

Francis Bacon

Selected Philosophical Works

Edited, with Introduction, by
Rose-Mary Sargent

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CONTENTS

General Introduction	vi
Note on the Text	xxxvii
I Advancement of Learning and Division of the Sciences	1
<i>Advancement of Learning</i> , Book One.....	4
<i>Advancement of Learning</i> , Book Two, Dedication	49
<i>De Augmentis</i> , Summary of Books Two through Nine.....	56
II Great Instauration, New Organon, and Preparative	63
<i>The Great Instauration</i>	66
<i>The New Organon</i> , Preface.....	86
<i>The New Organon</i> , Book One	89
<i>The New Organon</i> , Book Two	148
<i>Preparative</i>	190
III Natural History Selections	207
<i>Natural and Experimental History</i>	210
<i>History of Dense and Rare</i>	216
<i>Sylva Sylvarum</i>	225
<i>Medical Remains</i>	233
IV New Atlantis	239
<i>New Atlantis</i>	241
Selected Bibliography	269
Index	278

GENERAL INTRODUCTION

Francis Bacon (1561–1626) led a complicated life. He was born at the time of religious reformation, political upheaval, and the intellectual and artistic flourishing of late Renaissance Europe. He became a lawyer, statesman, essayist, historian, and philosopher, who not only exemplified the values and virtues that he had inherited from the Renaissance tradition but also ushered in early conceptions of modernity. It is not possible to do justice to all of the facets of Bacon's life here. What follows is a brief sketch of his legal and political career, a general account of his philosophical project, and a summary of the historical significance of his works through the twentieth century. For further reading on particular aspects of his life and thought, parenthetical references have been made to authors whose works can be found in the Selected Bibliography at the end of this volume. For general accounts of Bacon's life, see the biography written by his chaplain, William Rawley, as well as the twentieth-century biographical studies by Anderson, Coquillette, Jardine and Stewart, Jones, and Zagorin. There are also some helpful collections of essays that cover a wide range of Bacon's interests edited by Peltonen, Sessions, and Vickers.

LIFE AND PROFESSIONAL CAREER

Bacon was the youngest son of Nicholas Bacon, the Lord Keeper of the Great Seal under Queen Elizabeth I, and his second wife, Ann Cooke, a well-educated and devout Calvinist, who was the sister-in-law of William Cecil, Lord Burghley. When he was twelve, Francis and his older brother Anthony began a two-year residence at Trinity College, Cambridge, studying under the tutelage of Dr. John Whitgift, a future archbishop of Canterbury. In 1576 the two brothers were admitted for the study of law to Gray's Inn, London; however, in order to ensure that Francis would have more practical experience, the following year his father arranged for him to accompany the English Ambassador Sir Amias Paulet to France. On the untimely death of his father in 1579, Bacon returned home and learned that he had only a slight inheritance and would thus have to acquire a profession to earn his livelihood. He took up residence in his father's old rooms at Gray's Inn and began to study the law in earnest.

His legal career began well. In 1582 he qualified for admittance to the bar as utter barrister, and in 1586 he was made bencher at Gray's Inn. In

1588 he was appointed as one of four lawyers from Gray's Inn to a prestigious committee of sixteen lawyers who were charged with the review of statutes for the upcoming Parliament. During this period he wrote a number of legal tracts and also contributed to popular masques, which were dramatic performances of dance, song, and dialogue with actors masked and dressed in costume, that were put on at the Inns of Court for festive occasions. In the *Gesta Grayorum* masque for Christmas 1594, for example, he contributed a speech on law reform, suggesting the need for more simplicity and certainty in the legal system. In 1596 he wrote his first important legal work (not published until 1631), *Maxims of the Law*, which contained detailed analysis and argument on how the law should be restructured (for his legal works, see Cardwell, Coquillette, Hogan and Schwartz, Kocher, McCabe, and Shapiro).

While pursuing his legal career, Bacon also embarked on an active political life. In 1581 he began government service as a member of the House of Commons for a district in Cornwall and would continue representing various areas in Commons until late in life, when he finally became a member of the House of Lords. In 1584 he wrote his first political tract, *A Letter of Advice to Queen Elizabeth*, wherein he discussed the danger that the presence of Catholics in England posed for the government. In 1589 he extended his critique to what he perceived to be the biases of both Anglicans and Puritans in *An Advertisement Touching the Controversies of the Church of England*. As these works indicate, it had become apparent by this time that the multiplication of religious sects that was begun during the Reformation often led to social unrest and thus had important political consequences. As Bacon wrote, England had become "a kingdom laboring with intestine faction on account of religion" (Spedding, vol. 6, p. 309). Although Queen Elizabeth's father, Henry VIII, had avoided serious upheaval after his break from the Roman Catholic Church, his other daughter, Mary, who preceded Elizabeth to the throne, had created turmoil by persecuting Protestants in her failed attempt to return England to Catholicism. When Elizabeth succeeded Mary, she at first sought limited toleration, but as the years went by, she found it politically necessary to demand conformity and was thus instrumental in establishing the doctrines and rites of the Anglican Church.

Throughout the 1590s, Bacon sought to secure a political position in Elizabeth's court and thus improve his financial position partly by using the help and influence of his close friend, and the Queen's personal favorite, the Earl of Essex. These efforts were unsuccessful, however, perhaps largely because Bacon had lost the Queen's trust when he openly opposed the taxation policies that she set forth in her Triple Subsidy Bill of 1593. Bacon's relationship with Essex also provided one of the unfortunate

events in his life that would subsequently lead historians to question his moral character. In 1599 Essex fell out of favor with Elizabeth after he experienced a serious defeat in Ireland. In 1601, in an ill-advised attempt to rally citizen support for his cause, Essex entered London with two hundred armed followers. This action, which was seen as a rebellion, was quickly suppressed. Essex was arrested for treason, and Bacon was called by Elizabeth to serve as the Queen's advocate in the legal prosecution of the case. Essex was convicted and executed shortly thereafter. In 1601 Bacon published an account of the case in *A Declaration of the Practices and Treasons Attempted and Committed by Robert, late Earl of Essex* (vol. 9); then a few years later, in his 1604 work *An Apology in Certain Imputations Concerning the late Earl of Essex*, he attempted to justify his actions to the Earl's family and friends by arguing that his was the morally correct position because he had put his duty to Queen Elizabeth ahead of his personal affection for his friend (vol. 10).

Despite what some have found to be his betrayal of Essex, Bacon still failed to win Elizabeth's favor. On the death of Elizabeth in 1603 and the succession of James VI of Scotland to the throne as James I of England, Bacon's political and financial fortunes began to improve. To commemorate James's succession, Bacon wrote *A Brief Discourse Touching the Happy Union of the Kingdoms of England and Scotland* (vol. 10), and in July of that year he was rewarded with a knighthood—although this honor was mitigated by the fact that he was one of three hundred men knighted on the same occasion. In 1604, Bacon acted as the crown's advocate of union in sessions of Parliament, he advised James on the particular religious problems that had plagued England, and he published a tract on *Certain Considerations Touching the better Pacification and Edification of the Church of England* (vol. 10). Despite this new activity and recognition, Bacon still felt the need to improve his financial situation; therefore, in 1606 he entered into an arranged marriage with a teenage heiress, Alice Barnham, who was thirty years his junior. Unfortunately, the marriage proved to be childless and unhappy.

Finally, in 1607, Bacon achieved a more solid and lucrative position when he was appointed Solicitor General. During his tenure in this office, he wrote a number of legal decisions and arguments of law, some of which were quite significant, like the *Post Nati* case that settled the issue of inheritance after the unification of England and Scotland (vol. 7). He also wrote and delivered numerous speeches, advices to the King, and letters, some of which were published (vols. 12, 13, 14). In 1613 he began a three-year post as Attorney General, and in 1616 he was appointed Privy Counsellor to the King. In 1617 he ascended to his late father's position, Lord Keeper of the Seal, and a year later he surpassed his father

when he became Lord Chancellor, the most prestigious legal position under the Crown. In 1618 he was also made a peer of the realm, taking the title Baron Verulam, and assumed his seat in the House of Lords. In 1621, at the age of sixty, he was elevated once more when he became Viscount St. Albans.

After so many early years of struggle, Bacon achieved the height of political and financial success in a rather rapid series of appointments under James I, but his fall would be even more rapid. In March 1621, two men who had lost cases before Bacon at Chancery appeared in the House of Commons and brought charges of bribery against him. Although Bacon denied that he had intentionally taken “bribes,” he did admit that he had taken money while cases were pending and therefore had been negligent in his office. On 3 May 1621, after pleading guilty, he was removed from office by the High Court of Parliament (Bacon’s answers to the impeachment charges against him and his confession are in vol. 14). Although his punishment could have been severe, James arranged for most of the penalties to be limited. Bacon was ordered to be imprisoned at the discretion of the King (which turned out to be for three days only), fined £40,000 (which he was never required to pay), forbidden to come within the verge (twelve miles) of the court (the prohibition was rescinded in 1622), barred from state office, and forbidden to sit in Parliament. (For details on Bacon’s political theory and the intrigues surrounding his impeachment, see Coquillette, Epstein, Farrington, Martin, and Peltonen.)

Bacon retired to Gorhambury, his country estate near St. Albans. Although his legal and political career had come to an end, he continued to be intellectually active. He turned his attention to several literary and philosophical projects that he had started in the 1590s at a time when he believed that he could not gain the favor of Queen Elizabeth and thus had little hope for a political career. Among his literary works, the most famous and popular during his lifetime was his *Essays or Counsels Civil or Moral*, ten of which he published in 1597, followed by an expanded edition of thirty-eight essays in 1612. During his retirement he completed a third edition that contained twenty new essays as well as extensive revisions of the earlier ones. From some of the titles included in this work—such as “Of Truth,” “Of Death,” “Of Atheism,” “Of Seditions,” “Of Nobility,” “Of Gardens,” and “Of Study”—the breadth of Bacon’s interests can be seen (vol. 6). In addition, this work is historically significant because it introduced into the English language the new prose style of the essay that had been developed in France by Montaigne. Another primarily literary work also contained advice and admonitions. In his 1609 *Wisdom of the Ancients*, he described a collection of classical fables and gave his own philosophical,

political, or moral interpretations of them. He saw the fable of Cassandra, for example, as a cautionary tale against giving advice too freely (see Vickers for Bacon's literary accomplishments).

The first work that Bacon completed after his impeachment, *The History of the Reign of King Henry VII*, was published in 1622 and dedicated to Prince Charles, the eldest son of James I (vol. 6). James urged Bacon to follow up this work by writing a history of Henry VIII; also, Bacon had plans to write a history of England. These works were never begun, however, because he became increasingly preoccupied with natural philosophy in his final years. Except for two light pieces composed during periods of ill health—a *Translation of Certain Psalms into English Verse* and a collection of witty sayings published as *Apophthegms*—Bacon's time was devoted to the investigation of nature. Indeed, it was probably his philosophical interests that hastened his death. On 9 April 1626, he died at the home of the Earl of Arundel from a respiratory illness that was apparently aggravated by a chill he had received while gathering snow for an experiment designed to test the ability of cold to preserve the flesh of fowl.

PHILOSOPHICAL WORKS

Bacon's earliest discussion of his philosophical project can be found in a 1592 letter to his uncle Lord Burghley, in which he wrote about his desire to take "all knowledge to be my province" (vol. 8, p. 109). Throughout the next thirty years, he worked at perfecting his plan for a general reform of learning that included political, social, legal, and moral philosophy as well as natural philosophy, all of which would have been categorized by Bacon as "sciences" (from the Latin for knowledge, *scientia*). His plan, ultimately titled "The Great Instauration," was to be composed of six parts (see Section II of this book). In the first part, "The Divisions of the Sciences" would be constructed in order to make inquiry more systematic. The second part was "The New Organon; or Directions concerning the Interpretation of Nature," in which Bacon promised to develop the appropriate methods required for instituting the new learning. The third part involved the compilation of "The Phenomena of the Universe; or a Natural and Experimental History for the Foundation of Philosophy." The bulk of Bacon's philosophical works represents contributions to these first three parts, although he did at times give passing examples of the last three parts that he had outlined in *The Great Instauration* as "The Ladder of the Intellect"; "The Forerunners; or Anticipations of the New Philosophy"; and "The New Philosophy; or Active Science."

His work on this philosophical project was somewhat erratic. From the early 1600s, a few Latin manuscripts survived, parts of which would later be incorporated into his more mature works. The first publication related to the instauration was his *Two Books of the Advancement and Proficiency of Learning*, published in 1605 (in Section I). In the first book, he defended learning against those who maintained that it could be religiously, politically, or socially dangerous. The second book, a precursor to the first part of the Great Instauration, contained a preliminary catalogue, or inventory, of extant knowledge. As we have seen, after 1607 Bacon had become busy with his various political positions. Although he found time to compose a few Latin manuscripts relating to his plan (translated in Farrington) and to publish the *Wisdom of the Ancients*, some of the fables in which included lessons on natural philosophy, most of his time was spent in revising his great instauration. By 1620, however, he had apparently despaired of finishing the entire work. In order to leave some outline of his plan, he published *The New Organon*, presented explicitly as the second part of his project, together with prefatory material and an outline belonging to *The Great Instauration*. In addition, he appended the *Preparative towards a Natural and Experimental History* that represented the third part of his project (in Section II).

After his impeachment, he devoted most of his time to working on the third part of the instauration. In 1622 he published his *Natural and Experimental History for the Foundation of Philosophy*, with a Preface and Rule that gave slightly different directions for compiling histories than those contained in the earlier *Preparative*. He also gave the titles of six natural histories that he hoped to publish, one a month, the first of which, a *History of the Winds*, was published as part of the volume. Of the other histories listed there, only a *History of Life and Death* would be published in his lifetime (1623). His *History of Dense and Rare*, which was significant for its early use of quantitative methods and his discussion of the difficulties associated with making precise measurements, was left incomplete and published posthumously by Rawley in 1658. Bacon also compiled a different type of history, composed of one thousand observations and experiments taken primarily from the works of other authors and arranged in ten “centuries” of one hundred reports each. This work was published by Rawley the year after Bacon’s death as the *Sylva Sylvarum* or *A Natural History in Ten Centuries*. (See Section III for selections from some of the aforementioned histories.)

Bacon also produced a more complete version of the first stage of the instauration, *Of the Dignity and Advancement of Learning*, which was published in 1623 and is commonly known by its short Latin title of *De Augmentis*. For this work, he had the first book of the *Advancement of Learning*,

which originally had been published in English, translated into Latin, and he expanded the catalogue of learning from the second book into a much more detailed discussion of the divisions of the sciences in eight books (summarized in Section I). A final work, the *New Atlantis*, was published by Rawley with the *Sylva* edition of 1627. This curious work was modeled on both the utopian and the travel literature of Bacon's day. Although not technically a contribution to any of the particular stages of *The Great Instauration*, this fable about a secret island kingdom presents Bacon's optimistic vision of the benefits to be achieved within an enlightened, scientifically advanced society and thus could be seen as a sketch of what the final stage of the instauration would be like (Section IV).

Before turning directly to a discussion of the general themes contained in Bacon's philosophical works, it is necessary to say something about his religious views, although it will not be possible to do so in the depth that they rightly deserve (see Barnouw, Briggs, and Jones). Bacon's desire for religious harmony originated not only from the concerns that he had as a statesman but also because he knew that a peaceful society is necessary for the leisure required to pursue philosophical interests. Religious issues created another type of problem for learning as well, however. A somewhat common argument was made in Bacon's day that the type of inquiry he advocated was explicitly forbidden by Scripture. In support of this position, critics pointed to the Genesis story of the fall of man as having been precipitated by eating the forbidden fruit from the tree of knowledge in the Garden of Eden. In both his *Advancement of Learning* and *The Great Instauration*, Bacon argued that these critics had misinterpreted the Genesis story. Nonetheless, he appreciated the need to show not only that natural philosophy was religiously safe but also that it could be religiously sanctioned. He used a number of arguments to do so, two of which were among the most popular employed by natural philosophers of the seventeenth century.

First Bacon argued that in the division of learning, one should keep the studies of science and religion separate in order to avoid conflict. In *The New Organon*, he warned against an "unwholesome mixture of things human and divine" because it would produce "not only a fantastic philosophy but also a heretical religion" (Book One, aphorism 65). Secondly, he maintained that, although separate, the two studies could also be complementary by using a metaphor that likened the world to a book. In his *Advancement of Learning*, for example, he argued that philosophy could be "an effectual inducement to the exaltation of the glory of God" who gave us "two books or volumes to study . . . first the Scriptures, revealing the will of God, and then the creatures expressing his power" (page 34). In effect, he argued that philosophers had a religious duty to study nature as

God's creation. His belief that scientific investigation was biblically sanctioned can also be seen in the prayer that he used to end the Preface of *The Great Instauration*, where he expressed the hope that "if we labor in thy works with the sweat of our brows, thou will make us partakers of thy vision and thy Sabbath" (page 85).

Bacon's discussion of the relation between science and religion represents one of the ways in which his works signaled the beginning of a modern era in philosophy. Also representative of modernity is the rejection of traditional learning, particularly the call for the overthrow of the Aristotelian philosophy that dominated the curriculum of the medieval universities. In the dedication of Book Two of the *Advancement of Learning*, Bacon gave a detailed criticism of the university system, and in the Preface to *The Great Instauration*, he accused the schools of having "usurped a kind of dictatorship in the sciences" with the consequence that "philosophy and intellectual sciences" had been "fruitful of controversies but barren of works" (pages 71, 69). The revolutionary rhetoric of Bacon's day needs to be taken with some caution, however. The Aristotelian philosophy of the Middle Ages, although loosely based on Aristotle's writings, had become highly technical and speculative. As Rawley noted, although Bacon "fell into a dislike of the philosophy of Aristotle" while a student at Cambridge, it was "not for the worthlessness of the author, to whom he would ever ascribe all high attributes, but for the unfruitfulness of the way" and the idleness of the speculations (vol. 1, p. 2). In his letter to Burghley cited before, Bacon expressed his desire to improve philosophy by bringing in "industrious observations, grounded conclusions, and profitable inventions and discoveries." He noted that this plan, "whether it be curiosity, or vain glory, or nature, or (if one take it favorably) *philanthropia*, is so fixed in my mind as it cannot be removed" (vol. 8, p. 109).

Bacon did not make any profitable, technological inventions or discoveries of his own (see Rees and Vickers). Despite the fact that he failed to contribute to scientific knowledge per se, however, he did contribute greatly to the methodological innovations of his century. As the leading propagandist for the new science, he provided the rhetoric, the excitement, and the vision needed for a revolution in learning. In doing so, he also gave the earliest, most extensive, and most detailed discussion of the search for a new productive type of knowledge and the methods that could best be used to achieve the knowledge. His recurrent theme would be one of progress as the acquisition of useful and beneficial knowledge through organized research. The following brief overview of his philosophy focuses primarily on these two themes—knowledge and method—particularly on how Bacon contributed to the complex ways in which they were to be transformed.

1. Knowledge

In the Aristotelian tradition, explanations of natural bodies were given by reference to matter, privation, and form, the latter of which was said to provide individual portions of matter with the differing qualities of particular bodies. In addition, to explain the coming into being of a body, four sources of change were required: the material cause out of which the change comes; the formal cause that provides the specifying or defining factor; the agent or efficient cause that is the initiator of the change; and the final cause that provides the purpose (*telos*) for which a thing was said to be made. By Bacon's time, the formal cause had become prominent. In place of natural investigations, abstract reasoning had produced some rather metaphysical accounts by which the physical properties of bodies were explained by reference to the one substantial form of a body that was said to give it its necessary and essential characteristics. In opposition to this project, Bacon suggested that philosophers should actually "dissect nature" in order to discover the hidden physical processes within bodies that produce their manifest qualities. Bacon's discussion of this idea reveals his indebtedness to the tradition in medical chemistry that sought a "true anatomy" of bodies "by means of distillations and other modes of analysis" (Section II, Book Two, aphorism 7). But he went on to insist that the analysis had to take place not only by fire, "but by reasoning and true induction," which represents as well a return to the ancient atomistic philosophy of Democritus that had been explicitly rejected by Aristotle.

As early as the *Wisdom of the Ancients*, Bacon showed atomistic leanings by his references to Democritus in a number of the myths. In his interpretation of the myth of Cupid, for example, he wrote approvingly of "the natural motion of the atom; which is indeed the original and unique force that constitutes and fashions all things out of matter" (vol. 6, p. 729, see also p. 723). Bacon had to be careful here, however, because the ancient atomists had incorporated an atheistic doctrine into their natural philosophy, especially in their theory that the universe had been created by the chance encounter of atoms in a void. By the time of *The New Organon*, Bacon had become more circumspect. He maintained that when he spoke of Democritus, he did not intend to refer to the "doctrine of atoms, which implies the hypothesis of a vacuum" but "only to real particles, such as really exist" (Book Two, aphorism 8). This could be seen as a precursor to what would come to be known later in the century as the new mechanical, or corpuscular, philosophy that sought to explain the qualities of bodies by reference to the motion of the least parts of matter. But the case is not quite that clear. In his search for physical explanations of nature, Bacon rejected Aristotle's conception of final causality altogether, and he also rejected the importance of the material and agent causes,

describing them as “merely vehicles, or causes which convey the Form in certain cases” (Book Two, aphorism 3). But he retained the idea of the “Form” of a body as that which gave it its defining characteristics. The precise meaning of “Form” in Bacon’s philosophy has been the source of much controversy and debate. What is clear is that he did not mean to refer to the substantial forms of the schools when he used the term (see Alexander, Emerton, Hesse, Larsen, Perez-Ramos, and Rees).

In Book One of *The New Organon*, Bacon wrote that “forms are figments of the human mind, unless you will call those laws of action forms” (Book One, aphorism 51). In Book Two, when he began his more positive account of the type of knowledge to be acquired by his methods, he wrote that the “work and aim of human knowledge” should be the discovery of “the Form, or true specific difference” of a body (Book Two, aphorism 1), adding in the next aphorism that “it is this law, with its clauses, that I mean when I speak of *Forms*—a name which I the rather adopt because it has grown into use and become familiar” (Book Two, aphorism 2). Just as his atomism should not be equated with our ideas of such entities, so also one should be careful not to equate Bacon’s laws with the modern conception of a natural or mechanical law. Whatever the form of a body might mean, it is clear that it was intended to provide a causal explanation for a body’s properties, which in turn complemented his ideal of useful knowledge. Forms, said Bacon, “touch the deeper boundaries of things,” and “from the discovery of Forms, therefore, results truth in speculation and freedom in operation” (Book Two, aphorism 3). Whereas the aim of human knowledge is to discover the form, “the work and aim of human power” is “to generate and superinduce a new nature” (Book Two, aphorism 1). If the form of a body is that which produces its defining characteristics, then a knowledge of forms would be necessary in order to produce particular properties in natural bodies. In *The New Organon*, for example, his investigation into the nature of heat led him to conclude that heat is a type of motion, “*expansive, restrained, and acting in its strife upon the smaller particles of bodies,*” and on the basis of this finding, he advised that the rule for operation would be as follows: “*if in any natural body you can excite a dilating or expanding motion, and can so repress this motion and turn it back upon itself, that the dilation shall not proceed equably, but have its way in one part and be counteracted in another, you will undoubtedly generate heat*” (Book Two, aphorism 20).

Bacon’s belief that “knowledge is power” explains in part why he insisted on the need for joining together theory and practice—the contemplation of traditional philosophy with the action of the mechanical arts. As he had argued in the 1594 Masque at Gray’s Inn, learning should lead to the “conquest of the works of nature” (vol. 8, pp. 334–35). But his

was not to be merely a technologically driven science. Bacon wrote that although “it be true that I am principally in pursuit of works and the active department of the sciences . . . I well know that axioms once rightly discovered will carry whole troops of works along with them” (page 81). Knowledge-producing experiments, which were called “experiments of light,” must be made prior to “experiments of fruit” because “human knowledge and human power, do really meet in one; and it is from ignorance of causes that operation fails” (page 84). Conversely, however, once theory is put into practice, the production of successful effects can in turn serve as a sign for the truth of theory; “fruits and works are as it were sponsors and sureties for the truths of philosophies” (Book One, aphorism 73). Bacon repeated this early expression of the modern conception of the use of experimental testing for the justification of theoretical claims in a more straightforward manner when he made this declaration: “Truth, therefore, and utility are here the very same things. And works themselves are of greater value as pledges of truth than as contributing to the comforts of life” (Book One, aphorism 124).

As with other aspects of Bacon’s thought, his discussion of knowledge and power is not a simple one. In his *Advancement of Learning*, when he turned to the topic of the dignity of knowledge, he began with an account of the creation of the world in which “we see a double emanation of virtue from God: the one referring more properly to power, the other to wisdom” (page 30). Later, in *The New Organon*, when he argued for the priority of knowledge over works, he suggested that “the divine wisdom and order must be our pattern.” Since on the “first day” God “created light only,” philosophers should “first endeavor to discover true causes and axioms; and seek for experiments of Light, not for experiments of Fruit” (Book One, aphorism 70). The acquisition of useful knowledge also represented a religious mission of another type. The philanthropy that he discussed in his letter to Burghley, influenced in part by his mother’s Calvinist leanings, led Bacon to place great emphasis on the performance of good works. The new science was meant for the benefit of others and for the improvement of human health and welfare, and thus he urged his readers to “cultivate truth in charity” (page 74). These religious overtones came together in his fable of the *New Atlantis*, where the Fathers of “Solomon’s House,” the scientific institution of the island named after the biblical king, were responsible for dispensing useful knowledge and practical inventions for the benefit of citizens and strangers alike.

Of course, power also has obvious political, economic, and imperialist overtones, and Bacon, as a statesman, did not hesitate to point out how advances in scientific learning could aid the government. In the *Advancement of Learning*, he noted how great ages that are “renowned for arms are

likewise most admired for learning” (page 10); moreover, from his own day, he could point to how technological advances in warfare, shipping, and mining had enhanced the political and economic power of those in possession of such knowledge. In addition, not only would the military and economic fortunes of a country be improved, but also “learning does make the minds of men gentle, generous, and pliant to government” and thus encourages better citizenship (page 13). The role of the enhancement and use of political power in all of Bacon’s works, and particularly in his *New Atlantis*, has been hotly debated in this century (see Box, Farrington, Martin, Peltonen, Weinberger, and Whitney). Surely Bacon’s project was at least in part politically motivated. It is also the case, however, that he realized that his vast and complex method represented a “royal work” that included “much labor and expense” (vol. 1, p. 111). In order to succeed, he would need government support and funding, and thus it was expedient for him to show the monarchs how his project could serve to increase their political power.

2. Method

Bacon’s methodological dictates are contained primarily in *The New Organon*, the title of which was meant to indicate his intention of replacing the original logical works of Aristotle that were commonly referred to as Aristotle’s *Organon*. The first thing that Bacon discussed was the need to clear away the errors of the past and to recognize the causes of error, which he attributed to four classes of “idols” or “false notions” of the human mind that hinder the acquisition of truth, so that we may be “forewarned of the danger” and fortified “against their assaults” (Book One, aphorism 38). Another way to guard against introducing new errors into philosophy was to avoid hasty speculation by constraining the understanding from making “anticipations” about nature and to construct instead solid “interpretations” by slowly rising from particulars to more general truths. The purpose of this inductive method was to “command nature in action” in opposition to the deductive method of the schools, modeled on Aristotle’s syllogism, that was intended merely “to overcome an opponent in argument” (page 77). Later, in *De Augmentis*, Bacon explained that “knowledges are as pyramids, whereof history and experience are the basis. And so of natural philosophy the basis is natural history; the stage next the basis is physic; the stage next the vertical point is metaphysic” (vol. 4, pp. 361–62). (Among the numerous studies on Bacon’s method, see especially, Cohen, Ducasse, Hesse, Horton, McMullin, Perez-Ramos, Rossi, Shapiro, Urbach, and Vickers.)

The second and third parts of *The Great Instauration* are not separate stages of inquiry. Rather, they must be pursued in unison because the

histories of part three provide the materials on which the logic of part two operates. Although the compilation of histories is required in order to educe axioms, the process is not to proceed by a simple enumeration, which “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” (page 78). A true induction “must analyze nature by proper rejections and exclusions” (Book One, aphorism 105). In Book Two of *The New Organon*, Bacon provided an example of how inquiry could proceed in the series of aphorisms (11 through 20) concerned with his investigation of the nature of heat. First he constructed a “table of presence” that included all cases where heat was present—in the rays of the sun, for example. Then he constructed a “table of absence” where heat is not present even though the cases might be similar—in the rays of other celestial bodies such as the moon. Finally he constructed a “table of degrees” intended to provide cases of the different degree or intensity of heat in different substances. After the tables are constructed, inductive reasoning begins by making an attempt to “find such a nature as is always present or absent with the given nature, and always increases and decreases with it” (aphorism 15). After a review of the tables and a preliminary rejection of initially suspected forms is made, Bacon thought it “expedient” for the understanding to be allowed to make an “Interpretation of Nature in the affirmative way” concerning the cause of heat in bodies (aphorism 20).

Unlike hasty anticipations, this “First Vintage” or “indulgence of the understanding” represents a well-grounded speculation, which in turn gives rise to ideas for further trials that could be used for testing and correcting the original hypothesis. Bacon was not the first to understand or use this testing role of experiment, but he did popularize the idea that “the nature of things betrays itself more readily under the vexations of art than in its natural freedom” (page 82, see LeGrand, Newman, and Perez-Ramos). He recognized as well, however, that the performance and the interpretation of experiments are neither simple nor automatic. Bacon insisted that the experimentalist is not a mere empiric concerned only with the production of effects, such as the chemists who, he claimed, tended to restrict themselves to a few “petty tasks” and “pursued a kind of wandering inquiry, without any regular system of operations” (page 72). In contrast to this type of practice, Bacon wrote, “our steps must be guided by a clue, and the whole way from the very first perception of the senses must be laid out upon a sure plan” (page 73). Results must be produced by the conjunction of knowledge and skill. As Bacon advised, we must establish “forever a true and lawful marriage between the empirical and the rational faculty” (page 74).

Bacon also provided a lengthy discussion of the variety of experimental trials that could aid the natural philosopher. At the end of Book Two of *The New Organon* (summarized in Section II), he listed twenty-seven types of experiment that he said had special prerogative because they were useful “either in the informative part or in the operative, or in both.” They could “assist either the senses or the understanding,” or they could “point out, or measure, or facilitate practice” (Book Two, aphorism 52). Of these twenty-seven Prerogative Instances, one was destined to become quite controversial. Aphorism 36 contains a discussion of the “*instantia crucis*,” translated by Spedding and Ellis as an “Instance of the Fingerpost,” which could also be translated as an “Instance of the Cross,” because either expression may be used to refer to signs posted at cross-roads and used to indicate direction. About this instance, Bacon noted that we might meet one accidentally “but for the most part they are new, and are expressedly and designedly sought for and applied.” When one cannot decide between two or more possible causes, this type of experiment would have “high authority” because it could be designed to settle “the course of interpretation.” In the final aphorism of Book Two, he added that these instances aided the understanding “by guarding it against false forms and causes” (Book Two, aphorism 52). Later, in his *Natural and Experimental History*, he referred to these as “Crucial Instances by which the understanding may determine the true causes of things” (page 214).

Despite the fact that he had listed the Prerogative Instances as only one of nine helps for the understanding, *The New Organon* ends rather abruptly with his summary of these instances (Book Two, aphorism 52). In the *Preparative* appended to the incomplete *New Organon*, Bacon discussed other types of experiments from among the “mechanical and illiberal” arts that he thought would be the most useful for natural philosophy, particularly those in which the material composition of a body is altered in order to bring about a change in form, such as those performed in “agriculture, cookery, chemistry, dyeing; the manufacture of glass, enamel, sugar, gunpowder, artificial fires, paper, and the like” (page 195). Chemical analyses, distillations, and compositions could be quite informative, yet as we’ve seen, Bacon was critical of the chemists’ methods. He was also critical of the attitude by which they either conceived of themselves as solitary *magi* working in complete secrecy or envisioned collaboration as that which would ensue from the meeting of a few select *illuminati* (vol. 5, p. 191). In the place of such individual or quasi-collaborative efforts, a truly cooperative enterprise had to be instituted that would leave “little to the acuteness and strength of wits” and instead place “all wits and understandings nearly on a level” (Book One,

aphorism 61). Unlike those who retained a traditional philosophical emphasis on the power of individual reasoning, Bacon sought to institute a method for the investigation of nature based on the cooperative efforts of a large workforce. Two other practical inventions, printing and navigation, had contributed to the possibility for a cooperative research effort by producing an “openness of the world” and disclosing “multitudes of experiments, and a mass of natural history” (vol. 3, p. 476; cf. Book One, aphorisms 84 and 110). Bacon argued that to make the best use of this situation, the “great storehouse of facts should be accumulated” and added that because “the materials on which the intellect has to work are so widely spread, one must employ factors and merchants to go everywhere in search of them and bring them in” (vol. 4, pp. 251–52).

Once gathered, this experience had to be compiled into organized natural histories that could be printed and distributed throughout the learned world and thus could foster communication and the free exchange of ideas and information. As early as his advice to Elizabeth I in the 1590s, he had been urging the establishment of institutions that would advance this goal, such as “a most perfect and general library,” containing all “books of worth” whether “ancient or modern, printed or manuscript, European or of other parts”; a botanical and zoological garden for the collection of all plants as well as rare beasts and birds; a museum collection of all things that had been produced “by exquisite art or engine”; and a laboratory “furnished with mills, instruments, furnaces and vessels” (vol. 8, pp. 334–35). He again presented the ideal of a government funded research effort in his dedication to James I of Book Two of the *Advancement of Learning* when he discussed the need for the establishment of “foundations and buildings, endowments with revenues, endowments with franchises and privileges, institutions and ordinances for government; all tending to quietness and privateness of life, and discharge of cares and troubles” (page 50). As he would later insist in *The Great Instauration*, all must “join in consultation for the common good” (page 75). Solomon’s House, as it was described in detail in the *New Atlantis*, provided the final glowing image of the benefits that would accrue to the public by the advances in learning made by a government sponsored and supported research project, even though the open and democratic “levelling of wits” that he had originally proposed would be replaced there by a sometimes secretive organization based on a hierarchical division of labor (Section IV).

Bacon sought a “total reconstruction of sciences, arts, and all human knowledge” (page 66). Although the preceding discussion has been limited primarily to natural philosophy, Bacon was clear that all “other sciences, logic, ethics, and politics should be carried on by this method.” He suggested that one could as well use induction to “form a history and

table of discovery for anger, fear, shame, and the like; for matters political; and again for mental operations of memory, composition and division, judgment, and the rest, not less than for heat and cold, or light, or vegetation, or the like” (Book One, aphorism 127). The scope of Bacon’s project was ambitious, and many elements—such as his advocacy of a global method based on an active, collaborative, and critical approach to learning—are quite modern. The reader should use caution, however, and note well how many other elements, such as his adherence to traditions of lost civilizations and lost wisdom, are squarely within the intellectual world of the Renaissance. In addition, Bacon’s works exhibit a multifaceted richness of themes that are not always consistent. Tensions like those between knowledge and power, tradition and progress, openness and secrecy, have led to controversies over how best to interpret his works. These tensions are also representative of science today, however. They will be discussed more at the end of the next section after a brief survey of the changing assessments of Bacon’s significance and influence during the last four centuries.

HISTORICAL SIGNIFICANCE

Although Bacon never received state or popular support for his program, his rhetoric would set the agenda for the next generation of natural philosophers in England. In the two decades after Bacon’s death, a general reform of learning had taken place throughout Europe. Largely through the efforts of such seminal thinkers as René Descartes, Galileo, and William Harvey, the traditional scholastic philosophy was being gradually replaced by newer mechanical accounts of nature. In England this reform was accompanied by an emphasis on the practical implications of the new learning and on the ways in which knowledge could be used for charitable purposes. Bacon’s writings would play a central role in the programmatic works of these English reformers.

One of the first systematic attempts to bring to fruition Bacon’s vision of cooperative scientific research was that which occurred in London during the 1640s under the guiding force of Samuel Hartlib, a Prussian émigré, who envisioned a new educational system focused on practical studies such as glassmaking and metalworking. He also sought to encourage the free communication of information both through his correspondence with a number of European intellectuals and through his establishment in London of an informal circle of thinkers that included the evangelist John Dury, the poet and educational reformer John Milton, and the mechanical philosopher and chemist Kenelm Digby. According to Robert Boyle, one of the younger members of this circle who would

become the most vocal proponent of Baconian methods, in order to benefit all of humanity, Hartlib had established this “new philosophical college, that values no knowledge, but as it hath a tendency to use” (Boyle, vol. 1, p. xxxiv). Although Hartlib received a small pension from the parliamentary regime that subsidized his efforts, some of his more ambitious schemes, such as the building that he hoped to have constructed at Lambeth Marsh “designed for the execution of my Lord *Verulam’s New Atlantis*,” were never realized.

During this same period, another group, not as public as Hartlib’s circle and composed primarily of mathematicians, astronomers, and medical doctors, began weekly meetings to discuss general “philosophical inquiries” (Boyle, vol. 1, p. xlii). A member of this group, John Wilkins, was appointed by Oliver Cromwell as warden of Wadham College, Oxford, in the late 1640s, and shortly thereafter other members joined him at the university. The Oxford group continued to meet weekly to discuss philosophical topics and gradually incorporated new participants, in particular, two of the younger members of Hartlib’s circle, Boyle and the physician William Petty. Like the other groups, the Oxford philosophers advocated charitable works and religious toleration, and they believed that the development of natural philosophy could help put an end to sectarian controversy. Their experimental agenda was much more organized and sophisticated than that of the London groups, however. The members often worked together to improve experiments in chemistry, physiology, and pneumatics. They made detailed telescopic and microscopic observations, pioneered new techniques for anatomical dissections, and developed new instruments, such as the air pump constructed by Boyle and Robert Hooke that was used to determine the weight and pressure of the air. By the early 1660s, members of the Oxford group had begun to publish reports of their results and to achieve an international reputation for careful research (see Frank, Hunter, Maddison, Rossi, and Vickers).

The restoration of the English monarchy in 1660 provided the catalyst for members of both the London and the Oxford groups to suggest the establishment of a truly national research institution. In 1662 Charles II officially recognized their efforts by giving a charter to the newly established Royal Society of London, which had been purposefully and explicitly modeled after the scientific society of Bacon’s *New Atlantis*. Their plans were ambitious. Aside from public meetings to discuss developments in natural philosophy, they sought state funding to construct a “college” within the society “where we may meet, prepare and make our Experiments and Observations, lodge our Curators and Operators, have our Laboratory, Observatory and Operatory all together” (Hunter, 1981, p. 39). The founding members were frequently disappointed, however.

They received little funding from the king, and even their less ambitious plans often failed. There were also disagreements among the members about the true aim of the society. Some believed that it should be devoted to the development of theoretical knowledge as Bacon had advised in *The New Organon*, whereas others felt that most effort should be given to the construction of natural histories and practical inventions on the model of Bacon's *Sylva Sylvarum* (on the production of natural histories before and after Bacon, see Daston, Findlen, LeGrand, and Park). Despite these failings and disagreements, there was at least one resounding success. Under the careful editorial guidance of the society's secretary, Henry Oldenburg, the *Philosophical Transactions* of the Royal Society was established as an international journal that carried news about the society's endeavors, as well as information and critical papers from philosophical correspondents on the Continent.

With the official constitution of a society for the advancement of learning, the tensions inherent within cooperative research became all the more apparent. The society was neither as unified nor as democratic as the Baconian model. The lower classes, to which tradesmen and some merchants belonged, were not widely represented among the society's ranks, and some members believed that membership ought to be more selective and restricted. Members also disagreed about the extent to which knowledge should be freely communicated to the public. Because the society aimed at improving human welfare, it could be argued that they had a duty to restrict the dissemination of knowledge that would have a detrimental effect. Because the new experimental learning was concerned with the production of practical techniques and processes, it could also be argued that secrecy was necessary, since inventors should have the right to profit from their innovations. Tradesmen and artisans, for example, would be reluctant to share the secrets of their processes with the fellows of the Royal Society unless they had the assurance that these secrets would not in turn become public knowledge.

Other tensions surfaced as the Royal Society matured. Isaac Newton, who was the model of a lone scientific genius in contrast to the Baconian cooperative ideal, became the society's president in 1703 and remained in that office until his death in 1727. His position and his accomplishments significantly contributed to the shape of modern science, and yet his work was not all of one type. His first major scientific treatise, *The Mathematical Principles of Natural Philosophy* (1687), was, as its title suggests, a work more deductive and axiomatic than anything that Bacon had envisioned. In his work on optical theory, however, Newton was much more experimental. Although he did not mention Bacon by name, he used Bacon's concept of an "instance of the cross" to describe what he believed to be

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