

Selections from the
NOTEBOOKS OF
LEONARDO DA VINCI

Edited with Commentaries

English Edition

by

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PREFACE

During his youth in Renaissance Florence Leonardo conceived of painting as the noblest calling open to mankind and embarked with enthusiasm in its pursuit.

It was not only the beauty of nature but also the spirit at work beneath the world of appearance that fascinated him. Combining an artist's sensitivity with a scientist's desire of knowledge, he analysed the objects of vision and the way in which vision functioned. This entailed the study of nature, its structure and life. As he proceeded his interest in natural science deepened. He used scientific methods of research in order to ascertain Nature's laws and introduce them in his own work. He pursued these studies not merely in order to paint certain pictures commissioned by patrons but for the attainment of creative power. His compositions expressed actions, emotions; faces were moulded by the life within. Landscapes represented the formation of rocks, the growth of plants, the movement of water.

He often made use of his knowledge and experience for practical purposes. Thus this man who created a few works of art divinely well was also a precursor of a new age in science and, incidentally, a civil and military engineer whose inventions embodied in elementary form the principles of modern machinery.

He was enabled to achieve this because he was an artist. In his time there were no professional scientists working by experiment; and the observations of natural phenomena as handed down by Aristotle and other ancient philosophers continued to form the foundation of an authorized creed accepted by the Schoolmen, who deprecated experimental methods as subversive and 'unlettered'.

But being an artist Leonardo steered a course guided by visual experience. His intelligence was free and wholly devoted to inquiry.

At times he realized what fateful catastrophes the well-conceived and universal laws of nature might bring about. Some other time, he was trenchantly critical of the inherent egotism and wickedness of man. Gradually his attitude towards the world became that of a strangely aloof and impersonal observer. When doubts arose in his mind regarding some ancient long-established belief, he would say so in his notes. But since he was not an abstract theorist intent on establishing a logical system, nor a modern scientist concentrating on a special line of research, but a 'universal' genius of the Renaissance intent on artistic creation, he attempted to ground his natural science on an acceptance of the philosophic system, inherited from Greek thought and medieval thought, which conceived of the universe as an organized cosmos corresponding to a work of art; and he profited thereby.

We are enabled to gain insight into his thoughts by reading his notebooks. He used to carry these about with him to sketch instantaneous impressions or to write down ideas as they occurred on the spur of the moment—observations made during walks and travels, reflections on events and persons, on his domestic problems, on his work, on life in general. Manuscripts have survived containing drafts of letters, fanciful descriptions and fables, rough copies of treatises on the power of water, on the art of painting, on the anatomy and movement of the human figure, &c. But they are just notes. Often, remarks on diverse subjects are scribbled on one and the same page, or restatements and clarifications of one and the same idea occur on another page. The following words written on the

front sheet of a manuscript on physics is descriptive of his method of writing.

'This is to be a collection without order, taken from many papers, which I have copied here, hoping afterwards to arrange them according to the subjects of which they treat; and I believe that I shall have to repeat the same thing several times; for which, O reader, blame me not because the subjects are many, and memory cannot retain them . . . all the more because of the long intervals between one time of writing and another.'

Leonardo's intention to sort his notes was never carried out. The present volume constitutes an attempt to co-ordinate a selection of them on subjects of general interest. The choice has often been difficult since he was fascinated and distracted by so many problems, depending on his mood and circumstances. We have limited ourselves to quoting typical examples of the main themes. The number at the end of each excerpt refers to pp. 394 ff. where the sources are given. The first three chapters deal with science and nature. In the fourth chapter his treatise on painting is summarized and the ever persistent problems of art are discussed. The fifth chapter contains writings of a literary kind—tales, fables, maxims; the sixth chapter gives reflections on life. In the last chapter references to Leonardo's personal affairs and to his work have been arranged in chronological sequence, strung on the unifying thread of his life, like a diary. Light is thrown on the circumstances in which he lived, on historical events and personages that influenced his course.

Readers must not expect a continuous and coherent narrative. In the circumstances the alinement of texts had to be 'staccato'. Leonardo did not claim to be a man of

letters nor versed in classical literature like most authors of his time. With them in mind he would humbly call himself *uomo senza lettere*; but with irony, for he was proud of his own method, since he had things to say that were beyond their ken; and he did so in the clear and forceful language of the Italian people.

Now, after five hundred years, Leonardo's notebooks are considered of priceless value, and are to be included in the series of *World's Classics* by the Oxford University Press.

Readers will see him at work striving to express his thoughts. They will learn to know him, and they will discern an underlying unity. For these manifold observations spring from one consistent spirit. The life of one of the greatest men of the Italian Renaissance is here painted by himself in words.

Vasari begins his biography of the artist by saying: 'Occasionally heaven sends us someone who is not only human but divine, so that through his mind and the excellence of his intellect we may reach out to heaven.' To live close to great minds is the best education, and the happiest thing that can befall us. It is the aim of this book to offer its readers such an opportunity.

1952

ACKNOWLEDGEMENT

The present volume owes its existence to the work of many scholars. Within the last seventy years Leonardo's manuscripts have been transcribed and published (see 'References to Manuscripts', page 393). Being written backward from right to left, since he was left-handed, they were difficult to decipher. It has been possible to date them and ascribe each notebook to a certain period of his life. Attempts to arrange his writings according to subjects have also been made, and translations from the original Italian into other languages are now extant.

Most of the material has been taken from Jean Paul Richter's *Literary Works of Leonardo da Vinci*, the second edition of which was published by the Oxford University Press in 1939, and we refer the student intent on a more thorough study to this work. There he will find the history of the various manuscripts and the original Italian text in its sonorous and powerful style, inimitable in another tongue. In the rendering of translations advantage has also been taken of the *Notebooks of Leonardo da Vinci* by Edward MacCurdy; and in writing the biographical chapter the periodical publications of the Raccolta Vinciana, L. Beltrami's *Documentie Memorie*, and the recent studies on the chronology of Leonardo's manuscripts by Sir Kenneth Clark have proved useful. Among other recent books that have been consulted are Arturo Uccelli's works on Leonardo's mechanics, J. McMurrich Playfair's on his anatomy, and G. Giacomelli's on his aerodynamics.

LEONARDO DA VINCI

Born: Vinci, Tuscany, 15 April 1452

Died: Cloux, France, 2 May 1519

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I

TRUE SCIENCE

Leonardo's view of what science should be foreshadows the critical and constructive methods of modern times. He proceeded step by step. (1) Experience of the world around us as gained through the senses is taken as the starting-point. (2) Reason and contemplation, which, though linked to the senses, stands above and outside them, deduces eternal and general laws from transitory and particular experiences. (3) These general laws must be demonstrated in logical sequence like mathematical propositions, and finally (4) they must be tested and verified by experiment, and then applied to the production of works of utility or of art according to plan. For Leonardo's purpose in acquiring knowledge was that he might obtain power and produce creations of his own. Truth could thus be verified. He was opposed to philosophical systems founded solely on words.

I. EXPERIENCE

Consider now, O reader! what trust can we place in the ancients, who tried to define what the Soul and Life are—which are beyond proof—whereas those things which can at any time be clearly known and proved by experience remained for many centuries unknown or falsely understood.

Many will think that they can with reason blame me, alleging that my proofs are contrary to the authority of certain men held in great reverence by their inexperienced judgments, not considering that my works are the issue of simple and plain experience which is the true mistress

These rules enable you to know the true from the false—and this induces men to look only for things that are possible and with due moderation—and they forbid you to use a cloak of ignorance, which will bring about that you attain to no result and in despair abandon yourself to melancholy.

I am fully aware that the fact of my not being a man of letters may cause certain presumptuous persons to think that they may with reason blame me, alleging that I am a man without learning. Foolish folk! Do they not know that I might retort by saying, as did Marius to the Roman Patricians: 'They who adorn themselves in the labours of others will not permit me my own.'^{*} They will say that because I have no book learning, I cannot properly express what I desire to treat of—but they do not know that my subjects require for their exposition experience rather than the words of others. Experience has been the mistress of whoever has written well; and so as mistress I will cite her in all cases.¹

Though I have no power to quote from authors as they have, I shall rely on a far bigger and more worthy thing—on experience, the instructress of their masters. They strut about puffed up and pompous, decked out and adorned not with their own labours, but by those of others, and they will not even allow me my own. And if they despise me who am an inventor, how much more should they be blamed who are not inventors but trumpeters and reciters of the works of others.

Those who are inventors and interpreters between Nature and Man as compared with the reciters and trumpeters of the works of others, are to be regarded simply as is an object in front of a mirror in comparison with its image seen in the mirror, the one being something in itself, the other nothing: people whose debt to nature is small, since they

^{*} Marius' speech to the Quirites in Sallust, *Bellum Jugurthinum*, ch. 85, § 25.

are only by chance invested with the human form, and but for this, I might class them with the herds of beasts.²

Seeing that I cannot find any subject of great utility or pleasure, because the men who have come before me have taken for their own all useful and necessary themes, I will do like one who, because of his poverty, is the last to arrive at the fair, and not being able otherwise to provide for himself, takes all the things which others have already seen and not taken but refused as being of little value; I will load my modest pack with these despised and rejected wares, the leavings of many buyers; and will go about distributing, not indeed in great cities, but in the poor hamlets, taking such reward as the thing I give may be worth.¹

The abbreviators* (of works) do harm to knowledge and to love, for the love of anything is the offspring of knowledge, love being more fervent in proportion as knowledge is more certain. And this certainty springs from a complete knowledge of all the parts which united compose the whole of the thing which ought to be loved.

Of what use, then, is he who in order to abridge the part of the things of which he professes to give complete information leaves out the greater part of the things of which the whole is composed. True it is that impatience, the mother of folly, is she who praises brevity, as if such persons had not life long enough to acquire a complete knowledge of one single subject, such as the human body. And then they want to comprehend the mind of God which embraces the whole universe, weighing and mincing it into infinite parts as if they had dissected it. O human stupidity! do you not perceive that you have spent your whole life with yourself,

* The name 'abbreviatori' was given to the secretaries at the chancery of the Vatican. Leonardo during his stay in Rome was impeded in his anatomical researches by the Vatican and in writing this may have had their obstruction in mind.

and yet are not aware of the thing you chiefly possess, that is of your folly? And so with the crowd of sophists you deceive yourself and others, despising the mathematical sciences in which is contained the true information about the subjects of which they treat. And then you would fain occupy yourself with miracles and write and give information of those things of which the human mind is incapable, and which cannot be proved by any instance from nature. And you fancy you have wrought miracles when you have spoiled the work of some ingenuous mind and do not perceive that you are falling into the same error as he who strips a tree of its adornment of branches laden with leaves intermingled with fragrant flowers or fruit in order to demonstrate the suitability of the tree for making planks. As did Justinus,* abridging the histories of Trogus Pompeius, who had written in an ornate style all the great deeds of his forefathers full of admirable and picturesque descriptions; and by so doing composed a bald work fit only for such impatient minds who fancy they are wasting time when they spend it usefully in the study of works of nature and the deeds of men.³

All our knowledge has its origin in our perceptions.⁴

The eye, which is called the window of the soul, is the chief means whereby the understanding may most fully and abundantly appreciate the infinite works of nature.⁵

Experience never errs; it is only your judgement that errs in promising itself results as are not caused by your experiments. Because, given a beginning, what follows from it must be its true consequence unless there is an impediment. And should there be an impediment, the result which ought

* Iunianus Iustinus, Roman historian of the second century, compiler of a selection from the general history written by Pompeius Trogus in the time of Augustus. The book was much used in the Middle Ages.

to follow from the aforesaid beginning will partake of this impediment in a greater or less degree in proportion as this impediment is more or less powerful than the aforesaid beginning. Experience does not err, it is only your judgment that errs in expecting from her what is not in her power. Wrongly do men complain of Experience and with bitter reproaches accuse her of leading them astray. Let Experience alone, and rather turn your complaints against your own ignorance, which causes you to be carried away by your vain and foolish desires as to expect from Experience things which are not within her power; saying that she is fallacious. Wrongly do men complain of innocent Experience, accusing her often of deceit and lying demonstrations.⁶

To me it seems that all sciences are vain and full of errors that are not born of Experience, mother of all certainty, and that are not tested by Experience; that is to say, that do not at their origin, middle, or end, pass through any of the five senses. For if we are doubtful about the certainty of things that pass through the senses how much more should we question the many things against which these senses rebel, such as the nature of God and the soul and the like, about which there are endless disputes and controversies. And truly it so happens that where reason is not, its place is taken by clamour. This never occurs when things are certain. Therefore, where there are quarrels, there true science is not; because truth can only end one way—wherever it is known controversy is silenced for all time, and should controversy nevertheless again arise, then our conclusions must have been uncertain and confused and not truth reborn.

All true sciences are the result of Experience which has passed through our senses, thus silencing the tongues of litigants. Experience does not feed investigators on dreams, but always proceeds from accurately determined first principles, step by step in true sequences to the end; as can

be seen in the elements of mathematics. . . . Here no one argues as to whether twice three is more or less than six or whether the angles of a triangle are less than two right angles. Here all arguments are ended by eternal silence and these sciences can be enjoyed by their devotees in peace. This the deceptive purely speculative sciences cannot achieve.⁷

Beware of the teaching of these speculators, because their reasoning is not confirmed by Experience.⁸

II. REASON AND NATURE'S LAWS

The senses are of the earth; reason stands apart from them in contemplation.⁹

Wisdom is the daughter of experience.*¹⁰

Experience, the interpreter between formative nature and the human species, teaches that that which this nature works among mortals constrained by necessity cannot operate in any other way than that in which reason, which is its rudder, teaches it to work.¹¹

First I shall test by experiment before I proceed farther, because my intention is to consult experience first and then with reasoning show why such experience is bound to operate in such a way. And this is the true rule by which those who analyse the effects of nature must proceed: and although nature begins with the cause and ends with the experience, we must follow the opposite course, namely, begin with the experience, and by means of it investigate the cause.¹²

O marvellous necessity, thou with supreme reason constrainest all effects to be the direct result of their causes, and

* See Dante, *Paradiso*, ii. 94-96. 'Experience, the only fountain whence your arts derive their streams.'

by a supreme and irrevocable law every natural action obeys thee by the shortest possible process.¹³

Nature does not break her law; nature is constrained by the logical necessity of her law which is inherent in her.¹⁴

Necessity is the mistress and guide of nature.

Necessity is the theme and inventor of nature, its eternal curb and law.¹⁵

Nature is full of infinite causes that have never occurred in experience.¹⁶

In nature there is no effect without cause; understand the cause and you will have no need of the experiment.¹⁷

III. MATHEMATICAL DEMONSTRATION

The method recommended by Leonardo for submitting the results of his investigations corresponds to Euclidian geometry.

The presentation must be made in logical sequence. First came the statement of the theorem, the 'proposition'; then came 'concessions' or 'petitions', i.e. axioms which neither require nor are capable of proof and must be taken for granted; whereupon followed the examination of the subjects under consideration.

Let no man who is not a mathematician read the elements of my work.¹⁸

There is no certainty where one can neither apply any of the mathematical sciences nor any of those which are connected with the mathematical sciences.¹⁹

Whoever condemns the supreme certainty of mathematics