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BACON
Preface to *The great instauration;* *The new organon,* Aphorisms 1-46; selections from *The advancement of learning*

(*The Works of Francis Bacon*, James Spedding, Robert Ellis, and Douglas Heath, eds. 14 volumes (London: Longman, 1858-1874; reprinted in facsimilie Stuttgart: Frommann, 1962), vol. IV, pp. 13-17, 20-27, 47-57, and 294-98)

Early modern philosophy began with a break from the past. For eighteen hundred years — from the time of the founding of the Stoic, Sceptical, and Epicurean schools of philosophy in Athens in the third century BCE up to the 1500's — philosophers had done their work by commenting on that of their predecessors, particularly Aristotle, who was held in such high esteem that he was referred to simply as "the Philosopher." Original philosophical work was so little respected that those who attempted something new would often deny authorship and present their work as the recently rediscovered text of some ancient philosopher. But in the early modern period philosophers suddenly began to criticize the old philosophy of Plato, Aristotle, and their medieval commentators, reject it, and offer what they claimed was something entirely new.

There are a couple of reasons why this rebirth occurred when and where it did. One is that early modern Europe had undergone a religious reformation. During the medieval period, ancient philosophy, particularly the philosophy of Aristotle, had come to be intimately associated with the teachings of the established church. For many reformers, a rejection of the old philosophy was a natural concomitant of the rejection of the old religion. But there is another reason why the change occurred: the technological advances of late medieval Europe had begun to make the old wisdom taught by the ancient Greek philosophers look irrelevant.

People in the Ancient world lived behind what historians of technology have described as an energy bottleneck. The amount of energy available to them from plants, animals, and their own labour was too little to allow them to readily produce yet more energy. Consequently, they believed that there were definite, and very short limits to what they could do to control the forces of nature or improve the conditions of their lives. Consider, by way of example, the following passage from the Roman poet, Lucretius, writing in the first century CE, at a time when the period of ancient philosophy was drawing to a close:

> Quis regere immensi summam, quis habere profundi
> indu manu validas potis est moderanter habenas,
> quis pariter caelos omnis convertere et omnis
> ignibus aetheriis terras suffire feracis,
> omnibus inve locis esse omni tempore praesto?
>
> who is strong enough to rule the sum of the immeasurable,
> who to hold in hand and control the mighty bridle of the unfathomable?
> who to turn about all the heavens at one time and warm fruitful worlds with ethereal fires,
> or to be present in all places and at all times?
> [*De rerum natura* II 1095-1099, trans. W.H.D. Rouse, Loeb Classical Library (Cambridge, Mass.: Harvard University Press, 1982)]

Lucretius' unspoken answer to this question was that no one could do these things — not even the Gods. This last idea, that not even the Gods could intervene in the course of nature, was a minority view at the time, but it gave all the more eloquent expression to the view that mere human beings are certainly incapable of intervening in the course of nature to improve their circumstances.

By the beginning of the early modern period this outlook on the amount of power within our grasp had begun to change. The energy bottleneck had been traversed, first by water mills, which came to be widely employed in feudal times, and then by wind mills, which by the fourteenth century were able to produce energy equivalent to 20-30 horsepower. During the middle ages and the Renaissance a number of other inventions and discoveries had been made that had significantly improved the material conditions of life and given people far greater control over their circumstances: galleys that did not need to be rowed by slaves and that could harness enough wind energy to sail even though outfitted with heavy cannon; gunpowder to fire the cannon and to use in mines; the magnetic compass, which allowed people to sail out of sight of land; the mechanical clock; and the printing press, to name some of the most important.

Accordingly, when we look at the works of an early modern thinker like Francis Bacon, we find a more optimistic attitude about the potential for human beings to acquire the ability to intervene in the course of nature.

> [We] ought on the contrary to be surely persuaded of this; that the artificial does not differ from the natural in form or essence, but only in its efficient [cause]. Since [we] have no power over nature except that of motion, [we] can put natural bodies together and can separate them, and therefore wherever the case admits of the uniting or disuniting of natural bodies by joining (as they say) actives with passives, [we] can do everything. [*Works* IV 294]

Interestingly, there is nothing new to the conception of the nature that Bacon was giving voice to here. It is shot through with ideas and distinctions drawn from ancient, and particularly Aristotelian philosophy. Bacon's distinction between "the artificial" (that is, what is made by human beings) and "the natural" is of Aristotelian provenance, as are his notions that these things are characterized by a form or essence and that they are brought into being by "efficient causes." So also is his notion that the reason things change is because bodies with a certain "active potency" to transmit a form ("actives" as Bacon called them) have come into contact with bodies with a certain "passive potency" to receive that form.

But while the theory of nature that is expressed by this text was very old, the optimism it expresses about human abilities to intervene in the course of nature was quite new. There is a hint here that we might be able to do anything — even "control nature in action," as Bacon put it elsewhere — if only we could discover what "actives" to move into contact with what "passives." Of course, this presumes an ability to mine "actives" and "passives" and to move them appropriately. But the technological innovations of Bacon's day made him think that there was no longer an obvious limit to the extent of our power to mine, smelt, and move materials. New machines were giving us new powers, and those new powers were making it possible to make yet newer machines that would give us yet greater powers.

This new optimism led Bacon to a very different assessment of the worth and nature of knowledge than any that had been expressed in the centuries before him. The ancient pessimism about our ability to intervene in the course of nature had led people to suppose that even if we could come to understand what makes things happen in nature, this knowledge would be largely

useless. Not possessing the energy to intervene in the course of nature, the best knowledge of the causes of change in nature could give to us would be some ability to predict what would happen next, not an ability to prevent it.

Not surprisingly, those ancients who valued knowledge found it valuable for other purposes than those of gaining control over nature. Plato and Socrates supposed that wickedness and evil are products of ignorance of the ultimate consequences of our actions, so that no one could knowingly do wrong. For them, knowledge would make us virtuous and honourable. Aristotle supposed that the very essence of humanity involves rationality, so that we can only be truly happy when fulfilling this end and living a life of quiet contemplation. Lucretius maintained that knowledge of the workings of nature would teach us that not even the Gods can do anything to change the course of nature. In learning this, we would be freed from superstitious fears and would acquire a sort of peace of mind that would enable us to live happy and blessed lives. And the Stoics supposed that a knowledge of the workings of nature would help us appreciate the inevitably of things and see how even our own misfortune is part of an inexorable development towards the greater good. This knowledge would reconcile us to our fate and make us better able to endure adversity.

In sharp contrast to these assessments of the practical worth of knowledge in making us better, happier, more self-reliant, more honourable, and better able to endure adversity, Bacon thought that the proper end of knowledge is to show us how we can transform nature so as to improve the material conditions of life. As he put it, the proper goal of knowledge is to "command nature in action" and come up with "inventions" that can "in some degree overcome the necessities and miseries of humanity" (Works IV p.27). Looking back at the philosophy that had preceded him, and seeing how little it had managed to do in this regard, he charged that the ancient and medieval tradition represented the "boyhood" of human knowledge, and had the characteristic property of boys: it could talk (produce thick volumes of incomprehensible jargon), but it could not reproduce (Works IV p.14). And he even compared moral knowledge unfavourably to practical knowledge, observing that, according to accepted Christian mythology contained in the Book of Genesis of the Bible, it had been the pursuit of moral knowledge (of good and evil) that had gotten Adam and Eve expelled from the Garden of Eden, not the pursuit of practical knowledge (represented by Adam's activity of classifying and naming the species of living things).

For Bacon, any knowledge worthy of the name ought to be useful for producing something. It ought to show us how to invent machines and devices that improve the material conditions of our lives. Most importantly, it ought to generate new knowledge and works and inventions that put us in a position to invent and produce yet more powerful or yet finer instruments and devices.

But Bacon's comparatively traditional physics of "actives" and "passives" (alluded to above) also has implications for how one is to go about getting this knowledge. The kind of knowledge he wanted, knowledge that gives us power over nature, is knowledge of what "actives" to combine with what "passives" in order to produce change. The trouble is that when an active is combined with a passive, the change is brought about by nature "working within," as Bacon put it in Aphorism IV of the *New organon*. We usually cannot isolate what it is in the actives and passives that makes the change occur (what Bacon called the "latent constitution" of objects and "latent processes" they perform). Not being able to see the small mechanism responsible for the change, we are in no position to tell in advance, just by looking at different kinds of material, what kinds of change they will produce in combination. We have no choice

but to make the experiment of actually combining them, in various proportions and under various circumstances, and seeing what will happen.

In doing this we must take an active role. We must not simply collect our observations at random and by chance as nature happens to fortuitously reveal them to us. Rather, we must set out in advance to test all the different combinations of materials ourselves.

Doing this is a huge job, not only because there so many different kinds of material in nature, but also because these materials must be examined in all different proportions and under all sorts of different conditions (e.g., mixing under varying degrees of heat in a smelter, mixing in cold in winter, mixing under light or in darkness, mixing at certain times of year, and so on).

Bacon hoped that the job could eventually be mitigated. He thought that, over time, enough experience of what different combinations of materials produce what sorts of changes would put us in a position to theorize about the "latent constitution" of "actives" and "passives" and the "latent processes," whereby the latent constitution of an active works on that of a passive to transmit a form and so bring about change. But a great deal of research would have to be done before we would be in a position to formulate such theories. No single person could feasibly undertake this huge research project. It would have to be a collaborative effort. This led Bacon to propose the formation of research institutions dedicated to the execution of collaborative research projects, involving extensive, programmed experimentation, the eventual formulation of theories describing latent configurations and latent processes, and the *advancement* (as opposed to mere transmission) of learning.

QUESTIONS ON THE READING

1. What did Bacon mean by comparing the wisdom of the ancients to the boyhood of knowledge?
2. How is it that the mechanical arts are superior to philosophy?
3. How did Bacon respond to the charge that the works of the ancients have withstood the test of time, and that if more could have been done to improve the sciences it would have been done already?
4. How did Bacon respond to the charge that the pursuit of knowledge of nature may be impious and contrary to divine commands?
5. What are the true ends of knowledge?
6. What was the chief effect Bacon took the new science he was proposing to promise?
7. What is the proper method to pursue when inquiring into the nature of things?
8. How does the type of induction Bacon recommended differ from traditional forms of induction?
9. What is the key to rectifying the defects of sense experience, according to Bacon?
10. What is the "fixed and established maxim" that we must not forget on pain of being seduced by the insidious action of ineradicable idols?

NOTES ON THE READING

In the selections assigned for reading, we see Bacon attempting to open a way for his new approach between what he took to be the two rival positions of his day, the position of the Aristotelians, who were still in control of the universities, and the position of the sceptics, presented in the recently recovered texts of ancient thinkers such as Sextus Empiricus, but also

advanced by contemporaries such as Michel de Montaigne (in, notably, his *Apology for Raymond Sebond*). The sceptics, Bacon observed, had underestimated our capacities of knowledge. The Aristotelians, in contrast, had overestimated our store of knowledge. Both had ended up giving up in the search for new knowledge. The sceptics had given up because they thought knowledge is beyond our grasp; the Aristotelians had given up because they thought that they had already discovered everything it is possible for us to know, and so took themselves to have nothing left to do but exposit and comment on the works of "the Philosopher." (*Works* IV 13).

Bacon agreed with the sceptics that the Aristotelians were wrong. The Aristotelian philosophy taught in the schools and universities of his day was bogus, and the sceptics had been right to expose its errors, along with the errors of all the other dogmatic philosophical schools. But Bacon thought that the sceptics were also wrong to suppose that we could not do any better. Of course the sceptics had been right when they argued, as they famously did, that our senses are unreliable and deceptive, and that our intellect frequently contradicts our senses — even though it depends on the senses for all its information. But the sceptics had also been wrong, Bacon claimed, to suppose that we therefore have no criterion for distinguishing between the deceptive appearances produced by the senses or the intellect and what is a true reflection of reality. He had been able, Bacon claimed, to supply certain instruments or "helps" (i.e., certain methods) that would assist the senses and the intellect in gaining knowledge, just as recent technological inventions had supplied his fellows with instruments for bettering the material conditions of life. Bacon's answer to the sceptics is worth quoting at length.

> the information of senses I sift and examine in many ways. For it is certain that the senses deceive. But then at the same time they supply the means of discovering their own errors. Only the errors are [obvious]; the means of discovery are to be sought. The senses fail in two ways. Sometimes they give no information; sometimes they give false information. For first, there are very many things [that] escape the senses, even when best disposed and in no way obstructed. This happens either because of the subtlety of the whole body or the minuteness of its parts, or because of distance, or slowness or swiftness of motion, or familiarity of the object, or other causes. And again, when the senses do apprehend a thing their apprehension is not to be relied upon much. For the testimony and information of the senses has reference always to [us], not to the universe; and it is a great error to assert that the senses are the measure of things.
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> To meet these difficulties, I have sought diligently and faithfully on all sides to provide helps for the senses — substitutes to supply their failures, standards to correct their errors; and this I endeavour to accomplish not so much by instruments as by experiments. For the subtlety of experiments is far greater than that of the senses themselves, even when assisted by exquisite instruments — such experiments, I mean, as are skillfully and artificially devised for the express purpose of determining the point in question. To the immediate and proper perception of the senses therefore I do not give much weight, but I ensure that the task of the senses shall be only to judge the experiment, and that the experiment itself shall judge the thing. [*Works* IV 26]

The sceptics had famously argued that sense experience is unreliable and cannot be used as a basis for knowledge because sensory experiences are in conflict with one another. The same object can appear differently to different perceivers, or to different sense organs of the same perceiver, or to the same sense organ at different times or under different circumstances. This is a problem because we have no independent criterion that we can rely upon to decide which of the conflicting appearances is correct. We cannot appeal to the sense of touch in preference to that of vision, because it is party to the dispute; or to the experiences of "the wise" in contrast to

those of fools, because we need a way of identifying which people are wise, which we can't provide without begging the question of who perceives correctly. But Bacon claimed that there is a kind of sensory experience that is reliable. It is not the experience of a particular sense organ, or the sense experiences of a particular wise person. Neither is it the experience of the senses when used under optimal conditions, when they are healthy and unobstructed. It is rather sense experience of the results of properly conducted experiments.

Bacon's idea was that if our senses are inadequate because they give us conflicting experiences of the same object under varying circumstances, then we can correct for these errors by controlling the circumstances and relativising our observations to them, that is, by conducting controlled experiments. If, say, the same object looks different from different angles or in different surroundings, then we need to keep track of the viewing angle and the surroundings when we make our observations; we need to actively alter the viewing angle and the surroundings and record how the appearance of the object changes, and we need to develop a comprehensive picture of all the different ways the object appears under all the relevant variations in circumstances. This picture should allow us to work back to the intrinsic, circumstantially neutral constitution of the object (ideally, to the "latent constitution" of its parts, even its unobservably small parts), and to predict how that object will appear under any given set of circumstances when viewed in the future. Moreover, other investigators, replicating our experiments under the same controls, should obtain the same results. After all, under proper experimental conditions, the appearances to different perceivers should not be conflicting because the circumstances that produce variations in sensory experience would all have been controlled for. Sensory experience of the results of properly conducted experiments should therefore always yield the same results and so should be immune to the sceptical charge that sensory experience is unreliable because different sensory experiences give us conflicting testimony regarding the same object.

This notion, that knowledge should not be based simply on sensory experience, but rather on observations that have been made under rigorously controlled circumstances and that are replicable by others who repeat the experiment under those same conditions, still characterizes modern science. Today, a report does not count as "scientific" unless other researchers can replicate it in their own laboratories, and reports that fail to meet this test are rejected. Bacon deserves the credit for being the first to clearly articulate and promulgate this ideal for scientific knowledge and it is perhaps his major contribution to the history of ideas.

As noted earlier, Bacon was also concerned to contrast this new, experimental approach to obtaining scientific knowledge with the rival scientific method of the Aristotelians, as paradigmatically articulated in Aristotle's *Posterior analytics*. Aristotle's scientific method is what is known as the method of resolution and composition, and as Bacon pointed out, it involves two stages: abstracting a theory from experience (a stage variously referred to as resolution or reduction or induction or analysis), and then using this theory to predicting and explain events in nature (a stage variously referred to as composition or deduction or synthesis). For Aristotle, the theory would identify "forms," characteristic of "actives," and "potencies" to acquire forms, characteristic of "passives." The theory would also seek to construct a taxonomic hierarchy of "species" of actives and passives bearing similar sets of forms and potencies, ranged under genera which are in turn ranged under higher genera, and so on. For example, the fact that the sun heats a stone would be explained by the fact that the sun (in common with other objects such as fire) contains a form, the form of heat, whereas the stone has a passive potency to take on

this form, so that when the two are brought into contact the sun actualizes the potency the stone has to grow hot, that is, to take on that form.

The method Bacon himself wanted to recommend is a rather different one — the method of proceeding purely inductively. In making this recommendation he took himself to be doing more than just saying that we should confine ourselves to just the first stage of Aristotle's method, the stage at which we attempt to identify active forms and passive potencies. Bacon charged that the inductive stage of Aristotle's method is defective. Aristotle's inductions were hasty, based on just a few observations, and his observations were inadequate, gathered at random as nature happened to present them rather than through a carefully planned program of controlled experimentation. A proper induction would proceed on the basis of exhaustive, controlled experimentation, and it would slowly generalize to more and more general classes of phenomena, arriving at universal theories last of all. Think, for example of a physician who has over many years studied many patients with a certain disease. The physician might draw conclusions about the general symptomatology of the disease, how it tends to appear and develop, in what cases a cure is possible, and so on. These conclusions are established by careful observation, record-keeping and testing carried out over a long period of time on the patients the physician happens to have encountered. And they lead up just to certain very specific laws about how that particular disease behaves. If the physician gains more experience with a number of other diseases and compares these experiences with one another, the physician might notice certain similarities and infer certain more general facts about the whole group of diseases. This is the Baconian method of going by slow steps from experience up to more and more general concepts and principles.

The Aristotelian method, in contrast, tries to arrive very quickly at a theory, and then applies this theory to deduce what will happen next, often reaching a conclusion in advance of experience. For example, from a few observations of the symptoms of sick people the Aristotelian physician might infer that all diseases are produced by an imbalance of the bodily fluids, and will then deduce from this theory that a cure for a particular disease must consist in restoring the balance--say, by bleeding patients who are hot, or forcing those who are cold to sweat, or inducing vomiting in those with other symptoms.

Bacon's charge was that the Aristotelians had not been careful enough in trying to discover general principles by induction. They had, as he put it, "improperly and overhastily abstracted from facts, vague, not sufficiently definite, faulty in short in many ways," (*Works* IV 24) so that they could proceed at once to give demonstrations and "fly at once from sense and particulars up to the most general propositions … : a short way, no doubt, but precipitate; and one [that] will never lead to [an accurate description of] nature, though it offers an easy and ready way to disputation" (*Works* IV 25). Demonstration has occupied altogether too large a role in science up to now, as far as Bacon was concerned. It is a theatrical "idol" used to dress up fatuous knowledge claims. It needs to be replaced by more care in the execution of the important prior task of induction.

As Bacon saw it, this is no easy matter, because we have certain intellectual weaknesses that constantly tempt us to jump to accept grand theories even though the evidence for them is weak. (i) We like theories that are simple, elegant, and analogous to other theories because they are easier for us to understand and remember; and often we will accept a theory just because it has these features. (ii) We like theories that confirm our own personal prejudices, gleaned from education, conversation or accidental experience, and will often accept theories merely for that

reason and in defiance of contrary evidence. (iii) We like theories that are dressed up in fancy jargon and unintelligible technical terminology, and even though we might not be able to make any sense of them we will repeat them as if they were profound truths. Finally, (iv) we like theories that are pompously displayed in the full theatrical dress of an Aristotelian deductive system from supposedly first principles (or some other equivalent). All of these features are tempting to us. We have an inclination to want to assent to theories that exhibit these features without adequately investigating the evidence that they are based on. And even should the evidence be against them, these same factors will make us so enchanted with the theories that we will strive to preserve them anyway, by making fine distinctions or trying to salvage them with *ad hoc* hypotheses.

Bacon referred to these four inducements to hasty generalization as "idols" of the understanding. (He named them idols of the tribe, idols of the cave, idols of the marketplace, and idols of the theatre respectively.) The force of this term is lost on us today unless we recall that Bacon was writing at the time of the Protestant reformation and in a country that had just undergone a reformation. In his day, a violent reaction had set in against all the exterior forms of religious worship — rituals, liturgies, vestments, statuary, music, incense, and so on — and a alternative, purely inward form of worship — focusing on an intense personal experience of God — was in vogue. By talking about the evil influence of "idols" Bacon was presenting his point by means of an analogy that would have been powerfully evocative for his contemporaries. He was telling his readers to smash the idols of the understanding as the Protestant reformers had smashed the idols in the churches, and focus on an intense engagement with the evidence of experience.

ESSAY QUESTIONS AND RESEARCH PROJECTS

1. Over the opening aphorisms of Book II of the *New organon* (not assigned as part of the reading for this section) Bacon articulated what he meant by the form of a thing and took a position on why it is that change occurs when "actives" and "passives" are brought into contact with one another. Obtain a copy of the complete *New organon* and, proceeding from a study of the opening aphorisms of Book II as well as of the assigned readings, attempt to answer as many of the following questions as you can: What was the extent of Bacon's commitment to an atomistic or at least corpuscularian account of nature (one that attributes all change to the mixture and separation of particles)? Is this commitment consistent with his inductivism, that is, can it plausibly be supposed to be inductively well grounded? Is the commitment, if there is any at all, only partial, that is, does Bacon think that corpuscular accounts are correct only for certain phenomena but not all? What hope did Bacon hold out for our ever being able to reach an exact knowledge of the forms of things, whatever their exact nature may be?
2. Kant famously observed that while experience is able to tell us that something is now the case, it is not able to tell us that is must always or everywhere be so. In light of this observation, is Bacon's inductivist method feasible? Could any process of induction ever be adequate to put us in a position to make a general assertion or would a leap (i.e., a "hasty generalization" of some sort) always have to be involved if we were to formulate any general theories of nature whatsoever? How rigorous was Bacon's inductivism, that is, how much experiment and testing did he think we must do before being entitled to make a generalization? Might he have thought that an inductive leap becomes legitimate

after a certain point? In answering this question, give careful attention to the example Bacon gives of inductively discovering the cause of heat. This example is given in Book II of the *New organon* (which you will have to obtain separately, since it is not included in the readings for this course).

3. How adequate is Bacon's answer to scepticism? Assess whether a committed sceptic might or might not be able to mount a challenge to Bacon's position.