# A Guide to the Interpretation of Nature

Francis Bacon (1561-1626)

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The first quarter of the seventeenth century witnessed the appearance of new technical instruments (e.g., telescope, barometer, thermometer) and the increasing variety of experiments made possible by the flourishing of this new experimental technology. Francis Bacon marks the first systematic attempt to give formal shape to this rapidly emerging experimental science. Indeed, the central feature of his enormously influential philosophy of science is its commitment to the role of observation and experiment as prerequisites for the construction of scientific theory. Where his predecessors regarded experiment as a litmus test of theory that had been derived by a process of deductive reasoning, Bacon took experiment to be the very foundation of science and its generalized methodology. Bacon's work left an indelible imprint on all subsequent philosophical discussions of scientific method.

The title of Bacon's work, *Novum Organum*, or *The New Organon* (1620), from which this reading is taken, is based on Aristotle's work on logic, the 'Organon' or 'Instrument for Rational Thinking.' Bacon proposes a new style of reasoning to supplant Aristotle's — one tailored for the pursuit of knowledge in an age of science dominated by the appearance of new instruments and associated experiments. Where Aristotelian science was based on a set of rules that governed the consistency between conclusion and a set of premises accepted unquestioningly as true, Bacon's new experimental style was designed to

investigate the soundness of the very foundations of scientific theory — that is, to put nature itself to the test.

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It is part of our plan to set everything out as openly and clearly as possible. For a naked mind is the companion of innocence and simplicity, as once upon a time the naked body was. And therefore we must first lay out the order and plan of our work. It consists of six parts.

The first part gives a summary or general description of the science or learning which the human race currently possesses. It seemed good to us to spend some time on what is presently accepted, thinking that this would help the perfection of the old and the approach to the new. We are almost equally eager to develop the old and acquire the new. This also gives us credibility, according to the saying that "an ignorant man will not believe words of knowledge until you have told him what he has in his heart." Therefore, we shall not neglect to sail along the shores of the accepted sciences and arts, importing some useful items into them, in our passage.

However the divisions of the sciences which we employ include not only things which have been noticed and discovered but also things that until now have been missed but should be there. For in the intellectual as in the physical world, there are deserts as well as cultivated places. And so it is not surprising if we sometimes depart from the customary divisions. An addition not only changes the whole, but

necessarily also alters the parts and sections; and the accepted divisions merely reflect the currently accepted outline of the sciences.

In matters which we shall note as missing, we shall be sure to do more than simply suggest a bare title and an outline account of what is needed. For if we report among things missing anything (of some value) whose method seems so obscure that we are justified in suspecting that men will not easily understand what we mean, or what is the task which we imagine and conceive in our mind, we will always take the trouble either to add instructions for carrying out the task or a report of our own performance of a part of it, as an example of the whole; so that we may give some help in each case either by advice or in practice. We feel that our own reputation, as well as the interest of others, requires that no one should suppose that some superficial notions on these matters have simply entered in our heads, and that the things we desiderate and try to grasp are mere wishes. They are such that they are clearly within men's power (unless men fail themselves), and I do have a firm and explicit conception of them. I have undertaken not merely to survey these regions in my mind, like an auger taking the auspices, but to enter them like a general, with a strong will to claim possession. *And this is the first part of the work.*

After coasting by the ancient arts, we will next equip the human understanding to set out on the ocean. We plan therefore, for our second part, an account of a better and more perfect use of reason in the investigation of things and of the

true aids of the intellect, so that (despite our humanity and subjection to death) the understanding may be raised and enlarged in its ability to overcome the difficult and dark things of nature. And the art which we apply (which we have chosen to call *Interpretation of Nature*) is an art of logic, though with a great difference, indeed a vast difference. It is true that ordinary logic also claims to devise and prepare assistants and supports for the intellect; in this they are the same. But it differs altogether from ordinary logic in three particular ways: viz., in its end, in its order of demonstration, and in the starting points of its inquiry.

For the end we propose for our science is the discovery of arts, not of arguments, of principles and not of inferences from principles, or signs and indications or works and not probable reasonings. Different results follow from our different design. They defeat and conquer their adversary by disputation; we conquer nature* by work.

The nature and order of our demonstration agree with such an end. For in ordinary logic almost all effort is concentrated on the syllogism. The logicians seem scarcely to have thought about induction. They pass it by with barely a mention, and hurry on their formulae for disputation. But we reject proof by syllogism, because

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* Reading *natura*, for the *natura* of the edition of 1620. This is the reading which Kitchin's translation presupposes ( See *The Novum Ogranum;* or, *A True Guide to the Interpretation of Nature, by Francis Bacon, Lord Verulum by the Rev. G.W. Kitchin* (Oxford University Press, 1855)

it operates in confusion and lets nature slip out of our hands. For, although no one could doubt that things which agree in a middle term, agree also with each other (which has a kind of mathematical certainty), nevertheless, there is a kind of underlying fraud here, in that a syllogism consists of propositions, and propositions consist of words, and words are counters and signs of notions. And therefore if the very notions of the mind (which are like the soul of words, and the basis of every such structure and fabric) are badly or carelessly abstracted from things, and are vague and not defined with sufficiently clear outlines, and thus deficient in many ways, everything falls to pieces. And therefore we reject the syllogism; and not only so far as principles are concerned (they do not use it for that either) but also for intermediate propositions, which the syllogism admittedly deduces and generates in a certain fashion, but without effects, quite divorced from practice and completely irrelevant to the active part of the sciences. For even if we leave to the syllogism and similar celebrated but notorious kinds of demonstration jurisdiction over the popular arts which are based on opinion (for we have no ambitions in this area), still for the nature of things we use induction throughout, and as much for the minor propositions as for the major ones. For we regard induction as the form of demonstration which respects the senses, stays close to nature, fosters results and is almost involved in them itself.

And so the order of demonstration also is completely reversed. For the way the thing has normally been done until now is to leap immediately from sense and

particulars to the most general propositions, as to fixed poles around which disputations may revolve; then to derive everything else from them by means of intermediate propositions; which is certainly a short route, but dangerously steep, inaccessible to nature and inherently prone to disputations. By contrast, by our method, axioms are gradually elicited step by step, so that we reach the most general axioms only at the very end; and the most general axioms come out not as notional, but as well defined, and such as nature acknowledges as truly known to her, and which live in the heart of things.

By far the biggest question we raise is as to the actual form of induction, and of the judgment made on the basis of induction. For the form of induction which the logicians speak of, which proceeds by simple enumeration, is a childish thing, which jumps to conclusions, is exposed to the danger of instant contradiction, observes only familiar things and reaches no result.

What the sciences need is a form of induction which takes experience apart and analyzes it, and forms necessary conclusions on the basis of appropriate exclusions and rejections. And if the logicians' usual form of judgment has been so difficult and required so much intellectual exertion, how much more effort should we expend on this other judgment, which is drawn not only from the depths of the mind but from the bowels of nature.

And this is not all. For we place the foundations of the sciences deeper and lay them lower, and set our starting points further back than men have ever done

before, subjecting them to examination, while ordinary logic accepts them on the basis of others' belief. For logicians borrow (if I may put it this way) the principles of the sciences from the particular sciences themselves; then they pay respect to the first notions of the mind; finally they are happy with the immediate perceptions of healthy senses. But our position is that true logic should enter the provinces of the individual sciences with greater authority than is in our own principles, and compel those supposed principles themselves to give an account as to what extent they are firmly established. As for the first notions of the intellect: not one of the things which the intellect has accumulated by itself escapes our suspicion, and we do not confirm them without submitting them to a new trial and verdict given in accordance with it. Furthermore, we have many ways of scrutinizing the information of the senses themselves. For the senses often deceive, but they also give evidence of their own errors; however the errors are to hand, the evidence is far to seek.

The senses are defective in two ways: they may fail us altogether or they may deceive. First, there are many things which escape the senses even when they are healthy and quite unimpeded; either because of the rarity of the whole body or by the extremely small size of its parts, or by distance, or by its slowness or speed, or because the object is too familiar, or for other reasons. And even when the senses do grasp an object, their apprehensions of it are not always reliable. For the evidence and information given by the senses is always based on the analogy of man

not of the universe; it is a very great error to assert that the senses are the measure of things.

So to meet these defects, we have sought and gathered from every side with great and faithful devotion, assistants to the senses, so as to provide substitutes in the case of total failure and correction in the case of distortion. We do this not so much with instruments as with experiments. For the subtlety of experiments is far greater than that of the senses themselves even when assisted by carefully designed instruments; we speak of experiments which have been devised and applied specifically for the question under investigation with skill and good technique. And therefore we do not rely very much upon the immediate and proper perception of the senses, but we bring the matter to the point that the senses judge only of the experiment, the experiment judges of the thing. Hence we believe that we have made the senses (from which, if we prefer not to be insane we must derive everything in natural things) sacred high priests of nature and skilled interpreters of its oracles; while others merely seem to respect and humor the senses, we do so in actual fact. Such are the preparations which we make for the light of nature and its kindling and application; and they would be sufficient in themselves if men's understanding were unbiased, a blank slate. But as men's minds have been occupied in so many strange ways that they have no even, polished surface available to receive the true ray of things, it is essential for us to realize that we need to find a remedy for this too.

The *Idols* * by which the mind is occupied are either artificial or innate. The artificial *idols* have entered men's minds either from the doctrines and sects of philosophers or from perverse rules of proof. The innate idols are inherent in the nature of the intellect itself, which is found to be much more prone to error than the senses. For however much men may flatter themselves and run into admiration and almost veneration of the human mind, it is quite certain that, just as an uneven mirror alters the rays of things from their proper shape and figure, so also the mind, when it is affected by things through the senses, does not faithfully preserve them, but inserts and mingles its own nature of things as it forms and devises its own notions.

The first two kinds of *idols* can be eliminated, with some difficulty, but the last in no way. The only strategy remaining is, on the one hand, to indict them, and to expose and condemn the mind's insidious force, in case after the destruction of the old, new shoots of error should grow and multiply from the poor structure of the mind itself, and the result would be that errors would not be squashed but simply altered; and on the other hand, to fix and establish forever the truth that the intellect can make no judgment except by induction in its legitimate form. Hence the teaching which cleanses the mind to make it receptive to truth consists of

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* 'Idols' is the usual translation of Bacon's famous *idola.* We too have used it on most occasions, but the meaning of some passages seemed to be better conveyed by the translation 'illusion' …

three refutations: a refutation of philosophies; a refutation of proofs; and a refutation of natural human reason. When we have dealt with these, and clarified the part played by the nature of things and the part played by the nature of the furnished and adorned the bedchamber for the marriage of the mind and the universe. In the wedding hymn we should pray that men may see born from this union the assistants that they need and a lineage of discoveries which may in some part conquer and subdue the misery and poverty of man. *And this is the second part of the work.*

But we plan not only to show the way and build the roads, but also to enter upon them. And therefore the third part of our work deals with the *Phenomena of the Universe,* that is, every kind of experience, and the sort of natural history which can establish the foundations of philosophy. A superior method of proof or form of interpreting nature may defend and protect the mind from error and mistake, but it cannot supply or provide material for knowledge. But those who are determined not to guess and take omens but to discover and know, and not to make up fairytales and stories about worlds, but to inspect and analyze the nature of this real world, must seek everything from things themselves. No substitute or alternative in the way of intelligence, thought or argument can take the place of hard work and investigation and the visitation of the world, not even if all the genius of all the world worked together. This then we must unfailingly do or abandon the business

forever. But to this very day men have acted so foolishly that it is no wonder that nature does not give them access to her.

For in the first place, the information of the senses themselves is defective and deceiving; observation is lazy, uneven and casual; teaching is empty and based on hearsay; practice is slovenly bent on results; experimental initiative is blind, unintelligent, hasty, and erratic; and natural history is shallow and superficial. Between them they have accumulated very poor material for the intellect to construct philosophy and the sciences.

And the tendency to introduce subtle and intricate disputation prematurely comes too late to remedy a situation which is utterly desperate, and does nothing to move on the enterprise or remove error. Thus there is no hope of major development or progress except in a renewal of the sciences.

Its beginnings must come from a natural history, and a natural history of a new kind with a new organization. It would be pointless to polish the mirror if there were no images; and clearly we must get suitable material for the intellect, as well as making reliable instruments. And our history (like our logic) differs from that now in use in many ways: in its purpose or task, in its actual extent and composition, in its subtlety, and also in the selection and arrangement of it in relation to the next stage.

First we propose a natural history which does not so much amuse by the variety of its contents or give immediate profit a first breast to feed philosophy. For

although our ultimate aim is works and the active part of science, still we wait for harvest time and do not try to reap moss and the crop while it is still green. We know very well that axioms properly discovered bring whole companies of works with them, revealing them not singly but in quantity. But we utterly condemn and reject the childish desire to take some pledges prematurely, in the form of new works, like an apple of Atalanta which shows the race.* Such is the task of our natural history.

And as for its composition, we are making a history not only for nature free and unconstrained (when nature goes its own way and does its own work), such as a history of the bodies of heaven and the sky, of land and sea, or minerals, plants and animals; but much more of nature confined and harassed, when it is forced from its own condition by art and human agency, and pressured and molded. And therefore we give a full description of all the experiments of the mechanical arts, all the experiments of the applied part of the liberal arts, and all the experiments of several practical arts which we have not yet formed a specific art of their own (so far as we have had an opportunity to investigate and they are relevant to our purpose). Moreover (to be plain) we put much more effort and many more resources into this part than into the other, and pay no attention to men's disgust or what

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* This was one of the golden balls ( or apples) which Milanion threw in front of Atalanta while he was racing her, so that he could win the race and her hand in marriage.

they find attractive, since nature reveals herself more through the harassment of art than in her own proper freedom.

And we do not give a history of bodies only; we felt that we should also take the trouble to make a separate history of the powers themselves (we which plainly constitute the originals of nature, since they are the material for the first passions and desires, viz., *Dense, Rare, Hot, Cold, Solid, Liquid, Heavy, Light* and many others).

As for subtlety, we are certainly looking for a kind of experience which is far more subtle and simple than those which simply happen. For we bring and draw many things out of obscurity which no one would ever have thought to investigate if he were not following the sure and steady path to the discovery of causes. For in themselves they are of no great use, so that it is quite clear that they have not been sought for themselves. Rather they are to things and works exactly like the letters of the alphabet to speech and words: though useless in themselves, they are still the elements of all discourse.

And in the choice of narratives and experiences we think that we have served men better than those who have dealt with natural history in the past. For we use the evidence of our own eyes, or at least or our own perception, in everything, and apply the strictest criteria in accepting things; so that we exaggerate nothing in our reports for the sake of sensation, and our narrations are free and untouched by fable and foolishness. We also specifically proscribe and condemn many widely

accepted falsehoods (which have prevailed for many centuries by a kind of neglect and are deeply engrained), so that they may not trouble the sciences any more. For as someone wisely remarked that the stories and superstitions and trifles which nurses instill into children also seriously deprave their minds,* by the same reasoning we feel we must be careful, and even anxious, that philosophy should not at the start get into the habit of any kind of foolishness as we foster and nurture its infancy in the form of natural history. In every experiment which is new and even the least bit subtle, even if (as it seems to us) it is sure and proven, we give a frank account of the method of the experiment we used; so that after we have revealed every move we made men may see any hidden error attached to it, and may be prompted to find more reliable, more meticulous proofs (if any exist); and finally we sprinkle warnings, reservations, and cautions in all directions, with the religious scruple of an exorcist casting out and banishing every kind of fantasy.

Finally, since we have seen how much experience and history distort the sight of the human mind, and how difficult it is (especially for tender or prejudiced minds) at first to get used to nature, we often add our own observations, which are like the first turn or move of history towards philosophy (perhaps one might say, the first glance). They are intended to be like a pledge to men that they will not be forever floundering in the waves of history, and that when we come to the work of the understanding everything will be more ready for action. By such a natural

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* Perhaps a reference to Plato, *Republic* 377A, 387B, *Laws* 793Dff, and elsewhere.

history (as we have outlined) we believe that men may make a safe, convenient approach to nature and supply good, prepared material to the understanding.

After* we have surrounded the intellect with the more trustworthy aides and bodyguards, and have used the most stringent selection to build a fine army of divine works, it may seem that nothing remains to be done but to approach philosophy itself. But in such a difficult and doubtful task there are certain points which is seems necessary to introduce first, partly for instruction and partly for their immediate usefulness.

The first point is to give examples of investigation and discovery by our way and method, as exhibited in certain subjects. We particularly choose subjects which are most different from each other; so that in every *genus* we may have an example. We are not speaking of examples added to individual percepts and rules for illustration (these we were given in abundance in our second part); we simply mean types and variations, which may bridge before our eyes the whole procedure of the mind and the seamless fabric and order of its discovery of things, in certain subjects, which will be diverse and striking. The analogy that suggests itself in mathematics demonstration is easy and clear when the machine is used, whereas without this convenience everything seems complicated and more subtle than it really is. And so we devote the *fourth part* of our work to such examples, and thus it is truly and simply a particular and detailed application of the second part.

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* This is the beginning of the fourth part.

The *fifth part* is useful only for a time until the rest is completed; and is given as a kind of interest until we get the capital. We are not driving blindly towards our goal and ignoring the useful things that come up on the way. For this reason the fifth part of our work consists of things which we have either discovered, demonstrated or added, not on the basis of our methods and instructions for interpretation, but from the same intellectual habits as other people generally employ in investigation and discovery. For while we expect, from our constant converse with nature, greater things from our reflections than our intellectual capacity might suggest, these temporary results in the mean time serve as shelters built along the road for the mind to rest in for a while as it presses on towards more certain things. However, we insist in the meantime that we do not wish to be held to these results themselves, because they have not been discovered or demonstrated by the true form of interpretation. One should not be frightened of such a suspension of judgment in a doctrine which does not assert simply that nothing can be known, but that nothing can be known except in a certain order and by a certain method; and meanwhile it has set up some degrees of certitude for use and comfort until the mind reaches its goal of explanation of its causes. Nor were the schools of philosophers who maintained *lack of conviction** inferior to those who claimed a freedom to make pronouncements. Yet the former did not provide

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* Bacon uses the Greek word *acatalepsia*, the mark of the ancient Sceptics.

assistance to the sense and understanding, as we have done, but totally undermined believe and authority; which is a very different thing and almost the opposite.

Finally the *sixth* part of our work (which the rest supports and serves) at last reveals and expounds the philosophy which is derived and formed from the kind of correct, pure, strict inquiry which we have already framed and explained. It is beyond our ability and beyond our expectation to achieve this final part and bring it to completion. We have made a start on the task, a start which we hope is not despicable; the end will come from the fortune of mankind, such an end perhaps as in the present condition of things and present state of thought men cannot easily grasp or guess. It is not merely success in speculation which is in question, but the human situation, human fortune, and the whole potential of works. For man is nature's agent and interpreter; he does and understands only as much as he has observed of the order of nature in works or in inference; he does not know and cannot do more. No strength exists that that can interrupt or break that chain of causes; and nature is conquered only be obedience . Therefore these two goals of man *knowledge* and *power*, a pair of twins, are really come to the same thing, and works are chiefly frustrated by ignorance of causes.

The whole secret is to never let the mind's eye stray from things themselves, and to take images exactly as they are. May God never allow us to publish a dream of our imagination as a model of the World, but rather graciously grant us the

power to describe the true appearance and revelation of the prints and traces of the Creator in his creatures.

And therefore Father, You who have given visible light as the first fruits of creation and, at the summit of Your works, have breathed intellectual light into the face of man, protect and govern this work, which began in Your goodness and returns to Your glory. After You had turned to view the works which Your hand had made, You saw all things were very good and you rested. But man, turning to the works which his hands have made, saw that all things were vanity and vexation of spirit,* and has had no rest. Wherefore if we labor in Your works, You will make us to share in Your vision and Your Sabbath. We humbly beseech you that this mind may remain in us; and that you may be pleased to bless the human family with new mercies, through our hands and the hands of those others whom You will give the same.

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* Ecclesiastes, I;I4

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