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Francis Bacon and the Progress of Knowledge

Brian Vickers

Glorifications and denigrations continuously alternate in the history of Baconianism and of Bacon's fortunes.¹

One of the most famous images in English Renaissance literature is the engraved title page to Bacon's *Instauratio Magna*, showing the ship of learning sailing back through the "pillars of Hercules"—the straits of Gibraltar which traditionally marked the limits of human knowledge of the world—returning from the open seas, bringing with it new ideas and discoveries. Underneath the engraving is a quotation from the Book of Daniel (12:4) in the Latin Vulgate: *Multi pertransibunt et augebitur scientia*. Bacon adopted this quotation as his own, giving it a rather personal interpretation, as he explained when using it for the first time in chapter 1 of *Valerius Terminus*, entitled "of the limits and end of knowledge." Here he writes that although the highest "law of nature" is reserved for God, the inferior levels of knowledge are still "many and noble," and are

within man's sounding. This is a thing which I cannot tell whether I may so plainly speak as truly conceive, that as all knowledge appeareth to be a plant of God's own planting, so it may seem that the spreading and flourishing, or at least the bearing and fructifying of this plant, by a providence of God, nay not only by a general providence but by a special prophecy, was appointed to this autumn of the world: for to my understanding it is not violent to the letter, and safe now after the event, so to interpret that place in the prophecy of Daniel where speaking of the latter times it is said, *Many shall pass to and fro, and science shall be*

This is part of a lecture delivered at the Francis Bacon Library, Claremont, on 25 January 1989, to commemorate the 428th anniversary of Bacon's birth.

¹ Paolo Rossi, "Ants, Spiders, Epistemologists," in M. Fattori (ed.), *Francis Bacon: Terminologia e Fortuna nel XVII Secolo* (Rome, 1984), 245-60, at 245.

increased; as if the opening of the world by navigation and commerce and the further discovery of knowledge should meet in one time or age (III, 320-21).²

That is, Columbus's discovery of America was the fulfillment of Daniel's prophecy, inaugurating a new age of learning—a typically confident Renaissance assessment of its own newness.

Indeed, this idea of the constant growth of knowledge was both new in Bacon's formulation, and historically significant. Even Anthony Quinton,³ a critic not naturally sympathetic to Bacon, juxtaposes him approvingly with the medieval philosophers, who "saw themselves as orderers and preservers of knowledge, not as its creators" (29), a static position against which he sets Bacon's "more or less unprecedented notion of knowledge as cumulative." As Quinton says, "in order for knowledge to be thought of in this way, as something to be constantly added to, a new conception of true, basic, paradigmatic knowledge has to be adopted." Bacon took that step, Quinton writes, "by separating divine and natural knowledge," and

in his belief in the possibility of large and continuous growth of knowledge, of finding new knowledge rather than retrieving old knowledge before it disappears irrecoverably, he played a crucial part in creating a mental atmosphere or environment in which the natural-science centered conception of knowledge could flourish (30).

Not only in the natural sciences but in every field of knowledge today we confidently expect that new research will expand our understanding of a subject, enlarge or redefine the framework or conceptual categories within which we see, or think it.

From time to time it is salutary to take stock, and ask oneself how Bacon's legacy has been understood in recent years, and whether real progress has been made? Of the hundred or so books and essays that have appeared in the last twenty years, some have been successes and some failures. We have new reference-books: a concordance to the *Essays* from David Davies and Elizabeth Wrigley,⁴ a concordance to the *Novum Organum* from Marta Fattori,⁵ and a useful bibliography of recent English-language studies by William A. Sessions.⁶ On the debit

² All quotations from J. Spedding, D. D. Heath and R. L. Ellis (eds.), *The Works of Francis Bacon* (14 vols; London, 1857-74) are incorporated into the text in the form III,340. Bacon repeated this quotation, no longer diffident about his interpretation of it, in the *Advancement of Learning* (III,340) and its Latin expansion, *De Augmentis Scientiarum* (Latin, I,514; tr. IV,311-12), and in the *Novum Organum*, Book i, aphorism 93 (Latin, I,200; English, IV,92). In the Biblical text a vision reveals a prophecy that the angel Michael will deliver Israel from their troubles, and that the Kingdom of God will be established.

³ *Francis Bacon* (Oxford, 1980); page-references incorporated in the text.

⁴ David W. Davies and Elizabeth S. Wrigley (eds.), *A Concordance to the Essays of Francis Bacon* (Detroit, 1973); see my review in *Modern Language Review*, 70 (1975), 601-2.

⁵ Marta Fattori, *Lessico del "Novum Organum" di Francesco Bacone* (2 vols.; Rome, 1980).

⁶ "Recent Studies in Francis Bacon," *English Literary Renaissance*, 17 (1987), 351-71. Sessions has updated it in the volume he has edited, *Francis Bacon's Legacy of Texts* (New York, 1990), 325-27.

side, we have no fundamental alterations to R. W. Gibson's *Bibliography* of early editions and no supplement to his list of seventeenth-century allusions, although that badly needs updating.⁷ We have had an excellent edition of the *Essays* from Michael Kiernan, who is now editing the *Advancement of Learning*.⁸ We have had French, German, and Italian editions, translations, and scholarly monographs.⁹ This enlargement of Bacon studies throughout the world is a most heartening development of the last decade, and gives a new meaning to that passage in his will: "For my name and memory, I leave it to men's charitable speeches, and to foreign nations, and the next ages" (XIV, 539). The most fundamental contribution, in my opinion, is Peter Beal's account of Bacon in his monumental *Index to English Literary Manuscripts of the Renaissance*.¹⁰ Beal has located (and in some cases identified for the first time) some 322 separate manuscripts of Bacon's work from the sixteenth and seventeenth centuries, comprising in my count some 49 works in English (prose: 45; poetry: 2; drama: 4) and 20 in Latin. One of these newly-discovered works has been edited by Graham Rees,¹¹ from whose leadership a completely new edition of Bacon's works is to be expected, with the first volume projected for 1992-1993.¹²

⁷ R. W. Gibson, *Francis Bacon: A Bibliography of his Works and of Baconiana to the Year 1750* (Oxford, 1950); *Supplement* (Oxford, 1959). Gibson's own inter-leaved and corrected copies of these works are owned by the Francis Bacon Library, Claremont, and it is greatly to be hoped that its librarian, Elizabeth Wrigley, will issue a revised edition, in particular drawing on her own extensive knowledge of allusions to Bacon.

⁸ M. Kiernan (ed.), *Sir Francis Bacon. The Essayes or Counsels, Civill and Morall* (Oxford, 1985); see my account in *Modern Language Review*, 83 (1988), 403-5.

⁹ Restricting the list to books published in the last decade, see M. Malherbe and J. M. Pousseur (eds.), *Francis Bacon: Science et méthode* (Paris, 1985); the special numbers of *Les Etudes philosophiques* 1985 (No.3) and *Revue internationale de philosophie*, 40 (1986), dedicated to Bacon; J. M. Pousseur, *Bacon, inventer la science* (Paris, 1988); M. Fattori (ed.), *Francis Bacon* (op.cit. in note 1); E. De Mas, *Francis Bacon* (Florence, 1978); W. Krohn, *Francis Bacon* (Munich, 1987); Jürgen Klein, *Francis Bacon oder die Modernisierung Englands* (Hildesheim, 1990). Notable translations include a French version of *Valerius Terminus*, tr. M. Le Doeuff (Paris, 1983), and a German version, tr. F. and H. Traeger (Würzburg, 1984). Most of Bacon's works have long been available in Italian; France and Germany are beginning to catch up. A pioneering translation into Spanish of two astronomical works under the title *Teoría del Cielo*, by A. Elena and M. J. Pascual (Madrid, 1989), was the subject of a thoughtful essay-review by Antonio Pérez-Ramos, "Francis Bacon and astronomical inquiry," *British Journal for the History of Science*, 23 (1990), 197-205.

¹⁰ *Index of English Literary Manuscripts, 1450-1625*, (2 vols.; London, 1980).

¹¹ Graham Rees assisted by Christopher Upton, *Francis Bacon's Natural Philosophy: A New Source. A transcription of manuscript Hardwick 72A with translation and commentary* (Chalfont St Giles, Bucks., 1984), which I reviewed in *British Journal for the History of Science*, 21 (1988), 256-57. For other recently discovered manuscripts see Graham Rees, "Francis Bacon's Biological Ideas: A New Manuscript Source," in Brian Vickers (ed.), *Occult and Scientific Mentalities in the Renaissance* (Cambridge, 1984), 297-314; "An Unpublished Manuscript by Francis Bacon: *Sylva Sylvarum* Drafts and Other Working Notes," *Annals of Science*, 4 (1981), 377-412; "Bacon's Philosophy: Some New Sources with Special Reference to the *Abecedarium Novum Naturae*," in Fattori (op.cit. in note 1), 223-44.

¹² See Graham Rees, "A New Edition of the Works of Francis Bacon," *Bulletin of the Society for Renaissance Studies*, 5 (1988), 14-18.

In terms of our knowledge of Bacon's life there have been no major revelations but some smaller discoveries which fill in, or correct details. David Cressy has shown that the traditional belief that Bacon was not unusual in going up to Trinity College, Cambridge, at the age of 14 is wrong, since the median age at admission then was 17.2.¹³ Joel Epstein established (with the help of the researchers into parliamentary history) that Bacon first sat as an M.P. in the House of Commons in 1581, not 1585 as hitherto thought.¹⁴ Jonathan Marwil found evidence missed by other biographers that Bacon was on a government committee for the reform of the laws in December 1588, at the age of 27.¹⁵ A German scholar, Wolfgang Krohn, has noticed Bacon's name on a list of founders of the Newfoundland Company in 1607 and on that of the founders of the Virginia Company in 1609.¹⁶ As for his last years, D. R. Woolf has discovered in a Dutch library a letter showing that, when writing *Henry VII*, Bacon did in fact borrow manuscript histories from John Selden.¹⁷

These are all heartening developments, and in many books and journal articles other signs of growth and fruition can be discerned. Yet the study of recent literature shows that the growth of knowledge is neither automatic nor steady. There are, to begin with, backslidings, in which insights established by earlier studies are either not known or ignored. So we are still told that Bacon hated the imagination, distrusted drama, or fiction, or poetry.¹⁸ I fondly imagined that I had sufficiently refuted L. C. Knights's uncritical use of T. S. Eliot's notorious (and largely discredited) theory to make Bacon personally responsible for creating the "Seventeenth Century Dissociation of Sensibility," that denial of the free functioning of the imagination from which apparently also derived the evils of

¹³ D. Cressy, "Francis Bacon and the Advancement of Schooling," *History of European Ideas*, 2 (1981), 65-74, at 73 n5.

¹⁴ J. J. Epstein, *Francis Bacon. A Political Biography* (Athens, Ohio, 1977), 25, 32 n7.

¹⁵ J. Marwil, *The Trials of Counsel: Francis Bacon in 1621* (Detroit, 1976), 65.

¹⁶ Krohn, 1987 (*op.cit.* in note 8 above), 45.

¹⁷ D. R. Woolf, "John Seldon [*sic*], John Borough and Francis Bacon's *History of Henry VII*, 1621," *Huntington Library Quarterly*, 47 (1984), 47-53.

¹⁸ See, e.g., E. P. McCreary, "Bacon's Theory of Imagination Reconsidered," *Huntington Library Quarterly*, 36 (1973), 317-26, for such statements as "Bacon considers imagination as a rebel and lawbreaker" (320), and "the history of science has shown just how wrong Bacon was about imagination's role" (321)—the author claims that Bacon understood the role neither of hypothesis nor of "imaginative thinking" in scientific method (322), and "Perhaps his strongly Calvinist background prevented him from fully accepting and accounting for imagination's creative power and freedom, not only here in poetry but in science as well" (324). Even worse, L. G. Kelly, in "Medicine, Learned Ignorance, and Style in Seventeenth-Century Translation," *Language and Style*, 19 (1986), 11-21, describes Bacon as a "positivist" and "materialist," and breezily affirms that "Like most positivist thinkers Bacon feared the imagination, and in an age when imaginative language was prized, mistrusted language" (11). See also the extremely imperceptive essay by J. M. Cocking, "Bacon's view of imagination," in Fattori (*op.cit.* in note 1), 43-58. None of these writers is aware of the study by John L. Harrison, "Bacon's View of Rhetoric, Poetry, and the Imagination," *Huntington Library Quarterly*, 20 (1957), 107-25, repr. in Brian Vickers (ed.), *Essential Articles for the Study of Francis Bacon* (Hamden, Conn., 1968; London, 1972), 253-71. This is not ideal, but is at least a start.

soil erosion, the internal combustion engine, and America;¹⁹ but some critics of Bacon's style have recently revived it.²⁰ I thought that R. M. Adolph and myself, publishing independently of each other in 1968, had laid to rest the theories of English Renaissance prose style invented by Morris Croll and George Williamson, according to which Bacon wrote a "Senecan" or "Anti-Ciceronian" style;²¹ but that Hydra has developed more heads since then. If these attacks on old misconceptions have not succeeded, then they must be restated more forcefully, with further evidence.

I. In chronicling the misunderstanding of Bacon's work one major problem—which he shares with other philosophers—is that scholars do not pay accurate attention to what the texts actually say. For instance, Bacon discriminated two ways of doing science, one (negative) which he called the anticipation of nature, the other (positive) known as the interpretation of nature (and represented, in his work, by the *Novum Organum*). The former took a quick look at its subject and on the basis of a few observations leapt to conclusions overhastily and rested there, discouraging further research. The latter advanced slowly but methodically, evolving techniques of sifting the evidence, checking, attempting to refute it in the famous "negative instances" for which Bacon's inductive system remains justly celebrated.²² The distinction between the two ways of proceeding is perfectly clear, yet some critics, including Karl Popper, have thought that by "anticipation" Bacon must have meant hypothesis, a term to which he gave quite different connotations.²³

In approaching Bacon's writings we must try to understand the terms that he uses and the arguments that he develops in specific contexts, paying close attention to the distinctions and discriminations that he makes; and it is necessary to know something of the historical setting. A striking example of the failure to observe either principle is provided by the political historian Jonathan Marwil,²⁴ whose declared aim was to reconstruct the causes which led to Bacon writing his *History of King Henry VII* in the aftermath of his fall from office in 1621. In fact, Marwil backtracks to the beginning of Bacon's career, giving an undisguisedly

¹⁹ Brian Vickers, *Francis Bacon and Renaissance Prose* (Cambridge, 1988), 142, 151-201, 290.

²⁰ John Carey, "Sixteenth and Seventeenth Century Prose," in C. Ricks (ed.), *English Poetry and Prose, 1540-1674* (London, 1970), 339-431, at 396-97; John Pitcher (ed.), *Bacon's Essays* (Harmondsworth, 1985), 52. These two jaunty dismissals of Bacon, largely through the medium of derogatory metaphors, deserve a reply.

²¹ See R. M. Adolph, *The Rise of Modern English Prose Style* (Cambridge, Mass., 1968); and Vickers, *op.cit.* in note 19, 12-14, 96, 106-17, 134, 284, 285-87.

²² See, e.g., *Novum Organum*, i.19-22 (IV,50); 104 (IV,97), 125 (IV,111-12).

²³ For Popper's misunderstanding of Bacon's theory of hypothesis see Peter Urbach, *Francis Bacon's Philosophy of Science* (La Salle, Illinois, 1987), 23, 26, 34, 84; and Mary Horton, "In Defence of Francis Bacon: A Criticism of the Critics of the Inductive Method," *Studies in the History and Philosophy of Science*, 4 (1973), 241-78, at 248. For the claim (improbable at first sight, but welcomed by Rossi, *op.cit.* in note 1, 257-58) that Bacon influenced Popper, see Urbach, 32-33, 49-51, 56-58, 85-90, 122. Other readers are unpersuaded by this claim: see, e.g., the review by Roger Ariew in *Archiv für Geschichte der Philosophie*, 71 (1989), 350-52.

²⁴ *Op.cit.* in note 15; page-references incorporated into text.

hostile account of whatever event or work he discusses. Not content with denigrating Bacon's life and his literary, legal, historical, and political writings, Marwil also attacks the scientific works. Not, however, the *Novum Organum*, nor the *Parasceve*, nor the *Natural and Experimental History*—none of the works where Bacon's aims are both clearly expressed and exemplified in practical terms—but two minor works, only published by Gruter in 1653. The first was the *Descriptio Globi Intellectualis* (with the *Thema Coeli*). Marwil has consistently psychologized Bacon, arguing that his legal training deformed his mental processes so much that it disqualified him for science. According to Marwil, because legal modes of interpretation do not constitute “a method conducive to discovering what is unknown, particularly when language is either unavailable or irrelevant as a possible medium for knowing, Bacon will flounder when he *actually tries to do science*” (112, my italics). From this position Marwil now condescendingly dismisses these two fragmentary works:

Neither fragment has merit whether considered as a document intended to advance science or even as a statement of what was known about astronomy in its author's day. Simple ignorance cannot explain their inadequacy. . . . some defect besides sloth accounts for Bacon's ineptitude. As with all subjects, Bacon comes to astronomy as a self-styled devil's advocate, automatically challenging whatever has been hitherto accepted (138).

But there is nothing “automatic” or indiscriminating (“whatever”) about Bacon's critique, and Marwil has simply not understood the point at issue. He quotes Bacon's statement that astronomy deals with “hypotheses which are most suitable for compendious calculations, philosophy [with] those which approach nearest the truth of nature” (V, 557), and then declares that Bacon's “aversion” to mathematics “necessarily disqualified him from making any contribution to astronomy” (138). But the point at issue involves physics, not mathematics, and was stated perfectly clearly by Bacon himself; namely, that astronomy advances hypotheses which are intended to explain the observable phenomena of planetary motion but which are not necessarily true (and in any case, unverifiable at that time). Natural philosophy (or physics, as we should call it here) alone can explain physical causes in physical terms. This is why Bacon wrote of the hypotheses of astronomy in *Thema Coeli* that “it is useless to refute them, because they are not themselves asserted as true, and they may be various and contrary one to the other, yet so as equally to save and adjust the phenomena” (V, 557). Or, as he put it in *Descriptio Globi Intellectualis*, the astronomers do not claim that their hypotheses “are actually true, but only that they are convenient hypotheses for calculations and the construction of tables” (V, 511). But physics, Bacon believed, could study not only “the exterior of the heavenly bodies (I mean the number of the stars, their positions, motions, and periods)” but “the interior (namely the physical reasons),” accounting for, “the substance, motion, and influence of the heavenly bodies as they really are” (IV, 348). It is important to grasp this distinction if we are to understand the sense in which Bacon uses the term “hypothesis,” and his belief in the power of physics to discover truth.

In any case, as Peter Urbach has shown, Bacon is merely applying a traditional distinction between the two subjects that goes back to Plato and is still found in

William Gilbert in the early 1600s.²⁵ Simplicius, for instance, commenting on Aristotle in the 6th century AD, said that the scope of “‘physical theory’” was to study “‘the essence of the heavens and the stars, their power, their quality,’” and to “‘provide demonstrations concerning the size, shape, and arrangement of these bodies.’” All these topics lay beyond the astronomer’s powers, who, since he cannot “‘contemplate causes . . . feels obliged to posit certain hypothetical modes of being which are such that, once conceded, the phenomena are saved,’” that is, accounted for. Nine centuries later Osiander told Copernicus that the astronomer’s hypotheses are “‘not articles of faith but the basis of computation,’” and “‘need not be true or even probable, if they provide a calculus consistent with the observations.’” We may regret that Bacon allowed the distinction between the two sciences to solidify, failing to realize that astronomy could indeed lead to natural philosophy in the formation of a world system. But we must appreciate that his distinction between the two was no personal quirk but represented contemporary scientific belief.

Marwil is equally off-target in the other scientific work that he attacks, the *De Fluxu et Refluxu Maris*, which, he believes, “underlies the reason for Bacon’s failure as a scientist” (140). According to Marwil, Bacon,

for all his lip service to experience and induction, is restricted to an essentially deductive method when he does science. Simple extrapolation from hastily conceived laws often at variance with the work of other men is at the heart of this exquisitely verbal science. And the mode of reasoning, as well as the expectation of results, is distinctly reminiscent of his mind when it applies itself to law. (141)

In fact, as historians of science know, Bacon did not merely pay lip service to experiments and inductive method; he devoted a large part of his mature work to laying down the conditions within which they could be successfully pursued. Nor was he ever guilty of “simple extrapolation,” let alone forming “hastily conceived laws.” The biggest error is the phrase “exquisitely verbal science,” since a constant theme of Bacon’s polemic—the *pars destruens* as he called it, to be complemented by a *pars construens*—was the pointlessness of all forms of science which based themselves on books, language, or logical method dealing with words, not things. And as for Marwil’s criticism of Bacon as “at variance with the work of other men” (as if independence were a vice), Bacon’s theory of the tides attracted serious attention from Galileo. Indeed, as Paolo Rossi²⁶ and Antonio Pérez-Ramos have emphasized, Galileo almost certainly knew Bacon’s *De Fluxu et Refluxu Maris*, and “elaborated his own theory of the tides partly as a response to it.” Furthermore, and reciprocally, as it were, “Bacon’s *instantia crucis* in *Nov. Org.* ii.36 was also designed to test Galileo’s view (explicitly mentioned in ii. 46).”²⁷

²⁵ *Op.cit.* in note 23, 126-27. See also Pérez-Ramos, “Francis Bacon and astronomical inquiry,” *op.cit.* in note 9.

²⁶ Rossi, “Venti, maree, ipotesi astronomiche in Bacone e Galilei,” *Aspetti della rivoluzione scientifica* (Naples, 1971), 163-91.

²⁷ Pérez-Ramos, *Francis Bacon’s Idea of Science and the Maker’s Knowledge Tradition* (Oxford, 1988), 248n. On this outstanding study, the most important one to date on Bacon’s natural philosophy, see my brief notice in the *Times Higher Educational Supplement*, 5 May 1989, 28.

II. Scholars overreach themselves in moving into areas beyond their competence. The memorable verses that Jonathan Swift wrote as a mock epitaph for himself includes the lines:

True genuine Dulness mov'd his pity
Unless it offer'd to be witty.²⁸

Other misunderstandings of Bacon's scientific ideas are less surprising, since they derive in part from his own attitude to terminology. In the *Advancement of Learning*, for example, he drew attention to the fact that he was using "the word Metaphysic in a differing sense from that [which] is received":

it will easily appear to men of judgment that in this and other particulars, wheresoever my conception and notion may differ from the ancient, yet I am studious to keep the ancient terms. For hoping well to deliver myself from mistaking by the order and perspicuous expressing of that I do propound, I am otherwise zealous and affectionate . . . to retain the ancient terms, though I sometimes alter the uses and definitions. (III, 352-53; *De Augmentis*, IV, 344-45)

Bacon's hope that "the very order of the matter and the clear explanation which I give of everything will prevent the words I use from being misunderstood" (IV, 344) was too optimistic, for some readers have managed to misconstrue him. But before we protest that he ought to have invented a new terminology, we should remember that he was writing in Latin, where neologisms would have been far less easy than in English, and that both classical and Renaissance rhetoric warned against neologism.

To take two instances of misunderstanding, consider the key terms "Metaphysics" and "Form." Bacon's scientific theory had as its goal the discovery of the laws of nature and physical causes by a process that would rise gradually but inevitably from the particular to the general. In developing this notion, Bacon arranged knowledge into a pyramid or hierarchy of increasing generality. The base or primary level is "history and experience," that is, observable phenomena, which are "infinite in number." Above that comes physics; then metaphysics; and finally "summary philosophy," which bestrides all the other sciences by virtue of its generality. Metaphysics is defined as the discovery of forms, the innate structural properties of matter (III, 352-59; IV, 126, 344-47). This is obviously a highly idiosyncratic use of the term, but Bacon—as he had promised—defines it so carefully in its context that there is little excuse for misunderstanding it. Yet Michael Hattaway²⁹ managed to misconstrue it as "metaphysics"

²⁸ "Verses on the Death of Dr. Swift," lines 473-4 in Swift, *Poetical Works*, ed. H. Davis (Oxford, 1967), 512.

²⁹ "Bacon and 'Knowledge Broken': Limits for Scientific Method," *JHI*, 39 (1978), 183-97; page-references incorporated in the text. Another critic who has not attended to Bacon's contextual definition is John C. Briggs, who writes: "The true laws of nature, Bacon explains, are metaphysical—beyond traditional laws of physics": *Francis Bacon and the Rhetoric of Nature* (Cambridge, Mass., 1989), 42. This disappointingly glib study confirms the trend to which I have drawn attention (see note 43 below) of critics trained in English literature imagining that they can set out as commentators on Bacon without any training or first-hand research in the history of science. Misunderstandings are inevitable. So Joel Fineman diagnoses "a movement or development in Renaissance Humanist historiography" to "a more 'scientific,' presumptively Thucydidean, historicism," instanc-

with a small M, as a form of “Christian Aristotelianism” (184), and so he judged Bacon to have been “basically an Aristotelian,” like Richard Hooker (187), despite the fact that on innumerable occasions Bacon attacked the sterility of Renaissance Aristotelianism in being always bound to the same topics and the same methods. Hattaway redefines Bacon as “a Christian skeptic” but also an Aristotelian, while his notion of scientific law is said to be “a development of Aristotle’s formal cause with, however, a strange mixture of ultimately theological notions derived from alchemical or cabbalistic sources” (188-89). After the misunderstanding (as so often in Bacon studies) comes the dismissive attack, and Hattaway goes on to dismiss Bacon as “essentially a conservative thinker.” Those passages which *seem* to be “forward looking, even modern are in fact informed by metaphysical paradigms. Like most medieval and Renaissance thinkers Bacon worked largely by correspondences and analogies. . . .” (184). Having briskly but superficially reviewed Bacon’s whole output, Hattaway concludes: “Bacon’s old-fashioned confusion of essences and accidents, primary and secondary qualities, . . . may make us feel that most of Book II of the *Novum Organum* is not worth logical analysis” (189). For these charges of confusion Hattaway gives no evidence but simply asserts, for instance, that “Bacon’s notion of form is virtually inseparable from the notion of spirit” (190). But it would be hard to find two concepts which had less in common than these. Having mistakenly linked Bacon with the occultists who thought through “correspondences and analogies,” Hattaway errs further by following Frances Yates³⁰ in taking Bacon’s juxtaposition of the “outer courts of nature” with “her inner chambers”—a favorite metaphor of his to distinguish superficial from profound approaches—as being “a reference or analogue to the mystical vault of the Rosicrucians” (193). It is not surprising that he subsequently describes Bacon’s attitude to language as “magical” (194).

A thorough refutation of Hattaway’s dismissal was performed by Mary Horton, who shows that he distorted Bacon by selective quotation and omission (494, 499) and simply states that “in contradiction to Hattaway’s contention, Bacon does not blur the distinctions between form, cause, and spirit” (492).³¹ Most valuably, she clearly utters a basic principle in the understanding of any text, that “Bacon’s concepts, which he claimed were quite new, [should be] defined in

ing Bacon’s “Catalogue of Particular Histories by Titles,” such as the “History of the Heavenly Bodies”: Fineman, “The History of the Anecdote: Fiction and Fiction,” H. Aram Veese (ed.), *The New Historicism* (New York, 1989), 49-76, at 70, n.30. But Bacon uses the term *Historia* in its (now obsolete) synchronic sense as “A systematic account (without reference to time) of a set of natural phenomena . . . [cf. the use of *ιστορία* by Aristotle]” (*OED*, 4). This non-diachronic sense has nothing to do with historiography.

³⁰ As I showed many years ago, Yates’s discussion of Bacon in her book *The Rosicrucian Enlightenment* (London, 1972), can be faulted in virtually every detail. See Brian Vickers, “Frances Yates and the Writing of History,” *Journal of Modern History*, 51 (1979), 287-316. For further analyses of the very different occult tradition, which did indeed “think in analogies,” see B. Vickers, “Analogy versus identity: the rejection of occult symbolism,” in B. Vickers (ed.), *Occult and Scientific Mentalities in the Renaissance* (Cambridge, 1984), 95-163; and *id.*, “On the function of analogy in occult science,” in A. Debus and I. Merkel (eds.), *Hermeticism and the Renaissance* (Cranbury, N.J., 1988), 269-92.

³¹ “Bacon and ‘Knowledge Broken’: an Answer to Michael Hattaway,” *JHI*, 43 (1982), 487-504; page-references incorporated in the text.

terms of how *he* uses them in the structure of *his* arguments” (498). This principle is especially applicable to Bacon’s theory of Forms, often said to be confused and inconsistent. In his brief study of Bacon, Anthony Quinton gives a useful starting definition, writing that Forms are “the hidden states of the fine structure of things by reference to which their straightforwardly observable properties can be explained.” Form is “a latent structural property of the particles of which matter . . . is composed. . . an arrangement or configuration of matter, not a thing in its own right.”³² This seems to me essentially correct, if somewhat undifferentiated. Mary Horton, however, otherwise an able defender of Bacon against misunderstanding, writes that “forms are . . . no more nor less than the laws of nature.”³³ This is to give the term altogether too abstract a sense: Bacon always uses it concretely, albeit idiosyncratically.

Yet there are more surprising interpretations to come. Mary Slaughter, approaching Bacon from the history of linguistics in a useful study of “universal language” schemes in the seventeenth century,³⁴ claims that Bacon represents a late stage of Aristotelian essentialism. She states that although Bacon’s “method begins with modern ideas of observation and experimentation, it nevertheless ends with the classical procedures of classification and definition. Bacon’s scientific method starts with the collection and enumeration of ‘instances’ and ends with an accurate definition of the nature of those instances. This is . . . the paradigm of Aristotelian science” (93). For Bacon, as for “Aristotelian science,” she several times insists, “classification and, even more so, definition are the ends of his scientific activity” (94). But Bacon nowhere says that “classification and definition” are “the end and means of science” (*ibid.*): the whole aim of his science was the production of works, not words. The goal of his inductive method, he wrote, was “from works and experiments to extract causes and axioms, and again from those causes and axioms new works and experiments” (*NO*, i.117;

³² Quinton, *op.cit.* in note 3, 45, 63-64.

³³ Horton, *op.cit.* in note 23, 243. Rom Harré, in “A Note on Ms. Horton’s Defence of Bacon,” *Studies in the History and Philosophy of Science*, 5 (1974), 305-6, finds her “simply wrong” on this issue, having relied on the old Basil Montagu translation. As Harré points out, in the *Novum Organum* discussion, ii.4 (not i.4, as Harré has it), Bacon uses the word *deducere* to explain how a “true Form . . . deduces the given nature from some source of being which is inherent in more natures” (IV,121), and Harré rightly notes that *deducere* had, at this time, “the physical sense of ‘leads out’ or ‘produces’ rather than . . . the logical sense of ‘implies’ or ‘entails.’” Harré shows that Bacon’s discussion clearly “puts Form among the physical properties of things, substances and phenomena, not amongst propositions concerning such properties.” As Pérez-Ramos has shown, this misconception that Bacon’s “forms” are “scientific laws” has some distinguished predecessors, namely Whewell, C. D. Broad, F. Anderson, *et al.* (65-67, 116). For the whole issue see N. E. Emerton, *The Scientific Reinterpretation of Form* (Ithaca, N.Y., 1984).

³⁴ Slaughter, *Universal languages and scientific taxonomy in the seventeenth century* (Cambridge, 1982); page-references incorporated in the text. This author’s tendency to fit Bacon into pre-prepared slots without really registering his difference is seen also in her description of the *Advancement of Learning* as “a typical Renaissance compilation of information related to the encyclopedia tradition” (89, 230-31, n.23). But the *Advancement* is a critical survey of knowledge designed to expose deficiencies and gaps; it is an “encyclopedia” of work needed, of not yet existing knowledge, an encyclopedia of *lacunae*, as it were, which a new philosophy would fill in.

IV, 104). The aim of natural philosophy is “the Inquiry of Causes and the Production of Effects” (IV, 346). Aristotelian and scholastic logic are repeatedly criticized for their inability to go beyond the manipulation of concepts, the re-arrangement of what is already known, helpless in making any new discoveries which will benefit mankind (e.g., IV, 24-26, 51, 97-98). Bacon’s major claim for his science was that it would be a *scientia operativa* (IV, 22, 32, etc.), that is, productive of works.

Slaughter seems to have arrived at this strange misunderstanding of Bacon by relying on some antiquated secondary sources (231, n.32), who encourage her to believe that Bacon implied by “Forms” what she calls “abstract simple natures.” According to Slaughter, Bacon—like Aristotle—believed that “a concrete substance can be defined by the enumeration of these simple natures” (95), so that “what he is left with in the end are Aristotelian statements of essence, i.e., definitions by genus and difference” (96). But there is nothing abstract about Bacon’s concept of Form: indeed, he explicitly denounced Plato’s conception of Forms as being “absolutely abstracted from matter, and not”—as it should be—“confined and determined by matter” (III, 355; IV, 66). Similarly he attacked Aristotelian-scholastic notions of Form as being hypostatized abstractions (IV, 58-59, 64-65, 119-20). As he explains in the *Novum Organum*, “the form of a nature is such, that given the Form the nature infallibly follows. Therefore it is always present when the nature is present, and universally implies it, and is constantly inherent in it” (ii.4; IV, 121). It follows that “the Form of a thing is the very thing itself” (ii.13; IV, 137), and the goal of scientific enquiry is to investigate the structure of matter. Slaughter’s image of Bacon as an original Aristotelian, content to remain a scholastic essentialist, resembles R. E. Larsen’s attempt to write Bacon off as an Aristotelian and is open to the same devastating critique that Pérez-Ramos has made of that position.³⁵

An even stranger account of Bacon’s concept of Forms has recently been given by Brian Copenhaver in terms of Renaissance magic.³⁶ Copenhaver reviews some (but only some) of Bacon’s critiques of the occult arts (296-97), yet describes Bacon as merely making “certain physical and metaphysical departures from the post-Ficinian theory of magic”—taking as demonstrated, that is, Bacon’s identity with this school of thought. These “departures,” Copenhaver claims, include Bacon’s “reformulation on physical grounds of a magical theory of forms and occult qualities” (297). As to what Bacon meant by Form, Copenhaver declares:

Obviously, the Baconian form is not the Peripatetic abstraction, but its exact contours are obscure—a generative force, a defining essence, a taxonomic distinction, a natural law, a material quality, an alchemical additive, any of these will answer to Bacon’s description which, however, seems most akin to the fixed and distinguishing material properties of an object. This becomes clearer as one leafs through Bacon’s illustration of forms, a long list of ‘instances’ (298-99).

But this “long list” of instances is in fact a tightly-argued exposition of inductive method. What is magical about this, the reader may now be asking? Copenhaver

³⁵ See Larsen, “The Aristotelianism of Bacon’s *Novum Organum*,” *JHI*, 23 (1962), 435-50, and Pérez-Ramos (*op.cit.* in note 27), 115-32.

³⁶ “Astrology and magic,” in C.B. Schmitt (ed.), *The Cambridge History of Renaissance Philosophy* (Cambridge, 1988), 264-300, at 296ff; page-references incorporated in the text.

runs together several passages in the *Novum Organum* to argue that Bacon “did not deny the existence of occult virtues and sympathies, but he traced them to imperceptible physical structures in bodies called ‘latent configurations’ (*latentes schematismi*)” (299). But the latter quotation comes from Book 2, aphorism 6, Bacon’s first outline of his theory of Forms (IV, 124-26), where the “configurations” are said to apply to matter in general, not to occult sympathies. (Incidentally, Bacon uses the terms “occult and, as they are called, specific properties and virtues” as standard concepts in the Aristotelian scientific tradition, with no “magical” connotations.³⁷)

The second passage quoted by Copenhaver comes from Book 2, aphorism 50, discussing “Polychrest Instances, or Instances of General Use,” and itemizing seven ways in which “man operates upon natural bodies” (IV, 233ff). The sixth kind, Bacon writes, “often lies deeply hid. For what are called occult and specific properties, or sympathies and antipathies, are in great part corruptions of philosophy” (IV, 242). Bacon professes himself “almost weary of the words sympathy and antipathy on account of the superstitions and vanities associated with them,” and rejects many supposed “friendships and enmities of bodies” as false or fabulous (IV, 244). Yet he makes one exception to the rule, admitting that some consents can be found “in certain medicines, which by their occult (as they are called) and specific properties have relation either to limbs, or humours, or diseases, or sometimes to individual natures” (*ibid.*). According to Copenhaver, this brief remark is enough to show that “Bacon confirmed a tradition of pharmaceutical magic reaching back two millennia and more.” However, he observes, “in adopting the term *schematismus*, Bacon may not have known the kindred language in Plotinus”; and in a list of traditional sympathies “he may not have had in mind” a passage in Proclus (this is the rhetorical figure *insinuatō*, smuggling in a point while appearing to deny it). But, he asserts, Bacon *had* read Ficino, who used Proclus and Plotinus—“and in any event,” Copenhaver dismissively adds, “whatever the manner of their mediation, the resemblance of Bacon’s magical ideas to their Neoplatonic ancestors is apparent—as are the differences.” Bacon’s concept of Forms, he concludes, is “more physical” than his Greek analogues, “but still more magical than the quantitative conceptions of force and structure” in the new science (299-300).

Such a slender case needs no great refutation. We may wonder how many other writers before Plotinus, or between Plotinus and Bacon, used the word *schematismus* and in what range of contexts. We may wonder how many lists of “chains” of sympathetic correspondences exist in classical and Renaissance literature, and what the chances are that Bacon may be referring to such a rare text as Proclus’s *De sacrificio*—which, apart from a fragment discovered by Bidez, is known only from Ficino’s translation.³⁸ (It would be hard to find a more obscure text in late classical philosophy.) And in the face of Bacon’s oft-repeated criticisms of the occult tradition—magic, astrology, alchemy, “signatures,” and so on—for its delusory quality, its dishonesty, its appeal to the human appetite

³⁷ See, e.g., Keith Hutchinson, “What happened to occult qualities in the Scientific Revolution?,” *Isis*, 73 (1982), 233-53; and August Buck (ed.), *Die okkulten Wissenschaften in der Renaissance* (Wiesbaden, 1989).

³⁸ See D. Pingree, “Some of the Sources of the Ghāyat al-Hakīm,” *Journal of the Warburg and Courtauld Institutes*, 43 (1980), 1-15, at 13.

for speedy profits without effort,³⁹ we may wonder why Copenhagen wants to link Bacon with the magical tradition. (Does the occult gain respectability by being associated with science? Or does science lose it?)

A less question-begging reading of this passage in Bacon, such as the one by Graham Rees cited in Copenhagen's footnote (299 n68)—presumably as somehow supporting his thesis—concludes that the *schematismus* or “configuration” of a body “is its internal conformation, structure, or constitution which can be investigated by experimental techniques detailed in the *Novum Organum* and elsewhere. . . . Bacon's concept of conformity is not very clear but apparently if the configuration of two bodies ‘match’ then some kind of sympathetic effect can be expected.”⁴⁰ Throughout his developing theory of Forms (some twenty years of thinking, at least) Bacon always insisted that the discovery of underlying structures would reveal “the true differences of things” (e.g., IV, 360). It is only fitting that, at the end of this fullest discussion of the subject, in the *Novum Organum*, he should have allowed for the possibility of identity as well as difference. If he explained it in terms of sympathy, that is an ancient and widely diffused idea, not properly magical. Given the whole context of Bacon's theory of Forms, he seems to have drawn nothing from what Copenhagen defines, in such proprietary terms, as the Neoplatonic magical tradition. The antecedents of his concept of Form, as Pérez-Ramos has shown (74-82), developing the work of P. Reif and others,⁴¹ lie rather in the university text-book tradition, an Aristotelian background which Bacon decisively reinterpreted for his own, new vision of science.

III. If the preceding discussion has seemed rather negative, we draw comfort from the remark made by Darwin in one of his letters that it is just as valuable to correct a mistaken fact as to discover a new one. But there are also more positive grounds for hope in recent Bacon studies, in particular the two book-length studies by Peter Urbach and Antonio Pérez-Ramos. Although differing in scope and detail they both challenge the received view of Bacon by applying what are surely the two essential processes in intellectual history: reconstructing the situation in which a writer worked, and attending closely to the meaning of his texts. As Pérez-Ramos puts it, “the exploration of old meanings consists, largely, in the reconstruction of the ‘problem situation’ a given author was facing,” considering, that is, not just the statements or answers that he gave, “but of these together with the question they are meant to answer” (45). The only way to avoid “gross distortion of past texts . . . [is] to reconstruct the conceptual grammar in which they were originally embedded” (*ibid.*). The received image of Bacon as a “positivist inductivist,” applying an unsuitable logical method exhaustively and unimaginatively—as given by such commentators as Morris

³⁹ For Bacon's criticisms of the occult see, e.g., B. Vickers, “Analogy versus identity,” *op.cit.* in note 30, 133-34, and “On the goal of the occult sciences in the Renaissance,” in G. Kauffmann (ed.), *Die Renaissance im Blick der Nationen Europas* (Wiesbaden, 1991), 51-93, at 90-92.

⁴⁰ G. Rees, “Francis Bacon's semi-Paracelsian cosmology,” *Ambix*, 22 (1975), 81-101, at 97-98.

⁴¹ Reif, “The Textbook Tradition in Natural Philosophy,” *JHI*, 30 (1969), 17-32; Emerton, *op.cit.* in note 33 above.

Cohen, J. H. Randall, Alexandre Koyré, Karl Popper, Imre Lakatos, P. B. Medawar and others—is a product of an anachronistic twentieth-century history of science (40, 271-75). Peter Urbach reached the same conclusion (independently, and a bit earlier), that the received image of Bacon the inductivist—what he calls the “Infallible-Mechanical Thesis,” as argued by the commentators R. L. Ellis, Karl Popper, L. J. Cohen, and others (17-24)—is false. Although neither as methodologically rigorous nor as historically wide-ranging as Pérez-Ramos, Urbach performs a similar act of rehabilitation.

Reconstructing the contemporary climate of knowledge is less important to Urbach than analyzing Bacon’s ideas, but he makes some valuable points. As we have seen, he proves that Bacon’s distinction between the hypothetical nature of astronomy and the promised certainties of physics reflected classical ideas still accepted during the Renaissance. He also shows that Bacon’s concept of “proof” or “demonstration” did not then have the categorical implications those words have in modern English but described “the process whereby favourable evidence gradually raises a theory’s acceptability or plausibility” (44). This connotation was generally accepted in the period 1560 to 1680 and certainly did not imply claims of infallibility. In 1676 Joseph Glanvill distinguished two senses of “certainty.” “*Infallible Certainty*,” or “an absolute Assurance, that things are as we conceive and affirm, and not possible to be otherwise” may be known to God but it is denied human beings, since our faculties may always deceive us. We are capable, however, of “*Indubitable Certainty*,” or “a firm assent to any thing of which there is no reason of doubt,” and men may therefore “propose their Opinions as *Hypothesis*, that *may probably* be the true accounts, without peremptorily affirming that *they are*.” Significantly, Glanvill stated this to be Bacon’s way of proceeding (44-45).

Urbach recreates another contemporary context in clarifying Bacon’s critical comments on William Gilbert (passages that often puzzle modern readers, to whom *De Magnete* represents one of the key works of the new science). Bacon’s remarks can now be seen to reflect a general contemporary distrust of Gilbert’s more speculative cosmology. While Bacon accepted the demonstration of the earth’s magnetic properties (V, 454), he rejected the claims made by Gilbert in the sixth and final part of his book, that “the magnetic character of the earth makes it ‘fitted for circular movement’ ” and that magnetism “‘endowed the earth with a purpose and a soul,’ due to its ‘astral magnetic mind’ ” (115-18). As Urbach shows, William Barlow and Edward Wright—two of Gilbert’s closest scientific acquaintances—independently criticized his theory ascribing a diurnal motion to the earth, supposedly derived from its “magnetical force and virtue,” as “the merest [total] theorizing” (120-21). Bacon rejected astrology on similarly “scientific and experimental grounds” (121-22).

Analyzing Bacon’s orientation in natural philosophy, Urbach brings out well the importance of physics as what we might call the “norm science” in his system, based on the conviction that “every natural action depends on things infinitely small,” in “a process perfectly continuous, which for the most part escapes the sense” (IV, 124). For this reason the main task of Bacon’s physics was the investigation, as Urbach puts it, “of the latent processes and latent configurations of ordinary bodies.” Since “objects with ‘a specific character’ . . . have a ‘uniform structure,’ ” the goal of science, particularly in its operative role, is to discover

this underlying structure, for, as Bacon put it, “no one can endow a given body with a new nature, or . . . transform it into a new body, unless he has attained a competent knowledge of the body so to be altered or transformed” (61; IV, 122-26). It is important to grasp the extent of Bacon’s involvement with matter-theory (74-81), since it largely conditioned his concept of Forms as “the necessary and sufficient conditions for the manifestation of [natural] phenomena” (65). Bacon also talked of a form as being a “law” (e.g., IV, 120), or a “law of action or motion” (IV, 58); and Urbach helpfully suggests that in so doing “he presumably meant to convey that there is some kind of compulsion, analogous to the civil law, binding the form and its manifestation, that is to say, the two are related as cause and effect” (62). But this does not mean that we can identify Forms with “natural laws,” as some commentators do, since for Bacon the term always implies some concrete, material structure, “the configurations of minute and invisible particles” (190).

Urbach describes Bacon’s methodology, outlined in the *Novum Organum*, as a “hypothetico-inductive method” which was “both good *and* original,” constituting a properly “unified philosophy of science” (15). He goes on to argue that “Bacon welcomed hypotheses (in the sense of theories going beyond what is immediately given in perception) from the very beginning, and that they were always the intended product of the interpretative method” (34). This point once seen, many common criticisms of Bacon can be rejected as ill-founded. Rather than mechanically collecting observations without any controlling theory, Urbach points out, Bacon explicitly rejected “the indiscriminate, ant-like accumulation of facts, which he associated with the ‘empiric’ ” (153). In a famous analogy,⁴² Bacon contrasted two false paths in science: those of the empirics (who are “like the ant; they only collect and use”), and the reasoners (who “resemble spiders, who make cobwebs out of their own substance”). The proponents of a true natural philosophy resemble the bee, which gathers its material from various places, but “transforms and digests it by a power of its own.” So a true philosophy will rely neither on “the powers of the mind” unsullied by contact with matter, nor on “matter . . . from natural history and mechanical experiments” recorded and untransformed, but will lay up observations and experiments “in the understanding, altered and digested” (IV, 92-93). Since this insistence on uniting the rational and empirical faculties is “one of the most striking features of his philosophy,” Urbach describes the persistence of this myth of Bacon the indiscriminate fact-collector as “a mystery.” Far from advocating an exhaustive enumeration of instances, Bacon warned that “to note all these would be endless,” a process both “infinite, and foreign to the purpose” (IV, 129, 384-85). His plan was “not to note every single instance, for some—the so-called prerogative instances—have a greater inductive force than others.” Nor did he want to collect only similar instances but rather “a *variety* of instances, which would share the character in question but which would otherwise be very different.” As Urbach says, “this perceptive requirement is absolutely central to the Baconian principles of natural history” (154).

⁴² See the admirable essay by Paolo Rossi cited in note 1, which takes issue with a number of contemporary interpreters of Bacon as an unimaginative fact-collector, notably Agassi, Popper, and Lakatos.

The fact that so many modern historians of science have accepted the image of Bacon as a fact-collector who separated that process from an unworkable system of induction merely shows, I think, that received ideas constantly reproduce themselves if unchecked by recourse to the text or challenged by independent thought. Bacon insisted time and again on a reciprocal, symbiotic movement from “works and experiments” to “causes and axioms” and back again (e.g., IV, 80-81, 104-5). As Urbach points out, “the second book of the *Novum Organum* contains numerous predictions derived from theories which Bacon advanced, and which he intended should be checked in experiment” (155-56). He did not claim infallibility for his natural histories, since he explicitly stated that the formation of axioms will correct experiments shown to be false (157-59). The inductive method was neither mechanical nor unthinking, furthermore, but was ready to use analogy and conjecture. Among the “Instances of the Lamp” Bacon listed “those which supply information when the senses entirely fail us . . . either by gradual approximation or by analogy” (IV, 202-3). Similarities—that is, analogies—“may also provide information about invisible processes,” but by the same token, Bacon warned, they are “less certain” (165). Bacon’s “most famous contribution to the description and classification of experiments,” Urbach writes, was his notion of the *instantiae crucis*, instances of the fingerpost, for whereas other instances “just refute a hypothesis . . . they also establish one” (IV, 180-90; 169). In contrast to a recent categorical denial of Bacon’s originality in any sphere,⁴³ Urbach judges Bacon’s classification of the various types of experiment and the information they provide, to be “an almost entirely original contribution to the philosophy of science.” Indeed, Ian Hacking⁴⁴ has called him “the first, and almost last philosopher of experiments” (171). Urbach agrees that Bacon “well deserves the title of ‘Father of Experimental Philosophy’ ” (185). Bacon’s belief that “the generality of one’s assumptions should be increased only gradually and should be proportioned at every stage to the available evidence,” and his related belief that “the role of observation and experiment was both to suggest appropriate axioms and to examine those axioms, either confirming or disconfirming them”—these beliefs, Urbach judges, form “an essentially correct description of the method of science” (192).

IV. This high evaluation of Bacon’s achievement in natural philosophy may come as a surprise to those who have long accepted a lower rating, but it is more than borne out by the fuller study of Antonio Pérez-Ramos. This is a thoroughly researched, well-written book, conceptually fully at ease with the demanding criteria of contemporary methodology in the history and philosophy of science. All the more impressive, then, is the author’s criticism of many nineteenth- and twentieth-century historians’ account of Bacon. His opening section surveys Bacon’s reputation from the mid-seventeenth to the mid-twentieth centuries,

⁴³ For insistent dismissals of any claim to originality in Bacon as “falsity and incongruity,” a “bluff” that is also meaningless, see Charles Whitney, *Francis Bacon and Modernity* (New Haven, Conn., 1986), 10-11, 60, 88, 121-22, 127, 137, 151, 152, 154. I have discussed the deficiencies of this book’s treatment of science in “Bacon among the literati: science and language,” *Comparative Criticism*, 13 (1991), 249-71.

⁴⁴ “Experimentation and Scientific Realism,” in J. Leplin (ed.), *Scientific Realism* (Berkeley, Cal., 1984), 159.

showing how differing aspects of Bacon's legacy have been influential at different periods. The generation associated with the Royal Society valued his emphasis on the collection of data and the evolution of experimental methods, with less concern for induction (although Bacon's concept of the *instantia crucis* was important for Hooke and Newton).⁴⁵ For the Enlightenment Bacon became a generalized culture-hero, hailed as a founder of the new science but not drawn on in any detail.⁴⁶ In the revival of interest in the history of English science in the Victorian period (Herschel, Whewell), Bacon became the philosopher of inductivism, assimilated to J. S. Mill's concept of induction, an anachronism that—in a still cruder version—formed the dominant twentieth-century image of Bacon as “positivist,” “utilitarian,” and “materialistic.”

Pérez-Ramos produces a devastating exposure of the hollowness of so many judgments on Bacon made by contemporary historians of science, such as Imre Lakatos's dismissal of him as “a confused and inconsistent thinker” who only appeals to “provincial and illiterate” scholars (29). A major principle involved is the anachronistic nature of much contemporary historiography, which seems to move “in one way only: from the present to the past, generally with genealogical overtones” (240). This present-orientated attitude ignores the history of language and the vast changes in philosophical terminology, falsely assuming a “semantic continuity” in the meanings of such terms as “scientia” or “methodus” (which led to the Cassirer-Randall mistaken evaluation of Paduan Aristotelianism as the source of modern scientific method [224-25]). The very concept of “science,” indeed, “is for most historians and sociologists viciously uncritical and ahistorical, no less than their indiscriminate use of the term ‘scientist’ ” (40). Karl Popper is unrepentantly confident in claiming an “identity of aims, interests, activities, arguments and methods” between “Galileo and Archimedes, or Copernicus and Plato, or Kepler and Aristarchus,” whereas, Pérez-Ramos observes, in these thinkers “methods and aims differed greatly,” while “activities, arguments, and above all, interests were worlds apart” (42-43). This fundamentally ahistorical approach may account for Popper's violent anti-Baconianism, a once influential

⁴⁵ Almost the only point on which one can find Pérez-Ramos lacking concerns seventeenth-century knowledge of Bacon's inductive system. He says that “the real coiner” of the “celebrated” phrase *experimentum crucis* was Hooke (27n.), and that “the felicitous phrase *experimentum crucis* is not Bacon's but Hooke's in his *Micrographia* (1665).” In fact, the coinage was made by Robert Boyle, in his *Defence of the Doctrine touching the Spring and Weight of the Air* (1662), referring to Pascal's experiment on the Puy-de-Dôme as “an *experimentum crucis* (to speak with our illustrious *Verulam*)”: Boyle's *Works*, ed. T. Birch, (6 vols; London, 1772), I, 151. Pérez-Ramos also writes that “the term ‘induction’ . . . does not even appear in Boyle” (195), but this is to rely on the notoriously unreliable Index to Birch's edition. Boyle was certainly familiar with inductive techniques, indeed Pérez-Ramos himself quotes his reference to “the three tables of Bacon's induction” (176-77), and more evidence could be cited. As for Newton's inheritance of Baconian induction, for which the arguments for and against are cited (19n.), I find it hard to accept the cited claim by M. Blay that Newton uses “the proposals of *Nov. Org.* as figures de rhétorique or modes of presentation.” Newton's use of the term *experimentum crucis* in the early optical writings seems to me thoroughly Baconian in function, not a mere ornament: see Brian Vickers (ed.), *English Science, Bacon to Newton* (Cambridge, 1987), 198-203, 237.

⁴⁶ See also M. Malherbe, “Bacon, l'*Encyclopédie* et la Révolution,” *Les Etudes philosophiques*, 3 (1985), 387-404.

reading that is comprehensively demolished here (“Criticism of the ‘Popperian Bacon,’ ” 270-85) as “historically hollow,” a “gross travesty” of Bacon’s mode of science which “misses the whole point.”

As against such misreadings Pérez-Ramos deploys the essential two-handed method of intellectual history, diachronic and synchronic: both reconstructing “the ‘problem-situation’ a given author was facing” (45-47) and expounding the major ideas and their inter-relations within his work. As he rightly says, “philosophical historiography” involves “unearthing some leading motives or highly significant patterns of thought” (179), attempting “to assemble some pieces of a huge historiographic puzzle” (216). In Bacon’s case the pieces involved are what Pérez-Ramos defines as his “key concepts: *forma, opus, inductio*” (40-41). The first and third of these are familiar in Baconian studies, albeit on very variable levels of understanding, but the second, as the author modestly declares, “aspires to strike a novel interpretative note encompassing Bacon’s overall conception of human knowledge” (41). This is what he calls the “Maker’s knowledge” tradition (48-62, 150-66), a tradition which “postulates an intimate relationship between objects of cognition and objects of construction, and regards knowing as a kind of making or as a capacity to make (*verum factum*)” (48). Readers unfamiliar with this concept will be comforted to see it described as “one of those ‘subterranean’ currents in Western thought which are only made explicit from time to time” (150), most notably by Vico (189-95). The distinction is between “knowledge *derived* from its object (user’s or beholder’s), such as the musician’s or the astronomer’s, and knowledge which *determines* its object in the way in which a cobbler’s knowledge of a shoe determines his activity in producing one: maker’s knowledge” (150). Plato emphatically rejected the notion, declaring that “knowledge proper belongs to the user and not to the maker,” a preference shared by Aristotle, who also found it unsuitable to the *bios theoretikos* which formed the philosopher’s highest good (50, 55-56, 150-51).

In traditional post-Aristotelian terminology *scientia* designates “knowledge for its own sake,” thus Bacon’s “much-repeated phrase ‘*scientia operativa*’ ” (IV, 22, 32, 102, 252), and the link⁴⁷ he makes between *scientia* and *potentia* (IV, 47) is a completely novel collocation of words and ideas. “Nowhere in the Aristotelian tradition is the term *scientia* so expressly linked with a purposive attempt to alter the course of Nature’s processes so as to denote the field of operative knowledge. Man is or can become *sapiens* or ‘knower’ as a self-perfecting beholder, not as a

⁴⁷ It should be noted that the ascription to Bacon’s philosophical works of the generalized statement that “knowledge is power” is erroneous. The *Novum Organum*, i.3, states that “Human knowledge and human power meet in one; for where the cause is not known the effect cannot be produced” (IV, 47), where “knowledge” clearly means “knowledge of causes” as a precondition towards “the effecting of works” (i.4). The phrase does occur, as quoted, once in Bacon, but in the essay on “Heresies” in the early *Meditationes Sacrae* (published with the 1597 *Essays*), where Bacon distinguishes three kinds of heresies, the third being “of those who . . . give a wider range to the knowledge of God than to his power (for knowledge itself is power) whereby he knows, than to that whereby he works and acts.” (tr. Spedding; VII, 253). Bacon’s Latin reads, for the key phrase: “statuuntque latiores terminos scientiae Dei quam potestatis, vel potius ejus partis potestatis Dei (nam et ipsa scientia potestas est) qua scit” (VII, 241). The rather specific context again makes it impossible to extract the expression “knowledge is power” as some Baconian axiom.

self-debased maker” (84-85). As Pérez-Ramos shows, Bacon effects “a complete break with the tradition” in making the discovery of Forms the goal of his science, not as units for contemplation (as the Scholastics would) but as a stage towards *operatio* (86). Whoever is “acquainted with Forms,” Bacon writes in the *Novum Organum*, can “detect and bring to light things never yet done,” and achieve both “truth in speculation and freedom in operation (*operatio*)” (IV, 120). Bacon’s definition of natural philosophy as “the Inquiry of Causes” begins from an Aristotelian position, but the continuation—“and the Production of Effects” (IV, 346)—is radically new (106), a “most un-Aristotelian criterion of physical production of ‘effects’ ” (108). Thus Bacon grafts a new notion of “the operative or manipulative aspect of man’s cognitive enterprise” on to “notional analysis of the physical world” (110-11).

The precise meaning that Bacon gave to the terms *opera* and *operatio* is well brought out by Pérez-Ramos. Nineteenth-century utilitarians inevitably saw *opera* as referring to “artefacts or tools,” those “technical achievements” such as the inventions of gunpowder, the printing-press, and the mariner’s compass that Bacon often celebrated (136). Macaulay sneeringly dismissed Bacon as a utilitarian, but as Pérez-Ramos observes, Bacon distinguished “experiments of light” (yielding valuable information) from “experiments of fruit” (yielding immediate profit), and explicitly attacked the utilitarian desire for an early return on investments as an over-hasty demand that would in fact defeat the progress of knowledge (137-39). Bacon’s science is directed towards *opera* not in the sense of making artefacts but in searching for “Nature’s ‘effects,’ phenomena such as heat, colour, or motion” (142). These are the goals to be investigated by the inductive method, not “utensils; Bacon’s model of the true object of knowledge is not the *machine*” (143). If the “utilitarian” reading is anachronistic,⁴⁸ equally so is the proto-Marxist view of Benjamin Farrington and others that would turn Bacon into “the philosopher of the industrial revolution.”⁴⁹ Bacon’s goal was to produce “new works and active directions,” as he first put it in the *Valerius Terminus* (III, 242), developing a natural philosophy that will be “operative to relieve the inconveniences of man’s estate” (IV, 297). Where Aristotle saw the mechanical arts as stagnant, unchanging since their first discovery, Bacon reversed his judgment, holding up the mechanical arts “against philosophy as exhibiting the marks of true progress” (144, 164). Indeed, Bacon affirmed that “it is only by imitating the ways of artisans and mechanics”—by making and doing—“that the natural philosopher can come to grips with Nature and her mysteries” (145). Bacon’s formulation of a *scientia operativa* meant that man should be able not only to know but “to alter the occurrence of natural phenomena in various ways,” a re-direction of goals which assured him an important place in the new scientific movement (163-64). Pérez-Ramos sees Bacon’s historical significance as residing in “the astonishing degree of awareness with which he articulated a concept of knowledge hitherto alien to philosophical discourse. . . . Bacon provided categories wherewith to think of *operatio*; others were to translate Bacon’s insights into concrete results” (169).

⁴⁸ See Brian Vickers, “Bacon’s so-called ‘Utilitarianism’: sources and influences,” in Fattori (*op.cit.* in note 1), 281-314.

⁴⁹ See Farrington, *Francis Bacon. Philosopher of Industrial Science* (New York, 1949; London, 1951).

This emphasis on operative knowledge clearly breaks down the Greeks' distinction between a *bios theoretikos* and a *bios pràktikos*. Pérez-Ramos aligns Bacon with a tradition of "practical reason," that is, "reason as portrayed in human purposive action (doing / making)" (32). This attitude undoubtedly reflects that tendency in Renaissance thought to emphasize the power of the human will and to make the *vita activa* the dominant model for man as a social animal, sometimes subordinating to it the *vita contemplativa* (seen in secular terms as "pure intellectual enquiry" rather than the Christian monastic or meditative tradition).⁵⁰ Certainly Bacon's mature philosophy united the discovery of axioms (by which he meant not the "mathematico-deductive" model of first truths from which other truths descend but "any statement describing the successive steps through which research proceeds" [254]) with the effecting of works. In the *Novum Organum* Bacon describes the reciprocal interaction of theoretical and practical enquiries, commenting that "these two directions, the one active and the other contemplative, are one and the same thing; and that which in operation is most useful, that in knowledge is most true" (IV, 121). It follows that Bacon regarded pure science and technology not as two distinct pursuits but "as one single and indivisible enterprise" (112), indeed Pérez-Ramos contends that "the epistemic and not only 'ideological' core of Bacon's idea of science was precisely an attempt at integrating" the two notions of "pure" and "applied" science in the maker's knowledge tradition (135, 156-57, 238). For the same reasons Bacon rejected the traditional "chasm between natural and artificial things," the "whole thrust of the Baconian project" denying any real difference between the products of art and those of nature (175-76).

This new direction in Bacon's thinking marks a decisive break with scientific method as derived from Aristotle, in particular the concept of induction as set out in the *Prior* and *Posterior Analytics* and in the *Topics*, and surviving in Renaissance Aristotelianism (albeit contaminated by rhetoric). Bacon's concept of induction, Pérez-Ramos warns, must be "sharply distinguished" both from the Aristotelian tradition and from the Victorian-modern notion (199), neither of which has the explicitly "constructivist goal" that Bacon gives it (241). For all its rigorous rules, Aristotelian *epagôge* (*inductio*) belongs—as Bacon so often objected—to the communication rather than to the discovery of knowledge. It is an essentially verbal operation, proceeding from "words to words," not from "words to things," and nowhere "remotely resembles a methodology for natural enquiries" (215). Having reconstructed the medieval and Renaissance background, Pérez-Ramos can only support "Bacon's claims to originality as regards his 'logical machine' " (216). In the Middle Ages Aristotelian induction was reduced "to a mere dialecto-rhetorical device" (219), a tradition that persisted in the Renaissance, in line with the general rhetoricization of logic,⁵¹ so much so that in such humanist logicians as Agricola and Melancthon *inductio* is merely

⁵⁰ On the tendencies in Renaissance thought to unite the active and contemplative lives see my "Introduction" to *Arbeit, Musse, Meditation. Betrachtungen zur Vita activa und Vita contemplativa*, ed. Brian Vickers (Zurich, 1985; 1991), 13-15; and the essays by P. O. Kristeller, Victoria Kahn, and Letizia Panizza.

⁵¹ See, e.g., Cesare Vasoli, *La dialettica e la retorica dell' Umanesimo. "Invenzione" e "Metodo" nella cultura del XV e XVI secolo* (Milan, 1968).

“a device for presenting or imparting knowledge which the speaker already possesses” (223). This recreation of sixteenth-century practice entirely validates Bacon’s often repeated judgment that “the induction of which the logicians speak, which proceeds by simple enumeration, is a puerile thing; concludes at hazard; is always liable to be upset by a contradictory instance, takes into account only what is known and ordinary; and leads to no result” (IV, 25; also III, 387; IV, 70, 428-29). As Pérez-Ramos sums up his historical reconstruction, “pre-Baconian induction . . . finds its scope in the field of language. *Inventio* and *invenire* do not denote the discovery of something new by the knower/agent in the province of empirical data, and hence *operatio*, which is a distinctive connotation of Baconian induction, is conspicuously absent” (231-32). Aristotle’s flexible method of *epagôge* had become “fossilized into a rigid mould of argument,” and all the versions of it circulating in the sixteenth and seventeenth centuries “were simply irrelevant for modern science” (232-33).

His recreation of the intellectual context gives Pérez-Ramos the authority with which to define the distinctive nature of Bacon’s *inductio* as deriving from “a cluster of concepts radically different” to those involved with the Aristotelian type. It starts from *experientia literata* and aims at the discovery of Forms, which in turn involves the natural philosopher not merely observing but intervening in natural processes:

Bacon’s induction . . . is not confined to the realm of language as a putative vehicle for knowledge. It rather resorts to checks placed outside human discourse and belonging to human *material* agency, such as the inspection of certain unusual or normally unexamined phenomena, the devising of experiments, and the use and/or construction of artefacts. (239-40)

Baconian induction begins with the collection of particulars but soon moves on by “a process of elimination through a series of deductive steps,” *not*—despite the widespread myth—via an exhaustive “enumeration of cases” (243). The crucial principle, according to a historian of logic, is that “a generalization cannot be validated by any number of favourable instances, but can be invalidated by a single unfavourable instance” (243-44): as Bacon put it, “the negative instance is the more forcible” (IV, 56).

Pérez-Ramos goes on to argue that “Bacon’s *inductio exclusiva* can be regarded as a battery of deductive tests” which are later deployed “in a strategy of gradual hypothetical inference” (244). The method is neither mechanical nor monist but involves both deduction and hypothesis. The full account set out here (244-66) is rather technical but entirely convincing. Of particular interest, given the standard but mythical picture of an absolute hiatus between Bacon’s collection of data and his inductive model, is the demonstration that Bacon resorts to new experimental evidence to test or correct a theory in what can only be described as a “hypothetico-deductive method” (251, 256). As Pérez-Ramos argued earlier, “the Baconian *experimentum* was teleologically designed to decide between competing explanations, either in the spontaneous course of Nature or in a contrived situation designed by the inquirer, i.e. by *creating* new experience” (130).

Two further characteristics of Bacon’s induction need emphasizing. First its use of analogy in making a “leap from the observable to the unobservable” (259): this essentially “analogical procedure” involves making a “leap” that is

“‘intuitive’ or hypothetical and only in the light of subsequent evidence . . . can it be justified” (260). As Bacon put it, “there is no proceeding in invention of knowledge but by similitude” (III,218). In Bacon’s *ars inveniendi* analogy is “indispensable” (261) and “a crucial and defining trait of Baconian induction” is “the patterns of reasoning whereby hypotheses are reached” (262). Induction is for Bacon a hypothetical procedure “because each Form is tentative: an *opinabile*” as he puts it in the *Novum Organum* (244n.). Induction is an “open-ended and self-correcting” process (263), because “the material (re-)instantiation of the effects does not preclude the successive reformulation of the very axioms that point to and are directions for such effects” (267). Bacon’s method has a built-in flexibility that makes it open to correction in the light of experience, a two-way movement responsive to the process of discovery. In the course of elimination Baconian *inductio* uses “deductive steps, mostly falsificationist,” giving it a character which is simultaneously inductive, deductive, and intuitive or analogical (268). Credit is due to J. M. Keynes as one of the few modern students to have recognized the “all-important analogical component in Bacon’s theory of knowledge” (293).

Secondly, we should remind ourselves of the larger context within which Baconian *inductio* is placed. As a result of Bacon’s constructivist stance, “the semantic field of *opus* is no longer connected with *induction* or *deduction* but with *production*, that is to say, the (re-)enactment or (re-)instantiation of Nature’s ‘effects’ or ‘affections’ ” (238). As Bacon stated, “axioms established by argumentation” alone cannot “avail us for the discovery of new works” (*opera*); whereas “axioms duly and orderly formed from particulars easily discover the way to new particulars and thus render sciences active” (IV,51). The term *opera*, Pérez-Ramos shows, is “functionally synonymous with *particularia*” in Bacon’s usage, for “what are ‘particulars’ in the first stage of enquiry (i.e. things or effects observed) become ‘works’ (*opera*) as the enquiry proceeds: the knower will then be in a position to (re)produce such particulars by his own industry as knower / agent” (257). For Bacon, then, science is not concerned with “observable antecedents of events (beholder’s knowledge) but rather with the unveiling of latent structures and processes which could enable man to (re)produce Nature’s effects (maker’s knowledge)” (265). Thus the truth-claims in his scientific method depend on “the material re-instantiation of those natural ‘effects’ which Bacon’s *scientia* investigates” (291), that is, a *scientia operativa*.

The overall effect of this challenging reinterpretation is to rehabilitate Bacon as a founder of and contributor to the new science—setting aside the fruitless use of the concept of a “scientific revolution” (47). Agreeing with the arguments of Thomas Kuhn,⁵² Pérez-Ramos notes that in the seventeenth century “a whole cluster of now attainable ‘objects of knowledge’—heat, electricity, magnetism, life phenomena—was actually created and sanctioned by the Baconian tradition as properly belonging to the cognitive scope of natural philosophy” (35). This constituted an enormous expansion and legitimization of the study of nature, and Bacon’s influence can be traced not only on the thinkers mentioned here (such

⁵² “Mathematical versus Experimental Traditions in the Development of Physical Science,” *Journal for Interdisciplinary History*, 7 (1976), 1-31; repr. in *The Essential Tension* (Chicago, 1977), 31-66.

as Mersenne, Descartes, Hobbes, Locke⁵³), but in a great range of scientific pursuits, including geology, topography, statistics, medicine, and much else.⁵⁴ Bacon's originality is sometimes disguised by what the author calls his "lexical conservatism" (232) in retaining such terms as *forma* or *inductio* while giving them a radically new interpretation.⁵⁵ Bacon may borrow Aristotelian terminology for Form, but the notion is "immediately broken up into certain discrete parts embryonically mirroring a particulate matter-theory" (87). In other words, Bacon shifts the discussion from the concept of "entity" to the new idea that "it is solely the motion and arrangement of the minutest parts of bodies that can account for their macroscopic appearance" (92). By conceiving Forms as "combinations of material units and simple motions" which acted as "intrinsic agents" in the constitution of matter, Bacon opened the door "for a purely mechanistic or materialistic type of explanation in natural philosophy" (91). This "shift in the understanding of matter" came at an opportune moment in seventeenth-century science, which "required a fundamental change in underlying matter-theory in order to render possible alternative modes of physical research," some new "definition of matter, the substance of the corpuscles" (97-98).

Bacon's own solution to this problem, his "idiosyncratic version of Corpuscularianism" (146), has been variously described. To L. Landau "Bacon's approach to physical science was that of a biologist pre-eminently bent on classifying disparate creatures while perfecting his taxonomy, rather than, as Galilean physicist, trying to unearth some underlying mathematical regularities in the behaviour of the bodies studied in order to predict future occurrences" (105). While agreeing that Bacon does not conform to the latter, and so far dominant model in the twentieth-century historiography of the "Scientific Revolution," I feel that the former model of a classifying biologist is too static. Pérez-Ramos subsequently notes that Bacon's concept of maker's knowledge envisages "a field of research in which phenomena resembling chemical reactions play a far more significant role than, say, purely mechanical rules of impact" (129). That concern with the dynamic processes within matter seems more appropriate, given Bacon's great interest in such vitalist notions as "spirits."

As it turned out, that whole vitalist tradition—so strong in Renaissance natural philosophy—was among the major casualties of the new science's interest in matter and motion (stimulated by Bacon's thinking), which led to its resolute separation of animate and inanimate domains. If the history of science were only written from the viewpoint of astronomy or mathematics Bacon might continue to be dismissed as outside the select fold of "founding fathers." It is the great merit of Antonio Pérez-Ramos to have exposed the limitations of that mode of historiography and to have succeeded in his project for making "a fresh examination of Bacon's thought as lying at the root of one of the main trends of our philosophical legacy" (38).

⁵³ For suggestive links between Bacon and other seventeenth-century thinkers see 154 on Mersenne; 152-53 on Descartes; 187n on Hobbes; 181-82, 185 on Locke; 16-18, 27n, 195, 246n on Newton; and 169, 171, 195 on Boyle.

⁵⁴ See Charles Webster, *The Great Instauration: Science, Medicine, and Reform, 1620-1660* (London, 1975).

⁵⁵ Pérez-Ramos is rightly aware of what he calls Bacon's "idiosyncratic" terminology: see 101, 108, 124, 146.

V. In summarizing these two books I have had to condense some five hundred pages of closely argued and copiously documented historical analysis. I have tried to bring out faithfully the main lines of argument and to evaluate their contribution to Bacon studies. The result may be too long for some readers, too short for others (who can at least refer to the books themselves). It seemed to me worth doing since they jointly represent a major turning-point in the study of this philosopher. Bacon remains one of the key figures in the transition from the Renaissance to the modern world, and the amount of commentary he attracts is so great that we are all in danger of missing the truly substantial contributions by the normal accidents affecting the dissemination of knowledge and by the fatigue that sets in as we contemplate the annual list of publications, always assuming that they are complete and reliable. Bacon, as usual, falls between two stools, neither the literary nor the history of science bibliographies catching all the important work in their own field, let alone the other.

The evaluation of Bacon's work, furthermore, is a necessity to anyone interested in intellectual history, since it can act as a barometer of the state of knowledge at any one time. Since credit has traditionally been given to him for being among the first to formulate the idea of progress,⁵⁶ it is appropriate that his work can serve as a marker for the successes, and failures, of contemporary historiography in achieving a properly contextual and properly analytical understanding of a thinker from the past. His work remains, as it has always been, a challenge. Those who resist that challenge are perpetuating a state of mind that James Mill diagnosed as long ago as 1818. Writing to the Scottish philosopher Macvey Napier and thanking him for having revalidated Bacon as the "Father of Experimental Philosophy," Mill noted that "His is a battle which I often have to fight in conversation, at least; for English-educated people are all hostile to him, as they . . . are hostile to everybody who seeks to advance the boundaries of human knowledge, which they have sworn to keep where they are."⁵⁷

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⁵⁶ See J. B. Bury, *The Idea of Progress* (London, 1920), 50-63.

⁵⁷ Letter of 30 April 1818, in M. Napier (ed.), *Selections from the correspondence of the late Macvey Napier* (London, 1879), 18-19; quoted by Richard Yeo, "An idol of the market-place: Baconianism in nineteenth-century Britain," *History of Science*, 23 (1985), 251-98, at 263.