IV for receiving a volume of his like “one who is absolutely illiterate”, and he was pleasantly surprised by James’s ability to offer opinions on classical texts. Often starved of books in the past, he also appreciated the newly opened Bodleian Library, the large stipends of

Oxford Fellows and their freedom to do more than teaching. But he soon found that Scaliger had been right when he had warned: “I could tell you much of the English, what a disagreeable people they are, inhospitable to foreigners.... Do not precipitate the event. Wait till you are called; do not offer yourself, and sell your venture at as high a price as you can.” What most disillusioned Casaubon was the preoccupation of James and his learned circle with theological disputation, and the incessant pressure to publish religious apologetics. James frequently summoned him to stand at his dinner table and even to attend at his country hunting lodges to pursue the issues.¹⁷⁴

In his constant complaints about his lack of *otium* for disinterested study Casaubon was surely naïve.¹⁷⁵ As in France, it was his propaganda value that gained him royal patronage. The Jacobean court clearly saw Casaubon as employed in *negotium*, affairs of state of the highest religio-political order. As Hugo Grotius, another learned foreign visitor to James’s court, put it in 1613: “I come from England where there is little commerce of letters; theologians are there reigning authorities. Casaubon is the only exception; and he could have found no place in England as a man of learning; he was compelled to assume the theologian.” Mark Pattison, Casaubon’s Victorian biographer, lamented that “it is disappointing, when we come to look narrowly into the transaction, that this solitary instance of disinterested patronage of learning is no instance at all. Then, greek scholarship, however eminent, was not a commodity for which king, bishops or parliament of England would have paid £300”.¹⁷⁶ Casaubon himself advised a friend, who wanted him to broker a position, “It is not the manner of the English to import distinguished men of learning from other countries”. Even the homegrown scholar and friend of Prince Henry, Sir John Harington, was advised by the Earl of Suffolk that philological skills “are not things that men live by now a days”.¹⁷⁷

The pervasiveness of James’s religio-political agenda in most if not all of his intellectual patronage should caution us against making too great a contrast with the Elizabethan court. Nevertheless, Jacobean England offered some expansion from the relentless utilitarianism that earlier clients had met with. James’s and Anna’s interest in and support for Hermetic philosophers, chemical physicians, eminent classical scholars and new astronomers shows that Jacobean patronage was more intellectually adventurous, even ostentatious, than the Elizabethan norm.

The evolution of utilitarianism to include natural philosophy is also detectable in the satellite court of Prince Henry, where some of the clients were survivors from Elizabeth’s era. James and Anna appointed members of the prince’s household who would fashion him in the image of a sophisticated, learned prince poised to succeed James as a leader of Protestant Europe. His premature death in 1612, aged 18, was treated as a national catastrophe. In evocation of the earlier Henry, and in marked contrast to Elizabeth, the Henrician entourage spearheaded the patronage and collection of art, architectural work, the accumulation of a royal library of thousands of volumes — and the support of natural knowledge.

Prince Henry was provided with trusted, able tutors who were familiar with the learned noble academies that flourished in Italian states. Henry was, briefly, the

most elevated pupil in what Roy Strong has called a “small academy of aristocratic youths”, including Sir John Harington,¹⁷⁸ and what James himself called “a courtly college”.¹⁷⁹

But Henry’s court also became a centre for learning and research in science and exploration, and especially in navigation. In many ways, however, the activity remained quite Elizabethan or Cecilian in its utilitarianism. Given that it seems to have been co-ordinated by Thomas Chaloner, that is not surprising. Chaloner had received his Oxford education as a client of Burghley. He had a reputation as “an ardent natural philosopher”,¹⁸⁰ but was also a good mathematician, who tutored Robert Dudley, son of the Earl of Leicester, in mathematics at Oxford. In Cecilian style, Chaloner enriched himself by opening England’s first alum mine in Yorkshire in 1600, and profited from James’s subsequent prohibition of imported alum. As Elizabeth’s reign came to an end, Robert Cecil sent him to Scotland, where he gained James’s favour.¹⁸¹ Chaloner was appointed Henry’s tutor in 1603, and became the governor of his household.

Chaloner’s precise involvement with the Henrician programmes of natural knowledge remains unclear.¹⁸² He certainly continued Burghley’s projection policy, and “the scheme of M. Villeforest to extract silver from lead was entrusted by [Prince Henry] to Chaloner and Sir William Godolphin for trial”.¹⁸³ He may also have recruited William Barlow as the Prince’s chaplain. Whilst Barlow was ordained, he was better known as a navigation expert, who had published his *Navigators supply* in 1597, dedicated to the Earl of Essex, and who had discussed magnetism with William Gilbert.

Barlow’s duties certainly included continued research on Gilbert’s magnetic philosophy and navigation. He dedicated his 1609 manuscript on it to Chaloner, which formed the basis of his *Magneticall advertisements*, only published in 1616 after Henry’s court (and his position) was dissolved.

Another key member of Henry’s circle was Edward Wright, who moved from *ad hoc* lecturing and would have “become the Prince’s librarian had the tragic events of 1612 not taken place”.¹⁸⁴ Wright too was employed to further navigation, including the principles of magnetic navigation that he had worked on with Gilbert. These were significant additions to the second edition of his *Certaine errors*, published in 1610 and dedicated to Henry. Wright and others also advised explorers such as Hudson and Baffin, whose voyages were backed by members of Henry’s household. Thomas Lydiat was the Prince’s cosmographer, and Humphrey Cole advised on geography.

Thus, while the activity remained predominantly utilitarian, there were significant differences. Clients like Wright, Barlow and Lydiat now had stable positions at court. They formed the nucleus of a group of practitioners. And whilst it would not be true to say that Gilbert’s magnetic philosophy formed a major interest, Henry’s navigation experts were encouraged to explore this theoretically coherent, causal body of knowledge. Indeed, it was the English works of Wright, Barlow, and their acquaintance Mark Ridley who publicized *De magnete* to a non-Latinate audience, and who defended it from the attacks of Antony Linton and (his likely source) Guillaume de Nautonnier.

The Jacobean court even enjoyed ostentatiousness. The Dutchman Cornelis Drebbel fed the royal appetite for entertaining wonders, pyrotechnics, and the ‘arts mathematicall’, inventing among other things, a *perpetuum mobile* or automatic musical instrument made to play by the rays of the Sun, and a telescope. Drebbel was a client of both James and Prince Henry, until he attracted the attention of Rudolph II’s court in Prague and was permitted to go there in 1610. When Rudolph was deposed in 1612, Drebbel was imprisoned but freed at the request of Henry and, when Henry died also in 1612, James renewed his patronage.¹⁸⁵

Thus James went some way to putting Whitehall back on the European map as a centre of intellectual innovation, even if it was not learned enough to keep Casaubon happy or prestigious enough to lure Kepler away from Prague. He supported William Harvey, discoverer of the circulation of the blood, by making him a royal physician. Harvey’s *De motu cordis* was published outside the period of this study, in 1628, and dedicated to Charles I, although he arrived at his conclusions in the late 1610s. The work is a classic example of ostentatious natural knowledge so rarely patronized in Elizabethan England. His discovery and conclusions were novel contributions to the natural philosophy and anatomy of animals. They seemed to threaten traditional doctrine. There were no clear medical benefits. Above all Harvey crafted his physiology into an ostentatious Galileo-style emblem of the patronage relations that supported it — he analogised the blood circulating from a central heart to the body politic revolving around the vivifying monarch.¹⁸⁶

Much work remains to be done, especially upon significant Stuart patrons such as the Earl of Arundel.¹⁸⁷ Nevertheless, we think that we have established a *prima facie* case for a significant difference in style between Elizabethan and Jacobean patronage of natural knowledge.

6. FRANCIS BACON AND PATRONAGE POLICY IN EARLY MODERN ENGLAND

We have left to the end the man who was historically the most influential Jacobean writer on natural knowledge, Francis Bacon. He published his first programme for the reform of natural knowledge, *The advancement of learning*, and dedicated it to James I within two years of his accession in 1603.¹⁸⁸ It was a play for patronage (indeed, a wordplay on ‘advancement’), and Bacon bolstered his cause by presenting copies to leading courtiers such as Robert Cecil (now Chancellor of Cambridge University) and Lord Buckhurst (Cecil’s Oxford counterpart).¹⁸⁹ He made occasional attempts to gain support while active in James’s administration, but used his *Novum organum* (also dedicated to James, together with a private address to James)¹⁹⁰ and other parts of *Great instauration* as a ploy to regain favour after his dismissal from court for corruption in 1620.

Bacon’s project therefore seems ripe for analysis using patronage theory. In this regard, Julian Martin and John Leary have already produced valuable reassessments of Bacon’s project.¹⁹¹ They read it as the product of a lifelong court politician formed in the Elizabethan period and wielding power under James’s centralizing regime. For example, they point out how incongruous it is to interpret Bacon’s vision of natural

philosophy as free, open-ended enquiry, when Bacon (and his masters) feared the destabilizing potential to the state of free thinking, in natural philosophy as much as in religion. Conversely, they read Bacon's vision as a rigorous, hierarchical state programme. Individual investigators play strictly defined roles as they cooperate to produce knowledge of nature and applications that are primarily of use to the state or commonwealth. Gaukroger's recent analysis agrees that Bacon's project, which was well developed by 1592, was to bring natural philosophy within the orbit of *negotium*, and to refashion natural philosophers as civil servants.¹⁹²

This persuasive reading suggests that Bacon's project was born out of, if not tailor-made for, English courtly values. If so, then two questions arise. First, to what extent did Bacon draw upon his first-hand knowledge of court patronage of natural knowledge in formulating his vision? Secondly, why did his own efforts to gain James's support for it meet with such little success?

We have just begun to explore these questions. It is worth remembering that Bacon's career took off with the patronage of Essex but he also had some support from his uncle, Burghley, continued by Robert Cecil, and that he acquired the skills of administration in a fundamentally Cecilian regime.¹⁹³ His father had been Burghley's fellow Athenian, and Sir Thomas Gresham was his kinsman. Francis would certainly have been familiar with any Elizabethan patronage policy concerning natural knowledge. For James he controlled the economic system of monopoly patents that Burghley had set up.

Clearly, several elements of Bacon's 'reforms' reflect the utilitarian culture that dominated Elizabethan patronage. Consider, for example, Bacon's concern with 'the commonwealth', a concept often appealed to by client-practitioners. The first purpose of natural philosophy was to improve the material condition of the monarch's realm, through better health, living conditions and the availability of commodities. Its other purpose, of systematic knowledge of the causes of things, could wait its moment. As Martin and Leary have shown, Bacon's emphasis upon the humane purpose was grounded in sound politics. Those owed much to the commonwealth ideology forged in his father's England.

Then there is Bacon's positive evaluation of the practical arts, especially the mechanical arts. It is the progress made by inventors and practical producers that gives hope that nature can be dominated and the commonwealth given what it needs to be secure. This certainly was Burghley's policy. As Harkness has observed, London provided Bacon with concrete inspiration. Whilst a law student he had lived a "stone's throw from the St Clement – St Dunstan instrument-making neighbourhood ... Bacon did not need to actually dream up the displays of ingenuity and inventiveness that he describes [in the *New Atlantis*]"¹⁹⁴ What Bacon hoped to supply was a rational method that would link a flourishing community of practitioners with productive philosophy.

Gaukroger suggests that we read Bacon's famous maxim that "truth and utility are the very same thing" in Machiavellian, not Platonic terms.¹⁹⁵ As such it reflects the pragmatic operationalism that seems to have guided Elizabethan patrons. Useful

results, not spectacular theories, were the returns that they wanted from their practitioners.

There are grounds, then, for thinking of Bacon as a perceptive and ambitious codifier of a specifically Elizabethan patronage culture, a culture that eschewed ostentatious natural philosophy for a utilitarian mastery of nature. Bacon added two crucial dimensions. First, he proposed a method or procedure. The method would eliminate the trial-and-error nature of Elizabethan practice, of both the makers of true natural knowledge, who often lacked learning, and the state patrons, who were also unsystematic and reactive in the work they commissioned. Secondly, via the method, he reconnected the utilitarian aims of the Elizabethan system to the neglected natural philosophical aim of causal knowledge.

Little systematic research has been conducted into the reception of Bacon's programme in his own milieu of the Jacobean court. From what has been done, it is almost impossible to find a positive *domestic* reaction to Bacon's reforms. As Jardine and Stewart show, Bacon's most admiring correspondent was Tobie Matthew, the exiled and recusant son of an archbishop, whom Bacon had helped to get released from prison. Another admirer was Casaubon, who read *The advancement of learning* in Paris to improve his English, perhaps as preparation for exile in London. Bacon's Latin reply hints at his domestic frustrations:

You are right in supposing that my great desire is to draw the sciences out of their hiding-places into the light.... How great an enterprise in this kind I am attempting, and with what small helps, you will perhaps learn hereafter.¹⁹⁶

The helps were indeed small. James described the *New organon* as "like the peace of God, that passeth all understanding", and John Chamberlain reported Henry Cuffes's judgement that "a fool could not have written such a work, and a wise man would not". Harvey, physician to both James and Bacon himself, dismissed his work as philosophy written "like a Lord Chancellor", which Gaukroger takes to mean a criticism of Bacon's faith in expert systems.¹⁹⁷ His friend Thomas Bodley read and criticised *Cogitata et visa*, "entirely failing to comprehend the sweeping nature of Bacon's altered vision" and insisting upon the adequacy of tradition.¹⁹⁸

There are, of course, many reasons why James's court would not have patronized Bacon's revolution. Leaving aside philosophical arguments about the impossibility (or, to James, incomprehensibility) of a "Baconian method", the universities would have been as resistant as Bodley, Oxford's benefactor. Bacon, who would have headed any reform, was a disagreeable and controversial figure. The problems of funding and organization were beyond the Jacobean government and, suggests Gaukroger, Bacon himself.¹⁹⁹ The payback, in terms of "experiments of fruit" and enhanced stability, was most uncertain in such a long-term project, even if, as Bacon pleaded, James's support would have been worth one hundred years of work.²⁰⁰

All are weighty explanations, but we would like to suggest one other. If we are right to see Bacon's utilitarian plans as Elizabethan in inspiration, and if James did preside over a change of patronage culture, then it may be that *The great instauration* now

seemed inappropriate — too utilitarian, perhaps, or incapable of delivering results instantly enough to glorify a munificent, ostentatious but needy prince.

Whatever the reason, Baconianism flourished only after James's and Bacon's deaths in 1625 and 1626 respectively. 1626 is when Webster begins his study of the Puritan and anti-Stuart Baconian instauration attempted by Hartlib and others. Bacon the client-philosopher was eventually joined with a Stuart patron of natural knowledge — with Charles II on the frontispiece of Thomas Sprat's *History of the Royal Society* of 1667.²⁰¹

7. CONCLUSION: PATRONAGE, CONNECTIVITY AND SELF-FASHIONING — AN HYPOTHESIS

There is some evidence that Jacobean patronage of natural knowledge added to Elizabethan utilitarianism some of the cultural diversity and ostentation exhibited in the canonical courts of patronage studies. There were a few more opportunities for some clients to engage in disciplinary innovation and new natural philosophy. But the impression remains of a comparatively limited network under the control of key political patrons. This provisional conclusion returns us to a consideration of connectivity and self-fashioning.

For almost every form of our earlier classifications of patronage types and interests, the evidence suggests that English clients were poorly connected to diverse sources of patronage. First, and most obviously, England was geographically disconnected as an offshore island. Secondly, living in a politically independent Anglican state, clients could not seek the splendid patronage of imperial courts or the Catholic church without facing exile or worse. The Church of England's patronage was no match for that of Rome, and connections with Continental centres of Protestant intellectual endeavour were relatively weak. Moreover, Anglican patronage was under political control, effectively collapsing it into a branch of state patronage rather than an alternative, as it was for Aldrovandi. So far, we have found scant evidence that the Anglican episcopacy patronized natural knowledge.²⁰²

England's position as a centralizing nation state with imperial and colonial ambitions also reduced connectivity. Outside Oxbridge, only London hosted significant communities of natural knowledge makers. These were primarily mathematical and mechanical practitioners and medical men. At this time there were no other regional centres with grand patrons, colleges, informal humanist academies, or circles of physicians and practitioners of the arts, as there were in Italy, Germany and, as David Lux has shown for a later period, France. Moreover, court patrons generally directed clients to suitably utilitarian projects, and there were no successful 'oppositional' court subcultures. Moreover, London differed from the classic sites of court culture in having no university. Some scholars have coined the term 'London science', although Feingold insists that it was more closely connected to the universities than they, and perhaps we, believe.²⁰³

Patronage scholars conclude that innovation was stimulated by the geographical proximity (a fundamental form of connectivity) of different sites, personnel and

practices. The contiguity of university, dockyard and aristocratic households created this for Galileo in Venice, just as the university, pharmacy, botanical garden, senatorial and ecclesiastical networks provided it for Aldrovandi in Bologna. Both men moved effortlessly between the sites, fashioning new identities for themselves and acquiring status for new practices in natural knowledge — a process that Biagioli calls *bricolage*.²⁰⁴

It is much less obvious how English clients could creatively combine such roles or actively fashion high status identities. To be sure, the gentlemanly Inns of Court were called, even by contemporaries, England's "third university", but we have not found evidence that its institutional sociability promoted natural knowledge.²⁰⁵ Sir Thomas Gresham's college flourished in the early seventeenth century but its professors of astronomy and geometry were required to meet the utilitarian interests in practical mathematics of London's mercantile and maritime communities.²⁰⁶ The new 'patron' of the book-buying public seems to have been similarly interested in practical self-help manuals, not natural philosophy.

This leaves Oxford and Cambridge universities. The role of the universities in promoting new, more humanistic, courtly and useful natural knowledge has recently become a matter of debate. Set against the conservative picture drawn from an institutional, statutory perspective by Costello, historians such as Feingold and Cormack have pointed to the existence of an informal network of mathematics tutors, whose expertise mediated between the formal curriculum and new interests in practical mathematics. They rightly point to the university background of many of the London- and court-based innovators, and the range of contemporary instruction they acquired there. Feingold also reminds us of the presence within the universities of influential innovators such as Henry Savile, Thomas Allen and Henry Briggs, and of their membership of national and international circles, corresponding with European savants and aware of home-grown talents such as Harriot.²⁰⁷

Such work yields two salutary lessons for a study of patronage such as this. First, contrasts between England's university institutions and London must not be overdrawn. As this study confirms, universities were also permeated by networks of patronage centred on London. Burghley's many interventions confirm that there is less difference between court and Oxbridge culture than we once thought, just as its intellectual culture was more dynamic and open. Secondly, considerable and detailed research is needed to uncover informal communities whose interests defy a simple dichotomy between 'traditional' and 'innovative' work. Our preliminary findings may well be challenged by more fine-grained archival research, following up the patronage links and circles mentioned by Feingold and Cormack, and exploring connections with 'London science'.

Nevertheless, at this stage we hypothesize a greater divide between university and court culture in England than elsewhere in Europe, and than is portrayed by Feingold's revisionism. For example, it was difficult for clients to combine the roles of university professor with service to courtiers and merchants and with intimacy with sites of practice such as the Deptford dockyards or city instrument-making shops. If

humanists like Gabriel Harvey exaggerated the gulf between the *vita contemplativa* of Cambridge and the *vita activa* in London, colleges guarded their autonomous traditions and practices. This, and institutional inertia, gave patrons like Burghley less direct influence over the kind of knowledge pursued there than they had over their personal clients. Men like Edward Wright and Thomas Harriot were effectively forced to choose, as their Continental peers rarely had to, between the residences and roles of professor and courtier. And whilst Oxford and Cambridge provided a more fertile preparation than was once thought, alumni such as Gilbert and Bacon seem to have found material opportunities to develop and influence intellectual, practical and disciplinary innovation once they had left, both physically and spiritually.

We conclude, then, that English practitioners, perhaps uniquely, lacked the rich and various patronage connections of many European counterparts. Consequently, they were more dependent upon a small group of courtier politicians whose concerns, especially under Elizabeth, were uniform and utilitarian. In consequence, opportunities for self-fashioning were limited. Whilst relatively humble men were able to raise their status and that of the arts they practised, others with aspirations to become innovative natural philosophers were baulked. To repeat, we do not say that early modern English patronage did not support innovation. It was crucial to the consolidation of England as a military and economic power on the world stage and, we suggest, to the growing, confident contributions of empirical practitioners. But our studies thus far suggest that England's utilitarian patronage culture had no need of natural philosophers. This background may offer an explanation of the 'Baconian' character of the emerging 'new philosophy' later in the century.

ACKNOWLEDGEMENTS

We wish to acknowledge gratefully the award of small research grants from both the University of Lancaster and the Department of History, University of Lancaster, which made possible much of the pilot research in this article, and also the AHRB, which is now funding a three-year project. We also thank Gordon Batho, Tom Dixon, Richard Dutton, Alison Findlay, Penelope Gouk, Peter Harman, Paolo Palladino, Maurice Slawinski, Richard Wilson, other members of Lancaster University's Patronage Studies Group, and the editor and referees of *History of science* for their comments on earlier versions of this article.

REFERENCES

Where manuscript folio numbers are given, they have been consulted. Where a manuscript is referred to in the form (for example), BL MS Lansdowne 64.34, the reference is to an item number and description in the index.

1. Exemplary work on France includes David Lux, *Patronage and royal science in seventeenth century France: The Académie de Physique in Caen* (New York, 1989). See also Joel Shackelford, "Paracelsianism and patronage in early modern Denmark", in Bruce T. Moran (ed.), *Patronage and institutions: Science, technology and medicine at the European court, 1500–1750* (Woodbridge, 1991); Pamela H. Smith, *The business of alchemy: Science and culture in the Holy Roman*

- Empire* (Princeton, 1994); and R. W. J. Evans, *Rudolf II and his world: A study in intellectual history* (Oxford, 1972).
2. There is an extensive literature on patronage other than of natural knowledge. The most influential for this study includes: Stephen Greenblatt, *Renaissance self-fashioning from More to Shakespeare* (Chicago, 1980); Robert C. Evans, *Ben Jonson and the poetics of patronage* (London, 1989); Linda Levy-Peck, *Court patronage and corruption in early Stuart England* (London, 1993); Iain Fenlon, *Music and patronage in sixteenth century Mantua* (Cambridge, 1982); Rona Goffen, *Piety and patronage in Renaissance Venice: Bellini, Titian, and the Franciscans* (New Haven, 1986); Pauline Croft (ed.), *Patronage, culture and power: The early Cecils* (London, 2002); Bram Kempers (transl. by Beverley Jackson), *Painting, power and patronage: The rise of the professional artist in the Italian Renaissance* (London, 1992); Guy Fitch Lytle and Stephen Orgel, *Patronage in the Renaissance* (Princeton, 1991); Eleanor Rosenberg, *Leicester: Patron of letters* (New York, 1976); Graham Parry, *The golden age restor'd: The culture of the Stuart court, 1603–1642* (Manchester, 1981); Jonathan P. Wainwright, *Musical patronage in seventeenth-century England: Christopher, first baron Hatton (1605–1670)* (Aldershot, 1997); Rosemary O'Day, *The English clergy: The emergence and consolidation of a profession, 1558–1642* (Leicester, 1979); Claire Cross (ed.), *Patronage and recruitment in the Tudor and early Stuart church* (York, 1996); Natalie Zemon-Davis, *The gift in sixteenth century France* (Oxford, 2000); and Paul Whitefield White and Suzanne R Westman (eds), *Shakespeare and theatrical patronage in early modern England* (Cambridge, 2002).
 3. See Section 2 below. David Freedberg, *The eye of the lynx: Galileo, his friends, and the beginning of modern natural history* (Chicago, 2002). For Tycho see Victor Thoren, *The Lord of Uraniborg* (Cambridge, 1990), and John Robert Christianson, *On Tycho's island: Tycho Brahe and his assistants, 1570–1601* (Cambridge, 2000). For Westman, see ref. 22; for Biagioli and Findlen, see ref. 4; for Moran, see ref. 1.
 4. Nicholas Clulee, *John Dee's natural philosophy: Between science and religion* (London, 1988); Peter J. French, *John Dee: The world of an Elizabethan magus* (London, 1972); Geoffrey Keynes, *The life of William Harvey* (Oxford, 1966), the fullest recent biography; Max Caspar (transl. by C. Doris Hellman), *Kepler* (London, 1959); Pietro Redondi (transl. by Raymond Rosenthal), *Galileo heretic* (Princeton, 1987); and Mario Biagioli, *Galileo, courtier: The practice of science in the culture of absolutism* (Chicago, 1993). For della Porta see Paula Findlen, *Possessing nature: Museums, collecting and scientific culture in early modern Italy* (Berkeley, 1994), and William Eamon, *Science and the secrets of nature: Books of secrets in medieval and early modern culture* (Princeton, 1994), chap. 6.
 5. The picture of conservative stasis painted in W. T. Costello, *The scholastic curriculum at early seventeenth-century Cambridge* (Cambridge, Mass., 1958) has been refuted, notably by Mordechai Feingold, *The mathematicians' apprenticeship: Science, universities and society in England, 1560–1640* (Cambridge, 1984), and, for a later period, by Barbara Shapiro, "The universities and science in seventeenth-century England", *Journal of British studies*, x (1971), 47–82. The issue is discussed in Section 6 below.
 6. Allen Debus, *The English Paracelsians* (New York, 1966); Frances Dawbarn, "Conflict in early modern London: The College of Physicians and courtly patronage", Ph.D. dissertation, Lancaster University, 2000; and Margaret Pelling, *Medical conflicts in early modern London: Patronage, physicians, and irregular practitioners 1550–1640* (Oxford, 2003).
 7. Francis Ames-Lewis, *Sir Thomas Gresham and Gresham College: Studies in the intellectual history of London in the sixteenth and seventeenth centuries* (Aldershot, 1999), and Humphrey Gilbert "The erection of an Academy in London for the education of her Majesties Wards and others the youth of nobility and gentlemen", BL MS. Lansdowne 98, ff. 2–9. See also Sir Humphrey Gilbert, *Queen Elizabeth's Academy* (ed. by F. J. Furnivall) (London, 1869).

8. Lesley B. Cormack, *Charting an empire: Geography at the English universities, 1580–1620* (Chicago, 1997); Feingold, *op. cit.* (ref. 5); Stephen Johnston, “Mathematical practitioners and instruments in Elizabethan England”, *Annals of science*, xlviii (1991), 319–433; J. A. Bennett, “The mechanics’ philosophy and the mechanical philosophy”, *History of science*, xxiv (1986), 1–27; J. A. Bennett, “Geometry and surveying in early seventeenth-century England”, *Annals of science*, xlviii (1991), 345–54; and A. J. Turner, “Mathematical instruments and the education of gentlemen”, *Annals of science*, xxx (1973), 51–88.
9. Johnston, *op. cit.* (ref. 8), 243.
10. Eamon, *op. cit.* (ref. 4), 223, emphasis supplied.
11. Eamon, *op. cit.* (ref. 4), 222.
12. Biagioli, *Galileo, courtier* (ref. 4), 267–311.
13. Findlen, *Possessing nature* (ref. 4), 227–30.
14. Cosimo’s support of Galileo’s Copernicanism signalled cultural but not *de facto* independence from Rome. One might suggest that when Aldrovandi’s natural historical collections outgrew the flora and fauna of Northern Italy, he could promise possession only of an abstract, systematized nature. As political possessors of vast territories of equally vast biodiversity, the Spanish or Austrian Hapsburgs became more appropriate patrons.
15. Owen Hannaway, *The chemists and the word* (London, 1975).
16. Bruce T. Moran, “Patronage”, in Wilbur Applebaum (ed.), *Encyclopedia of the Scientific Revolution* (New York, 2000), 484–8, p. 485.
17. For music, see Penelope Gouk, *Music, science and natural philosophy in seventeenth-century England* (Yale, 1999), and Gaukroger, *op. cit.* (ref. 70).
18. An English example of an ostentatious instrument was Blagrave’s “mathematicall jewel”. See John Blagrave, *The Mathematicall Jewell* (London, 1585). Blagrave equally produced a staff “cleane devoid of all loftie florishes, singular easie to be conceived”. See John Blagrave, *Baculum Familiare* (London, 1590), dedicatory epistle.
19. *The Elements of Geometrie ... now first translated into the Englishe toung, by H. Billingsley, with a preface by ... M. J. Dee, specifying the chiefe Mathematicale sciences, what they are, etc* (London, 1570).
20. John Dee, *General and rare memorials pertayning to the perfect art of nauigation* (London, 1577). It was dedicated to Christopher Hatton. See also J. H. Crossley (ed.), *Autobiographical tracts of John Dee* (Manchester, 1851), 50–67, p. 50.
21. On “Brytan”, see I. Seymour, “The political magic of John Dee”, *History today*, January 1989, 29–35. Dee created for Elizabeth an ideology of a British monarchy based on Arthurian history, see Nicholas Clulee, *op. cit.* (ref. 4), 196–8. For Rudolph II’s patronage see Evans, *op. cit.* (ref. 1).
22. Robert S. Westman, “The astronomer’s role in the sixteenth century: A preliminary study”, *History of science*, xviii (1980), 105–47.
23. Francis R. Johnson, *Astronomical thought in Renaissance England: A study of the English scientific writings from 1500–1645* (New York, 1937).
24. Westman, “Astronomer’s role” (ref. 22), 106, states that “[b]etween 1543 and 1600 I can find no more than ten thinkers who choose to adopt the main claims of heliocentric theory”. In note 6 he lists Thomas Digges and Thomas Harriot, and the “weak or inconclusive” case of Recorde. We would not count Gilbert because, whilst he almost certainly accepted the Earth’s motion, he did not accept Copernicus’s astronomical arguments. The biggest group was of Germans, with Italy second equal to England but, as we argue, England did not share the patronage systems of Germany and Italy.
25. See Section 4 below.
26. Biagioli, *op. cit.* (ref. 4). The most critical opinion is Michael J. Shank, “How shall we practice

- history? The case of Mario Biagioli's Galileo, Courtier", *Early science and medicine*, i (1996), 106–50.
27. The Dutch recipient of James's patronage, Cornelis Drebbel, is another example. See Section 5 below.
 28. See Shackelford, "Paracelsianism and patronage" (ref. 1).
 29. See Smith, *The business of alchemy* (ref. 1).
 30. See for example Bruce T. Moran, "German prince-practitioners: Aspects in the development of courtly science, technology, and procedures in the Renaissance", *Technology and culture*, xxii (1981), 253–74.
 31. Bruce T. Moran, "Privilege, communication and chemistry: The Hermetic-alchemical circle of Moritz of Hessen-Kessel", *Ambix*, xxxii (1985), 110–26; *idem*, *The alchemical world of the German court: Occult philosophy and chemical medicine in the circle of Moritz of Hessen* (Stuttgart, 1991); *idem*, "Wilhelm of Hesse-Kassel: Informal communication and the aristocratic context of discovery", in Thomas Nickels (ed.), *Scientific discovery: Case studies* (Dordrecht, 1978), 67–96; Percy, ninth Earl of Northumberland (G. B. Harrison, ed.), *Advice to his son* (London, 1930); G. R. Batho, "The library of the "wizard earl": Henry Percy, ninth Earl of Northumberland (1564–1632)", *The library*, 5th series, xv (1960), 246–61; and John William Shirley, "The scientific experiments of Sir Walter Raleigh, the wizard earl, and the three magi in the Tower 1603–1617", *Ambix*, iv (1945–51), 52–66.
 32. Gordon R. Batho. "Thomas Harriot and the Northumberland household", in Robert Fox (ed.), *Thomas Harriot: An Elizabethan man of science* (Aldershot, 2000), 28–47; John W. Shirley, "Sir Walter Raleigh and Thomas Harriot", in John W. Shirley (ed.), *Thomas Harriot, renaissance scientist* (Oxford, 1974), 16–35. See also the fuller work, John W. Shirley, *Thomas Harriot: A biography* (Oxford, 1983).
 33. Findlen, *Possessing nature* (ref. 4).
 34. See Section 3.3 below.
 35. Lisa Jardine and Alan Stewart, *Hostage to fortune: The troubled life of Francis Bacon, 1561–1626* (London, 1998); Steven A. Walton, *Thomas Harriot's ballistics and the patronage of military science* (Durham, 1991); and Gordon Batho, in Fox (ed.), *Thomas Harriot* (ref. 32), 28–47. Blagrave's patrons include Sir Thomas Parry; Sir Francis Knollys; William Cecil, Lord Burghley; and Lord Charles Howard, Baron of Effingham, Lord High Admiral of England. See Stephen Pumfrey, "Was Harriot the English Galileo? An answer from patronage studies", *Bulletin of the Society for Renaissance Studies*, xxi (2003), 11–22.
 36. In one of a well-known series of marginalia to his copy of John Blagrave's *Mathematical Jewel* (London, 1585), Harvey recommends on the title page "mie mathematical mechanicians" James Kynvin and Humphrey Cole, as well as "Jon Reynolds, Jon Redd, and Christopher Payne", who were in turn recommended to him by his fellow Leicester clients Thomas Digges and Cyprian Lucar. See the British Library copy, shelf mark 1653/294.
 37. Alan G. R. Smith, *Servant of the Cecils: The life of Sir Michael Hickes* (New Jersey, 1977); Roy Strong, *Henry Prince of Wales and England's lost renaissance* (London, 2000); and Mark Pattison, *Isaac Casaubon, 1559–1614* (London, 1875).
 38. Evans, *Rudolf II and his world* (ref. 1).
 39. Simon Adams, *Leicester and the court: Essays on Elizabethan politics* (Manchester, 2002), 46, and Leeds Barroll, *Anna of Denmark, Queen of England: A cultural biography* (Philadelphia, 2001), 4, 16 and 37. See also Christianson, *On Tycho's island* (ref. 3), 14 seq.
 40. See, for example, Biagioli, *op. cit.* (ref. 4), chap. 5, on Galileo and Barbarini (Urban VIII), and Findlen, *op. cit.* (ref. 4), 357.
 41. Luce Giard, "Remapping knowledge, reshaping institutions", in S. Pumfrey, P. L. Rossi and M.

- Slawinski (eds), *Science, culture and popular belief in Renaissance Europe* (Manchester, 1991), 19–47.
42. See Section 3.2 below.
 43. See W. B. Patterson, *King James VI and I and the reunion of Christendom* (Cambridge, 1997), chap. 4, and Pattison, *Isaac Casaubon* (ref. 37), chaps. 5–9.
 44. Arthur F. Marotti, “Poetry, patronage and print”, in Cedric C. Brown (ed.), *Patronage, politics, and literary traditions in England, 1558–1658* (Detroit, 1993), chap. 1.
 45. See Mario Biagioli, “Etiquette, interdependence, and sociability in seventeenth-century science”, *Journal of critical inquiry*, xxii (1996), 193–238. Biagioli argues that the social practices of these academies evolved, albeit in differing ways, from courtly models.
 46. See Section 3.3 below.
 47. Thomas Digges interpreted the star for Lord Burghley. See below (ref. 94). Another English work dealing with the star was Anon., *A Letter sent by a gentleman of England, to his freende, contayning a confutation of a French mans errors, in the report of the myraculous starre nowe shyninge* (London 1573). On the comet, see Thomas Twyne, *A view of certain wonderful effects, of late dayes come to passe and now conferred with the presignyfications of the comete ...* (London, 1578); on the conjunction see Richard Harvey, *An astrological discourse upon the great and notable coniunction of the two superiour planets ...* (London, 1583), and an addition by John Harvey.
 48. Hugh Trevor-Roper, “The court physician and Paracelsianism”, in V. Nutton (ed.), *Medicine at the courts of Europe, 1500–1837* (London, 1985), 79–94. For Bomelius and Dee see Section 3.3 below. For Dickson see David Stevenson, *The origins of freemasonry: Scotland’s century, 1590–1710* (Cambridge, 1988), chap. 5, p. 92.
 49. Donald S. Pady, “Sir William Paddy M.D. (1554–1634)”, *Medical history*, xviii (1974), 68–82.
 50. In dedicating to Sir Francis Walsingham his *Abridgement of Fox* (London, 1589), Bright mentioned his receipt of “that especiall protection from the bloody massacre of Paris nowe 16 years passed...”. See *Dictionary of national biography*, ii, 1245–7, s.v. “Bright, Timothy (1551?–1615)”. The original at our disposal does not contain a dedication.
 51. Moran, “Patronage” (ref. 16), 485.
 52. Moran, “Prince-practitioners” (ref. 30).
 53. Christianson, *On Tycho’s island* (ref. 3), 258–4. See also Thoren, *The Lord of Uraniborg* (ref. 3), and Evans, *Rudolf II and his world* (ref. 1).
 54. Edward Wright, *Certain Errors in Navigation* (London, 1599), “Praeface to the Reader”, 3.
 55. Felicity Heal and Clive Holmes, “The economic patronage of William Cecil”, in Croft (ed.), *Patronage, culture and power* (ref. 2), 199–229, p. 204.
 56. Levy-Peck, *op. cit.* (ref. 2); Wallace T. MacCaffery, “Place and politics in Elizabethan politics”, in John Neale (ed.), *Elizabethan government and society* (London, 1961), 95–126.
 57. Croft, *op. cit.* (ref. 2), p. ix; the client was Timothie Bright. See William J. Carlton, *Timothie Bright, Doctor of Physicke* (London, 1911), 28–29. See also J. Hesselby, “Architecture at Burghley House: The patronage of William Cecil, 1553–1598”, Ph.D. dissertation, University of Warwick, 1996.
 58. Neal Cuddy, “The revival of the entourage: The bedchamber of James I, 1603–1625”, in David Starkey *et al.* (eds), *The English court from the Wars of the Roses to the Civil War* (London, 1987), 71–118.
 59. Levy-Peck, *Court patronage* (ref. 2), chap. 2.
 60. See, for example, Greenblatt, *Renaissance self-fashioning*; Evans, *Ben Jonson and the poetics of patronage*; Croft, *Patronage, culture and power*; Parry, *The golden age restor’d*; Wainwright, *Musical patronage in seventeenth century England*; and Cross, *Patronage and recruitment in*

- the Tudor and early Stuart church* (see ref. 2).
61. Croft, *op. cit.* (ref. 2), pp. ix, xv.
 62. Rosenberg, *Leicester* (ref. 2), *passim*.
 63. Louis A. Knafla, "The country Chancellor: The patronage of Thomas Egerton, Baron Ellesmere", in French R. Fogel and Louis A. Knafla (eds), *Patronage in late Renaissance England: Papers read at a Clark Library Seminar 1977* (Los Angeles, 1983), 33–103. For dedications see "Appendix".
 64. Hugh Platt, *Jewell House of Art and Nature* (London, 1594), Preface, sig. A2–3.
 65. John Blagrave, *Astrolabium Uranicum Generale* (London, 1596), sig. A2, and *The Art of Dyalling in two parts ...* (London, 1609), sig. A2v. His *Baculum familiare* (ref. 18) of 1590 was dedicated to Francis Knollys, and *The Mathematical Jewell* (ref. 18) of 1585 to William Cecil.
 66. Clulee, *John Dee's natural philosophy* (ref. 4), 196–8.
 67. Pattison, *Isaac Casaubon* (ref. 43).
 68. Shirley, *op. cit.* (ref. 32); Pumfrey, *op. cit.* (ref. 35); and Walton, *op. cit.* (ref. 35).
 69. Stephen Pumfrey, *Latitude and the magnetic Earth* (Cambridge, 2002), 19–23.
 70. Keynes, *William Harvey* (ref. 4); William H. Huffman, *Robert Fludd: Essential readings* (London, 1992); D. H. Willson, *King James VI & I* (London, 1956); John E. Leary, *Francis Bacon and the politics of science* (Ames, 1994); Julian Martin, *Francis Bacon and the reform of natural philosophy* (Cambridge, 1992); Jardine and Stewart, *Hostage to fortune* (ref. 35); and Stephen Gaukroger, *Francis Bacon and the transformation of early-modern science* (Cambridge, 2001).
 71. Marotti, *op. cit.* (ref. 44).
 72. Simon Forman, *The Groundes of the Longitude ...* (London, 1591), sig. A1v, and Thomas Hood, *The Mariners Guide* (London, 1596), Dedicatory Epistle.
 73. Pumfrey, *Latitude* (ref. 69), 194–9.
 74. Franklin Williams, *Index of dedications and commendatory verses in English books before 1641* (London, 1962).
 75. John Widdowes, *A Description of the World* (London, 1621), "Epistle Dedicatorie", sig. A1.
 76. *Dictionary of national biography*, xix, 1330–1, s.v. "Twyne, Thomas (1543–1613)".
 77. *The New Testament of Our Lord Iesus Christ translated out of Greeke by Theod. Beza: whereunto are adioyned brief summaries of doctrine vpon the Euangelistes and Actes of the Apostles, together with the methode of the Epistles of the Apostles by the said Theod. Beza: and also short expositions on the phrases and hard places taken out of the large annotations of the foresaid authour and Ioach. Camerarius*. By P. Loseler, Villerius. Englished by L. Tomson (London, 1576).
 78. Thomas Twyne, *The Garlande of Godly Flowers* (London, 1574).
 79. Beza was Theodore Mayerne's godfather. See Ralph Vigne, "Mayerne and his successors: Huguenot physicians under the Stuarts", paper delivered at the Royal College of Physicians in December 1985, and published by the Wellcome Institute for the History of Medicine.
 80. Pattison, *Isaac Casaubon* (ref. 43), 296–7.
 81. Niccolo Tartaglia, *Three bookes of colloquies concerning the arte of shooting* (London, 1588).
 82. See also Rosenberg, *Leicester* (ref. 2), *passim*.
 83. Rosenberg, *Leicester* (ref. 2), 140–1.
 84. Simon Stevin, *Haven finding art by the latitude and variation* (London, 1599).
 85. Knafla, *op. cit.* (ref. 63), Appendix.
 86. William Vaughan, *Directions for Health, both naturall and artificiall* (London, 1617). Richard Gething, *Calligraphotechnia, or the art of faire writing sett forth, and newly enlarged* (London, 1619), is not a treatise but a series of engraved templates illustrating a formal bureaucratic style.

87. Auger Ferrier, *A learned astronomical discourse, of the iudgement of nativities* (London, 1593), and John Ford, *The golden meane... Discoursing of the nobleness of perfect virtue in extreames* (London, 1614).
88. See BL MS. Stowe 573.
89. BL MS. Lansdowne 64.34. See also <http://www.exlibris.org/nonconform/engdis/brownists.html>
90. BL MS. Lansdowne 121 f. 13; also William Bourne, "The Nature and Quality of Water: as touching the Swimming and Sinking of Things", c. 1565, according to E. G. R. Taylor, *Mathematical practitioners of Tudor and Stuart England* (Cambridge, 1968), 176, 319.
91. BL MS. Add. 18035.
92. BL MS. Lansdowne, 100, f. 19.
93. BL MS. Lansdowne, 101, ff. 8–15.
94. Digges offered Cecil an "astronomical manuscript" on 14 May 1574, BL MS. Lansdowne 19.30. See also *Calendar of State papers domestic, Edward VI, Mary, and Elizabeth*, i, 1547–1580, 11 December 1572, Thomas Digges to Lord Burghley. Digges "has waded as far as ancient grounds of astrology would bear him to sift out the unknown influences of this new star or comet. Sends notes of observations and predictions". He probably produced for Leicester "The Second Paradoxe. That the antique Roman and Grecian discipline martiall doth farr exceede in excellencie our modern, notwithstanding all alterations by reason of the late invention of artillery and fireshott", BL MS. Lansdowne 98 f. 6 ff.
95. See William Barlow, *Magneticall Advertisements* (London, 1616), Preface.
96. See Section 3.5 below.
97. Sidney, of course, also gave military service, which stimulated his utilitarian concerns. He wrote from the Netherlands asking, "to what purpose should our thoughts be directed to various kinds of knowledge, unless room be afforded for putting it into practice, so that public advantage may be the result". We are grateful to Thomas Dixon for this quotation, cited in Alan Sinfield, "Power and ideology: An outline theory and Sidney's *Arcadia*", *English literary history*, iii (1985), 259–77, p. 270.
98. Frances Dawbarn, "New light on Dr Thomas Moffet: The triple roles of an early modern physician, client, and patronage broker", *Medical history*, xlvii (2003), 3–23.
99. Margaret P. Hannay, "'How I these studies prize': The Countess of Pembroke and Elizabethan science", in Lynette Hunter and Sarah Hutton (eds), *Women, science and medicine: 1500–1700: Mothers and sisters of the Royal Society* (London, 1997), 108–21.
100. Heal and Holmes, "The economic patronage of William Cecil" (ref. 55).
101. On Cecil see Conyers Read, *Lord Burghley and Queen Elizabeth* (New York, 1960), and the recent shorter survey by Michael A. R. Graves, *Burghley: William Cecil, Lord Burghley* (London, 1998).
102. John Guy, *Tudor England* (Oxford, 1990), 387.
103. Croft, *op. cit.* (ref. 2), p. xiv.
104. This is also a major contention of Adams, *op. cit.* (ref. 39).
105. See Mordechai Feingold, *Mathematicians' apprenticeship* (ref. 5), 77, and Johnston, "Mathematical practitioners" (ref. 8), 319–44.
106. The extent to which Burghley operated an economic policy (and whether it was conservative or radical) is discussed in Heal and Holmes, *op. cit.* (ref. 55), *passim*.
107. *A discourse of the commonweal of England, attributed to Thomas Smith*, ed. by Mary Dewar (Charlottesville, 1969); see also Mary Dewar, *Thomas Smith: A Tudor intellectual in office* (London, 1964).
108. Joan Thirsk, *Economic policy and projects: The development of a consumer society in early modern England* (Oxford, 1988); Heal and Holmes, "The economic patronage of William Cecil" (ref. 55), 203.

109. This is an important point. In England as elsewhere, universities were ultimately under local political control and patronage influence. However, Oxford and Cambridge possessed an institutional inertia that left courtiers with less power to determine policy and personnel than they exerted over London clients.
110. BL MSS. Lansdowne 18.90; 19.20; 12.48.
111. BL MS. Lansdowne 42.45.
112. BL MS. Lansdowne 23.14–16.
113. Roger Ascham, *The Scholemaster* (London, 1570). In the dedication Margaret Ascham mentioned not only Cecil's chancellorship of Ascham's university, but also "how much my sayd husband was many wayes bound vnto you, and how gladly and comfortably he vsed in hys lyfe to recognise and report your goodnesse toward hym, leauyng with me then hys poore widow and a great sort of orphanes a good comfort in the hope of your good continuance". See also the editions of 1571, 1579, and 1589.
114. See BL MSS. Lansdowne 34.21; 39.48; 54.70; 71.85; 107.4.
115. BL MSS. Lansdowne 102.16; 34.12; Guy, *op. cit.* (ref. 102), 414; and W. R. Sorley, "The beginnings of English philosophy", in A. W. Ward and A. R. Waller (eds), *The Cambridge history of English and American literature in 18 volumes* (1907–21), iv: *Prose and poetry: Sir Thomas North to Michael Drayton*, chap. 14, section 6.
116. BL MS. Lansdowne 107.92.
117. BL MS. Lansdowne 107, f. 155.
118. John Gerard, *The Herball or Generall Historie of Plants* (London, 1597), sig. A2.
119. See BL MS. Lansdowne 107, f. 155, and Gerard, *Herball* (ref. 118), "To the well affected Reader and peruser of this booke".
120. BL MS. Lansdowne 21.60.
121. BL MS. Lansdowne 12.73. See also BL MS. Lansdowne 12.79 for the Archbishop of Canterbury's response.
122. Timothie Bright, *Hygieina, id est de sanitate tuenda medicinae* (London, 1582).
123. For example, Dr Henry Hector proposed to cure his gout and later collated remedies from Averroes and others. Dr Masters and Mr Dion among others provided advice, while Dr Henry Landwer prescribed some medical slippers. Burghley even asked one Kelley [probably Edward Kelly] to return to England and cure him. Other physicians sent him directions for pains in the head, recipes for sage water and healing baths, and Burghley wrote out his own regimens. In his old age he received from John Evelyn a paper describing his cure for deafness, accompanied, of course, by a petition. See BL MSS. Lansdowne 27.43; 55.43; 18.35–6; 121.19; 29.7; 104.56; 46.12; 68.88; 77.92; 75.78; 77.90.
124. Even the case for Timothie Bright, the Burghley physician and inventor of shorthand or secret writing, to become Robert Cecil's tutor was made through Hickes, see BL MS. Lansdowne 51.27. Bright had just completed his *The Art of Short, Swifte and Secret Writing* (London, 1588), dedicated to Elizabeth. Francis Bacon sought, with limited success, to advance his early legal career through Burghley (his uncle) and his son Robert (his cousin). Thus in 1593 Bacon asked Hickes to advance his suit (BL MS. Lansdowne 75, f. 56). Hickes received rewards for such services (BL MS. Lansdowne 46.14). It was also through Hickes that suits for the Mastership of St John's College, Cambridge were promoted (BL MS. Lansdowne 108, 109). Ralph Parr, an Oxford scholar, attempted to advance his suit by sending him some Latin verses (BL MS. Lansdowne 99.71).
125. Heal and Holmes, "The economic patronage of William Cecil" (ref. 55), 208. (Osborne was also the dedicatee of Timothie Bright's *Treatise of Melancholie* of 1588.)
126. The following is a representative sample of the scores of petitions intended for Burghley's attention

after 1570: a description of a newly invented portable mill, useful for soldiers on campaign; practical information on the cultivating of vines and grapes; suggestions for improving the mechanical arts that included new designs for hoists lifts, and pulleys which could be used in warfare, and a device “to make a boat to goe faster on the water without ower or saile”; a letter concerning the “conditions necessary for to bring to passe the invention of brimston and oyle, And the profite that may grow thereof to the Queenes Majestie and her subjectes”; notes in Burghley’s own distinctive hand concerning the production of gold and silver ore; an offer to Lord Burghley of a “thin Aqua Chymica” which came with a peremptory “demande off your honour [for] a new yeares gifte”; news of a grant by the Queen for the production of new furnaces; a general petition assuring Burghley that “her Majestie shall profite by the effort of my inventions ... from ten to twelve thousand pounce, or more ...”. See BL MSS. Lansdowne 101, f. 65; 101, ff. 36–42; 19, f. 52; 22, ff. 68–72; 25, f. 144; 60, f. 177; 105, ff. 176–178; 108, f. 36.

127. See *Calendar of State papers domestic, Elizabeth*, xl, 28, 15 July 1566: “Arm. Waad to Leicester and Cecil. Has repaired to the Tower and examined Mr Cornelius [Lannoy] as to delay in assays of metals, etc. Particulars of the conversation which took place.” See also Heal and Holmes, “The economic patronage of William Cecil” (ref. 55), 209.
128. John Strype, *The life of the learned Sir Thomas Smith* (Oxford, 1820), 100–5, 161, 282. In BL MS. Lansdowne 29, f. 139, T. Smith wrote to Lord Burghley on 8 March 1579, urging haste in Medley’s business, and worrying if the profit of his new art would answer the expense.
129. BL MS. Lansdowne 103, ff. 217.
130. Heal and Holmes, “The economic patronage of William Cecil” (ref. 55), 208, 220.
131. See the biographical information usefully collated at http://es.rice.edu/ES/humsoc/Galileo/Catalog/Files/digges_tho.html and http://es.rice.edu/ES/humsoc/Galileo/Catalog/Files/digges_leo.html
132. Thomas Digges to Lord Burghley (ref. 94).
133. Thoren, *The Lord of Uraniborg* (ref. 3).
134. See ref. 94.
135. Thomas Digges, *Arithmaticall militare treatise, named stratoticos* (London, 1579).
136. Leonard Digges, amended by Thomas Digges, *An Arithmaticall Militare Treatise, named Stratoticos* (London, 1579), “Preface”.
137. http://es.rice.edu/ES/humsoc/Galileo/Catalog/Files/digges_tho.html
138. Of the considerable correspondence between Digges and Leicester, see especially BL Add. MS. 48084, ff. 232–311b, “Letters and papers, mostly of Thomas Digges, Muster-master-General, relating to musters; 1585–1595”; and BL Add. MS. 48083, ff. 235–46 concerns Digges’s dispute with Commander John Norris. Digges also petitioned Burghley in a complaint against Waad, BL MS. Lansdowne 72.63. BL MS. Lansdowne 67.5–6 documents Digges’s complaint to Burghley against one William Digges, over a matter of several thousand pounds. See also BL MS. Egerton 1694.
139. See ref. 32.
140. See Batho, *op. cit.* (ref. 31) for Percy’s occultism.
141. Percy, *op. cit.* (ref. 31), 67.
142. Shirley, *Thomas Harriot* (ref. 32), 19.
143. Walton, *Thomas Harriot’s ballistics* (ref. 35).
144. See Pumfrey, *op. cit.* (ref. 35), 18–19.
145. See Pumfrey, *op. cit.* (ref. 35), 20–22, and Walton, *op. cit.* (ref. 35).
146. Batho, *op. cit.* (ref. 31), 30, and Shirley (ed.), *Thomas Harriot* (ref. 32), 29.
147. His utilitarian *Tract on the Use of Globes* (London, 1593) was dedicated to Raleigh.
148. Appropriately, he bequeathed his two “perspective trunckes” to Percy, Taylor, *Mathematical*

- practitioners* (ref. 90), 183.
149. Batho, *op. cit.* (ref. 32), 31–32, 45–46. That the accusations were unfounded is shown by Scott Mandelbrote, “The religion of Thomas Harriot”, in Fox (ed.), *op. cit.* (ref. 32), 246–79.
150. French, *op. cit.* (ref. 4), 102–3.
151. Edward Wright, *Certaine Errors in Navigation* (London, 1599), sig. Q4–Qbv; Preface, 2.
152. Pumfrey, *Latitude* (ref. 69), 19–23.
153. Gilbert’s half-brother was able to get the “Nova Physiologia” placed in Prince Henry’s library, with a dedication to him. It was published in Amsterdam in 1651.
154. Bennett, “Geometry and surveying” (ref. 8).
155. Though see Alan Stewart, *The cradle King: A life of James VI and I* (London, 2003). He describes (pp. 38–39) how James cultivated a coterie of court poets called “the Castilian band”.
156. David Irving, *Memoirs of the life of George Buchanan* (Edinburgh, 1817), 160–1, cited in Roger Lockyer, *James VI & I* (London and New York, 1998), 9.
157. Arthur H. Williamson, “Number and national consciousness: The Edinburgh mathematicians and Scottish political culture at the union of the crowns”, in Roger A. Mason (ed.), *Scots and Britons: Scottish political thought and the union of 1603* (Cambridge, 1994), 197–212, p. 210.
158. Williamson, *op. cit.* (ref. 157), 205.
159. Williamson, *op. cit.* (ref. 157), 197–99; *Dictionary of national biography*, xvi, 91–94, s.v. “Pont, Robert (1524–1606)”.
160. Williamson, *op. cit.* (ref. 157), 188–9.
161. David Stevenson, *The origins of Freemasonry: Scotland’s century 1590–1710* (Cambridge, 1988), 49.
162. Stevenson, *op. cit.* (ref. 161), 91–93.
163. Robert Fludd, *Utriusque Cosmi majoris scilicet et minoris metaphysica atque technica historia in duo volumina secundum cosmi differentiam divisa* (Frankfurt, 1617/18). For dedication see Frances Yates, *The Rosicrucian enlightenment* (London, 1972), 78.
164. Isaac Casaubon, *De rebus sacris et ecclesiasticis* (London, 1614). See Pattison, *Isaac Casaubon* (ref. 37), chap. 6. Isaac Casaubon, *De rebus sacris et ecclesiasticis exercitationes XVI. Ad Cardinalis Baronii Prolegomena in Annales, & primam eorum partem, de Domini Nostri Iesu Christi natiuitate, vita, passione, assumptione* (London, 1614); his death prevented later volumes of this Protestant assault on Baronius. For his re-dating of the Hermetic corpus, see F. A. Yates, *Giordano Bruno and the Hermetic tradition* (London, 1964), chap. 21, “After Hermes Trismegistus was dated”.
165. Williamson, private communication.
166. Stevenson, *op. cit.* (ref. 161), 30–31. For Craig see Williamson, *op. cit.* (ref. 157), 199.
167. Allen Debus, *The French Paracelsians: The chemical challenge to medical and scientific tradition in early modern France* (Cambridge, 1991), and Sir Charles Cornwallis, “Copie of a letter touching the death of Henry, Prince of Wales”, 1613, BL Add. MS. 11, 532.
168. Debus, *op. cit.* (ref. 6), and Charles Webster, “Alchemical and Paracelsian medicine”, in Webster (ed.), *Health, medicine and mortality in the sixteenth century* (Cambridge, 1979), 301–34, esp. p. 320.
169. Hugh Trevor-Roper, “The court physician and Paracelsianism”, in V. Nutton (ed.), *Medicine at the courts of Europe, 1500–1837* (London, 1990), 79–94. See also Barroll, *op. cit.* (ref. 39), 16.
170. Stewart, *Cradle King* (ref. 155), 115.
171. See Patterson, *King James VI and I* (ref. 43), 125–7. Caspar, *Kepler* (ref. 4) notes that Kepler considered James I was his “great hope in matters of creed” and had “intended to dedicate *Harmonices Mundi Libri V* to James I of England”, but because of the political situation of the

- time the dedication was “forbidden by the censor”. See pp. 252, 288.
172. Pattison, *op. cit.* (ref. 37) published an appendix that includes Casaubon’s plans for future works. He intended an edition of the classical physician Celsus, and a work “De coloribus”. Pattison also noted (p. 500) his love of natural marvels.
173. Pattison, *Isaac Casaubon* (ref. 37), 318.
174. *Ibid.*, 297, 227, 316, 403–4, 298.
175. *Ibid.*; see, for example, p. 354.
176. Though Carleton reported Casaubon’s complaint that his fellow Huguenot émigré, the royal (and his) physician Mayerne, got £1400. Pattison, *Isaac Casaubon* (ref. 37), 323, 435. For Grotius see *ibid.*, 322.
177. *Ibid.*, 294, 326.
178. Strong, *Henry Prince of Wales* (ref. 37), 5. The boys at Henry’s court included Lord Cranbourne (son of Robert Cecil, first Earl of Salisbury, and grandson of William Cecil, Lord Burghley); the third Earl of Essex (son of Elizabeth’s favourite, Robert Devereux, second Earl of Essex); and John Harington, heir to the Prince’s tutor, Lord Harington of Exton.
179. *Dictionary of national biography*, iii, 1367–8, s.v. “Chaloner, Thomas (1561–1615)”.
180. Feingold, *Mathematician’s apprenticeship* (ref. 5), 63.
181. See ref. 179.
182. But see Strong, *Henry Prince of Wales* (ref. 37).
183. See ref. 179.
184. Strong, *Henry Prince of Wales* (ref. 37), 164.
185. *Ibid.*, 162. The major work on Drebbel is still F. M. Jaeger, *Cornelis Drebbel en zijne tijdgenooten* (Groningen, 1922); see also G. Tierie, *Cornelis Drebbel (1572–1633)* (Amsterdam, 1932), and <http://es.rice.edu/ES/humsoc/Galileo/Catalog/Files/drebbel.html>. In another example of ostentation, James commissioned Phineas Pett to build for Henry a model galleon, the *Disdain*. See Strong, *Henry Prince of Wales* (ref. 37), 35.
186. For natural philosophy as emblematic of patronage see Mario Biagioli, “Galileo the emblem maker”, *Isis*, lxxxi (1990), 230–58.
187. For Arundel’s patronage of the fine arts see Parry, *The golden age restor’d* (ref. 2), chap. 5.
188. *The Two Bookes of Francis Bacon. Of the proficiencie and aduancement of Learning, diuine and humane* (London, 1605).
189. Jardine and Stewart, *op. cit.* (ref. 35), 285–8.
190. Jardine and Stewart, *op. cit.* (ref. 35), 437–8.
191. Martin and Leary, *op. cit.* (ref. 70).
192. Gaukroger, *op. cit.* (ref. 70), 45–57.
193. Jardine and Stewart, *op. cit.* (ref. 35). See for example p. 149.
194. Deborah E. Harkness, “Strange ideas and ‘English’ knowledge: Natural science exchange in Elizabethan London”, in Pamela H. Smith and Paula Findlen (eds), *Merchants and marvels: Commerce, science, and art in early modern Europe* (London, 2002), 137–60, p. 151.
195. Gaukroger, *op. cit.* (ref. 70), 17.
196. Jardine and Stewart, *op. cit.* (ref. 35), 301–9, p. 303. For Bacon and Casaubon see also Pattison, *Isaac Casaubon* (ref. 37), 325, 334–6.
197. Gaukroger, *Francis Bacon* (ref. 70), 163, n. 52.
198. Jardine and Stewart, *op. cit.* (ref. 35), 439, 311.
199. Gaukroger, *Francis Bacon* (ref. 70), 164.
200. Jardine and Stewart, *op. cit.* (ref. 35), 438.

201. Thomas Sprat, *The history of the royal-society of London, for the making of natural knowledge* (London, 1667), frontispiece.
202. A possible exception is John Thornborough, Bishop of Worcester, who continued the Scottish court's interest in Paracelsism and the occult. Appointed chaplain-in-ordinary to Elizabeth in 1587, he was already a known supporter of Paracelsian medicine. As Bishop of Worcester he authored *Lithothorikos, sive, Nihil, aliquid, omnia, antiquorum sapientum vivis coloribus depicta, Philosophice-theologice, In gratiam eorum qui Artem auriferam Physico-chymice & pie profitentur* (Oxford, 1621), dedicated to Ludovic, Duke of Lennox. The work immediately elicited a dedication from one R. N. E. (putatively Robert Napier of Edinburgh, son of John), who published in 1622 a translated work called *A revelation of the Secret Spirit. Declaring the most concealed secret of Alchymie* (London 1622). See *Dictionary of national biography*, xix, 766–7, s.v. "Thornborough, John (1551–1641)".
203. Lux, *Patronage and royal science in seventeenth century France* (ref. 1), and Feingold, *op. cit.* (ref. 5), chap. 5.
204. Mario Biagioli, "Scientific revolution, social bricolage, and etiquette", in *The scientific revolution in national context*, ed. by Roy Porter and Mikuláš Teich (Cambridge, 1992), 11–53.
205. Wilfred R. Prest, *The Inns of Court under Elizabeth and the early Stuarts, 1590–1640* (London, 1972), and Brian P. Levack, *The civil lawyers in England, 1630–1641* (Oxford, 1973).
206. Ames-Lewis, *Sir Thomas Gresham and Gresham College* (ref. 7), and John Ward, *The lives of the professors of Gresham College* (London, 1740; reprinted 1967).
207. Feingold, *Mathematicians' apprenticeship* (ref. 5), and Lesley Cormack, *Charting an empire* (ref. 8). It may be significant that Feingold's examples become more significant as he moves, in chap. 4, from 1560 to 1640.