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# THE IMAGE OF THE MAN OF SCIENCE

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The relations between the images of the man of science and the social and cultural realities of scientific roles are both consequential and contingent. Finding out "who the guys were" (to use Sir Lewis Namier's phrase) does indeed help to illuminate what kinds of guys they were thought to be, and, for that reason alone, any survey of images is bound to deal – to some extent at least – with what are usually called the realities of social roles.[1] At the same time, it must be noted that such social roles are always very substantially constituted, sustained, and modified by what members of the culture *think* is, or should be, characteristic of those who occupy the roles, by precisely whom this is thought, and by what is done on the basis of such thoughts. In sociological terms of art, the very notion of a social role implicates a set of norms and typifications – ideals, prescriptions, expectations, and conventions thought properly, or actually, to belong to someone performing an activity of a certain kind. That is to say, images are part of social realities, and the two notions can be distinguished only as a matter of convention.

Such conventional distinctions may be useful in certain circumstances. Social action – historical and contemporary – very often trades in juxtapositions between image and reality. One might hear it said, for example, that modern American lawyers do not really behave like the high-minded professionals

[1] For introductions to pertinent prosopography, see, e.g., Robert M. Gascoigne, "The Historical Demography of the Scientific Community, 1450–1900," *Social Studies of Science,* 22 (1992), 545–73; John Gascoigne, "The Eighteenth-Century Scientific Community: A Prosopographical Study," *Social Studies of Science,* 25 (1995), 575–81; Steven Shapin and Arnold Thackray, "Prosopography as a Research Tool in History of Science: The British Scientific Community, 1700–1900," *History of Science,* 12 (1974), 1–28; and especially William Clark, "The Prosopography of Science," in this volume. The use of anything but this gendered language to designate the eighteenth-century "man of science" 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. Women's role in eighteenth-century science is surveyed in this volume by Londa Schiebinger.

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portrayed in official propaganda, and statements distinguishing image and reality in this way thus present themselves as real to those who wish to understand contemporary American society. But such a disjunction constitutes a new image to be contrasted with the old, perhaps one portraying lawyers to be as venal as car salespeople, and those who deal with lawyers on that basis help to constitute new social realities. Nor – for historians or sociologists – is there some methodological sin that is inherently attached to asking, for example, whether eighteenth-century men of science – individually or collectively – "really" possessed the range of virtues, vices, or capacities widely attributed to them, just so long as we appreciate that any social role is constituted through *some* set of beliefs about what its members are like and should be like.

So it is not proper – either in historical or in sociological practice – to speak of social roles without what might be termed their "characterology." What typifications attached to the person of the eighteenth-century man of science? What virtues, vices, dispositions, and capacities was such a person thought to possess, and in what combinations? What relationships were there between the socially recognized characters of the man of science and those attached to other social roles? What variation was there in the characterology of the man of science? Was there one settled image of the man of science, or were there several, possibly conflicting characterizations, attached to different versions of his identity – the mathematician, the philosopher, the ornithologist, and so on – or expressing different sensibilities toward what these people were like *tout court?*[2] Qualified in these ways, characterology can be used as a pertinent organizing principle for a survey of images of the man of science in the eighteenth century.

Yet before that characterology can even be presented, a possible preconception about eighteenth-century social roles should be confronted and dismissed. At neither end of the eighteenth century did the role of the "man of science" exist as a coherent and distinctive social kind. In the late seventeenth century the pursuit of natural knowledge took place within a wide variety of existing social roles. The typifications and expectations bearing on those who happened to pursue different sorts of natural knowledge within those roles were not those of the professional scientist – that social kind did not, of course,

[2] Although characterology dates back to antiquity – in the work of Theophrastus – the delineation of "characters" has the advantage of being a revived early modern usage as well. A number of sixteenth-, seventeenth-, and early eighteenth-century men of letters compiled the "characters" of, for example, "the philosopher," "the mathematician," "the School-man," "the scholar," "the courtier," etc., as well as the more traditional allegorical embodiment of the virtues and vices; see, e.g., Joseph Hall, *Characters of Vertues and Vices* (London, 1608); Samuel Butler, *Characters and Passages from Note-Books,* ed. A. R. Waller (Cambridge University Press, 1908); John Earle, *Micro-cosmographie, or, A Piece of the World Characteriz'd in Essays and Characters* (London, 1650); Jean de la Bruyère, *Characters,* trans. Henri Van Laun (London: Oxford University Press, 1963; orig. publ. 1690). And for practical uses of characterology in eighteenth-century social relations, see, e.g., Philip Dormer Stanhope, Earl of Chesterfield, *Letters to His Son,* ed. Oliver H. Leigh, 2 vols. (New York: Tudor Publishing, n.d.; orig. publ. 1774), vol. 1, pp. 105–6, 387; vol. 2, p. 16.

exist – but rather were predominantly those of what might be called the host social role. The roles of the university professor, the physician or surgeon, the gentleman, the courtier, the crown or civil servant, the cleric, and many others were each accompanied by a set of widely understood, and relatively coherent, characters, conventions, and expectations, and it was these that colored whatever pursuit of natural knowledge might happen to occur within such roles. That is to say, the images of eighteenth-century men of science – in all their variety – were very significantly shaped by appreciations of what was involved in the host roles: what sorts of people occupied such roles, with what characteristics and capacities, doing what sorts of things, and acquitting what sorts of recognized social functions, with what sorts of value attached to such functions?[3]

Moreover, in the eighteenth century it did not necessarily follow from an individual's being recognized as having produced natural knowledge of great scope or acknowledged quality that such an individual was clearly *identified* – by his contemporaries or even by himself – with a distinct intellectual role, still less with the role of the man of science. In the middle of the seventeenth century Blaise Pascal gave up natural philosophy and mathematics for a higher religious calling, as did the Dutch entomologist Jan Swammerdam some years later. At the turn of the century Isaac Newton, having exchanged his mathematical professorship for the administration of the Royal Mint, insisted that correspondents recognize he was not "*trifling* away" his time "about Mathematical things" when he "should be about ye Kings business."[4] Nor, despite Gottfried Wilhelm Leibniz's European reputation as mathematician and philosopher, did this count for much with his Hanoverian employers, who demanded, at the end of his life, that he devote himself wholly to completing a politically useful dynastic history. In America, Benjamin Franklin achieved international celebrity as inventor of the lightning rod and, to a lesser extent, as a theorist of electricity, but, so far as his local culture was concerned, he was identified primarily as a printer, a businessman, a diplomat, and a statesman. To *do* science – as current sensibilities recognize it – was not necessarily the same thing as to *be* a man of science, to occupy that social role. What historians recognize as crucially important scientific research might be, in contemporary terms, only a moment or an element – among others – in a life fundamentally shaped by other concerns and lived out within other identities. This is just another way of noting the disjunction between activities,

[3] The methodological framework for this way of conceptualizing the social role of the man of science is sketched in Steven Shapin, "The Man of Science in the Early Modern Period," in Lorraine Daston and Katharine Park (eds.), *The Cambridge History of Science,* vol. 3: *Early Modern Science* (Cambridge University Press, forthcoming), which can be treated as preface to the present chapter. See also Roy Porter, "Gentlemen and Geology: The Emergence of a Scientific Career, 1660–1920," *The Historical Journal,* 21 (1978), 809–36, at 809–15.

[4] Isaac Newton to John Flamsteed, 6 January 1698/99, in Newton, *The Correspondence of Isaac Newton,* eds. H. W. Turnbull, J. D. Scott, A. R. Hall, and Laura Tilling, 7 vols. (Cambridge University Press, 1959–77), vol. 4, p. 296.

identities, and roles that was characteristic of virtually all scientific activity until the professionalized arrangements of the twentieth century.[5] The cultural character of scientific work, and of scientific workers, was taken substantially from practitioners' identification with established host roles.

This state of affairs obtained at both ends of the eighteenth century, and it persisted into much of the nineteenth. Yet a series of subtle and consequential changes was being effected from about the 1680s to about the 1820s – changes that were partly shifts in concrete social realities and partly shifts in social aspirations and in cultural images of what it was to do science. It was these changes that by the 1830s inspired systematic and public agitation for the professionalization of science and that allowed such agitation to be regarded as meaningful, if not as wholly and effectively persuasive. Those changes were more closely associated with some characters of the man of science than with others, and I shall be using the notion of characters to indicate both those structures and images that were conserved across our period and those that experienced the sorts of changes whose social and cultural significance became most clear in nineteenth-century professionalizing movements. The characters I shall treat in this survey are the Godly Naturalist, the Moral Philosopher, and the Polite Philosopher. By way of conclusion, I shall make some briefer remarks about the developing eighteenth-century character of the Civic Expert.[6]

## THE GODLY NATURALIST

The roles of the pious naturalist and, more specifically, of the parson-naturalist, were thickly populated and culturally understood throughout the period, especially, but not exclusively, in Protestant culture. The Renaissance argument that God had written two books by which His existence, attributes, and intentions might be known – Scripture and the Book of Nature – continued in currency in the developing culture of "natural theology." Sentiments that inspired parson-naturalists, and even parson-experimentalists, at the time of the Glorious Revolution were still vigorous at the time of the French Revolution. The "argument from design" (inferring God's existence,

[5] The point being made here is not at all the same as the traditional distinction between "professionalism" and "amateurism," if the latter is taken to indicate a less than wholehearted or serious commitment to science. At issue here are not distinctions in seriousness or quality but rather differences in personal and cultural identities and their contemporary cultural consequences. See Porter, "Gentlemen and Geology," pp. 814–15.

[6] Although this set of characters emerges "naturally" from recognized eighteenth-century cultural discourse, it necessarily reflects both a late twentieth-century historian's selective criteria of significance and the pragmatic constraints of such a survey. Were there space enough, other characters would merit extended discussion, e.g., those associated with medical practice and with the popularization of science. And, almost needless to say, a given individual might be described through the repertoires of more than one recognized character. Indeed, for such celebrated individuals as Newton, there was typically a cultural contest over which character best described him, what kind of person he *was*.

wisdom, benevolence, and power from the evidence of contrivance in organic and material nature) seemed overwhelmingly persuasive to such English clerics as the Reverend John Ray in the 1690s, the Reverend Stephen Hales in the 1720s, the Reverend Gilbert White of Selborne in the 1780s, and the Reverend William Paley in the 1800s, and to such French divines as the Abbé Noel Antoine Pluche, whose *Spectacle de la nature* was an international bestseller from the 1730s. And even though many parishioners undoubtedly found the spectacle of a bird-watching and bug-hunting vicar mildly amusing – the Scottish parishioners of the natural historian John Walker called him "the mad minister from Moffat" – valued natural-theological sensibilities were available to offset any appearance of culpable oddness in such pursuits. The naturalist-parson belonged to the century's inventory of recognized characters, and the scientific portion of his activities was understood to flow from some version of what it was to *be* a minister. And, in the parson's self-understanding, doing science might not be a mere avocation; it might be counted as a legitimate and important part of his priestly vocation. The parson-naturalist's scientific inquiries were surrounded by the aura shed by his priestly role.[7]

Nor were natural theological justifications and motives confined to men of the cloth. They were widely available to explain what sort of thing one was doing when one was doing science, what kind of person one was, what place and value science had in the overall culture, and what role in the social system was supposed to be occupied by those engaged in the pursuit of natural knowledge. So whatever was understood about the virtues and capacities of the priest was available to understand those godly investigators who were called "priests of nature."[8] These justifications and appreciations were a ubiquitous feature of eighteenth-century culture, again especially in Britain, and they might be importantly expressed by the occupants of a great range of roles: the university professor, the academician, the medical man, the gentleman, the instrument-maker, and the popular lecturer, writer, and showman, as well as by those whose roles were contained within formal religious institutions.

The aura of holiness that "naturally" surrounded the priest might also be discerned around a range of ostensibly secular practitioners. In the Netherlands the draper-microscopist Antoni van Leeuwenhoek saw the wisdom of God in the architecture of even the tiniest of his creatures. In America, the Quaker botanist John Bartram announced that it was through the "telescope" of nature that "God in his glory" could be seen. In Sweden Carl Linnaeus was described as "a second Adam," giving species their proper names and conceiving

[7] For a survey of forms of natural theology through this period and beyond, see John Hedley Brooke, *Science and Religion: Some Historical Perspectives* (Cambridge University Press, 1991), especially chaps. 4–6; and, for aspects of the British case, see John Gascoigne, "From Bentley to the Victorians: The Rise and Fall of British Newtonian Natural Theology," *Science in Context,* 2 (1988), 219–56.

[8] For this usage in the later seventeenth century, see 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.

of his binomial nomenclature as a "psalter for divine worship": "Man is made for the purpose of studying the Creator's works that he may observe in them the evident marks of divine wisdom." In Germany Leibniz reckoned that there was great religious utility in science, on the condition that natural inquiry was informed by a proper "intellectualist" theology, showing that God's wisdom had created the "best of all possible worlds."[9] In England, the Unitarian chemist Joseph Priestley wrote, "A Philosopher ought to be something greater, and better than another man." If the man of science was not already virtuous, then the "contemplation of the works of God should give a sublimity to his virtue, should expand his benevolence, extinguish every thing mean, base, and selfish in [his] nature."[10]

The culture of natural theology was not uniformly institutionalized and honored. It was never as influential in Catholic as in Protestant cultures. And during the course of the eighteenth century it took notable knocks: in Scotland from David Hume; in Germany from Immanuel Kant; and in France from the *philosophes* and *Encyclopédistes.* Yet wherever the writ of natural theology ran, its sensibilities supported a character of the man of science as godly and the doing of science as the acquittal of religious goals.

## THE MORAL PHILOSOPHER

A natural order bearing the sure evidence of divine creation and superintendence was understood to uplift those who dedicated themselves to its study. Godly subject matter made for godly scholars. This was the major way in which the culture of natural theology sustained an image of the man of science as virtuous beyond the normal run of scholars. But eighteenth-century cultures that were not powerfully marked by natural theology also produced pictures of the man of science as specially or uniquely virtuous. The cultural resources for constructing those images and rendering them credible linked the eighteenth century to antiquity as well as to the immediate past.

The eloges presented in commemoration of recently deceased members of the Paris Academy of Sciences offer the eighteenth century's most highly developed and influential portraits of the virtuous man of science. Although a

[9] For the religious sensibilities of Swammerdam, Leeuwenhoek, and other Dutch microscopists of the late seventeenth and early eighteenth centuries, see Edward G. Ruestow, *The Microscope in the Dutch Republic: The Shaping of Discovery* (Cambridge University Press, 1996), especially pp. 116–20, 137–45, 166–7, 219–20; for Bartram and Quaker strands of natural theology, see Thomas P. Slaughter, *The Natures of John and William Bartram* (New York: Alfred A. Knopf, 1996), especially chap. 3 (quoting pp. 62–3); for Linnaeus and Leibniz, see remarks in Brooke, *Science and Religion,* pp. 160–3, 197, 231–4 (quoting pp. 162, 197, 232); Lisbet Koerner, *Linnaeus: Nature and Nation* (Cambridge, MA: Harvard University Press, 1999); and Sten Lindroth, "The Two Faces of Linnaeus," in Tore Frängsmyr (ed.), *Linnaeus: The Man and His Work* (Canton, MA: Science History Publications, 1994; orig. publ. 1983), pp. 1–62, especially pp. 11–16.

[10] Joseph Priestley, *The History and Present State of Electricity,* 2 vols., 3rd ed. (London, 1775), vol. 1, p. xxiii.

natural-theological idiom was not strong in that setting, other resources were available to display the superior virtue of the man of science. Many of the more than two hundred eloges composed by Bernard le Bovier de Fontenelle (and his successors Jean-Jacques Dortous de Mairan, Jean-Paul Grandjean de Fouchy, and the Marquis de Condorcet) from 1699 to 1791 drew upon Stoic and Plutarchan tropes to establish both the special moral qualities possessed by those drawn to science and the additional virtues that a life dedicated to scientific truth encouraged in its devotees.[11]

Like many of Plutarch's Greek and Roman heroes, Fontenelle's eighteenth-century men of science were described as embodiments of Stoic fortitude and self-denial. The life of science held out few prospects of material reward and little hope for fame, honor, and the applause of the polite and political worlds. The dedication to truth that drew men to such a life was made manifest by neglect of self and of material self-interest, and by a disregard for public favor and approval. Such power as men of science came to possess was not vaingloriously sought but rather was thrust upon them by patrons who often wanted the material goods understood to flow from scientific knowledge. Moreover, even in the absence of a pronounced natural-theological idiom, it was repeatedly said that the life spent in pursuit of natural knowledge tended to make men humble, serious, simple, and sincere. The immensity, grandeur, and sublimity of nature made modest those who studied it, as did the awareness of the little that was securely known about nature as compared with the vastness of what remained to be known. Sincerity, candor, tranquility, and contentment were naturally instilled in men who lived for the love of nature's truth.[12]

By the 1770s these sentiments were supplemented by Condorcet's Renaissance-humanist preferences for a life of action and civic benevolence. The man of science, in Condorcet's picture, had the capacity to benefit the public realm both materially and spiritually. Condorcet's eloge of Benjamin Franklin accordingly celebrated both Franklin's technological ingenuity and the political reformism that was reckoned to flow from the very nature of modern scientific inquiry. Science would at once produce technological change

[11] For these éloges, see especially Charles B. Paul, *Science and Immortality: The Éloges of the Paris Academy of Sciences (1699–1791)* (Berkeley: University of California Press, 1980), on which the following paragraphs largely rely, and, for Georges Cuvier's éloges of the late eighteenth and early nineteenth centuries, see Dorinda Outram, "The Language of Natural Power: The Funeral *Éloges* of Georges Cuvier," *History of Science,* 18 (1978), 153–78. For important treatment of eighteenth- and early nineteenth-century debates over the virtue and mental capacities of Isaac Newton, see Richard Yeo, "Genius, Method, and Morality: Images of Newton in Britain, 1760–1860," *Science in Context,* 2 (1988), 257–84.

[12] In Scotland, Adam Smith was greatly impressed with Fontenelle's eloges. *The Theory of Moral Sentiments* (1759) endorsed the Parisian celebration of mathematicians' and natural philosophers' "amiable simplicity of . . . manners." Their "tranquillity" and their indifference to public opinion flowed from an inner assurance that their claims were both true and important. The same could not be said of "poets and fine writers": Adam Smith, *The Theory of Moral Sentiments,* eds. D. D. Raphael and A. L. Macfie (Oxford: Clarendon Press, 1976), pp. 124–6.

and encourage those mental and moral attributes that would naturalize rational industrial society. "Forever free amidst all manners of servitude, the sciences," Condorcet wrote in the year after the storming of the Bastille, "transmit to their practitioners some of their essence of independence or either fly from countries ruled by arbitrary power or gently prepare the revolution that will eventually destroy it."[13]

The image of the selfless man of science, offering much to the nation and neither receiving nor expecting to receive much in return, was lent credibility by some recognized social circumstances affecting scientific work. In the eighteenth century, as in the seventeenth, a decision to pursue many forms of scientific learning might well be taken against plausible calculations of material self-interest, and often against strong parental wishes or directions. For those lacking independent means, the professions of law, religion, and medicine were understood to ensure an honest and legitimate living. Very many eighteenth-century men of science chose their calling against their fathers' encouragement toward a career at the bar or in the church; in maturity, others managed to combine scientific research with at least nominal legal, administrative, or clerical careers; and many others managed the much easier combination of science and medicine. But social respectability was only dubiously associated with the calling of the practical mathematician or engineer, and it was difficult to envisage clear remunerative and polite career prospects for the physicist, the geographer, the naturalist, or, to a lesser extent, for the astronomer.

If one were battling to rise from the lower orders – as, for example, were the electrician Stephen Gray, the chemist John Dalton, and the geologist William Smith – a career as scientific lecturer, author, or technical consultant might have both its material and its social attractions. If one possessed independent means freeing him from material concerns – as did, for example, the naturalists the Comte de Buffon, the Earl of Bute, and Sir Joseph Banks, the physicist Henry Cavendish, and the geological chemist Sir James Hall – one could afford to adopt an insouciant attitude toward remuneration, toward orthodox notions of cultural respectability, and even toward scientific authorship and the public assertion of property in intellectual goods.[14] But for many in middling social circumstances – from younger sons of the aristocracy to the offspring of the professional and mercantile classes – scientific

[13] Condorcet's éloge of Franklin (read 13 November 1790), quoted in Paul, *Science and Immortality,* p. 67; see also Roger Hahn, *The Anatomy of a Scientific Institution: The Paris Academy of Sciences, 1666–1803* (Berkeley: University of California Press, 1971), p. 165; Keith M. Baker, *Condorcet: From Natural Philosophy to Social Mathematics* (Chicago: University of Chicago Press, 1975), especially pp. 293–9.

[14] Porter, "Gentlemen and Geology," p. 815, incisively notes "the lack of pressure to publish" bearing on gentlemen-geologists in the eighteenth century. Indeed, gentlemen-amateurs often worried about the gentility of "appearing in the character of an author." See also David P. Miller, "'My Favourite Studdys': Lord Bute as Naturalist," in Karl W. Schweizer (ed.), *Lord Bute: Essays in Reinterpretation* (Leicester: Leicester University Press, 1988), pp. 213–39, at pp. 215, 218.

inquiry would have to be combined with an adequately remunerated professional or public life. There were many such possible hybrid forms of life in the eighteenth century beyond those attached to the universities and the learned professions: Antoine Laurent Lavoisier famously served as a "tax-farmer"; Leibniz and Johann Wolfgang von Goethe were government officials; Charles Augustin Coulomb worked as a military and civil engineer; and the young Alexander von Humboldt was both a diplomat and a supervisor of mining. For those of intermediate social standing a decision to devote oneself solely or mainly to scientific scholarship might be understood – against this background – as testimony to a particularly selfless and wholehearted kind of dedication. Fontenelle's eloge of the mathematician Michel Rolle notably asserted that "there is between science and wealth an old and irreconcilable distinction," and Condorcet's eloge of another mathematician, Etienne Bézout, explained why his family opposed the young man's scientific vocation: "A father . . . knows that education and enlightenment lead neither to honour nor to fortune." What could account for a commitment to science other than a genuine vocation?[15]

## THE POLITE PHILOSOPHER OF NATURE

The same images of vocation, dedication, and detachment that testified to the virtue of the eighteenth-century man of science also constituted a potential handicap to his unconditional membership in polite society and to that society's approval of his activities. Since antiquity, the line between virtuous, holy, or learned disengagement from the conventions of everyday society, on the one hand, and culpable incivility, on the other, had always been subject to contest and conflict. Did the philosopher or learned man fall under the compass of civil and polite society, or did he play by different rules – rules that excused him from obeying society's obligations and expectations? Should the philosophical "citizen of the world" be exempted – wholly or partly – from the responsibilities of mundane citizenship?[16]

Such an exemption created a special cultural space in which the learned

[15] Quoted in Roger Hahn, "Scientific Careers in Eighteenth-Century France," in Maurice Crosland (ed.), *The Emergence of Science in Western Europe* (London: Macmillan, 1975), pp. 127–38, on pp. 131–2. Hahn importantly points out (ibid., p. 131) that even in the highly "professionalized" eighteenth-century French setting – where state support of science was at a far higher level than it was in Britain or even Germany – *very* few members of the Paris Academy of Sciences could expect to make a living solely from their state stipends or pensions: "A serious gap existed between what historians refer to proudly as funded government sponsorship of French science, and the life of the individual scientist." For treatment of these issues in the French context, see also Paul, *Science and Immortality,* pp. 69–85, and Maurice Crosland, "The Development of a Professional Career in Science in France," in Crosland (ed.), *The Emergence of Science in Western Europe,* pp. 139–59 (for changes and continuities on either side of the Revolution).

[16] These questions are discussed in Steven Shapin, "'The Mind Is Its Own Place': Science and Solitude in Seventeenth-Century England," *Science in Context,* 4 (1991), 191–218.

man could be recognized and valued, but at the same time it posed a problem for the relations between scholarly society and its civil, gentle, court, or mercantile counterparts. These possibilities and problems were not peculiar to the man of science – in general form they also applied to the logician, rhetorician, and theologian, and to philosophers not primarily concerned with the natural order – although the predicament of the man of science was subject to some special tensions during the course of the Scientific Revolution and Enlightenment.

Seventeenth-century "modern" critics of Scholastic knowledge insisted on its barrenness just as they condemned Scholastic society for its incivility. Criticisms of knowledge and of social forms were strongly linked: the schoolmen's wrangling was said to be so ferocious because – as the current quip has it – so little was at stake. If their inquiries had solid intellectual substance on which to feed, and if the veracity of their claims could be made manifest, then wrangling would truly come to an end. Such moderns as Bacon, Descartes, Hobbes, and Boyle proposed to remedy wrangling through both conceptual and methodological reform. Mechanical metaphors and micro-mechanical explanations might link the natural to the artificial and the natural philosopher to the world of mechanical artifice, thus subjecting intellectual abstraction to the discipline of the concrete and the intelligibly contrived. Correct method would discipline philosophical process and judgment by eliminating or mitigating the role of subjectivities, passions, interests, and cultural conventions. The result would be a new natural philosophy whose products were socially useful and whose practitioners were suitable for membership in civil society. Empirical and experimental methods – favored by the English – would replace Aristotelian "learned gibberish" and dogmatic arrogance with work, fact, and lowered norms of natural-philosophical certainty. Rational methods – preferred by the French – would bind dissension in iron chains of logic, and they were advertised as no less capable of producing useful outcomes. A new utility would rightly attract the esteem of the state and of civil society; a new civility would make the practitioners of natural knowledge fit for the drawing room and the salon.

Such were the claims made by and on behalf of the practitioners of reformed science in the late seventeenth and early eighteenth centuries. Tracing the credibility and consequences of these claims through the eighteenth century is, however, no simple matter. To some extent, natural knowledge had always had a place in courtly and commercial society, and it continued to enjoy that place through the eighteenth century. Wonder, weapons, gadgets, glory, and natural legitimations had long been social desiderata, and these goods might be supplied at least as visibly and efficiently by eighteenth-century scientific practitioners as by their predecessors. Seventeenth-century wondermongers such as Athanasius Kircher and keepers of curious cabinets such as Ulisse Aldrovandi had their eighteenth-century counterparts in such itinerant scientific demonstrators and electrical showmen as Benjamin Martin, Pierre

Polinière, and the Abbé Jean Antoine Nollet, just as Franz Anton Mesmer's spectacular late-eighteenth-century presentation of self was similar to that of the Renaissance theatrical therapist Paracelsus.[17]

Galileo established his practical value to the early seventeenth-century Florentine court with the military compass and the telescope, and his symbolic value through the discovery and naming of the "Medicean stars."[18] To centralizing and imperialist nation-states, his eighteenth-century successors promised – and in many cases delivered – an expanded range of aids to power and glory: cosmological legitimation (as before) but also solutions to the problem of longitude; reliable maps of new colonies; primary surveys of domestic and colonial flora and fauna and techniques for transplanting them around the world; improved agricultural, chemical, ceramic, mining, and metallurgical techniques; better ships, better guns, healthier seamen; and even perpetual motion machines.[19]

[17] For Kircher and Aldrovandi, see Paula Findlen, *Possessing Nature: Museums, Collecting, and Scientific Culture in Early Modern Italy* (Berkeley: University of California Press, 1994); see also Krzystof Pomian, *Collectors and Curiosities: Paris and Venice, 1500–1800* (Cambridge: Polity Press, 1990), for contests over the legitimacy of curiosity. For eighteenth-century electricians and natural philosophical showmen, see, e.g., J. L. Heilbron, *Electricity in the 17th and 18th Centuries: A Study of Early Modern Physics* (Berkeley: University of California Press, 1979); Simon Schaffer, "Natural Philosophy and Public Spectacle in the Eighteenth Century," *History of Science,* 20 (1983), 1–43; Schaffer, "The Consuming Flame: Electrical Showmen and Tory Mystics in the World of Goods," in John Brewer and Roy Porter (eds.), *Consumption and the World of Goods* (London: Routledge, 1993), pp. 489–526; Schaffer, "Augustan Realities: Nature's Representatives and Their Cultural Resources in the Early Eighteenth Century," in George Levine (ed.), *Realism and Representation: Essays on the Problem of Realism in Relation to Science, Literature, and Culture* (Madison: University of Wisconsin Press, 1993), pp. 279–318; Roy Porter, "Science, Provincial Culture and Public Opinion in Enlightenment England," *British Journal for Eighteenth-Century Studies,* 3 (1980), 20–46; Geoffrey V. Sutton, *Science for a Polite Society: Gender, Culture, and the Demonstration of Enlightenment* (Boulder, CO: Westview Press, 1995), chaps. 6, 8 (for Polinière and Nollet); Alan Q. Morton (ed.), *Science Lecturing in the Eighteenth Century,* Special Issue of *British Journal for the History of Science,* 28 (March 1995); Alan Q. Morton and Jane Wess, *Public & Private Science: The King George III Collection* (Oxford: Oxford University Press, 1993), chap. 2; Stephen Pumfrey, "Who Did the Work? Experimental Philosophers and Public Demonstrations in Augustan England," *British Journal for the History of Science,* 28 (1995), 131–56; and Larry Stewart, "Public Lectures and Private Patronage in Newtonian England," *Isis,* 77 (1986), 47–58. For Mesmer, see Robert Darnton, *Mesmerism and the End of the Enlightenment in France* (Cambridge, MA: Harvard University Press, 1968).

[18] Mario Biagioli, *Galileo, Courtier: The Practice of Science in the Culture of Absolutism* (Chicago: University of Chicago Press, 1993).

[19] For case studies of eighteenth-century cosmological legitimation, see Steven Shapin, "Of Gods and Kings: Natural Philosophy and Politics in the Leibniz-Clarke Disputes," *Isis,* 72 (1981), 187–215; Simon Schaffer, "Authorized Prophets: Comets and Astronomers after 1759," *Studies in Eighteenth-Century Culture,* 17 (1987), 45–74; Schaffer, "Newton's Comets and the Transformation of Astrology," in Patrick Curry (ed.), *Astrology, Science and Society: Historical Essays* (Woodbridge: Boydell and Brewer, 1987), pp. 219–43; and, for speculations about national variation in requirements for cosmological legitimation, see Mario Biagioli, "Scientific Revolution, Bricolage, and Etiquette," in Roy Porter and Mikuláš Teich (eds.), *The Scientific Revolution in National Context* (Cambridge University Press, 1992), pp. 11–54, at pp. 24–25. For science and naval medicine, see Christopher J. Lawrence, "Disciplining Disease: Scurvy, the Navy, and Imperial Expansion, 1750–1825," in David Philip Miller and Peter Hanns Reill (eds.), *Visions of Empire: Voyages, Botany, and Representations of Nature* (Cambridge University Press, 1996), pp. 80–106. For astronomy and the problem of longitude, see, e.g., David W. Waters, "Nautical Astronomy and the Problem of Longitude," in John G. Burke (ed.), *The Uses of Science in the Age of Newton* (Berkeley: University of California Press, 1983),

So utilitarian images of the man of science were nothing new in the eighteenth century, although the last section of this chapter picks out some subtle and incremental changes affecting these images through this period. Nor was it novel for eighteenth-century advocates to insist that natural knowledge had a proper place in polite culture as supplier of wonders and conversation pieces. Practitioners of natural knowledge in the eighteenth century could still supply marvels, delight, and edifying instruction to polite society. What was new in the early eighteenth century was the insistence that a particular reformed version of natural philosophy had eliminated the disputatious, along with the pedantic, tendencies that had for so long disqualified the scientific practitioner from membership in polite society and his knowledge from a central place in its culture.

From the culture of the mid-seventeenth-century *précieuses* to that of the eighteenth-century *salonnières,* French scientific savants enjoyed some success in making the case for the contribution of science to *politesse* and for the man of (reformed) science as a valued member of polite society. It was, as Geoffrey Sutton nicely puts it, "the philosopher's *honnêteté,* the naturalist's *politesse,* that brought science into elite society" during the last quarter of the seventeenth century and that – together with the developing institutions of natural-philosophical entertainment – sustained the place it had achieved there into the eighteenth century. The presence of significant numbers of women in French places of scientific conversation, entertainment, and instruction was taken as testimony to the innocuousness, and even the politeness, of scientific culture. The Abbé Nollet told potential auditors of his demonstration-lectures that "the path had been cleared by people of condition and merit so respectable" that, as Sutton notes, "no woman needed [to] fear for her reputation by enrolling in the course." By the mid-1730s Madame du Châtelet wrote to a friend that Nollet's lectures were attracting "the carriages of duchesses, peers, and lovely women."[20]

pp. 143–69. For natural history in connection with both utility and politeness, see John Gascoigne, *Joseph Banks and the Enlightenment: Useful Knowledge and Polite Culture* (Cambridge University Press, 1994), and especially Gascoigne, *Science in the Service of Empire: Joseph Banks, the British State and the Uses of Science in the Age of Revolution* (Cambridge University Press, 1998). For perpetual motion devices, see Simon Schaffer, "The Show that Never Ends: Perpetual Motion in the Early Eighteenth Century," *British Journal for the History of Science,* 28 (1995), 157–89. For a range of studies of eighteenth-century science, technology, and the culture of utility, see, e.g., Larry Stewart, *The Rise of Public Science: Rhetoric, Technology and Natural Philosophy in Newtonian Britain, 1660–1750* (Cambridge University Press, 1992), especially pts. 2–3; Jan Golinski, *Science as Public Culture: Chemistry and Enlightenment in Britain, 1760–1820* (Cambridge University Press, 1992); Karl Hufbauer, *The Formation of the German Chemical Community (1720–1795)* (Berkeley: University of California Press, 1982); Myles W. Jackson, "Natural and Artificial Budgets: Accounting for Goethe's Economy of Nature," *Science in Context,* 7 (1994), 409–31; Steven Shapin, "The Audience for Science in Eighteenth Century Edinburgh," *History of Science,* 12 (1974), 95–121 (for agriculture); and Ken Alder, *Engineering the Revolution: Arms and Enlightenment in France, 1763–1815* (Princeton, NJ: Princeton University Press, 1997).

[20] Sutton, *Science for a Polite Society,* pp. 141, 225 (for Nollet and Châtelet); see also Anne Goldgar, *Impolite Learning: Conduct and Community in the Republic of Letters, 1680–1750* (New Haven, CT: Yale University Press, 1995), for the Huguenot scholarly diaspora after the Revocation of the Edict of

But this central role for the man of science in polite society remained rather more an aspiration than a substantial reality in the eighteenth century. Even in France, where the case was more effectively put than elsewhere, the claims of reformed science to an important place in polite culture were not overwhelmingly successful: civil history, *belles-lettres,* rhetoric, ancient and modern languages, genealogy, antiquarianism, geography, and chorography remained far more significant than natural science as polite studies. And in Britain the notion of polite science attracted much skepticism and even ridicule.[21] For one thing, members of polite society could rarely be relied on to observe and appreciate the distinction between reformed science and the Scholastic practice it was supposed to have supplanted. Even if the superior civic virtues of the modern man of science were evident, it was necessary for polite society to encounter such men and to mark the difference in character. The buildup of such patterns of familiarity took time. Eighteenth-century British courtesy texts frequently, and tellingly, missed the distinction between Scholastic and mechanically reformed natural knowledge: it was all metaphysical, all obscure, and all irrelevant to mundane affairs. So far as such handbooks were concerned, the seventeenth-century Scientific Revolution had never happened and the changes that this Revolution was supposed to have effected in the fitness of the man of science for polite society were not worth noticing.[22]

To be sure, those who fashioned polite British opinion occasionally went

Nantes; Dena Goodman, "Enlightenment Salons: The Convergence of Female and Philosophic Ambitions," *Eighteenth-Century Studies,* 22 (1989), 329–50; James A. Secord, "Newton in the Nursery: Tom Telescope and the Philosophy of Tops and Balls, 1761–1838," *History of Science,* 23 (1985), 127–51 (for science texts written for the children of the British polite classes); and Alice N. Walters, "Conversation Pieces: Science and Politeness in Eighteenth-Century England," *History of Science,* 35 (1997), 121–54 (for polite science in English domestic settings), especially pp. 130–6 (for women's participation).

[21] For the importance of literary and antiquarian studies even within the eighteenth-century Royal Society of London, see David P. Miller, "'Into the Valley of Darkness': Reflections on the Royal Society in the Eighteenth Century," *History of Science,* 27 (1989), 155–66. Even a late seventeenth-century partisan of reformed science like John Locke was only lukewarm about the place of any form of natural philosophy in the education of a gentleman: see John Locke, *Some Thoughts Concerning Education* (Cambridge University Press, 1899; orig. publ. 1690), pp. 74, 129, 153. The Earl of Chesterfield's detailed mid-eighteenth-century directions for his son's studies mention scientific subjects only very rarely and fleetingly, recommending a few hours turning the pages of a popular astronomy text and the acquisition of "a general knowledge" of practical mathematics relevant to fortification: Chesterfield to his son, 6 December 1748 and 27 April 1749, in Chesterfield, *Letters,* vol. 1, pp. 143–4, 173. Nor did even Joseph Priestley, advocating "a new and better furniture of mind" for those actively engaged in the emerging industrial order, recommend education in the natural sciences for any gentlemen save those whose business might come specially to require the pertinent specialized knowledge: Priestley, "An Essay on a Course of Liberal Education for Civic and Active Life," in John A. Passmore (ed.), *Priestley's Writings on Philosophy, Science, and Politics* (London: Collier-Macmillan, 1965; essay orig. publ. 1765), pp. 285–304, at pp. 286, 294–5.

[22] See, for example, William Darrell, *The Gentleman Instructed, in the Conduct of a Virtuous and Happy Life . . . Written for the Instruction of a Young Nobleman . . . ,* 8th ed. (London, 1723; orig. publ. 1704–12), p. 15; see also Adam Petrie, *Rules of Good Deportment, or of Good Breeding* (Edinburgh, 1720), pp. 46, 58. For early eighteenth-century polite skepticism about the virtues of the reformed man of science, see Steven Shapin, "'A Scholar and a Gentleman,'" *History of Science,* 29 (1991), 279–327.

on record approving the study of nature. Polite people might have drawn polite lessons from nature, although whether these lessons were widely available is doubtful. Joseph Addison and Richard Steele's *The Spectator,* for example, insisted that

> a man of polite imagination is let into a great many pleasures that the Vulgar are not capable of receiving. . . . It gives him, indeed, a kind of property in every thing he sees, and makes the most rude uncultivated parts of nature administer to his pleasures: So that he looks upon the world, as it were, in another light, and discovers in it a multitude of charms, that conceal themselves from the generality of mankind.[23]

Yet almost all influential eighteenth-century British commentators on genteel society and manners worried about the effect on polite conversation of too great a commitment to formal, systematic, and "speculative" learning. Such learning – of whatever sort – was liable to stimulate pedantry, dogma, obscurity, and the spirit of contention; the Earl of Chesterfield warned that "deep learning is generally tainted with pedantry, or at least unadorned by manners."[24] Some writers picked out the special troubles introduced into polite society by those who made either the minute or the systematically speculative investigation of nature their particular study. The proper study of mankind was not stars or starfish, but man.

Early eighteenth-century wits ridiculed the Royal Society's virtuosi and philosophers for mucking around with "the very dregs of Nature." Boyle's swilling about in human urine and feces to extract phosphorus and Leeuwenhoek's investigations into the globular structure of mouth-slime elicited a polite retch reflex as well as a smirk.[25] *The Tatler* worried that those who made minute, trivial, and "despicable" phenomena their objects of study would themselves become debased and coarsened. Nature offered for study both the immense and the minute, and polite society was concerned that scientific

[23] Joseph Addison, *The Spectator,* 21 June 1712, in Addison, *Essays of Joseph Addison,* ed. Sir James George Frazer, 2 vols. (London: Macmillan, 1915), vol. 2, p. 180. For Dr. Johnson's (very general) endorsement of philosophically modest Baconian practices, see Richard B. Schwartz, *Samuel Johnson and the New Science* (Madison: University of Wisconsin Press, 1971), especially pp. 68–73 (for his biographical essays on Sydenham and Boerhaave) and pp. 125–45 (for his approval of physico-theology).

[24] Chesterfield to his son, 12 September 1749, in Chesterfield, *Letters,* vol. 1, p. 206. Chesterfield singled out Maupertuis as a type "one rarely meets with, deep in philosophy and mathematics, and yet *honnête et amiable*" (4 October 1752, in ibid., vol. 2, p. 133), but Chesterfield also offered his son the instructive example of the Earl of Macclesfield, whose astronomical and mathematical expertise was bested in public argument over calendar reform by the superior rhetorical skills of Chesterfield himself, no mathematician at all (18 March 1751, in ibid., vol. 1, p. 394). For Continental criticism of English culture for its lack of "lofty speculation," and for English defense of "coffee table philosophy," see Roy Porter, "The Enlightenment in England," in Porter and Mikuláš Teich (eds.), *The Enlightenment in National Context* (Cambridge University Press, 1981), pp. 1–18, especially pp. 5–6.

[25] William King, "Useful Transactions in Philosophy, and Other Sorts of Learning . . . ," in King, *Original Works,* vol. 2, pp. 57–178 (orig. publ. 1709), on pp. 98–99 (for Boyle's phosphorus); 103–14, 121–5 (for Leeuwenhoek); 135 (for dregs); King, "A Journey to London, In the Year 1698. After the Ingenious Method of that made by Dr. Martin Lister to Paris . . . ," ibid. (orig. publ. 1699), vol. 1, p. 198 (for cats in air-pumps).

scholars had too long made too much of too little.[26] Chesterfield agreed: Fontenelle's popular astronomy was to be preferred to the works of the "insect-mongers, shell-mongers, and pursuers and driers of butterflies."[27] So did the Earl of Shaftesbury: there was nothing about learning in itself that disqualified it from a proper place in the furnishing of a gentleman, but when

> our speculative genius and minute examiner of Nature's works proceeds with equal or perhaps superior zeal in the contemplation of the insect life, the conveniencies, habitations, and economy of a race of shell-fish; . . . he then indeed becomes the subject of sufficient raillery, and is made the jest of common conversations.[28]

The worry here fastened on the effects of scientific inquiry in its minute mode, but many late-eighteenth-century English critics rejected both the pertinence and the propriety of investigating nature, however it was performed and on whatever aspects it happened to focus.[29] The "abstruseness" complained of in both minute and speculative philosophy was added to in the course of the eighteenth century by increasing specialization in almost all the sciences, thereby putting additional pressure on the very idea of the polite man of science taking his conversational part in the general culture. Some societies – notably the Scots – worried about this specialization and its fragmenting effects on social solidarity; others – for example, the French and the Germans – seemed more relaxed about it.[30] The divorce between "the two cultures" was by no means irrevocable by the end of the eighteenth century – a common context significantly endured in many domains – but the withdrawal of the man of science from the general conversation was then well under way. One could not have a polite conversation with an author one could not understand; one could only be lectured at.[31] During the eighteenth century no version of the character of the man of science was immune to polite imputations of abstruseness, pedantry, and incivility. "Nothing," wrote the mental philosopher

[26] *The Tatler,* 10–12 January 1709/10, 24–26 August 1710, in Joseph Addison and Richard Steele, *The Tatler,* ed. George A. Aitken, 4 vols. (London: Duckworth, 1898), vol. 3, p. 31; vol. 4, p. 110.

[27] Chesterfield to his son, 6 December 1748, in Chesterfield, *Letters,* vol. 1, pp. 143–4, and, for the particular polite qualifications of astronomy, see Walters, "Conversation Pieces," pp. 124–7.

[28] Anthony Ashley Cooper, 3rd Earl of Shaftesbury, *Characteristics of Men, Manners, Opinions, Times,* ed. John M. Robertson, two vols. in one (Indianapolis: Bobbs-Merrill, 1964; orig. publ. 1711), vol. 2, p. 253. See also Lawrence E. Klein, *Shaftesbury and the Culture of Politeness: Moral Discourse and Cultural Politics in Early Eighteenth-Century England* (Cambridge University Press, 1994), especially chap. 1, and Walters, "Conversation Pieces," pp. 122–3, 126.

[29] See Joseph M. Levine, *Dr. Woodward's Shield: History, Science, and Satire in Augustan England* (Berkeley: University of California Press, 1977), p. 125.

[30] For Scottish anxiety about scientific specialization – continuing into the nineteenth century – see, e.g., George Elder Davie, *The Democratic Intellect: Scotland and Her Universities in the Nineteenth Century* (Edinburgh: Edinburgh University Press, 1961), pt. 2; Shapin, "Audience for Science in Eighteenth Century Edinburgh," especially pp. 99–101, 115–16; and Shapin, "Brewster and the Edinburgh Career in Science," in A. D. Morrison-Low and J. R. R. Christie (eds.), *'Martyr of Science': Sir David Brewster 1781–1868* (Edinburgh: Royal Scottish Museum, 1984), pp. 17–23.

[31] Secord, "Newton in the Nursery," pp. 143–6.

David Hartley, "can easily exceed the Vain-glory, Self-conceit, Arrogance, Emulation, and Envy, that are found in the eminent Professors of the Sciences, Mathematics, [and] Natural Philosophy."[32]

So the image of the polite man of science was indeed systematically presented to gentlemanly society for its acceptance during the eighteenth century. These presentations were part of concerted attempts to justify aspects of scientific inquiry and to show its congruence with the norms and conventions of genteel society. Looked at from the point of view of polite society, however (and especially from its English forms), the credibility of such presentations during the course of the eighteenth century was limited. Yet both the definition and the legitimacy of polite culture were being contested throughout the century. There were major attempts to redefine what it was to be authentically polite, and there were also attempts to reject polite values as a whole. Notions of what science was, what science was for, and who the man of science was all figured in these efforts.

From the late seventeenth century onward, radical "deists" and "freethinkers" appropriated mechanical conceptions of nature to subvert the civic and ecclesiastical hierarchies whose support was one of the explicit purposes of such earlier natural philosophers as Mersenne, Gassendi, Boyle, Ray, and Newton. Natural knowledge was a resource sufficiently plastic in its interpretation to find uses in undermining as well as buttressing existing social inequalities.[33] Hence, the character of the man of science as champion of orthodoxy was joined during the course of the century by the impolite man of science as hero of social reform or revolution, or as antihero of social subversion. In France, Jacobin radicals harvested the crop earlier sown by the *philosophes* and encyclopedists. When science became a tool of ancien régime power, hitherto innocuous images of an open and egalitarian Republic of Science could come to have real political bite.[34] Accordingly, Marat's friend, the radical journalist Jacques-Pierre Brissot, turned the tables on the exclusivity of the Paris Academy in his 1782 book *De la Vérité:*

[32] David Hartley, *Observations on Man,* 2 vols. (London, 1749), vol. 2, p. 255; see also Porter, "The Enlightenment in England," 14–15.

[33] For the implication of cosmological ideas in these contests, see, e.g., Margaret C. Jacob, *The Newtonians and the English Revolution 1689–1720* (Ithaca, NY: Cornell University Press, 1976); Jacob, *The Radical Enlightenment: Pantheists, Freemasons, and Republicans* (London: Allen & Unwin, 1981); Jacob, *Living the Enlightenment: Freemasonry and Politics in Eighteenth-Century Europe* (New York: Oxford University Press, 1991); see also Steven Shapin, "Social Uses of Science," in G. S. Rousseau and Roy Porter (eds.), *The Ferment of Knowledge: Studies in the Historiography of Eighteenth-Century Science* (Cambridge University Press, 1980), pp. 93–139; Shapin, "Of Gods and Kings"; and C. B. Wilde, "Hutchinsonianism, Natural Philosophy and Religious Controversy in Eighteenth Century Britain," *History of Science,* 18 (1980), 1–24.

[34] Charles Coulston Gillispie, "The *Encyclopédie* and the Jacobin Philosophy of Science: A Study in Ideas and Consequences," in Marshall Clagett (ed.), *Critical Problems in the History of Science* (Madison: University of Wisconsin Press, 1959), pp. 255–89; see also Hahn, *The Anatomy of a Scientific Institution,* chap. 5.

> The empire of science can know neither despots, nor aristocrats, nor electors. . . . To admit a despot, aristocrats, or electors who by edicts set a seal upon the products of geniuses is to violate the nature of things and the liberty of the human mind. It is an affront to public opinion which alone has the right to crown genius.[35]

Who needed the sober method and the arduously acquired expertise of the academies and schools when conceptions of innate and intuitive genius could be touted as guarantors of philosophic truth? In 1793 the Republic's Committee of Public Instruction followed Brissot in announcing that "true genius is almost always *sans culotte,*" implying, as Simon Schaffer has written, that genius had been both collectivized and democratized.[36]

English apologists for social stability or for gradual and organic change reckoned that they had learned the lesson: mechanical and experimental philosophy was both protean and powerful; it was likely to do as much social harm as good. Proper science could indeed support proper social order, but the Revolution was, in Edmund Burke's view, rationalism and speculative philosophy gone mad, bad, and dangerous: those who concocted the new French constitution had "much, but bad, metaphysics; much, but bad, geometry; much, but false, proportionate arithmetic."[37] The "wild gas" and the "fixed air" that Burke said were now let loose in France had, in his view, been manufactured domestically as well and, unless vigilance was exercised, were likely to wreak similar effects in Britain.[38]

Burke and his allies marked the radical intellectual egalitarianism and the radical antiauthoritarianism in, for example, these pronouncements of Joseph Priestley: "Any man has as good a power of distinguishing truth from falsity as his neighbours"; "This rapid progress of knowledge will, I doubt not, be the means under God of extirpating all error and prejudice, and of putting an end to all undue and usurped authority in the business of religion as well as of science"; and "The English hierarchy (if there be anything unsound in its constitution) has . . . reason to tremble even at an air pump or an electrical machine."[39] The pneumaticist Thomas Beddoes joined Priestley on a Home

[35] Jacques-Pierre Brissot de Warville, *De la Vérité* . . . (Neufchâtel, 1782), pp. 165–6, quoted in Hahn, *The Anatomy of a Scientific Institution,* p. 153.

[36] Simon Schaffer, "Genius in Romantic Natural Philosophy," in Andrew Cunningham and Nicholas Jardine (eds.), *Romanticism and the Sciences* (Cambridge University Press, 1990), pp. 82–98, on p. 85.

[37] Edmund Burke, *Reflections on the Revolution in France,* ed. Conor Cruise O'Brien (Harmondsworth: Penguin, 1986; orig. publ. 1790), p. 296.

[38] Burke, *Reflections,* p. 90. For Burke against Priestley, see Golinski, *Science as Public Culture,* pp. 176–87, and Maurice Crosland, "The Image of Science as a Threat: Burke versus Priestley and the 'Philosophical Revolution,'" *British Journal for the History of Science,* 20 (1987), 277–307.

[39] Joseph Priestley, *An Examination of Dr Reid's Enquiry into the Human Mind on the Principles of Common Sense* (London, 1774), p. 74, and Priestley, *Experiments and Observations on Different Kinds of Air,* 3 vols. (London, 1774–77), vol. 1, p. xiv (both quoted in Dorinda Outram, "Science and Political Ideology, 1790–1848," in R. C. Olby et al. (eds.), *Companion to the History of Modern Science* (London: Routledge, 1990), pp. 1008–23, at p. 1017); see also Schaffer, "Genius in Romantic Natural

Office list of "Disaffected & seditious persons," likely by his radical teaching to seduce the youth of Oxford.[40] Yet Burke had less to fear from radically impolite British men of science than he thought. Although there were some republican appropriations of science by working-class English Jacobins from the onset of the Revolution to the end of the Napoleonic Wars, effective Home Office policing kept subversion at bay while those members of the British middle classes concerned at all with scientific culture mobilized it less as a subversive resource than as an element in a new conception of what politeness should be.[41]

During the eighteenth century, developments largely outside the two English universities and such metropolitan centers of power as the Royal Society had been gradually drawing science into the heart of an emerging new culture that offered a reformed understanding of what genuine politeness was. Excluded from Oxford, Cambridge, and many traditional venues of professional and political power, English Dissenters – Unitarians, Quakers, Methodists, other nonconforming Protestants and Catholics – developed their own educational institutions and cultural forums. The "dissenting academies" taught scientific subjects and employed notable men of science such as Joseph Priestley and John Dalton to teach them.[42] Informally constituted provincial conversation groups, bringing together progressive Dissenting industrialists and men of science, sprang up from mid-century, their distribution roughly following the contours of industrialization. The Lunar Society of Birmingham (founded in the 1760s) included, among others, Joseph Priestley, the steam engine manufacturers Matthew Boulton and James Watt, the potter Josiah Wedgwood, the physician and chemical manufacturer James Keir, and the

Philosophy," pp. 89–90 (for Priestley and Kant on the distribution of philosophic genius); Robert Schofield, *The Enlightenment of Joseph Priestley: A Study of His Life and Work from 1733 to 1773* (University Park: Pennsylvania State University Press, 1998).

[40] Quoted in Trevor H. Levere, "Dr. Thomas Beddoes at Oxford: Radical Politics in 1788–1793 and the Fate of the Regius Chair in Chemistry," *Ambix,* 28 (1981), 61–9, at p. 65. For Beddoes, science, and radical politics, see also Levere, "Dr. Thomas Beddoes (1750–1808): Science and Medicine in Politics and Society," *British Journal for the History of Science,* 17 (1987), 187–204; Dorothy A. Stansfield, *Thomas Beddoes M.D. 1760–1808: Chemist, Physician, Democrat* (Dordrecht: D. Reidel, 1984); Roy Porter, *Doctor of Society: Thomas Beddoes and the Sick-Trade in Late-Enlightenment England* (London: Routledge, 1992); and Golinski, *Science as Public Culture,* chap. 6.

[41] For a relevant survey, see Ian Inkster, "Introduction: Aspects of the History of Science and Science Culture in Britain, 1780–1850," in Inkster and Jack Morrell (eds.), *Metropolis and Culture: Science in British Culture, 1780–1850* (London: Hutchinson, 1983), pp. 11–54; see also Inkster, "London Science and the Seditious Meetings Act of 1817," *British Journal for the History of Science,* 12 (1979), 192–6; J. B. Morrell, "Professors Robison and Playfair, and the *Theophobia Gallica:* Natural Philosophy, Religion and Politics in Edinburgh, 1789–1815," *Notes and Records of the Royal Society,* 26 (1971), 43–63 (for Scottish philosophic anti-Jacobinism and Home Office surveillance of radicals); and Schaffer, "Genius in Romantic Natural Philosophy," pp. 86–7 (for reaction by Burke and Robison to radically impolite natural philosophy).

[42] Nicholas Hans, *New Trends in Education in the Eighteenth Century* (London: Routledge, 1951). These academies were especially numerous in the Midlands and North of England, although there were important ones in the metropolis as well, e.g., the Hackney College.

physician, poet, and natural philosopher Erasmus Darwin.[43] By the 1780s and 1790s provincial scientifically oriented societies (often called "literary and philosophical") had become a common feature of the cultural landscape in the Midlands and North: the Manchester Literary and Philosophical Society was founded in 1781, followed shortly by the Derby Philosophical Society and by similar organizations in Newcastle-upon-Tyne, Liverpool, Leeds, Glasgow, and in many other industrial and mercantile centers.[44]

Early historical interpretations saw such organizations as sites at which useful concrete links were being forged between industry and scientific knowledge and in which seriously impolite conceptions of the man of science were being elaborated. The man of science was here being thrust to the center of the provincial cultural stage, where he could symbolically challenge polite aristocratic and gentlemanly values. The character of the Dissenting provincial man of science would juxtapose hard-nosed utilitarianism to belles-lettristic conversation, radical progressivism to interests in social stability, subversive materialism to orthodox spiritualism, and cultural and political egalitarianism to social hierarchy and deference.

More recent scholarship significantly modifies that picture. There was only a partial discontinuity, it is now considered, between the images and uses of scientific culture in these new cultural forums and those surrounding earlier conceptions of the polite and moral man of science. Indeed, as Arnold Thackray has argued, the centrality of science to these spontaneously produced expressions of provincial and industrial culture did depend "on a particular affinity between progressivist, rationalist images of scientific knowledge and the alternative value system espoused by a group peripheral to English society."[45] If the periphery was here challenging the political and cultural center, and if gentlemanly politeness substantially defined the central value system, then science was a mode of cultural self-expression that could be used

[43] Robert S. Schofield, *The Lunar Society of Birmingham: A Social History of Provincial Science and Industry in Eighteenth-Century England* (Oxford: Clarendon Press, 1963); Neil McKendrick, "The Role of Science in the Industrial Revolution: A Study of Josiah Wedgwood as a Scientist and Industrial Chemist," in Mikuláš Teich and Robert M. Young (eds.), in *Changing Perspectives in the History of Science: Essays in Honour of Joseph Needham* (London: Heinemann, 1973), pp. 274–319.

[44] Traditional presumptions about the "decline" and inutility of the eighteenth-century Royal Society of London are both refined and qualified in David Philip Miller, "'Into the Valley of Darkness'"; Miller, "The Usefulness of Natural Philosophy: The Royal Society of London and the Culture of Practical Utility in the Later Eighteenth Century," *British Journal for the History of Science,* 32 (1999), 185–201; Richard Sorrenson, "Towards a History of the Royal Society in the Eighteenth Century," *Notes and Records of the Royal Society of London,* 50 (1996), 29–46; Larry Stewart, "Other Centres of Calculation, or, Where the Royal Society Didn't Count: Commerce, Coffee-Houses and Natural Philosophy in Early Modern London," *British Journal for the History of Science,* 32 (1999), 133–53.

[45] Arnold W. Thackray, "Natural Knowledge in Cultural Context: The Manchester Model," *American Historical Review,* 79 (1974), 672–709, at 678; see also Thackray, "The Industrial Revolution and the Image of Science," in Thackray and Everett Mendelsohn (eds.), *Science and Values: Patterns of Tradition and Change* (New York: Humanities Press, 1974), pp. 3–18; Thackray, *John Dalton: Critical Assessments of His Life and Science* (Cambridge, MA: Harvard University Press, 1972).

symbolically to challenge traditional canons of politeness. Yet, as Thackray has shown, scientific culture in such venues as the Manchester Literary and Philosophical Society was primarily a resource used to redefine rather than to reject the values of politeness. For provincial medical men, organized culture of any sort lent social cachet, and no cultural form was more natural for such men than science. And for those few manufacturers and tradesmen who felt the need for cachet – most did not – science was also an attractive vehicle. The rhetoric of scientific utility linked it to progressive industrial values whereas the rhetoric of scientific politeness offered an access point to English gentility. "A taste for polite literature, and the works of nature and of art," said a self-made Manchester man, "is essentially necessary to form the gentleman." Participation in scientific culture was commended as an alternative to "the tavern, the gaming table or the brothel," and "a relish for manly science" was advertised as "next to religion, the noblest antidote" to "dissipation" and habits "unfavourable to success in business." Natural philosophy, in the Manchester mode, was much more about refinement than revolution, much less about industrial practice than about redefined politeness.[46]

## CONCLUSION: THE CIVIC EXPERT AND THE FUTURE

To varying extents each of the characters of the eighteenth-century man of science treated here survived, even flourished, well into the following century. The character of the Godly Naturalist was bruised by Darwinism but did not immediately disappear from the cultural landscape. The character of the Moral Philosopher likewise suffered from the secularization of nature encouraged by scientific naturalism. When nature was no longer conceived as a divinely written book, the study of Nature had diminished power to uplift, and the credibility of ancient conceptions of philosophic disengagement and heroic selflessness was undermined by the professionalization and bureaucratization of scientific research and teaching. Both the receipt of government subvention and the institutionalization of scientific research in the professorial role made it harder to portray the man of science as fulfilling his calling through ascetic self-denial.[47] Similarly, although notions of polite culture continued

[46] Thomas Henry, "On the Advantages of Literature and Philosophy," *Manchester Memoirs,* 1 (1785), 7–28, on pp. 9, 11; and Thomas Barnes, "A Plan of Liberal Education," ibid., 2 (1785), 35 (both quoted in Thackray, "Natural Knowledge in Cultural Context," pp. 688–90).

[47] For important treatments of the emergence in eighteenth- and early nineteenth-century German universities of the dual role of the professor – as original researcher as well as teacher – see R. Steven Turner, "The Growth of Professorial Research in Prussia, 1818 to 1848 – Causes and Context," *Historical Studies in the Physical Sciences,* 3 (1971), 137–82; Turner, "University Reformers and Professorial Scholarship in Germany, 1760–1806," in Lawrence Stone (ed.), *The University in Society, Vol. 2* (Princeton, NJ: Princeton University Press, 1974), pp. 495–531; Turner, "The Prussian Universities and the Concept of Research," *Internationales Archiv für Sozialgeschichte der Deutschen Literatur,* 5 (1980), 68–93; also Joseph Ben-David, *The Scientist's Role in Society: A Comparative Study,* new ed. (Chicago: University of Chicago Press, 1984; orig. publ. 1971), chap. 7; see also J. B. Morrell, "The University

in some vigor through the nineteenth century – the heyday of the character of the "scholar and gentleman" – science was no more central to the identity of polite learning among *The Spectator*'s readers of the early twentieth than of the early eighteenth century. Moreover, the power tapped by plugging notions of polite science into gentle and aristocratic culture was gradually diminished by the declining authority of those classes over the past two centuries.

One must, therefore, look elsewhere for a character of the man of science that had its roots in the eighteenth century and reached its fruition in more modern conceptions of the scientist's role. There are many places one might look for such roots, but there is one to which special attention should be drawn, if only because of its apparent mundanity. Long before the eighteenth century, men of science – of various descriptions – had a valued place in both government and commercial enterprises owing to their recognized possession of relevant expertise about the natural world and practical interventions in it. The ancients knew all about the roles of, for example, the mathematically competent military engineer who could design fortifications, the astronomer who made calendars, and the physicians and surgeons who could advise on diet or cut for the stone.

So too did their eighteenth-century counterparts: there is nothing qualitatively new in this period about the character of the man of science as "civic expert." Nor was this character particularly linked to the rhetoric of utility that, from the seventeenth century, picked out the special capacity of some methodologically modernized versions of natural science to contribute to useful outcomes – a rhetoric that might be viewed, as we have seen, with considerable skepticism by other sectors of society. The point here does not hinge on the hoary debate over the relations between scientific theory and technical utility; rather, it concerns the roles and the historical appreciations of scientifically knowing people. And what the eighteenth century witnessed was a vast expansion in the numbers of scientifically trained people employed as civic experts in commerce, the military, and the government settings. The character of the man of science as otherworldly scholar or irrelevant pedant coexisted through the century with his emerging identity as valued civic expert. Sometimes, indeed, these opposing characters were attached to the same person. Who was Ben Franklin – a speculative electrical theorist or the inventor of the lightning rod? Who was Sir Joseph Banks – another collector of curiosities or Britain's national expert adviser on colonial horticulture?

The character of the medical expert needs no special introduction, but eighteenth-century settings in which his expertise was called upon proliferated. The dark satanic mills of the Industrial Revolution generated vast numbers of proletarian casualties that in turn created a demand for infirmaries and for

of Edinburgh in the Late Eighteenth Century: Its Scientific Eminence and Academic Structure," *Isis,* 62 (1971), 158–71.

the physicians and surgeons to staff them. Warfare was, of course, a constant in European history, but an increase in its scale, as well as the expansion of long-distance trade and colonization, likewise produced government demand for naval and military surgeons: the experts who might be able to offer effective prophylactics for scurvy were as valuable to imperial powers as those who offered solutions to the problem of longitude.

The placement of scientifically skilled people in mercantile and industrial enterprises was a matter of state policy in France, whereas in laissez-faire Britain matters took a more circuitous course to a similar recognition of the value of such expertise. Here are a few of many pertinent examples: the geologist James Hutton was also an improving farmer, an innovator in the manufacture of sal ammoniac, and an adviser on the building of the Forth-Clyde canal. The autodidact stratigrapher William Smith established the importance of the fossil record to mining. He was a canal company employee for a number of years at the end of the century and he was encouraged by Sir Joseph Banks to produce a geological map of England and Wales. The chemical expertise of Joseph Black was deployed in furnace construction and glass manufacture and was called upon in connection with bleaching techniques by the Scottish Board of Trustees for Manufactures. The Edinburgh- and Leiden-trained chemist John Roebuck managed an industrial complex that manufactured sulphuric acid, ceramics, and iron. And the story of the relations among Joseph Black, James Watt, and Matthew Boulton in steam-engine manufacture has passed into industrial legend. In France, Coulomb's governmental role as military and civil engineer has already been mentioned. Lavoisier's chemical training was brought to bear on his early official work in factory inspection, in the management of municipal water supplies, and as commissioner in the Royal Gunpowder Administration.

Throughout eighteenth-century Europe and North America, governments increasingly drew on the services of scientifically skilled people and thus helped to constitute the character of the man of science as civic expert. The Swiss anatomist Albrecht von Haller resigned his Göttingen chair to pursue a political career, and for six years he served as director of the Bern saltworks. The Italian natural historian Lazzaro Spallanzani was sent by the Austrian government to visit mines and collect fossils in the Alps. The Croatian natural philosopher Rudjer Boscovich worked as a hydraulic engineer for the Vatican. The mineralogist Abraham Gottlob Werner taught for most of his life in the Saxon mining academy. The young Leibniz was an engineering consultant for the duke of Brunswick-Lüneberg; the young Goethe was a superintendent of mines for the Weimar court; and the young Alexander von Humboldt worked in the Prussian mining service. Everywhere men of science were employed by governments to standardize weights and measures. The vitally important problem of determining longitude at sea was perhaps the most visible instance in which governments acknowledged that their national in-

terests crucially depended on the work of highly skilled men of science, the embodied repositories of esoteric natural knowledge.[48]

However, there was one enterprise of special significance to eighteenth-century patterns constituting the man of science as civic expert, if only because its scale and scope expanded so much during the century. This was the primary survey of the globe, especially in the context of long-distance trade and in imperialist ventures. Here the term "primary survey" includes (i) the compilation and central accumulation of inventories of what natural kinds and phenomena existed in distant parts of the world; (ii) the development of techniques effectively to standardize the representation and retrieval of such information and to ensure its robustness in circulation among those who recorded it, those who wished to gain access to it, and those who wished to use it in practical enterprises; and (iii) the explication of the virtues and values of distant natural kinds and phenomena, possibly, though not necessarily, with respect to the material interests of individual nations. Alexander von Humboldt's isoline mapping program in geophysics is one example of a primary survey, and techniques for representing, orienting, and moving about in a digitized natural world were among its major products.[49] In America, Benjamin Franklin helped raise public subscriptions to support John Bartram's surveying and collecting travels from New York to Florida, and President Thomas Jefferson later commissioned Lewis and Clark to find out what there was in the unknown lands between the settled parts of America and the Pacific.[50]

Consider the questions that might be asked of a botanical expert in this context: What kinds of plants were there in and around Botany Bay in New South Wales? How could one be sure that a species from there was the same as one from Tahiti? What was this particular species good for? And, if it had a commercial value, could it be made to grow in the south of England or in British colonies in the West Indies? Such questions were precisely those that occupied Sir Joseph Banks in the late eighteenth and early nineteenth centuries as he developed both Kew Gardens and his London house in Soho Square into crucially important centers of calculation and accumulation.[51] Could tea be grown economically in the British East Indies, and, if so, where?

[48] See also the involvement of British and French governments in expeditions to observe the transit of Venus in 1761 and 1769: Harry Woolf, *The Transits of Venus: A Study of Eighteenth-Century Science* (Princeton, NJ: Princeton University Press, 1959).

[49] See Michael Dettelbach, "Global Physics and Aesthetic Empire: Humboldt's Physical Portrait of the Tropics," in Miller and Reill (eds.), *Visions of Empire,* pp. 258–92; for plant geography, see Malcolm Nicolson, "Alexander von Humboldt, Humboldtian Science, and the Origins of the Study of Vegetation," *History of Science,* 25 (1987), 167–94.

[50] For materials on men of science and the primary survey of America, see, e.g., Raymond Phineas Stearns, *Science in the British Colonies of America* (Urbana: University of Illinois Press, 1970).

[51] See David Philip Miller's appropriation of a notion from Bruno Latour, in Miller, "Joseph Banks, Empire, and 'Centres of Calculation' in Late Hanoverian London," in Miller and Reill (eds.), *Visions of Empire,* pp. 21–37. For Latour's usage, see Bruno Latour, *Science in Action: How to Follow Scientists and Engineers through Society* (Milton Keynes: Open University Press, 1987), especially pp. 215–57.

The Board of Trade and the East India Company wanted to know, so they drew on the expertise of Joseph Banks. Banks was able to advise them, since he had accumulated and maintained records of trials growing *Camellia sinensis* in English gardens.[52] Banks was, in Daniel Baugh's phrase, a "natural resource imperialist," his expertise available to the British government, military, and trading companies and valued by them for its reliability.[53]

Examples of civic expertise for hire in the context of trade, war, and imperialism could be multiplied indefinitely in a wide range of scientific disciplines: mathematics, astronomy, geography and cartography, geology and mineralogy, meteorology, medicine, chemistry, and physics. Although the role of the man of science as civic expert was not new in the eighteenth century, the numbers occupying that role were increasing along with the expansion of trade, war, and imperialism. The recognized importance of scientific experts followed from their success in constituting themselves and their workplaces as centers of calculation vital to the exercise of long-distance control.

Men of science as civic experts became more numerous during the eighteenth century, and it became increasingly common to hear references to such people. And, as their presence became more usual, the character of the man of science as "useful chap" circulated more widely. The ground was gradually being prepared for the professionalizing movements of the nineteenth century. Governments could plausibly be called on to become the paymasters for scientific inquiry, not because widely persuasive systematic arguments had been made about the ultimate utility of scientific theory but rather because governments could now be reminded of their indebtedness to a corps of skilled experts, many of whom attributed their know-how to their possession of scientific knowledge. Nor was this either a simple or a wholly demand-driven process. The character of the man of science as useless pedant was still available in the early nineteenth century to those resisting the professionalizers' utilitarian rhetoric. Eighteenth-century men of science did respond to demands for their expertise, but they also labored hard to *tell* governments that such expertise was available, authentic, and potent; that they were the people who possessed expertise; and that governments' material interests depended on the nurturing and effective deployment of said expertise. The expertise of men of science and the interests of governments had to be, in many cases, artfully aligned. Such alignment could fail, and superficial appearances of artful alignment may be deceptive. Humboldt, for example, was not in the pay of a naval

[52] Miller, "Joseph Banks, Empire," pp. 31–2; also David Mackay, "Agents of Empire: The Banksian Collectors and Evaluation of New Lands," in Miller and Reill (eds.), *Visions of Empire,* pp. 38–57.

[53] Daniel Baugh, "Seapower and Science: The Motives for Pacific Exploration," in Derek Howse (ed.), *Background to Discovery: Pacific Exploration from Dampier to Cook* (Berkeley: University of California Press, 1990), pp. 1–55, at p. 40; see also Simon Schaffer, "Visions of Empire: Afterword," in Miller and Reill (eds.), *Visions of Empire,* pp. 335–52, especially pp. 338–9.

power or its institutions when he developed his techniques for isoline mapping. Function and motive may differ.[54]

Nevertheless, by the end of the eighteenth century a new possibility for the character of the man of science had begun to open up, although the full development of that character was not to occur for many years. The man of science might be conceived of as someone who was neither particularly godly, nor particularly virtuous, nor particularly polite.[55] It could be considered that there was nothing very special about the sorts of people drawn to the study of the natural world, nor anything very special about the effects on character wrought by the study of the natural world. The man of science was not thought to be constitutionally better or worse than other men, nor did his manner of inquiry or object of study make him better or worse than other men. Within his domain of legitimate expertise he knew more, and knew it more reliably. Such men were useful.

[54] Dettelbach, "Global Physics," p. 264; but compare British Royal Navy support for Edmond Halley's Atlantic voyages (1698–1701) to produce isoline maps of magnetic variation: Alan Cook, *Edmond Halley: Charting the Heavens and the Seas* (Oxford: Clarendon Press, 1998), chap. 10.

[55] On the decline of virtue in the image of the man of science, see Steven Shapin, "The Philosopher and the Chicken: On the Dietetics of Disembodied Knowledge," in Christopher Lawrence and Shapin (eds.), *Science Incarnate: Historical Embodiments of Natural Knowledge* (Chicago: University of Chicago Press, 1998), pp. 21–50, especially pp. 42–6; and Shapin and Lawrence, "Introduction: the Body of Knowledge," *Science Incarnate,* pp. 1–20, especially pp. 14–15.