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The Man of Science

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Part II

PERSONAE AND SITES OF
NATURAL KNOWLEDGE

 THE MAN OF SCIENCE

Steven Shapin

It is difficult to refer to the early modern man of science in other than negative terms. He was not a “scientist”: The English word did not exist until the nineteenth century, and the equivalent French term – *un scientifique* – was not in common use until the twentieth century. Nor did the defined social and cultural position now picked out by “the scientist’s role” exist in the early modern period. The man of science did not occupy a single distinct and coherent role in early modern culture. There was no one social basis for the support of his work. Even the minimal organizing principle for any treatment of the man of science – that he was someone engaged in the investigation of nature – is, on reflection, highly problematic. What *conceptions* of nature, and of natural knowledge, were implicated in varying cultural practices? The social circumstances in which, for example, natural philosophy, natural history, mathematics, chemistry, astronomy, and geography were pursued differed significantly.

The *man* of science was, however, almost always male, and to use anything but this gendered language to designate the pertinent early modern role or roles would be historically jarring. The system of exclusions that kept out the vast numbers of the unlettered also kept out all but a very few women. And although it is important to recover information about those few female participants, it would distort such a brief survey to devote major attention to the issue of gender¹ (see the following chapters in this volume: Schiebinger, Chapter 7; Cooper, Chapter 9; Outram, Chapter 32).

Any historically responsible treatment of the early modern man of science has to embrace a splitting impulse and resist temptations toward facile

¹ Women do become rather more substantial philosophical presences in the salons of the Enlightenment; see, for example, Dena Goodman, “Enlightenment Salons: The Convergence of Female and Philosophic Ambitions,” *Eighteenth-Century Studies*, 22 (1989), 329–50.

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generalization.² The diversity of past patterns needs to be insisted upon, and not as a matter of mere pedantry. Even those historical actors concerned with bringing into being a more coherent and dedicated role for some version of the man of science were well aware of contemporary diversities. Francis Bacon (1561–1626) noted that “natural philosophy, even among those who have attended to it, has scarcely ever possessed, especially in these later times, a disengaged and whole man . . . , but that it has been made merely a passage and bridge to something else.”³

So the man of science was not a “natural” feature of the early modern cultural and social landscape: One uses the term *faute de mieux*, aware of its impropriety in principle, yet confident that no mortal historical sins inhere in the term itself. Although it is a proper historical question to ask “how we got from there to here,” one should at the same time be wary about transporting into the distant past the coherences of present-day social roles. Despite the legitimacy of asking how the relatively stable professionalized role of the modern scientist emerged from diverse sixteenth- and seventeenth-century arrangements, it would be misleading to mold historical inquiry solely to fit the contours of present-day interest in “origins stories” or to construe historical inquiry solely as a search for traces of present arrangements.⁴

Early modern scientific work – of whatever version – was pursued within a range of traditionally established social roles. One has to appreciate the expectations, conventions, and ascribed attributes of those existing roles, as well as the changes they were undergoing and their mutual relations, in order to understand the social identities of men of science in the period. Yet, vital as it is to insist on the heterogeneity of existing roles in which natural knowledge was harbored and extended in the early modern period, a brief survey such as this one can treat just a few of the more consequential roles – and here I have elected to focus on the university scholar or professor, the medical man, and the gentleman.

² For justification of such splitting sensibilities, see, for example, Thomas S. Kuhn, “Mathematical versus Experimental Traditions in the Development of Physical Science,” in *The Essential Tension: Selected Studies in Scientific Tradition and Change*, ed. Thomas S. Kuhn (Chicago: University of Chicago Press, 1977), pp. 31–65, and the archaeology of disciplines and roles mooted in Robert S. Westman, “The Astronomer’s Role in the Sixteenth Century: A Preliminary Study,” *History of Science*, 18 (1980), 105–47.

³ Francis Bacon, *The New Organon* [1620], bk. I, aphorism 80, ed. Fulton H. Anderson (Indianapolis: Bobbs-Merrill, 1960), p. 77.

⁴ A well-known essay on “the emergence and development of the social role of the scientist,” strongly shaped by the assumptions of structural-functionalist sociology and by the so-called professionalization model, is Joseph Ben-David, *The Scientist’s Role in Society* [1971] (Chicago: University of Chicago Press, 1984), esp. chaps. 4–5 (for early modern topics). Note that the negative claims of this and the preceding paragraph are direct contradictions of Ben-David’s assertion (p. 45; cf. p. 56 n. 20) that it was in the seventeenth century that “certain men . . . view[ed] themselves for the first time as scientists and [saw] the scientific role as one with unique and special obligations and possibilities.” For well-judged criticism of ahistorical assumptions in Ben-David’s account, see Thomas S. Kuhn, “Scientific Growth: Reflections on Ben-David’s ‘Scientific Role’,” *Minerva*, 10 (1972), 166–78; cf. Roy Porter, “Gentlemen and Geology: The Emergence of a Scientific Career, 1660–1920,” *The Historical Journal*, 21 (1978), 809–36, at pp. 809–13.

A more complete survey would be able to treat a whole range of other contemporary roles and their importance for the conduct of natural knowledge. The clerical role, for example, overlapped significantly, but only partially, with that of the university scholar, and a number of key figures spent the whole, or very considerable portions, of their working lives within religious institutions or sustained by clerical positions: among many examples, Nicholas Copernicus (1473–1543) in his Ermland chapter house, Marin Mersenne (1588–1648) in the order of Minims in Paris, and Pierre Gassendi (1592–1655), whose canonry at Digne assured his financial independence. The significance of the priestly role for contemporary appreciations of the proper relationship between natural knowledge and religion cannot be overemphasized. When some seventeenth-century practitioners circulated a conception of natural philosophers as “priests of nature,” they meant to display the theological equivalence of the Books of Nature and Scripture and also to imbue scientific work with the aura surrounding the formally religious role.⁵

Still other major scientific and philosophical figures spent much of their careers as amanuenses, clerks, tutors, or domestic servants of various kinds to members of the gentry and aristocracy, a common career pattern for Renaissance humanist intellectuals in several countries. Thomas Hobbes (1588–1679) functioned in a variety of domestic service roles to the Cavendish family for almost the whole of his adult life, and one of John Locke’s (1632–1704) first positions was as private physician, and later as general secretary, to the Earl of Shaftesbury. Relationships binding the practice of science to the patronage of princes and wealthy gentlemen were pervasive and consequential: The significance of the Tuscan court’s patronage for Galileo Galilei’s “socioprofessional identity” and for the direction of his scientific work has been vigorously asserted, and the importance of patronage and clientage relations for the careers and authority of very many other notable early modern men of science – and for the authority of the knowledge they produced – merits much fuller study.⁶ Finally, a more extensive account of the early modern man of science would treat a whole range of less exalted figures – mathematical practitioners, instrument makers, lens grinders, and various types of “superior artisans” – whose significance both for the practical conduct of scientific research and for the development of empirical methods was much insisted upon by the Marxist historiography of the 1930s and 1940s and as vigorously denied by idealist historians.⁷

⁵ See, for example, Harold Fisch, “The Scientist as Priest: A Note on Robert Boyle’s Natural Theology,” *Isis*, 44 (1953), 252–65; and Simon Schaffer, “Godly Men and Mechanical Philosophers: Souls and Spirits in Restoration Natural Philosophy,” *Science in Context*, 1 (1987), 55–85.

⁶ Mario Biagioli, *Galileo, Courtier: The Practice of Science in the Culture of Absolutism* (Chicago: University of Chicago Press, 1993); see also Bruce T. Moran, ed., *Patronage and Institutions: Science, Technology, and Medicine at the European Court, 1500–1750* (Woodbridge: Boydell Press, 1991).

⁷ For classic stress on the crucial significance of craft roles in the emergence of modern science, see Edgar Zilsel, “The Sociological Roots of Science,” *American Journal of Sociology*, 47 (1942), 544–62. For Alexandre Koyré-inspired rejection of any such idea, see A. Rupert Hall, “The Scholar

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The man of science, and almost all specific versions thereof, represented a subset of the early modern learned classes. By construing the investigation of nature as an act within learned culture, one is immediately marking out a massively important social division in early modern Europe, that between those who were literate and those who were not, between those who had passed through formal schooling and those who had not. European cultures did differ in the extent to which their populations were schooled, and therefore literate, but, in general, the fraction of the literate was very small and that of the learned even smaller.⁸ What was understood about the characters of the learned elite was, *mutatis mutandis*, understood of the learned man of science as well.

By no means all noteworthy early modern men of science were systematically shaped by university training. Among those who did not formally attend university at all were Blaise Pascal (1623–1662), Robert Boyle (1627–1691), and René Descartes (1596–1650), though Descartes' training at the Jesuit school of La Flèche was considerably more significant to his intellectual development than was Boyle's time at Eton College. At both ends of the social scale, the future man of science might escape university training – those being bred to artisanal or mercantile work, such as the potter and natural historian Bernard Palissy (1510–1590) or the merchant and microscopist Antonie van Leeuwenhoek (1632–1723), because they lacked the means or current interest,⁹ and the aristocrat (e.g., Boyle) because private resources might be preferred and because there was no professional or material inducement to secure formal

and the Craftsman in the Scientific Revolution,” in *Critical Problems in the History of Science*, ed. Marshall Clagett (Madison: University of Wisconsin Press, 1959), pp. 3–23. For revived interest in the role and standing of mathematical practitioners, see, for example, Mordechai Feingold, *The Mathematicians' Apprenticeship: Science, Universities, and Society in England, 1560–1640* (Cambridge: Cambridge University Press, 1984); J. A. Bennett, “The Mechanics' Philosophy and the Mechanical Philosophy,” *History of Science*, 24 (1986), 1–28; Bennett, “The Challenge of Practical Mathematics,” in *Science, Culture, and Popular Belief in Renaissance Europe*, ed. Stephen Pumfrey, Paolo L. Rossi, and Maurice Slawinski (Manchester: Manchester University Press, 1991), pp. 176–90; Mario Biagioli, “The Social Status of Italian Mathematicians, 1450–1600,” *History of Science*, 27 (1989), 41–95; Richard W. Hadden, *On the Shoulders of Merchants: Exchange and the Mathematical Conception of Nature in Early Modern Europe* (Albany: State University of New York Press, 1994); Frances Willmoth, *Sir Jonas Moore: Practical Mathematics and Restoration Science* (Woodbridge: Boydell Press, 1993); Amir Alexander, “The Imperialist Space of Elizabethan Mathematics,” *Studies in History and Philosophy of Science*, 26 (1995), 559–91; Stephen Johnston, “Mathematical Practitioners and Instruments in Elizabethan England,” *Annals of Science*, 48 (1991), 319–44; and Katherine Hill, “‘Juglers or Schollers?': Negotiating the Role of a Mathematical Practitioner,” *British Journal for the History of Science*, 31 (1998), 253–74.

⁸ For treatment of changing relations between elite and lay cultures in the early modern period, see Peter Burke, *Popular Culture in Early Modern Europe* (London: Temple Smith, 1978), esp. chaps. 2 and 9; see also Paul J. Bagley, “On the Practice of Esotericism,” *Journal of the History of Ideas*, 53 (1992), 231–47; and Carlo Ginzburg, “High and Low: The Theme of Forbidden Knowledge in the Sixteenth and Seventeenth Centuries,” *Past and Present*, 73 (1976), 28–41.

⁹ The experimentalist Robert Hooke was at Christ Church, Oxford, as a chorister, and it is unclear whether he ever availed himself of formal university instruction.

training. For a larger number of other men of science, university education was part of a background preparation for roles in civic life, and the acquisition of scientific expertise, or at least of that expertise for which they became known, occurred elsewhere. The mathematician Pierre de Fermat (1601–1665) and the astronomer Johannes Hevelius (1611–1687) studied law at a university, as did many other future men of science; William Gilbert (1544–1603), author of *De magnete* (On the Magnet, 1600), and the mathematician and physicist Isaac Beeckman (1588–1637) studied medicine; and Johannes Kepler (1571–1630) studied mainly theology.

In their mature careers, however, many scientific practitioners in the sixteenth and seventeenth centuries were professionally engaged by universities or related institutions of higher learning, though the proportion of these among the great figures making up the canon of early modern science can be overestimated.¹⁰ Andreas Vesalius (1514–1564), Galileo, and Isaac Newton (1642–1727) were professors (for at least part of their careers), whereas Copernicus, Kepler, Bacon, Descartes, Mersenne, Pascal, Boyle, Tycho Brahe (1546–1601), and Christiaan Huygens (1629–1695) were not. Moreover, the professorial role was by no means a stable one. Although for late twentieth-century scientists a permanent university appointment generally represents a natural career culmination, this was not necessarily the case for the early modern man of science. Occupying a university chair or fellowship might be just an episode in a career that included a variety of other social roles. There was indeed an early modern pattern of using university employment as a stepping stone to more desirable positions directly supported by court patronage. A figure such as the mathematician and astronomer Christoph Clavius (1538–1612) was arguably exceptional in remaining at his professorial position (in the Jesuits' Collegio Romano) for almost the whole of his adult life. Both Isaac Barrow (1630–1677) and his successor in the Cambridge Lucasian Chair of Mathematics, Isaac Newton, abandoned their university appointments while they were relatively young men – Barrow for brighter prospects as a royal chaplain (returning to Cambridge later as Master of Trinity and University Vice Chancellor), and Newton (after health problems) to become an official of the Royal Mint. Their contemporary Seth Ward (1617–1689), the Savilian Professor of Astronomy at Oxford, gave up his professorial career in early middle age, accepting several church livings and ultimately becoming bishop of Exeter.

Thomas Willis (1621–1675) vacated the Sedleian Chair of Natural Philosophy at Oxford for a lucrative medical practice in London. Vesalius left his teaching at the University of Padua in mid-career for medical service in the

¹⁰ This brief survey does not aim at a prosopography of early modern men of science and their institutional affiliations. Such an exercise would first have to establish social and intellectual criteria for identifying who *was* a man of science, whereas a major purpose of this chapter is to draw attention to the problematic nature of *any* coherent set of criteria the present-day historian might draw up.

imperial household; the astronomer Gian Domenico Cassini I (1625–1712) combined duties as a professor at the University of Bologna with engineering work for the pope before abandoning both for a stipend as a member of the new Académie Royale des Sciences in Paris; the French Huguenot inventor Denis Papin (1647–1712) had no compunction about leaving his chair of mathematics at the university of Marburg because of its miserable salary and heavy teaching load, and the Danish astronomer Ole Römer (1644–1710) equally understandably quit his chair of mathematics at the University of Copenhagen to become a powerful officeholder – first mayor and then state councillor. Hence the identification of scientific work with the professorial career was significant but tenuous and patchy during the early modern period. If you were, for example, a cleric-professor, or a physician-professor, then it needs no special explanation that you gave up your chair – and even gave up your scientific research – when better-paid or more prestigious ecclesiastical or medical opportunities presented themselves.

Professional affiliation with institutions of higher education and the stewardship of learning meant three things above all. First, it signaled links with organized forms of Christian religion. Throughout the early modern period, universities outside Italy were widely under church control – the Reformation splitting the institutional nature of that control but not, with some important exceptions, diluting it. The universities had as one of their major purposes the training of individuals for clerical roles, and membership in the clergy, or formal subscription to church doctrines, were very general conditions for matriculation, graduation, or entry to the fellowship and professoriate.

Second, the university combined curatorial and culturally reproductive roles, and its professors' activities and identities were primarily understood in those lights. Universities signified both responsible custodianship of the knowledge inherited from the past and its reliable transmission to future generations, and, although a significant number of professors took it upon themselves to engage in research that challenged orthodox beliefs, nowhere in early modern Europe was such a conception of the professorial role standard. Original research was not, so to speak, a role requirement.

Third, affiliation with the university associated the man of science with specific hierarchical social forms: The master was understood to be a master of knowledge traditionally accumulated and traditionally vouched for, and his institutional purpose was to transmit that mastery to future generations. The value placed on these hierarchical forms implicated the value placed on traditional forms of knowledge. The “modern” assault on school-knowledge proceeded importantly by way of criticisms of the schools' hierarchical social forms and the role of the professor in those forms. The university setting vouched for expertise, authenticity, and orthodoxy, and those ascribed characteristics spoke in favor of the knowledge housed there. But to those of a mind to criticize university arrangements, the same site and role were associated with authoritarianism, dogmatism, pedantry,

disputatiousness, and melancholic sequestration from the civic and material worlds.

Indeed, some of the new scientific societies that began to emerge in the mid-seventeenth century developed in self-conscious opposition to the universities: A peaceable and useful community of inquiring equals was juxtaposed with bastions of school-mastery, divisiveness, and inconsequentiality.¹¹ The Royal Society of London was a notable site in which such sentiments were expressed, whereas in Germany Gottfried Wilhelm Leibniz's (1646–1716) plans for a state-supported scientific academy stressed the importance of selecting persons who were not only knowledgeable but who were “also endowed with a unique goodness of mind; in whom rivalry and jealousy are wanting; who will not use despicable devices to appropriate for themselves the labors of others; who are not factious and have no wish to be regarded as the founders of sects; who labor for love of learning and not for ambition or sordid pay.”¹² In such venues, disapproving assessments of the professorial character precipitated by negation, as it were, the developing identity of the free academic member of the Republic of Science. Yet, apart from a very general commitment to a harmoniously collaborative – or at least collective – pursuit of natural knowledge, there is no single coherent pattern to be discerned in the establishment or structure of seventeenth-century scientific societies. Members of the Académie Royale des Sciences in Paris enjoyed substantial Crown pensions and devoted themselves effectively to the extension of state power through reformed natural knowledge and technology, but, although fellows of the Royal Society of London intermittently expressed their desire to realize the imperializing dreams of the utopian research institute described in Bacon's *New Atlantis* (1627), the English Crown offered no stipends and little financial support. Charles II laughed at them for wasting their time on intellectual trivialities.¹³

¹¹ Some of these issues are treated for the English setting in Allen G. Debus, *Science and Education in the Seventeenth Century: The Webster–Ward Debate* (London: Macdonald, 1970); Michael R. G. Spiller, “Concerning Natural Experimental Philosophie”: Meric Casaubon and the Royal Society (The Hague: Martinus Nijhoff, 1980); and James R. Jacob, *Henry Stubbe, Radical Protestantism and the Early Enlightenment* (Cambridge: Cambridge University Press, 1983), esp. chap. 5. The relations between the Royal Society of London and gentlemanly conventions are briefly treated later in this chapter. For a general sketch of the academic institutional form as it developed in Europe beginning in the mid-fifteenth century, see Ben-David, *The Scientist's Role*, pp. 59–66.

¹² Gottfried Wilhelm Leibniz, “On the Elements of Natural Science,” in Leibniz, *Philosophical Papers and Letters* [ca. 1682–4], ed. and trans. Leroy E. Loemker, 2nd ed. (Dordrecht: Reidel, 1969), pp. 277–90, at p. 282. For the context and outcome of Leibniz's plans for establishing scientific societies, see Ayyal Ramati, “Harmony at a Distance: Leibniz's Scientific Academies,” *Isis*, 87 (1996), 430–52.

¹³ There is a very large secondary literature on particular seventeenth-century scientific societies, as well as some attempt to identify their collective significance: see, for example, Sir Henry Lyons, *The Royal Society, 1660–1940: A History of Its Administration under Its Charters* (Cambridge: Cambridge University Press, 1944), chaps. 1–4; Dorothy Stimson, *Scientists and Amateurs: A History of the Royal Society* (New York: Henry Schuman, 1948); Sir Harold Hartley, ed., *The Royal Society: Its Origins and Founders* (London: The Royal Society, 1960); Margery Purver, *The Royal Society: Concept and Creation* (Cambridge, Mass.: MIT Press, 1967); Michael Hunter, *Establishing the New Science: The Experience of the Early Royal Society* (Woodbridge: Boydell Press, 1989); Hunter, *The Royal Society*

Membership in a scientific society or academy therefore had no one stable significance for the identity of the seventeenth-century man of science, though eighteenth-century developments, and especially patterns emerging in France, did eventually make the academic role increasingly important for scientific identity.¹⁴ The role of the seventeenth-century scientific academician might be recognized as a modified form of long-standing social roles – the court bureaucrat or the recipient of Crown patronage – or, where the ties between scientific societies and the state were weaker, patterns of gentlemanly conversation and virtuosity might be more central to his identity. In the former case, the contribution of academic membership to the recognized role of the man of science could be substantial; in the latter, the significance of such membership might be subsumed in the gentlemanly role.

THE MEDICAL MAN

The profession of medicine also associated the pursuit of natural knowledge with recognized and authoritative early modern social roles, and many medical men pursued scientific investigations within the rubric of a professorial role, such as Vesalius (at Padua) and Marcello Malpighi (1628–1694) (at Bologna). Established colleges of physicians and surgeons might also offer quasi-academic roles, such as the lectureship on surgery held for many years by William Harvey (1578–1657) at the London Royal College of Physicians. Nevertheless, the medical role was one that in principle provided for the authoritative pursuit of natural knowledge outside the rubric of the

and Its Fellows, 1660–1700: The Morphology of an Early Scientific Institution (British Society for the History of Science Monographs, 4) (Chalfont St. Giles: British Society for the History of Science, 1982); Roger Hahn, *The Anatomy of a Scientific Institution: The Paris Academy of Sciences, 1666–1803* (Berkeley: University of California Press, 1971); Claire Salomon-Bayet, *L'Institution de la science et l'expérience du vivant: Méthode et expérience à l'Académie Royale des Sciences, 1666–1793* (Paris: Flammarion, 1978); Alice Stroup, *A Company of Scientists: Botany, Patronage, and Community at the Seventeenth-Century Parisian Royal Academy of Sciences* (Berkeley: University of California Press, 1990); W. E. Knowles Middleton, *The Experimenters: A Study of the Accademia del Cimento* (Baltimore: Johns Hopkins University Press, 1971); Knowles Middleton, "Science in Rome, 1675–1700, and the Accademia Fisicomatematica of Giovanni Giustino Ciampiani," *British Journal for the History of Science*, 8 (1975), 138–54; David S. Lux, *Patronage and Royal Science in Seventeenth-Century France: The Académie de Physique in Caen* (Ithaca, N.Y.: Cornell University Press, 1989); Daniel Roche, *Le siècle des lumières en province: Académies et académiciens provinciaux, 1680–1789*, 2 vols. (Paris: Mouton, 1978); K. Theodore Hoppen, *The Common Scientist in the Eighteenth Century: A Study of the Dublin Philosophical Society, 1683–1708* (London: Routledge and Kegan Paul, 1970); Harcourt Brown, *Scientific Organizations in Seventeenth Century France (1620–1680)* (Baltimore: Williams and Wilkins, 1934); Martha Ornstein, *The Role of Scientific Societies in the Seventeenth Century* (Chicago: University of Chicago Press, 1928); R. J. W. Evans, "Learned Societies in Germany in the Seventeenth Century," *European Studies Review*, 7 (1977), 129–51; and James E. McClellan III, *Science Reorganized: Scientific Societies in the Eighteenth Century* (New York: Columbia University Press, 1985), chaps. 1–2. See also many of the works cited in notes 17–24.

¹⁴ Eighteenth-century developments are treated in Steven Shapin, "The Image of the Man of Science," in *The Cambridge History of Science*, vol. 4: *Eighteenth-Century Science*, ed. Roy Porter (Cambridge: Cambridge University Press, 2003), pp. 159–83. See also works cited in note 24.

universities or, indeed, of incorporated learning. To become a physician, of course, one had to pass through the institutions of higher learning – sometimes only quite nominally – but once one had done so, one could occupy that role, and be active in scientific inquiry, without necessarily being a member of any university or in the pay of any medical corporation.¹⁵

Unlike the role of the university scholar in general, the social role of the medical man strongly linked natural knowledge with practical interventions. No matter how much the physician's role – though not the surgeon's or apothecary's – was argued to belong to the world of polite and pure learning, the value of the physician's knowledge was nevertheless vouched for by its ability both to explain the real vicissitudes of human bodies and, where possible, to guide those practices that maintained health and alleviated disease.¹⁶ Although physicians were commonly mocked for what were seen as their illegitimate therapeutic pretensions, the very existence of the role testified to the overall esteem in which formal medical knowledge was held and the overall efficacy attributed to that knowledge. Medicine was therefore one important domain within which natural knowledge enjoyed well-established social authority and credibility.

Moreover, medical roles – unlike those of the professoriate generally – were centrally concerned with the description, explanation, and management of natural bodies. And however much many early modern philosophers insisted upon the dual nature of human beings – spiritual and material – the medical role tended to focus its interventions on human beings in their material aspects. For these reasons, it was common for medical men to pursue those scientific subjects most closely linked with the form and functioning of the human body. The medical role therefore “naturally” propelled some of its members toward the study of anatomy and physiology, including among very many examples Harvey, Malpighi, Willis, Santorio Santorio (1561–1636), Olof Rudbeck (1630–1702), Richard Lower (1631–1691), Francesco Redi (1626–ca. 1697), and Regnier de Graaf (1641–1673). Similar professional concerns attracted others to natural history, such as Conrad Gessner (1516–1565), Jan Swammerdam (1637–1680), and Nehemiah Grew (1641–1712), or chemistry, in the cases of Georgius Agricola (1494–1555) and John Mayow (1641–1679).¹⁷

¹⁵ Training in natural philosophy and natural history was a key preparatory requirement for a medical degree at many medieval and early modern universities. That is one reason why so many men trained in natural philosophy and natural history were physicians, and also why membership of early scientific societies was so heavily weighted toward medical men.

¹⁶ The cultural and social boundaries that reserved “professional” standing to bookishly trained physicians and that relegated surgeons and apothecaries to trade or craft status were hard to enforce. In England, at any rate, more liberal and inclusive notions of “the medical profession” were emerging by the late seventeenth and early eighteenth centuries, with interesting consequences for relations between medicine and the culture of science; see, for example, Geoffrey Holmes, *Augustan England: Professions, State, and Society, 1680–1730* (London: Allen and Unwin, 1982), chaps. 6–7.

¹⁷ See, for example, Harold J. Cook, “Physicians and Natural History,” in *Cultures of Natural History*, ed. Nicholas Jardine, James A. Secord, and Emma C. Spary (Cambridge: Cambridge University Press, 1996), pp. 91–105. Cook notes how materia medica provided a substantive link between natural

However, the participation of medical men was not confined to subjects strictly related to medical practice; see, for example, the work of such physicians as Gilbert (in magnetism), Nicolaus Steno (1638–1686) (in geology), and Henry Power (1623–1668) (in experimental natural philosophy). John Locke earned a medical degree before establishing his reputation in mental and political philosophy, and it might be said that Thomas Sydenham's (1624–1684) key achievement was a methodology of quite wide scientific applicability. Nor was substantial interest in medical subjects restricted to those occupying the social role of physician or surgeon: Bacon, Descartes, and Boyle lacked professional qualifications but either theorized on medical subjects or dabbled in medical therapeutics and dietetics.

THE GENTLEMAN

Like the roles of the scholar and the medical man, the gentlemanly role offered both problems and opportunities for changing conceptions of what it was to make natural knowledge. On the one hand, the traditional gentlemanly role was not, of course, primarily defined around the acquisition and pursuit of formal knowledge, though humanist writers argued strenuously through the sixteenth and early seventeenth centuries that virtuous and polite knowledge *ought to be* central to legitimate conceptions of gentility. Although there were important overlaps between the gentle and the learned classes, gentlemanly culture was uncomfortable – in England more than in Italy or France – with the idea that the wellborn should make the pursuit of formal knowledge a professional activity, either in a remunerative sense or in the sense of the pursuit being fundamental to one's social identity. Scholars might in many cases be genuinely respected by gentle society, but that society importantly distinguished the roles of the gentleman and the professional scholar or pointed to features of the scholar's "character" that handicapped his ability to take part in gentlemanly conversation. Particular targets of criticism were the scholar's traditional isolation, his "morose" or "melancholic" complexion, his tendency toward disputation, and his pedantry.¹⁸

On the other hand, the gentle classes were widely literate, sometimes well educated, and, especially on the Continent, often disposed to act as patrons to men of science – in the case of the "mixed" mathematical sciences because of their acknowledged utility to the arts of war, wealth-getting, and political

history, chemistry, and medical therapeutic concerns; see also Paula Findlen, *Possessing Nature: Museums, Collecting, and Scientific Culture in Early Modern Italy* (Berkeley: University of California Press, 1994), chap. 6.

¹⁸ Steven Shapin, "A Scholar and a Gentleman?: The Problematic Identity of the Scientific Practitioner in Early Modern England," *History of Science*, 29 (1991), 279–327; Shapin, *A Social History of Truth: Civility and Science in Seventeenth-Century England* (Chicago: University of Chicago Press, 1994), chaps. 2–4; Adrian Johns, "Prudence and Pedantry in Early Modern Cosmology: The Trade of Al Ross," *History of Science*, 35 (1997), 23–59.

control, and, in the case of other scientific practices, such as astronomy or natural history, because they lent luster to the patron and sparkle to civil conversation.¹⁹ The gentry, aristocracy, and nobility therefore controlled an enormously important pool of resources for supporting the work of men of science, while cultural and social attitudes placed obstacles between patronage or amateurism, on the one hand, and the professional pursuit of, or systematic identification with, scientific practice on the other. In the sixteenth and early seventeenth centuries, those obstacles could in principle be set aside – there were some very notable aristocratic men of science – but contemporary culture possessed few resources for appreciating and approving a substantive merger between the role of the professionally learned and the role of the gentle.

Those cultural resources soon began to be available, with potential consequences for changing notions of the social role of the man of science and of scientific knowledge itself. Beginning in the late sixteenth century, Francis Bacon – English aristocrat and Lord Chancellor – argued strenuously for methodological and organizational reforms in natural knowledge that would at once make that knowledge an effective arm of state power and render it a pursuit suitable for civically engaged gentlemen. Natural knowledge was to be hauled out of the privacy of the traditional scholar's study – which made science disputatious, wordy, and barren – and into the bright light of real-world phenomena and practical civic concerns.²⁰ The reformed man of science was supposed to live a *vita activa*, and reformed science was to be done in public places.²¹

Bacon's vision of a civically pertinent science practiced by civically situated scholars was further developed in England starting in the 1660s by the new Royal Society of London. Here such publicists as Henry Oldenburg (1618–1677), Thomas Sprat (1635–1713), and Joseph Glanvill (1636–1680) announced that the Royal Society had turned traditionally deductive natural philosophical practice upside down, and, placing particular facts before causal and metaphysical systems, had cured science of its disputatiousness, pedantry, individualism, authoritarianism, and aridity. And when the social and intellectual virtues of the new practice were embodied in the person of the Honourable Robert Boyle – a great Anglo-Irish aristocrat – the Royal

¹⁹ See, for example, Biagioli, *Galileo, Courtier*; Mario Biagioli, "Le prince et les savants: La civilité scientifique au 17^e siècle," *Annales: Histoire, Sciences Sociales*, 50 (1995), 1417–53; Biagioli, "Etiquette, Interdependence, and Sociability in Seventeenth-Century Science," *Critical Inquiry*, 22 (1996), 193–238; Willmoth, *Sir Jonas Moore*; Findlen, *Possessing Nature*; Moran, ed., *Patronage and Institutions*; Stroup, *A Company of Scientists*; and Pamela H. Smith, *The Business of Alchemy: Science and Culture in the Holy Roman Empire* (Princeton, N.J.: Princeton University Press, 1994).

²⁰ See Julian Martin, *Francis Bacon, the State, and the Reform of Natural Philosophy* (Cambridge: Cambridge University Press, 1992).

²¹ For early modern debates over whether the scientific life should be "active" or "contemplative," see Owen Hannaway, "Laboratory Design and the Aim of Science: Andreas Libavius versus Tycho Brahe," *Isis*, 77 (1986), 585–610; and Steven Shapin, "The House of Experiment in Seventeenth-Century England," *Isis*, 79 (1988), 373–404.

Society declared that it had realized Bacon's dream of joining a new science to a new social role for the man of science: not a professional scholar, not a schoolman, not a slave to a philosophical system, not a professional cleric, and not a professional physician, but a free, independent, modest, and virtuous seeker of truth about God's nature. Science, the Society said, had been remade into both a polite and a useful practice, fit for gentlemanly participation and equipped to secure and extend state power.²²

It is the gentlemanly pattern of changing conceptions of the social role of the man of science that poses the greatest challenge to the traditional "professionalization model." Historians and sociologists working within that model searched the historical record for traces of modern arrangements, particularly for emerging appreciations of the distinctiveness and autonomy of science and for a remunerative basis for the conduct of scientific research. Yet gentle culture tended to be suspicious of intellectual specialization and scholarly isolation, and, again especially in England, those who offered their intellectual labor in exchange for pay were sometimes considered to have sacrificed that freedom of action and integrity considered vital to making reliable knowledge.²³ Where the pursuit of natural knowledge was not specifically sustained by resources attached to such other social roles as that of the university scholar, the cleric, and the physician, that pursuit – like most other early modern learned activities – was supported and made possible by accumulated capital. Inherited independent means overwhelmingly provided the practical resources to seek natural knowledge, while such independence might be pointed to as a powerful symbolic guarantee of the integrity and disinterestedness of the authentic amateur, he who pursued knowledge for love rather than for lucre.

The gentlemanly conception of a new social role for the man of science was important in new practitioners' self-conceptions and in justifications of new intellectual practices. Yet its wider cultural legitimacy was circumscribed, both in England and on the Continent. In England, influential wits and courtiers poked fun at the utilitarian pretensions of the Royal Society and recognized no substantial differences between the new social forms and the old pedantry and dispute. In the Royal Society itself, Boylean patterns of modest

²² The significance of particular patterns of gentility associated with some Continental men of science has been addressed by Stephen Gaukroger, *Descartes: An Intellectual Biography* (Oxford: Oxford University Press, 1995), esp. pp. 28–67; Peter Dear, "A Mechanical Microcosm: Bodily Passions, Good Manners, and Cartesian Mechanism," in *Science Incarnate: Historical Embodiments of Natural Knowledge*, ed. Christopher Lawrence and Steven Shapin (Chicago: University of Chicago Press, 1998), chap. 2; Albert Van Helden, "Contrasting Careers in Astronomy: Huygens and Cassini," *De zeventiende eeuw*, 12 (1996), 96–105; and Victor E. Thoren, *The Lord of Uraniborg: A Biography of Tycho Brahe* (Cambridge: Cambridge University Press, 1990).

²³ Studies of Hooke and Boyle that have treated these aspects of remunerated science include Stephen Pumfrey, "Ideas above His Station: A Social Study of Hooke's Curatorship of Experiments," *History of Science*, 29 (1991) 1–44; Steven Shapin, "Who Was Robert Hooke?," in *Robert Hooke: New Studies*, ed. Michael Hunter and Simon Schaffer (Woodbridge: Boydell Press, 1989), pp. 253–85; and Shapin, *A Social History of Truth*, chap. 8.

empiricism and polite probabilism were soon challenged by a Newtonian persona and a Newtonian natural philosophical program that suggested to many a revival of older conceptions of scholarly isolation and philosophical authority. Early Royal Society rhetoric about the proper conduct of inquiry and the proper role of the man of science was widely applauded on the Continent, but the grip of corresponding social patterns was never very secure in France, Italy, and the German states. Everywhere the social role of the man of science remained heterogeneous, the pursuit of natural knowledge adventitiously attached in all sorts of ways to the preexisting social roles of the professional scholar, the medical man, the gentleman, and to as many other roles as figured in the production of learned culture generally.²⁴

²⁴ The early to mid-eighteenth century developed much more elaborate cultures of both politeness and utility, and more contested notions of the role of the man of science within those cultures. On politeness, see Anne Goldgar, *Impolite Learning: Conduct and Community in the Republic of Letters, 1680–1750* (New Haven, Conn.: Yale University Press, 1995); Geoffrey V. Sutton, *Science for a Polite Society: Gender, Culture, and the Demonstration of Enlightenment* (Boulder, Colo.: Westview Press, 1995); and Alice N. Walters, “Conversation Pieces: Science and Politeness in Eighteenth-Century England,” *History of Science*, 35 (1997), 121–54. For science and utility, see Larry Stewart, *The Rise of Public Science: Rhetoric, Technology, and Natural Philosophy in Newtonian Britain, 1660–1750* (Cambridge: Cambridge University Press, 1992); Jan Golinski, *Science as Public Culture: Chemistry and Enlightenment in Britain, 1760–1820* (Cambridge: Cambridge University Press, 1992), esp. chap. 4; and also Shapin, “The Image of the Man of Science.”