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Stephen Gaukroger

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Prologue

Cicero tells us that Cato had applied himself to philosophy, not that he might dispute like a philosopher, but that he might live like one. Bacon quotes this remark on a number of occasions, and it invokes a conception of philosophy that dominated not just antiquity but also the early-modern era. It is a conception according to which there is a way of engaging intellectual, cultural, moral, scientific, and aesthetic problems which is not only distinctive, marking out the philosophical treatment of these problems from that of the theologian or the statesman or the artist, for example, but whereby the philosopher is someone who has a particular standing, a particular claim to be heard. Rightly or wrongly, the scientist has now largely usurped much of this role from the philosopher – it is now the scientist, rather than the philosopher, who lays claim to a ‘theory of everything’, for example – and although this shift was consolidated only in the nineteenth century, the influence of Bacon has been such that it is to him, more than anyone else, that we must trace its origins. For it is Bacon who, more than anyone else, urges and guides the transformation of philosophers into what later came to be known as scientists, inducing the birth of a new discipline quite different from philosophy as traditionally practised, and leaving not just philosophy, but the humanities generally, with the problem of forging a new identity for themselves.

From the time of his death in 1626 onwards, Bacon’s fortunes have risen and fallen dramatically. As Pérez-Ramos has pointed out, the fluctuations in Baconian stocks derive in large part from the kinds of investments that have been made in them.¹ Immediately after his death, a rad-

¹ Antonio Pérez-Ramos, *Francis Bacon’s Idea of Science and the Maker’s Knowledge Tradition* (Oxford, 1988), chap. 2, which serves as the best general account of these questions. See also Theodore M. Brown, ‘The Rise of Baconianism in Seventeenth-Century England: A Perspective on Science and Society during the Scientific Revolution’, in *Science and History: Studies in Honor of Edward Rosen*, *Studia Copernica* 16 (Wrocław, 1978), 501–22.

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ical ‘Puritan’ interpretation was placed on his work, which located it firmly within a millenarian framework and emphasised the idea of the mechanical arts as a means of moral self-perfection.² By 1660, however, Baconianism was the foundation for the apologetics of the Royal Society, which saw itself as the only heir to Bacon, a view institutionalised in Sprat’s *History of the Royal Society of London*, which appeared in 1667.³ This view was reinforced by a wholesale association of Baconianism and Newtonianism. In spite of the fact that Newton, who owned a significant number of books, probably possessed neither of Bacon’s two key ‘methodological’ works – *Novum Organum* and *De Dignitate & Augmentis Scientiarum*⁴ – Bacon was widely regarded as having provided Newton with his methodological foundations. This was a reading propounded by Newton’s editors – Maclaurin, Cotes, and Pemberton – in the eighteenth century, and at the end of that century Reid could write confidently that ‘Lord Bacon first delineated the only solid foundation on which natural philosophy can be built; and Sir Isaac Newton reduced the principles laid down by Bacon into three or four axioms which he calls *regulae philosophandi*.’⁵

Bacon’s success in Europe in the latter part of the seventeenth century was spectacular. In the Netherlands, which was the principal source of Latin editions of Bacon, there were forty-five printings/editions of his

2 This episode in the history of Baconianism is pursued in detail in Charles Webster, *The Great Instauration: Science, Medicine and Reform (1626–1660)* (London, 1975). See also Stephen Clucas, ‘In Search of “The True Logicke”: Methodological Eclecticism among the “Baconian Reformers”’, in Mark Greengrass, Michael Leslie, and Timothy Raylor, eds., *Samuel Hartlib and Universal Reformation* (Cambridge, 1994), 51–74.

3 Different as the Puritan and Royal Society conceptions of Baconianism are, it is worth noting that John Wallis records that the suggestion of regular scientific meetings which were to form of basis of the Royal Society first came from the Puritan Theodore Haak in 1645, although neither Sprat in his *The History of the Royal-Society of London for the Improving of Natural Knowledge* (London, 1667), nor Wallis himself in his *A Defence of the Royal Society in Answer to the Cavails of Doctor William Holder* (London, 1678), make any mention of Haak. See Webster, *Great Instauration*, 54–6. On the beginnings of the Royal Society see Michael Hunter, *The Royal Society and Its Fellows, 1660–1700: The Morphology of an Early Scientific Institution*, 2d ed. (London, 1994).

4 Pérez-Ramos, *Francis Bacon’s Idea of Science*, 17 n. 24, notes that Harrison’s catalogue of Newton’s library lists only the *Essayes*, the *De Sapientia Veterum*, and Rawley’s *Opuscula Varia Posthuma*. Harrison’s listing is about 90 per cent complete.

5 *The Works of Thomas Reid*, ed. Sir William Hamilton, 2 vols. (London, 1863), i.437b (*Essays on the Intellectual Powers of Man*, essay 6). See the discussion in Larry Laudan, *Science and Hypothesis: Historical Essays on Scientific Methodology* (Dordrecht, 1981), chap. 7.

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works before 1700.⁶ In Italy, there were fourteen printings/editions before 1700,⁷ and following the closing of the Accademia del Cimento in 1667, a new academy, the Accademia della Traccia ('academy of traces/footprints/tracks') was founded along explicitly Baconian lines, as 'tracking down the true understanding of nature along the . . . road of experience.'⁸ In France, England's great competitor for the mantle of patron of the sciences, where there were thirty-three printings/editions of Bacon before 1700,⁹ the Académie Royale des Sciences, founded in 1666, was created by Colbert, chief minister to Louis XIV, in what Colbert referred to as 'the manner suggested by Verulam'.¹⁰ Voltaire devotes the twelfth of his *Lettres philosophiques* to the praise of Bacon, and his impact on the French Enlightenment was considerable.¹¹ Indeed, Baconianism was so deeply implicated in the Enlightenment advocacy of science that with the Romantic reaction to it Bacon was singled out as a prime culprit: William Blake claimed that it was Bacon who had ruined England, while De Maistre was blaming the French Revolution on Bacon.¹² And it is certainly true that in the late-eighteenth-century French debate over 'republican' versus 'monarchical' science, Baconianism was employed by supporters of the former, principally in the advocacy of natural history as a nonelitist form of science.¹³

6 See the list of editions in R. W. Gibson, *Francis Bacon: A Bibliography of His Works and of Baconiana, to the Year 1750* (Oxford, 1950). Most of the editions produced in the Netherlands were Latin editions, as Leiden and Amsterdam were centres of Latin publishing.

7 Ibid.

8 See Marta Cavazza, 'Bologna and the Royal Society of the Seventeenth Century', *Notes and Records of the Royal Society of London* 35 (1950), 105–23, at 107.

9 Gibson, *Francis Bacon: A Bibliography*.

10 See letter of 1666 from Huygens to Colbert in Huygens, *Oeuvres complètes de Christiaan Huygens*, ed. La Société Hollandaise des Sciences, 22 vols. (The Hague, 1888–1950), vi.95–6. The Académie, which received funds from the king, was comprised largely of professional researchers. The Royal Society, on the other hand, relied on private funding, and two-thirds of its membership was made up of the nobility (honorary members) and amateurs who were able to top up funding. See Henry Lyons, *The Royal Society, 1660–1940* (New York, 1968), 76–7.

11 Diderot's 'Introduction' to the *Encyclopédie* makes Bacon's influence clear. On this question more generally, see M. Malherbe, 'Bacon, l'*Encyclopédie* et la Révolution', *Études philosophiques* 3 (1985): 387–404.

12 Pérez-Ramos, *Francis Bacon's Idea of Science*, 20. Not all Romantics derided science, of course, and Coleridge remarked that Bacon was 'the founder of a revolution scarcely less important for the scientific . . . world than that of Luther for the world of religion and politics': cited in Perez Zagorin, *Francis Bacon* (Princeton, 1998), 32.

13 See William Eamon, *Science and the Secrets of Nature: Books of Secrets in Medieval and Early Modern Culture* (Princeton, 1994), 349.

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A similar phenomenon took place in American thought, and the American Constitution drew on Bacon's advocacy of induction, with Jefferson commissioning portraits of the three 'great minds' – Bacon, Newton, and Locke – for his office in the State Department. Bacon was considered of particular significance because the lessons of experience were more important for the New World than they had ever been for Europeans: There was something especially appropriate about Bacon's outlook for the colonisers of the New World.¹⁴ By the nineteenth century, however, we find a very significant change of focus. During the revival of interest in Bacon in England in that century, in writers such as the astronomer John Herschel, the historian of science William Whewell, and the philosopher John Stuart Mill, Baconianism comes to be stripped of any political connotations, and methodological-cum-epistemological questions now dominated the discussion,¹⁵ a domination that continued at least until the middle of the twentieth century.¹⁶

These changes to what has been seen as relevant in Bacon's work in many ways mirror developments in the discipline of philosophy itself. Such changes in the discipline have often been thought about purely in terms of variations in the content of philosophical doctrines – this is what histories of philosophy almost always confine themselves to, for example – even though there is some awareness that more than just content changes between the late-mediæval and Renaissance philosophers and the pioneers of early modern philosophy such as Descartes, Hobbes, and Gassendi. There has been a change in mentality, a change in the un-

14 See I. Bernard Cohen, *Science and the Founding Fathers* (New York, 1995), 56–9.

15 There is an exemplary nineteenth-century discussion of Bacon in chap. 11 of Book 12 of William Whewell's *The Philosophy of the Inductive Sciences*, rev. ed., 2 vols. (London, 1847), ii.226–51.

16 Nothing brings out more graphically the fact that Bacon was taken to be representative not just of seventeenth-century thought, but of modern thought more generally, than his reception in China. When Western philosophy was reintroduced into China in the nineteenth century (having first been introduced briefly, along with Western science and theology, two centuries earlier by Jesuit missionaries, before their expulsion), it was Bacon who was taken as representative of Western thought, as being a key English thinker, along with Darwin and Spencer. The article on Bacon published in 1873 by Wang Tao, who collaborated with the missionary James Legge in his translations of classical Chinese philosophical texts, was the first article in Chinese devoted to a Western philosopher, and Wang followed it up in 1877 with a translation of Bacon's *Novum Organum*. Indeed, Bacon's work was widely read and discussed in the 1890s and early decades of the twentieth century in China, and it formed virtually a sole point of entry into the modern Western philosophical tradition. For details, see Yuan Weishi, 'A Few Problems Related to Nineteenth Century Chinese and Western Philosophies and Their Cultural Interaction', *Journal of Chinese Philosophy* 22 (1995), 153–92, esp. 164–5, 174–5.

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derstanding of the point of the exercise, a change in what the rationale of pursuing philosophy was. What emerged in the West in the early-modern era was a style of doing natural philosophy, a way of thinking about the place of natural philosophy in culture generally, and of thinking about oneself as a natural philosopher. This phenomenon is wider than Bacon, and the transformation is one that lasts into the nineteenth century, when the modern notion of a 'scientist' was born.¹⁷ But Bacon's was the first systematic, comprehensive attempt to transform the early-modern philosopher from someone whose primary concern is with how to live morally into someone whose primary concern is with the understanding of and reshaping of natural processes. And his was the first systematic, comprehensive attempt to transform the epistemological activity of the philosopher from something essentially individual to something essentially communal.

¹⁷ Andrew Cunningham and Perry Williams, 'De-centering the "Big Picture": The Origins of Modern Science and the Modern Origins of Science', *British Journal for the History of Science* 26 (1993), 407–32.

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The nature of Bacon's project

From arcane learning to public knowledge

Bacon's project was to harness firmly to the yoke of the state a new attitude to knowledge, and in the course of attempting to do this, he was led to think through and transform this new attitude to knowledge. At the most elementary level, his aim was to reform natural philosophy, but what exactly he was reforming, and how he envisaged its reform, are not straightforward questions. The object of this reform was both the practice and the practitioners of natural philosophy. He was concerned to reform a tradition of natural philosophy in which the central ingredients were areas such as natural history and alchemy: empirical, labour-intensive disciplines.

In a pioneering essay, Kuhn attempted to distinguish between what he referred to as the mathematical and the experimental or 'Baconian' traditions.¹ This is a useful first approximation, and it indicates a divergence of research in the seventeenth and eighteenth centuries (although Newton, for example, was considered to have produced models in both traditions, in his *Principia* and his *Opticks*, respectively).² It is only to be expected that this characterisation is of less help in understanding the way in which fields of research were structured at the time Bacon was writing – and of course it is this that we need to understand if we are to comprehend what Bacon's reforms were directed towards – but there is a similar divergence between two broad kinds of discipline. The first is what I shall call 'practical mathematics' (principally geometrical optics, astronomy, statics, hydrostatics, harmonics, as well as some very ele-

¹ Thomas S. Kuhn, 'Mathematical versus Experimental Traditions in the Development of Physical Science', in his *The Essential Tension*, 2d ed. (Chicago, 1977), 31–65. Compare Ian Hacking, *The Emergence of Probability* (Cambridge, 1975), who contrasts the 'high' (i.e., mathematical) sciences with the 'low' (i.e., probabilistic) sciences such as medicine and alchemy, which reason probabilistically rather than conclusively.

² See I. Bernard Cohen, *Franklin and Newton* (Philadelphia, 1956).

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mentary kinematics), which had been pursued in irregular bursts of activity – in the Hellenistic Greek diaspora, in mediæval Islam, in twelfth- and thirteenth-century Paris and Oxford – until, starting in Italy and the Netherlands from the mid-sixteenth century onwards, it began to be pursued in a concerted way in Western Europe. Bacon had very little interest in this kind of area. His concerns in natural philosophy were focused on disciplines and activities which make up a second, far more disparate, grouping, the ingredients of which were resolutely practical and relatively piecemeal. Many of them had traditionally been associated with crafts, like metallurgy, where the secrets were jealously protected; or with agriculture where, along with widely shared abilities which those who worked the land picked up as a matter of course, there were closely guarded skills – in viniculture, for example – which were not shared outside the trade; or with the herbal treatment of various maladies, where esoteric knowledge played a very significant role; or with alchemy, where the arcane nature of the knowledge was virtually a *sine qua non* of the discipline.³ William Eamon has recently drawn attention to the shift from esoteric to public knowledge, a shift he traces primarily to the sixteenth and seventeenth centuries, and has shown how it played an important role in the transformation of scientific culture in this period.⁴ There can be little doubt that this is a crucial element in Bacon's reform. As he puts it in the *Advancement of Learning*,

The sciences themselves which have had better intelligence and confederacy with the imagination of man than with his reason, are three in number; Astrology, Natural Magic, and Alchemy; of which sciences nevertheless the ends are noble. For astrology pretendeth to discover that correspondence or concatenation which is between the superior globe and the inferior; natural magic pretendeth to call and reduce natural philosophy from variety of speculations to the magnitude of works; and alchemy pretendeth to make separation of all the unlike parts of bodies which in mixtures of nature are incorporate. But the derivations and prosecutions to these ends, both in the theories and in the practices, are full of error and vanity; which the great professors themselves have sought to veil over and conceal by enigmatical writings, and referring themselves to auricular traditions, and such other devices to save the credit of impostures. (*Adv. Learn. I: Works iii.289*)⁵

3 A good example of the esoteric nature of alchemy is to be found in George Starkey – aka Eirenæus Philalethes ('a peaceful lover of truth') – one of the most important seventeenth-century alchemists: See the discussion of Starkey and this question in William R. Newman, *Gehennical Fire: The Lives of George Starkey, an American Alchemist in the Scientific Revolution* (Cambridge, Mass., 1994), chap. 4.

4 William Eamon, *Science and the Secrets of Nature: Books of Secrets in Medieval and Early Modern Culture* (Princeton, 1994).

5 As the alchemical adept Abraham Andrewes put it at the beginning of 'The Hunting of the Greene Lyon': 'All haile to the noble Companie / Of true Students in

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Yet deep questions are raised by this issue of the transformation of previously esoteric disciplines into public knowledge. There is some case to be made that the esoteric nature of knowledge in the Middle Ages played a crucial positive role in its development. Comparing the situation in the mediæval West with roughly contemporary societies having strong scientific cultures – the Islamic Middle East and China – Toby Huff, pursuing what might broadly be termed a Weberian approach to these questions, has argued that the formation of autonomous corporate bodies, in the wake of the Investiture Controversy (1050–1122), created a decentralisation of responsibilities and expertise which fostered a protected climate, a neutral space for inquiry, in which intellectual innovation could flourish.⁶ What happened as a result of the Investiture Controversy was that the church was effectively formed as a corporation, declaring itself legally autonomous from the secular order and claiming for itself all spiritual authority. Other corporate bodies were soon formed on this model – towns, cities, guilds, universities, professional groups – and the introduction of corporate structure in the last two cases, in particular, meant that the context in which natural philosophy was pursued was very different from that in the Islamic world and China. Mediæval Islamic thought was very much a development of classical and Hellenistic work in the area of ‘practical mathematics’, but individual successes in optics and astronomy could not be followed up properly because of the very localised and isolated level on which this research was pursued. In China, on the other hand, a totalising bureaucratic structure ruled out opportunities for innovation which were not part of some state-sanctioned programme. Moreover, the model for corporate structure brought with it an elaborate legal structure which harmonised legal traditions and provided a foundation for law, in addition producing a new science of law which became a model of intellectual achievement. Crucial to this cultural dominance of law was a staunchly adversarial mode of reasoning, absent in Chinese legal argument and in its relatively internally undifferentiated pursuit of natural knowledge.⁷

Note 5 (cont.)

holy *Alchimie*, /Whose noble practice doth hem teach /to vaile their secrets wyth mistie speach’. The poem is given, along with many like it, in Elias Ashmole, *Theatrum Chemicum Britannicum. Containing Severall Poeticall Pieces of our Famous English Philosophers, who have written the Hermetique Mysteries in their owne Ancient Language* (London, 1652), 278.

⁶ Toby Huff, *The Rise of Early Modern Science: Islam, China, and the West* (Cambridge, 1993).

⁷ For a critical and far more nuanced evaluation of the contrast between the Greek adversarial or agonistic approach and the Chinese irenic or ‘authority-bound’ approach, see G. E. R. Lloyd, *Adversaries and Authorities: Investigations into Ancient Greek and Chinese Science* (Cambridge, 1996), chap. 2.

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So, in sum, what we have is a culture of self-governing autonomous corporate bodies which strictly regulated entry to their ranks and protected the privileges associated with membership. Exclusivity is crucial to such bodies, and Bacon is criticising the exclusivity both of the guilds, where practical information is esoteric by virtue of keeping knowledge or techniques within a trade or profession to which access is then restricted, and of the universities, where an esoteric and often convoluted language renders information inaccessible to all but those accepted into the university system. In the case of the universities, Bacon, in common with some of his reform-minded contemporaries, associates its convoluted systems with its adversarial approach, whose aim is to win arguments rather than produce new knowledge, and he rejects both.

Having suggested, however, that Bacon's project for the reform of natural philosophy is at least in part motivated by a desire to shift from esoteric to public knowledge, a word of qualification is necessary. Bacon did not envisage such reforms, if successful, resulting in universal access to knowledge. Quite the contrary, he explicitly argues against such universal access; rather, he sees such knowledge as being something which might serve the monarch, in some ways on a par with territorial conquest:

And this proficience in navigation and discoveries may plant also an expectation of the further proficience and augmentation of all sciences; because it may seem they are ordained by God to be coevals, that is, to meet in one age. For so the prophet Daniel speaking of the latter times foretelletth ['many pass to and fro, and knowledge shall be multiplied'], as if the openness and through passage of the world and the increase of knowledge were appointed to be in the same ages. (*Adv. Learn.* II: *Works* iii.340)⁸

The association of the conquest of land with the conquest of knowledge is something strikingly depicted in the frontispiece to his *Instauratio Magna* of 1620, where a warship is shown sailing back through the Pillars of Hercules, a traditional symbol of the limits of knowledge but also an emblem the Spanish kings had commandeered to represent their empire.⁹ Bacon explicitly wants to limit access to such knowledge to the

8 The image is also to be found earlier in *Val. Term.* (*Works* iii.220–1), and later in *De Aug.* (*Works* i.514/iv.311–12) and *Nov. Org.* I, Aph. 93 (*Works* i.200/iv.92). On the widespread millenarian reading of the passage from Daniel in the first half of the seventeenth century, see Charles Webster, *The Great Instauration: Science, Medicine and Reform (1626–1660)* (London, 1975), chap. 1.

9 The analogy between territorial conquest and scientific conquest in the science of this period is explored in Timothy Reiss, *The Discourse of Modernism* (Ithaca, 1982), and more recently in Amir Alexander, 'The Imperialist Space of Elizabethan Mathematics', *Studies in History and Philosophy of Science* 26 (1995): 559–92.

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monarch: It is to serve national purposes rather than those of some local grouping. In order to do this, however, the information must be acquired and presented in a new way, and correspondingly he wants those who pursue natural philosophy to be very different from traditional practitioners.

A via media

A crucial ingredient in the reform of natural philosophy for Bacon is a reform of its practitioners: If we neglect this element in his programme, we will fail to see what was its practical cutting edge.¹⁰ In this respect, his concerns can be seen as part of a general concern with the reform of behaviour which began outside scientific culture but which was rapidly internalised in English natural philosophy in the seventeenth century.¹¹ A particular way of pursuing natural philosophy was associated with what can only be called a particular form of civility. The investigation of natural processes – observation and experimentation – was contrasted with and pitted against verbal dispute, the first being construed as a procedure by which we actually learn something, the second as consisting of mere unproductive argumentation for its own sake. In a famous passage in the *Advancement of Learning*, Bacon chastises Aristotle on these grounds in strong terms:

And herein I cannot a little marvel at the philosopher Aristotle, that did proceed in such a spirit of difference and contradiction toward all antiquity; undertaking not only to frame new words of science at pleasure, but to confound and extinguish all ancient wisdom; inasmuch as he never nameth or mentioneth an ancient author or opinion, but to confute and reprove. (*Adv. Learn.* II: *Works* iii.352)

And later in the same work he tells us:

I like better that entry of truth which cometh peaceably with chalk to mark up those minds which are capable to lodge and harbour it, than that which cometh with pugnacity and contention. (*Works* iii.363)

In the context of English thought in the early-modern era, the advocacy of experiment over Scholastic disputation, and the advocacy of a ‘civil’

¹⁰ Two recent accounts of Bacon’s reforms have drawn attention to this aspect of his programme: Julian Martin, *Francis Bacon, the State, and the Reform of Natural Philosophy* (Cambridge, 1992), and John E. Leary, Jr., *Francis Bacon and the Politics of Science* (Ames, Iowa, 1994).

¹¹ The phenomenon was not confined to England. For an overview of the situation in England and continental Europe, see Lorraine Daston, ‘Baconian Facts, Academic Civility, and the Prehistory of Objectivity’, in Alan Megill, ed., *Rethinking Objectivity* (Durham, N.C., 1994), 37–63.