

The Diaries of Leonardo Da Vinci
Originally published in 1883 as
The Literary Works of Leonardo Da Vinci
Translated by Jean Paul Richter
This edition edited by Michael R. Poll

The Diaries of Leonardo Da Vinci
A Cornerstone Book
Published by Cornerstone Book Publishers
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Cornerstone Book Publishers
New Orleans, LA

www.cornerstonepublishers.com

ISBN: 1-887560-84-X
ISBN 13: 978-1-887560-84-9

MADE IN THE U.S.A.

PREFACE.

A singular fatality has ruled the destiny of nearly all the most famous of Leonardo da Vinci's works. Two of the three most important were never completed, obstacles having arisen during his life-time, which obliged him to leave them unfinished; namely the Sforza Monument and the Wall-painting of the Battle of Anghiari, while the third--the picture of the Last Supper at Milan--has suffered irremediable injury from decay and the repeated restorations to which it was recklessly subjected during the XVIIth and XVIIIth centuries. Nevertheless, no other picture of the Renaissance has become so well-known and popular through copies of every description.

Vasari says, and rightly, in his Life of Leonardo, "that he laboured much more by his word than in fact or by deed", and the biographer evidently had in his mind the numerous works in Manuscript which have been preserved to this day. To us, now, it seems almost inexplicable that these valuable and interesting original texts should have remained so long unpublished, and indeed forgotten. It is certain that during the XVIth and XVIIth centuries their exceptional value was highly appreciated. This is proved not merely by the prices which they commanded, but also by the exceptional interest which has been attached to the change of ownership of merely a few pages of Manuscript.

That, notwithstanding this eagerness to possess the Manuscripts, their contents remained a mystery, can only be accounted for by the many and great difficulties attending the task of deciphering them. The handwriting is so peculiar that it requires considerable practice to read even a few detached phrases, much more to solve with any certainty the numerous difficulties of alternative readings, and to master the sense as a connected whole. Vasari observes with reference to Leonardo's writing: "he wrote backwards, in rude characters, and with the left hand, so that any one who is not practiced in reading them, cannot understand them". The aid of a mirror in reading reversed handwriting appears to me available only for a first experimental reading. Speaking from my own experience, the persistent use of it is too fatiguing and inconvenient to be practically advisable, considering the enormous mass of Manuscripts to be deciphered. And as, after all, Leonardo's handwriting runs backwards just as all Oriental character runs backwards--that is to say from right to left--the difficulty of reading direct from the writing is not insuperable. This obvious peculiarity in the writing is not, however, by any means the only obstacle in the way of mastering the text. Leonardo made use of an orthography peculiar to himself; he had a fashion of amalgamating several short words into one long one, or, again, he would quite arbitrarily divide a long word into two separate halves; added to this there is no punctuation whatever to regulate the division and construction of the sentences, nor are there any accents--and the reader may imagine that such difficulties were almost sufficient to make the task seem a desperate one to a beginner. It is therefore not surprising that the good intentions of some of Leonardo's most reverent admirers should have failed.

Leonardo's literary labours in various departments both of Art and of Science were those essentially of an enquirer, hence the analytical method is that which he employs in arguing out his investigations and dissertations. The vast structure of his scientific theories is consequently built up of numerous separate researches, and it is much to be lamented that he should never have collated and arranged them. His love for detailed research--as it seems to me--was the reason that in almost all the Manuscripts, the different paragraphs appear to us to be in utter confusion; on one and the same page, observations on the most dissimilar subjects follow each other without any connection. A page, for instance, will begin with some principles of astronomy, or the motion of the earth; then come the laws of sound, and finally some precepts as to colour. Another page will begin with his investigations on the structure of the intestines, and end with philosophical remarks as to the relations of poetry to painting; and so forth.

Leonardo himself lamented this confusion, and for that reason I do not think that the publication of the texts in the order in which they occur in the originals would at all fulfill his intentions. No reader could find his way through such a labyrinth; Leonardo himself could not have done it.

Added to this, more than half of the five thousand manuscript pages which now remain to us, are written on loose leaves, and at present arranged in a manner which has no justification beyond the fancy of the collector who first brought them together to make volumes of more or less extent. Nay, even in the volumes, the pages of which were numbered by Leonardo himself, their order, so far as the connection of the texts was concerned, was obviously a matter of indifference to him. The only point he seems to have kept in view, when first writing down his notes, was that each observation should be complete to the end on the page on which it was begun. The exceptions to this rule are extremely few, and it is certainly noteworthy that we find in such cases, in bound volumes with his numbered pages, the written observations: "turn over", "This is the continuation of the previous page", and the like. Is not this sufficient to prove that it was

only in quite exceptional cases that the writer intended the consecutive pages to remain connected, when he should, at last, carry out the often planned arrangement of his writings?

What this final arrangement was to be, Leonardo has in most cases indicated with considerable completeness. In other cases this authoritative clue is wanting, but the difficulties arising from this are not insuperable; for, as the subject of the separate paragraphs is always distinct and well defined in itself, it is quite possible to construct a well-planned whole, out of the scattered materials of his scientific system, and I may venture to state that I have devoted especial care and thought to the due execution of this responsible task.

The beginning of Leonardo's literary labours dates from about his thirty-seventh year, and he seems to have carried them on without any serious interruption till his death. Thus the Manuscripts that remain represent a period of about thirty years. Within this space of time his handwriting altered so little that it is impossible to judge from it of the date of any particular text. The exact dates, indeed, can only be assigned to certain note-books in which the year is incidentally indicated, and in which the order of the leaves has not been altered since Leonardo used them. The assistance these afford for a chronological arrangement of the Manuscripts is generally self evident. By this clue I have assigned to the original Manuscripts now scattered through England, Italy and France, the order of their production, as in many matters of detail it is highly important to be able to verify the time and place at which certain observations were made and registered. The consecutive numbers (from 1 to 1566) at the head of each passage in this work, indicate their logical sequence with reference to the subjects; while the letters and figures to the left of each paragraph refer to the original Manuscript and number of the page, on which that particular passage is to be found. Thus the reader, by following the sequence of the numbers, may reconstruct the original order of the Manuscripts and recompose the various texts to be found on the original sheets--so much of it, that is to say, as by its subject-matter came within the scope of this work. It may, however, be here observed that Leonardo's Manuscripts contain, besides the passages here printed, a great number of notes and dissertations on Mechanics, Physics, and some other subjects, many of which could only be satisfactorily dealt with by specialists. I have given as complete a review of these writings as seemed necessary in the Bibliographical notes.

In 1651, Raphael Trichet Dufresne, of Paris, published a selection from Leonardo's writings on painting, and this treatise became so popular that it has since been reprinted about two-and-twenty times, and in six different languages. But none of these editions were derived from the original texts, which were supposed to have been lost, but from early copies, in which Leonardo's text had been more or less mutilated, and which were all fragmentary. The oldest and on the whole the best copy of Leonardo's essays and precepts on Painting is in the Vatican Library; this has been twice printed, first by Manzi, in 1817, and secondly by Ludwig, in 1882. Still, this ancient copy, and the published editions of it, contain much for which it would be rash to hold Leonardo responsible, and some portions--such as the very important rules for the proportions of the human figure--are wholly wanting; on the other hand they contain passages which, if they are genuine, cannot now be verified from any original Manuscript extant. These copies, at any rate neither give us the original order of the texts, as written by Leonardo, nor do they afford any substitute, by connecting them on a rational scheme; indeed, in their chaotic confusion they are anything rather than satisfactory reading. The fault, no doubt, rests with the compiler of the Vatican copy, which would seem to be the source whence all the published and extensively known texts were derived; for, instead of arranging the passages himself, he was satisfied with recording a suggestion for a final arrangement of them into eight distinct parts, without attempting to carry out his scheme. Under the mistaken idea that this plan of distribution might be that, not of the compiler, but of Leonardo himself, the various editors, down to the present day, have very injudiciously continued to adopt this order--or rather disorder.

I, like other enquirers, had given up the original Manuscript of the *Trattato della Pittura* for lost, till, in the beginning of 1880, I was enabled, by the liberality of Lord Ashburnham, to inspect his Manuscripts, and was so happy as to discover among them the original text of the best-known portion of the *Trattato* in his magnificent library at Ashburnham Place. Though this discovery was of a fragment only--but a considerable fragment--inciting me to further search, it gave the key to the mystery which had so long enveloped the first origin of all the known copies of the *Trattato*. The extensive researches I was subsequently enabled to prosecute, and the results of which are combined in this work, were only rendered possible by the unrestricted permission granted me to investigate all the Manuscripts by Leonardo dispersed throughout Europe, and to reproduce the highly important original sketches they contain, by the process of "photogravure". Her Majesty the Queen graciously accorded me special permission to copy for publication the Manuscripts at the Royal Library at Windsor. The Commission Centrale Administrative de l'Institut de France,

Paris, gave me, in the most liberal manner, in answer to an application from Sir Frederic Leighton, P. R. A., Corresponding member of the Institute, free permission to work for several months in their private collection at deciphering the Manuscripts preserved there. The same favour which Lord Ashburnham had already granted me was extended to me by the Earl of Leicester, the Marchese Trivulsi, and the Curators of the Ambrosian Library at Milan, by the Conte Manzoni at Rome and by other private owners of Manuscripts of Leonardo's; as also by the Directors of the Louvre at Paris; the Accademia at Venice; the Uffizi at Florence; the Royal Library at Turin; and the British Museum, and the South Kensington Museum. I am also greatly indebted to the Librarians of these various collections for much assistance in my labours; and more particularly to Monsieur Louis Lalanne, of the Institute de France, the Abbate Ceriani, of the Ambrosian Library, Mr. Maude Thompson, Keeper of Manuscripts at the British Museum, Mr. Holmes, the Queens Librarian at Windsor, the Revd Vere Bayne, Librarian of Christ Church College at Oxford, and the Revd A. Napier, Librarian to the Earl of Leicester at Holkham Hall.

In correcting the Italian text for the press, I have had the advantage of valuable advice from the Commendatore Giov. Morelli, Senatore del Regno, and from Signor Gustavo Frizzoni, of Milan. The translation, under many difficulties, of the Italian text into English, is mainly due to Mrs. R. C. Bell; while the rendering of several of the most puzzling and important passages, I owe to the indefatigable interest taken in this work by Mr. E. J. Poynter R. A. Finally I must express my thanks to Mr. Alfred Marks, of Long Ditton, who has most kindly assisted me throughout in the revision of the proof sheets.

The notes and dissertations on the texts on Architecture I owe to my friend Baron Henri de Geymuller, of Paris.

I may further mention with regard to the illustrations, that the negatives for the production of the "photo-gravures" by Monsieur Dujardin of Paris were all taken direct from the originals.

It is scarcely necessary to add that most of the drawings here reproduced in facsimile have never been published before. As I am now, on the termination of a work of several years' duration, in a position to review the general tenor of Leonardo's writings, I may perhaps be permitted to add a word as to my own estimate of the value of their contents. I have already shown that it is due to nothing but a fortuitous succession of unfortunate circumstances, that we should not, long since, have known Leonardo, not merely as a Painter, but as an Author, a Philosopher, and a Naturalist. There can be no doubt that in more than one department his principles and discoveries were infinitely more in accord with the teachings of modern science, than with the views of his contemporaries. For this reason his extraordinary gifts and merits are far more likely to be appreciated in our own time than they could have been during the preceding centuries. He has been unjustly accused of having squandered his powers, by beginning a variety of studies and then, having hardly begun, throwing them aside. The truth is that the labours of three centuries have hardly sufficed for the elucidation of some of the problems which occupied his mighty mind.

Alexander von Humboldt has borne witness that "he was the first to start on the road towards the point where all the impressions of our senses converge in the idea of the Unity of Nature" Nay, yet more may be said. The very words which are inscribed on the monument of Alexander von Humboldt himself, at Berlin, are perhaps the most appropriate in which we can sum up our estimate of Leonardo's genius:

"Majestati naturae par ingenium."

LONDON, April 1883.

F. P. R.



Plate I

I.

Prolegomena and General Introduction to the Book on Painting.

Clavis sigillorum.

1. In the few instances in which Leonardo has written from left to right in the ordinary way this is stated in a note. In all other cases the writing is backwards.

2. The numbers printed above the line in the revised text: ², ³, ⁴ &c. indicate the heads of the lines in the original MS. In many instances the breaking off of the lines in the original MS. accounts for peculiarities in the construction of Leonardo's sentences. In the translation the numbers refer only to the footnotes and they have been introduced in such passages, which require an explanation.

3. Clerical errors and obvious mistakes in spelling have been corrected in the text, but are given in the notes, so that all the peculiarities of the original text which are omitted in the revised text may be seen at a glance.

4. Leonardo frequently employs the following abbreviations:--

℞ for per or pr; e. g. ℞ che = perche; so ℞ a = sopra.

℞ for di.

℞ for br; e. g. ℞ eve = breve.

℞ for ver; e. g. in ℞ so = inverso.

℞ for ser; e. g. ℞ vo = servo.

These occur so constantly and are so unimportant that it has not been thought necessary to point them out. He also uses:

î for uno.

î for una.

5. Such abbreviations as are common in familiar speech are retained in the text; e. g. un sol punto.

6. Leonardo's usual way of spelling, ochio specchio for occhio specchio, has also been left unaltered.

7. The combinations of two or three words into one, which Leonardo so frequently used, and which are so puzzling to the eye as to render reading difficult, though plain to the ear, have been separated in the revised text; e. g. leforme ditutti = le forme di tutti. These combinations were,

however, intentional no doubt; in almost every case they indicate the author's desire of substituting a sort of phonetic writing for the rules in general use. This doubling of the letters--as, for instance in chessia for che sia and essella for e se la--is, I believe, clear evidence of what may be called the orthography of Leonardo da Vinci. The separation of the words has involved the loss of these doubled letters, but the original spelling has been given, for reference, in the foot notes.

8. Leonardo commonly wrote ā ē ī ō ū or v for an, en, in, on, un. This sign occasionally, but not often, represents m. It has been retained, as it was usual in printed type in the XVth and XVIth centuries.

9. Leonardo sometimes writes j for i, particularly where it is joined to m, n or u; e. g. linje, tienj, mjnor. As he never sets a dot over the ordinary i (at any rate when he writes from right to left), it is plain that he uses j for i (he does not dot the j) simply to avoid confounding ni or ui with m, or mi with nu. As this difficulty cannot occur in print I have restored the usual spelling i for j without referring to it in the notes.

10. Accents and apostrophes are entirely lacking in the original manuscript, but it seemed necessary to introduce them into the printed text. The accent has also been added in those parts of the verb avere in which Leonardo had dropped the h: as ò, ài, à, ànno.

11. | ||| () In the MSS. there are no marks of punctuation but these, and they have been retained wherever they occur. • is always placed by Leonardo just above the line of writing and is never used as a full stop, but only to divide the words according to the sense; it very often occurs between every word, particularly in MSS. of about 1490. When a letter or number is placed between two points, as . a ., or . 3 ., it usually refers to a corresponding sign on a diagram or sketch.

| ||| commonly serve to separate sentences which are entirely distinct.

| . This mark commonly indicates that words written above or below the line are to be inserted. In the revised text they have been simply inserted.

In the notes these passages are distinguished by the following signs:--

« » indicates that the words were written above the line.



“ ” that the words were written below the line.

() This mark is used by Leonardo to mark off a digression, or parenthesis, or a quotation from some other work of his own; but it often takes the place of the colon:

(A simple bracket placed at the beginning of one or more lines serves to lay stress on particular sentences; it is also used to mark distinct sentences which have no connection with the rest of the text on the same page. In the printed text such sentences have been denoted by the mark ¶.

-- The last line of a section commonly ends with a horizontal line of variable length, making it of equal length with the preceding lines of writing.

12. 3, 4, 5. These figures, if written large, or some similar mark, are occasionally placed at the end of a page or at the beginning of a passage that has been crossed out; and this indicates that the continuation is to be sought for elsewhere, where the same sign is repeated.

The signs  , which occur in the passages on painting, have been added by some early copyist and have therefore not been reproduced in the notes.

13. , . : ; ! ? These stops are never used in the original MSS. It seemed necessary however to insert such marks in order to render the text intelligible. A full stop is only used at the end of a section to avoid confusion with Leonardo's own use of points (see No. 11), for he never places one at the end of a section or paragraph. Wherever a full stop seemed wanting in the course of the text I have put a semi colon () The colon (:) is used instead of a full stop where, in the original, a point (.) occurs.

14. [] Passages between brackets are crossed out in the original.

15. When a word or passage of the revised text is printed in small type it indicates that the reading is doubtful in consequence of partial obliteration.

16. indicates passages in which the original writing is entirely destroyed.

17. R indicates that the passage is written in red chalk.

18. (R) indicates that the original writing in red chalk has been written over in pen and ink.

19. P indicates that the original writing is in silverpoint.

20. 1^a 2^a 3^a &c. the front page--recto--of sheet 1, 2, 3, &c.

1^b 2^b 3^b &c. the back page--verso--of sheet 1, 2, 3, &c.

The MSS. Tr. and S. K. M. I² are the only ones in which the pages are numbered. In all other MSS. the leaf only is numbered. In referring to the Codex Atlanticus a double series of numbers has been used. The first apply only to the larger leaves of the Codex, on which two or more of the original leaves of the MS. have been mounted; the second series does not exist in the Codex itself; it refers to the original pages in the order in which they have been placed in it. By this second series of numbers the correspondence of the front and back pages has been verified. Wherever, in addition to the consecutive numbering, a different number occurs in Leonardo's writing it is quoted in a parenthesis, thus:--C 27^b (3^a), and this indicates that the back page of leaf 27 in the MS. C was originally numbered 3.

21. A Roman II, as 26 II^a 26 II^b, indicates that the same number (26) occurs twice. In the Codex Atlanticus $\frac{\text{I}}{\text{I}}$ is used for II.

22. O', O" indicates that the passages so marked are originally notes written on the inside of the cover of the MS.; O' within the front or upper cover, O" within the under cover.

23. The wood-cuts introduced into the text are facsimile-reproductions of Leonardo's own sketches and drawings which accompany the MSS. But the letters and numbers affixed to them have been inserted in ordinary writing.

Contrary to the universal custom of western nations, Leonardo committed almost all his notes to paper in a handwriting that goes from right to left. This singular habit has sometimes been accounted for by supposing that Leonardo felt it necessary to put every difficulty in the way of the publication of his works. This assumption, however, seems to me to rest on no solid grounds, and is but an hypothesis at best. Perfectly explicit statements prove, on the contrary, that Leonardo wished to publish his writings, and that he cared greatly that they should be known and read; and any one who has taken the trouble to make himself familiar with the Master's writing will, I think, hardly resist the conviction that even the character of the writing was expressly adapted to that view.

We know from the evidence of his friend Luca Paciolo that Leonardo drew with his left hand, and used it with perfect ease. In point of fact, in almost every drawing authentically known to be genuine--as those included in the texts of MSS. must be--wherever shading is introduced the strokes lie from left to right (downwards) as they would be drawn with the left hand.

The question as to why Leonardo drew and wrote with his left hand is now probably a vain one. There is nothing to justify us in deciding whether accidental circumstance or mere caprice was the cause. It is worthy of remark, that the earliest notes, written in his twenty-first year, when he could hardly have had such reasons for caution as are attributed to him, are written backwards.

The contents of Leonardo's MSS. sufficiently prove that he certainly intended them for publication, though the form is probably not always what he finally meant it to be.

The appeal or address 'tu', which frequently occurs and more particularly in theoretical passages, is often no doubt meant for the reader; but in other cases it indicates rather the specially meditative character of the passage. Abstract speculations acquire a particular charm from this soliloquizing form--it is as if we overheard the mental process of the author.

In the passages indicated below Leonardo expresses himself clearly as to the end and purpose of his literary labours.

In one passage in the MS. at Holkham (No. 1) he speaks of keeping a certain invention to himself, and not making it public. As he uses this reserve in no other instance, this exception sufficiently proves the rule.

In the passage from the MS. F (No. 2) the expression "mettere insieme" is equally characteristic of his method of working and of the condition of the MSS. By it he means the classification of the separate details of his researches so as to make a connected whole, which could be done the more easily since it was his practice to write separate chapters on separate sheets.

The MS. in the British Museum begins with an apology (No. 4) which is very interesting, for the self-evident disorder of the MS. This apology applies equally well to the notes on mathematics--where it is placed--and to all the branches of science on which Leonardo wrote.

The passages (Nos. 5-7) are soliloquies, and refer to the arrangement of different MSS. as preparatory to publication in the form intended by Leonardo himself. From all this it was clearly not his intention that the notes should be printed as they lay, in confusion, under his hand.

The schemes, which Leonardo himself proposed for the arrangement of the Book on Painting, as well as of his other writings, give us a clue--as we shall presently see--which enables us perfectly to construct the whole work on the basis of his own rules and with some pretention to logical sequence.

We may conclude that the sections 9, 10 and 11 headed 'Proemio' refer to the Book on Painting, and more particularly to the lessons on Perspective, because section 21 with its special title "Proemio di prospettiva" is, in the original (Cod. At. 117^b; 561^b), written on the same sheet.

Sections 12 to 20 give us the guiding idea of the general plan and of the object and purpose of the Libro di Pittura.

No. 21 'Proemio di prospettiva, cioè dell' ufizio dell' ochio' follows naturally after the other general introductions. Our acceptance of this introduction, it is true, wholly invalidates the arrangement of the materials which has been adopted by every editor of the old copies of the Trattato since DUFRESNE; but those, it must be remembered, contain only disconnected fragments of Leonardo's treatise on Perspective. His investigations in all the branches of optics do not, of course, come under consideration here. With regard to the physiology of the eye the reader will find, in Nos. 24, 28-39, passages which show that Leonardo understood the effect of the variation in the size of the pupil on the perception of objects. The insertion of these passages seemed indispensable because they form the basis of certain general principles of Perspective. The same may be said about his explanation of the difference between seeing with one eye and seeing with two (No. 25-29) as well as of his acute remarks as to the apparent variation in the size of objects according to the amount of light in which they are seen (No. 30-39).

1.

I. General Introduction to the Book on Painting

How by a certain machine many may stay some time under water. And how and wherefore I do not describe my method of remaining under water and how long I can remain without eating. And I do not publish nor divulge these, by reason of the evil nature of men, who would use them for assassinations at the bottom of the sea by destroying ships, and sinking them, together with the men in them. Nevertheless I will impart others, which are not dangerous because the mouth of the tube through which you breathe is above the water, supported on air sacks or cork.

2.

When you put together the science of the motions of water, remember to include under each proposition its application and use, in order that this science may not be useless.—

3.

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

4.

Begun at Florence, in the house of Piero di Braccio Martelli, on the 22nd day of March 1508. And this is to be a collection without order, taken from many papers which I have copied here, hoping to arrange them later each in its place, according to the subjects of which they may treat.

But I believe that before I am at the end of this [task] I shall have to repeat the same things several times; for which, O reader! do not blame me, for the subjects are many and memory cannot retain them [all] and say: 'I will not write this because I wrote it before.' And if I wished to avoid falling into this fault, it would be necessary in every case when I wanted to copy [a passage] that, not to repeat myself, I should read over all that had gone before; and all the more since the intervals are long between one time of writing and the next.

2. *addi 22 di marzo 1508*. The Christian era was computed in Florence at that time from the Incarnation (Lady day, March 25th). Hence this should be 1509 by our reckoning.

3. *racolto tratto di molte carte le quali io ho qui copiate*. We must suppose that Leonardo means that he has copied out his own MSS. and not those of others. The first thirteen leaves of the MS. in the Brit. Mus. are a fair copy of some notes on physics.

5.

Of digging a canal. Put this in the Book of useful inventions and in proving them bring forward the propositions already proved. And this is the proper order; since if you wished to show the usefulness of any plan you would be obliged again to devise new machines to prove its utility and thus would confuse the order of the forty Books and also the order of the diagrams; that is to say you would have to mix up practice with theory, which would produce a confused and incoherent work.

6.

I am not to blame for putting forward, in the course of my work on science, any general rule derived from a previous conclusion.

7.

The Book of the science of Mechanics must precede the Book of useful inventions.--Have your books on anatomy bound!

8.

The order of your book must proceed on this plan: first simple beams, then (those) supported from below, then suspended in part, then wholly [suspended]. Then beams as supporting other weights.

9.

INTRODUCTION.

Seeing that I can find no subject specially useful or pleasing--since the men who have come before me have taken for their own every useful or necessary theme--I must do like one who, being poor, comes last to the fair, and can find no other way of providing himself than by taking all the things already seen by other buyers, and not taken but refused by reason of their lesser value. I, then, will load my humble pack with this despised and rejected merchandise, the refuse of so many buyers; and will go about to distribute it, not indeed in great cities, but in the poorer towns, taking such a price as the wares I offer may be worth.

10.

INTRODUCTION.

I know that many will call this useless work; and they will be those of whom Demetrius declared that he took no more account of the wind that came out their mouth in words, than of that they expelled from their lower parts: men who desire nothing but material riches and are absolutely devoid of that of wisdom, which is the food and the only true riches of the mind. For so much more worthy as the soul is than the body, so much more noble are the possessions of the soul than those of the body. And often, when I see one of these men take this work in his hand, I wonder that he does not put it to his nose, like a monkey, or ask me if it is something good to eat.

INTRODUCTION.

I am fully conscious that, not being a literary man, certain presumptuous persons will think that they may reasonably blame me; alleging that I am not a man of letters. Foolish folks! do they not know that I might retort as Marius did to the Roman Patricians by saying: That they, who deck themselves out in the labours of others will not allow me my own. They will say that I, having no literary skill, cannot properly express that which I desire to treat of; but they do not know that my subjects are to be dealt with by experience rather than by words; and [experience] has been the mistress of those who wrote well. And so, as mistress, I will cite her in all cases.

11.

Though I may not, like them, be able to quote other authors, I shall rely on that which is much greater and more worthy:--on experience, the mistress of their Masters. They go about puffed up and pompous, dressed and decorated with [the fruits], not of their own labours, but of those of others. And they will not allow me my own. They will scorn me as an inventor; but how much more might they--who are not inventors but vaunters and declaimers of the works of others--be blamed.

INTRODUCTION.

And those men who are inventors and interpreters between Nature and Man, as compared with boasters and declaimers of the works of others, must be regarded and not otherwise esteemed than as the object in front of a mirror, when compared with its image seen in the mirror. For the first is something in itself, and the other nothingness.--Folks little indebted to Nature, since it is only by chance that they wear the human form and without it I might class them with the herds of beasts.

12.

Many will think they may reasonably blame me by alleging that my proofs are opposed to the authority of certain men held in the highest reverence by their inexperienced judgments; not considering that my works are the issue of pure and simple experience, who is the one true mistress. These rules are sufficient to enable you to know the true from the false--and this aids men to look only for things that are possible and with due moderation--and not to wrap yourself in ignorance, a thing which can have no good result, so that in despair you would give yourself up to melancholy.

13.

Among all the studies of natural causes and reasons Light chiefly delights the beholder; and among the great features of Mathematics the certainty of its demonstrations is what preeminently (tends to) elevate the mind of the investigator. Perspective, therefore, must be preferred to all the discourses and systems of human learning. In this branch [of science] the beam of light is explained on those methods of demonstration which form the glory not so much of Mathematics as of Physics and are graced with the flowers of both. But its axioms being laid down at great length,

I shall abridge them to a conclusive brevity, arranging them on the method both of their natural order and of mathematical demonstration; sometimes by deduction of the effects from the causes, and sometimes arguing the causes from the effects; adding also to my own conclusions some which, though not included in them, may nevertheless be inferred from them. Thus, if the Lord--who is the light of all things--vouchsafe to enlighten me, I will treat of Light; wherefore I will divide the present work into 3 Parts.

**14.
ON THE THREE BRANCHES OF PERSPECTIVE.**

There are three branches of perspective; the first deals with the reasons of the (apparent) diminution of objects as they recede from the eye, and is known as Diminishing Perspective.--The second contains the way in which colours vary as they recede from the eye. The third and last is concerned with the explanation of how the objects [in a picture] ought to be less finished in proportion as they are remote (and the names are as follows):

Linear Perspective.
The Perspective of Colour.
The Perspective of Disappearance.

**15.
ON PAINTING AND PERSPECTIVE.**

The divisions of Perspective are 3, as used in drawing; of these, the first includes the diminution in size of opaque objects; the second treats of the diminution and loss of outline in such opaque objects; the third, of the diminution and loss of colour at long distances.

**16.
THE DISCOURSE ON PAINTING.**

Perspective, as bearing on drawing, is divided into three principal sections; of which the first treats of the diminution in the size of bodies at different distances. The second part is that which treats of the diminution in colour in these objects. The third [deals with] the diminished distinctness of the forms and outlines displayed by the objects at various distances.

**17.
ON THE SECTIONS OF [THE BOOK ON] PAINTING.**

The first thing in painting is that the objects it represents should appear in relief, and that the grounds surrounding them at different distances shall appear within the vertical plane of the foreground of the picture by means of the 3 branches of Perspective, which are: the diminution in the distinctness of the forms of the objects, the diminution in their magnitude; and the diminution in their colour. And of these 3 classes of Perspective the first results from [the structure of] the eye, while the other two are caused by the atmosphere which intervenes between the eye and the objects seen by it. The second essential in painting is appropriate action and a due variety in the figures, so that the men may not all look like brothers, &c.

Translator's Footnotes

This and the two foregoing chapters must have been written in 1513 to 1516. They undoubtedly indicate the scheme which Leonardo wished to carry out in arranging his researches on Perspective as applied to Painting. This is important

because it is an evidence against the supposition of H. LUDWIG and others, that Leonardo had collected his principles of Perspective in one book so early as before 1500; a Book which, according to the hypothesis, must have been lost at a very early period, or destroyed possibly, by the French (!) in 1500 (see H. LUDWIG. L. da Vinci: *Das Buch van der Malerei*. Vienna 1882 III, 7 and 8).

18.

These rules are of use only in correcting the figures; since every man makes some mistakes in his first compositions and he who knows them not, cannot amend them. But you, knowing your errors, will correct your works and where you find mistakes amend them, and remember never to fall into them again. But if you try to apply these rules in composition you will never make an end, and will produce confusion in your works.

These rules will enable you to have a free and sound judgment; since good judgment is born of clear understanding, and a clear understanding comes of reasons derived from sound rules, and sound rules are the issue of sound experience--the common mother of all the sciences and arts. Hence, bearing in mind the precepts of my rules, you will be able, merely by your amended judgment, to criticize and recognize every thing that is out of proportion in a work, whether in the perspective or in the figures or any thing else.

19.

OF THE MISTAKES MADE BY THOSE WHO PRACTISE WITHOUT KNOWLEDGE.

Those who are in love with practice without knowledge are like the sailor who gets into a ship without rudder or compass and who never can be certain whether he is going. Practice must always be founded on sound theory, and to this Perspective is the guide and the gateway; and without this nothing can be done well in the matter of drawing.

20.

The painter who draws merely by practice and by eye, without any reason, is like a mirror which copies every thing placed in front of it without being conscious of their existence.

21.

INTRODUCTION TO PERSPECTIVE:--THAT IS OF THE FUNCTION OF THE EYE.

Behold here O reader! a thing concerning which we cannot trust our forefathers, 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 ages unknown or falsely understood. The eye, whose function we so certainly know by experience, has, down to my own time, been defined by an infinite number of authors as one thing; but I find, by experience, that it is quite another.

22.

Here [in the eye] forms, here colours, here the character of every part of the universe are concentrated to a point; and that point is so marvelous a thing ... Oh! marvelous, O stupendous Necessity--by thy laws thou dost compel every effect to be the direct result of its cause, by the shortest path. These [indeed] are miracles;...

In so small a space it can be reproduced and rearranged in its whole expanse. Describe in your anatomy what proportion there is between the diameters of all the images in the eye and the distance from them of the crystalline lens.

23.

OF THE 10 ATTRIBUTES OF THE EYE, ALL CONCERNED IN PAINTING.

Painting is concerned with all the 10 attributes of sight; which are:--Darkness, Light, Solidity and Colour, Form and Position, Distance and Propinquity, Motion and Rest. This little work of mine will be a tissue [of the studies] of these attributes, reminding the painter of the rules and methods by which he should use his art to imitate all the works of Nature which adorn the world.

24.

ON PAINTING.

1st. The pupil of the eye contracts, in proportion to the increase of light which is reflected in it. 2nd. The pupil of the eye expands in proportion to the diminution in the day light, or any other light, that is reflected in it. 3rd. The eye perceives and recognizes the objects of its vision with greater intensity in proportion as the pupil is more widely dilated; and this can be proved by the case of nocturnal animals, such as cats, and certain birds--as the owl and others--in which the pupil varies in a high degree from large to small, &c, when in the dark or in the light. 4th. The eye [out of doors] in an illuminated atmosphere sees darkness behind the windows of houses which [nevertheless] are light. 5th. All colours when placed in the shade appear of an equal degree of darkness, among themselves. 6th. But all colours when placed in a full light, never vary from their true and essential hue.

25.

OF THE EYE.

If the eye is required to look at an object placed too near to it, it cannot judge of it well--as happens to a man who tries to see the tip of his nose. Hence, as a general rule, Nature teaches us that an object can never be seen perfectly unless the space between it and the eye is equal, at least, to the length of the face.

26.

OF THE EYE.

When both eyes direct the pyramid of sight to an object, that object becomes clearly seen and comprehended by the eyes.

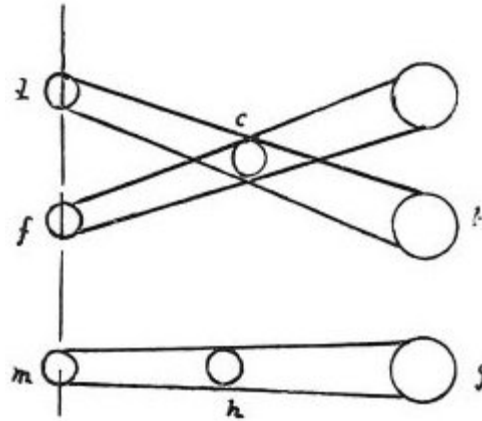
27.

Objects seen by one and the same eye appear sometimes large, and sometimes small.

28.

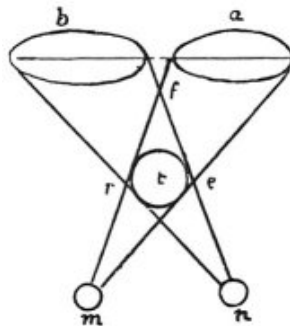
The motion of a spectator who sees an object at rest often makes it seem as though the object at rest had acquired the motion of the moving body, while the moving person appears to be at rest.

ON PAINTING.



Objects in relief, when seen from a short distance with one eye, look like a perfect picture. If you look with the eye a, b at the spot c , this point c will appear to be at d, f , and if you look at it with the eye g, h will appear to be at m . A picture can never contain in itself both aspects.

29.



Let the object in relief t be seen by both eyes; if you will look at the object with the right eye m , keeping the left eye n shut, the object will appear, or fill up the space, at a ; and if you shut the right eye and open the left, the object (will occupy the) space b ; and if you open both eyes, the object will no longer appear at a or b , but at e, r, f . Why will not a picture seen by both eyes produce the effect of relief, as [real] relief does when seen by both eyes; and why should a picture seen with one eye give the same effect of relief as real relief would under the same conditions of light and shade?

Translator's Footnotes

In the sketch, m is the left eye and n the right, while the text reverses this lettering. We must therefore suppose that the face in which the eyes m and n are placed is opposite to the spectator.

30.

The eye will hold and retain in itself the image of a luminous body better than that of a shaded object. The reason is that the eye is in itself perfectly dark and since two things that are alike cannot be distinguished, therefore the night, and other dark objects cannot be seen or recognized by the eye. Light is totally contrary and gives more distinctness, and counteracts and differs from the usual darkness of the eye, hence it leaves the impression of its image.

31.

Every object we see will appear larger at midnight than at midday, and larger in the morning than at midday.

This happens because the pupil of the eye is much smaller at midday than at any other time.

32.

The pupil which is largest will see objects the largest. This is evident when we look at luminous bodies, and particularly at those in the sky. When the eye comes out of darkness and suddenly looks up at these bodies, they at first appear larger and then diminish; and if you were to look at those bodies through a small opening, you would see them smaller still, because a smaller part of the pupil would exercise its function.

33.

When the eye, coming out of darkness suddenly sees a luminous body, it will appear much larger at first sight than after long looking at it. The illuminated object will look larger and more brilliant, when seen with two eyes than with only one. A luminous object will appear smaller in size, when the eye sees it through a smaller opening. A luminous body of an oval form will appear rounder in proportion as it is farther from the eye.

34.

Why when the eye has just seen the light, does the half light look dark to it, and in the same way if it turns from the darkness the half light look very bright?

35.

ON PAINTING.

If the eye, when [out of doors] in the luminous atmosphere, sees a place in shadow, this will look very much darker than it really is. This happens only because the eye when out in the air contracts the pupil in proportion as the atmosphere reflected in it is more luminous. And the more the pupil contracts, the less luminous do the objects appear that it sees. But as soon as the eye enters into a shady place the darkness of the shadow suddenly seems to diminish. This occurs because the greater the darkness into which the pupil goes the more its size increases, and this increase makes the darkness seem less.

36.

ON PERSPECTIVE.

The eye which turns from a white object in the light of the sun and goes into a less fully lighted place will see everything as dark. And this happens either because the pupils of the eyes which have rested on this brilliantly lighted white object have contracted so much that, given at first a certain extent of surface, they will have lost more than 3/4 of their size; and, lacking in size, they are also deficient in [seeing] power. Though you might say to me: A little bird (then) coming down would see comparatively little, and from the smallness of his pupils the white might seem black! To this I should reply that here we must have regard to the proportion of the mass of that portion of the brain which is given up to the sense of sight and to nothing else. Or--to return--this pupil in Man dilates and contracts according to the brightness or darkness of (surrounding) objects; and since it takes some time to dilate and contract, it cannot see immediately on going out of the light and into the shade, nor, in the same way, out of the shade into the light, and this very thing has already deceived me in painting an eye, and from that I learnt it.

have borrowed the broad lines of his theory from some views commonly accepted among painters at the time; but he certainly worked out its application in a perfectly original manner.

The axioms as to the perception of the pyramid of rays are followed by explanations of its origin, and proofs of its universal application (58--69). The author recurs to the subject with endless variations; it is evidently of fundamental importance in his artistic theory and practice. It is unnecessary to discuss how far this theory has any scientific value at the present day; so much as this, at any rate, seems certain: that from the artist's point of view it may still claim to be of immense practical utility.

According to Leonardo, on one hand, the laws of perspective are an inalienable condition of the existence of objects in space; on the other hand, by a natural law, the eye, whatever it sees and wherever it turns, is subjected to the perception of the pyramid of rays in the form of a minute target. Thus it sees objects in perspective independently of the will of the spectator, since the eye receives the images by means of the pyramid of rays "just as a magnet attracts iron".

In connection with this we have the function of the eye explained by the Camera obscura, and this is all the more interesting and important because no writer previous to Leonardo had treated of this subject (70--73). Subsequent passages, of no less special interest, betray his knowledge of refraction and of the inversion of the image in the camera and in the eye (74--82).

From the principle of the transmission of the image to the eye and to the camera obscura he deduces the means of producing an artificial construction of the pyramid of rays or--which is the same thing--of the image. The fundamental axioms as to the angle of sight and the vanishing point are thus presented in a manner which is as complete as it is simple and intelligible (86--89).

Leonardo distinguishes between simple and complex perspective (90, 91). The last sections treat of the apparent size of objects at various distances and of the way to estimate it (92--109).

**40.
ON PAINTING.**

Perspective is the best guide to the art of Painting.

41.
The art of perspective is of such a nature as to make what is flat appear in relief and what is in relief flat.

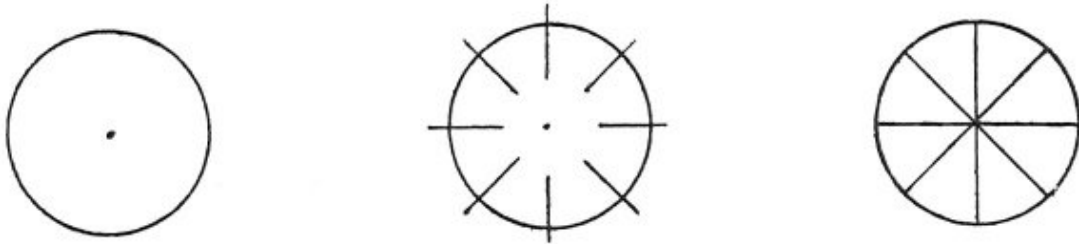
42.
All the problems of perspective are made clear by the five terms of mathematicians, which are:-- the point, the line, the angle, the superficies and the solid. The point is unique of its kind. And the point has neither height, breadth, length, nor depth, whence it is to be regarded as indivisible and as having no dimensions in space. The line is of three kinds, straight, curved and sinuous and it has neither breadth, height, nor depth. Hence it is indivisible, excepting in its length, and its ends are two points. The angle is the junction of two lines in a point.

43.
A point is not part of a line.

**44.
OF THE NATURAL POINT.**

The smallest natural point is larger than all mathematical points, and this is proved because the natural point has continuity, and any thing that is continuous is infinitely divisible; but the mathematical point is indivisible because it has no size.

45.
1, The superficies is a limitation of the body. 2, and the limitation of a body is no part of that body. 4, and the limitation of one body is that which begins another. 3, that which is not part of any body is nothing. Nothing is that which fills no space.



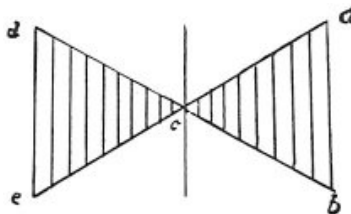
If one single point placed in a circle may be the starting point of an infinite number of lines, and the termination of an infinite number of lines, there must be an infinite number of points separable from this point, and these when reunited become one again; whence it follows that the part may be equal to the whole.

46.
The point, being indivisible, occupies no space. That which occupies no space is nothing. The limiting surface of one thing is the beginning of another. 2. That which is no part of any body is called nothing. 1. That which has no limitations, has no form. The limitations of two conterminous bodies are interchangeably the surface of each. All the surfaces of a body are not parts of that body.

**47.
DEFINITION OF THE NATURE OF THE LINE.**

The line has in itself neither matter nor substance and may rather be called an imaginary idea than a real object; and this being its nature it occupies no space. Therefore an infinite number of lines may be conceived of as intersecting each other at a point, which has no dimensions and is only of the thickness (if thickness it may be called) of one single line.

HOW WE MAY CONCLUDE THAT A SUPERFICIES TERMINATES IN A POINT?



An angular surface is reduced to a point where it terminates in an angle. Or, if the sides of that angle are produced in a straight line, then--beyond that angle--another surface is generated, smaller, or equal to, or larger than the first.

48.

OF DRAWING OUTLINE.

Consider with the greatest care the form of the outlines of every object, and the character of their undulations. And these undulations must be separately studied, as to whether the curves are composed of arched convexities or angular concavities.

49.

The boundaries of bodies are the least of all things. The proposition is proved to be true, because the boundary of a thing is a surface, which is not part of the body contained within that surface; nor is it part of the air surrounding that body, but is the medium interposted between the air and the body, as is proved in its place. But the lateral boundaries of these bodies is the line forming the boundary of the surface, which line is of invisible thickness. Wherefore O painter! do not surround your bodies with lines, and above all when representing objects smaller than nature; for not only will their external outlines become indistinct, but their parts will be invisible from distance.

50.

[Drawing is based upon perspective, which is nothing else than a thorough knowledge of the function of the eye. And this function simply consists in receiving in a pyramid the forms and colours of all the objects placed before it. I say in a pyramid, because there is no object so small that it will not be larger than the spot where these pyramids are received into the eye. Therefore, if you extend the lines from the edges of each body as they converge you will bring them to a single point, and necessarily the said lines must form a pyramid.]

[Perspective is nothing more than a rational demonstration applied to the consideration of how objects in front of the eye transmit their image to it, by means of a pyramid of lines. The *Pyramid* is the name I apply to the lines which, starting from the surface and edges of each object, converge from a distance and meet in a single point.]

[Perspective is a rational demonstration, by which we may practically and clearly understand how objects transmit their own image, by lines forming a Pyramid (centered) in the eye.]

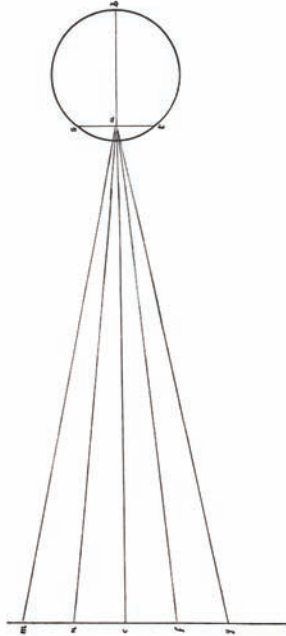
Perspective is a rational demonstration by which experience confirms that every object sends its image to the eye by a pyramid of lines; and bodies of equal size will result in a pyramid of larger or smaller size, according to the difference in their distance, one from the other. By a pyramid of lines I mean those which start from the surface and edges of bodies, and, converging from a distance meet in a single point. A point is said to be that which [having no dimensions] cannot be divided, and this point placed in the eye receives all the points of the cone.

51.

IN WHAT WAY THE EYE SEES OBJECTS PLACED IN FRONT OF IT.

The perception of the object depends on the direction of the eye.

Supposing that the ball figured above is the ball of the eye and let the small portion of the ball which is cut off by the line $s t$

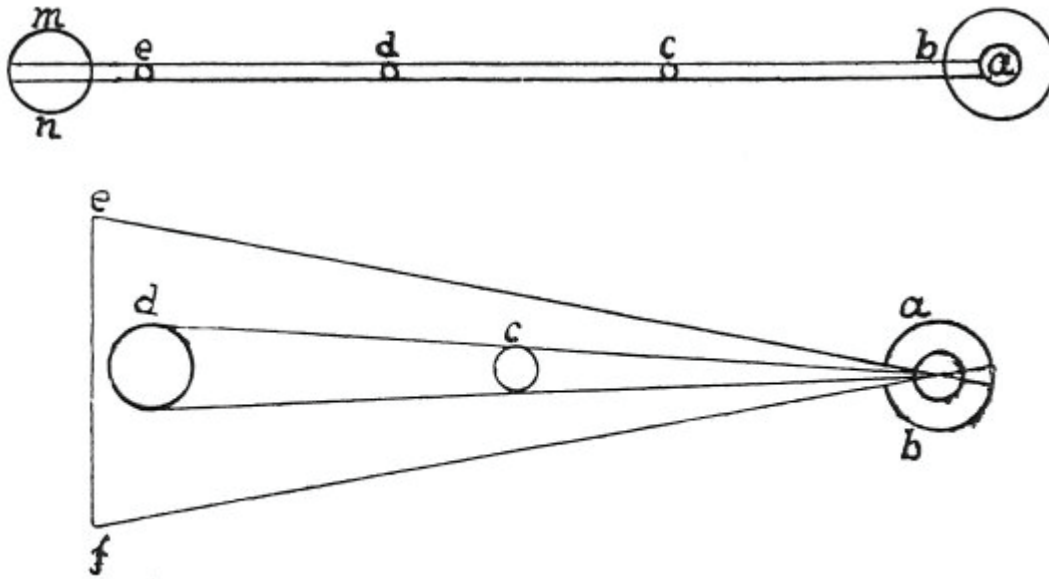


be the pupil and all the objects mirrored on the centre of the face of the eye, by means of the pupil, pass on at once and enter the pupil, passing through the crystalline humour, which does not interfere in the pupil with the things seen by means of the light. And the pupil having received the objects, by means of the light, immediately refers them and transmits them to the intellect by the line *a b*. And you must know that the pupil transmits nothing perfectly to the intellect or common sense excepting when the objects presented to it by means of light, reach it by the line *a b*; as, for instance, by the line *b c*. For although the lines *m n* and *f g* may be seen by the pupil they are not perfectly taken in, because they do not coincide with the line *a b*. And the proof is this: If the eye, shown above, wants to count the letters placed in front, the eye will be obliged to turn from letter to letter, because it cannot discern them unless they lie in the line *a b*; as, for instance, in the line *a c*. All visible objects reach the eye by the lines of a pyramid, and the point of the pyramid is the apex and centre of it, in the centre of the pupil, as figured above.

52.

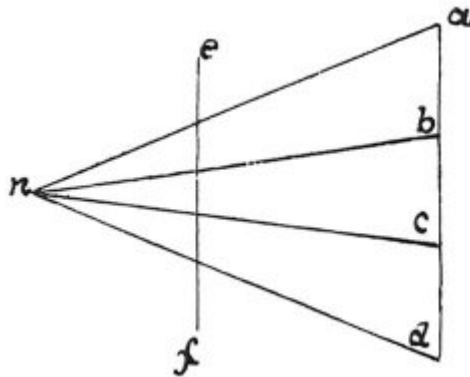
Perspective is a rational demonstration, confirmed by experience, that all objects transmit their image to the eye by a pyramid of lines.

By a pyramid of lines I understand those lines which start from the edges of the surface of bodies, and converging from a distance, meet in a single point; and this point, in the present instance, I will show to be situated in the eye which is the universal judge of all objects. By a point I mean that which cannot be divided into parts; therefore this point, which is situated in the eye, being indivisible, no body is seen by the eye, that is not larger than this point. This being the case it is inevitable that the lines which come from the object to the point must form a pyramid. And if any man seeks to prove that the sense of sight does not reside in this point, but rather in the black spot which is visible in the middle of the pupil, I might reply to him that a small object could never diminish at any distance, as it might be a grain of millet or of oats or of some similar thing, and that object, if it were larger than the said [black] spot would never be seen as a whole; as may be seen in the diagram below. Let *a*.



be the seat of sight, $b e$ the lines which reach the eye. Let $e d$ be the grains of millet within these lines. You plainly see that these will never diminish by distance, and that the body $m n$ could not be entirely covered by it. Therefore you must confess that the eye contains within itself one single indivisible point a , to which all the points converge of the pyramid of lines starting from an object, as is shown below. Let $a . b$. be the eye; in the centre of it is the point above mentioned. If the line $e f$ is to enter as an image into so small an opening in the eye, you must confess that the smaller object cannot enter into what is smaller than itself unless it is diminished, and by diminishing it must take the form of a pyramid.

53.
PERSPECTIVE.



Perspective comes in where judgment fails [as to the distance] in objects which diminish. The eye can never be a true judge for determining with exactitude how near one object is to another which is equal to it [in size], if the top of that other is on the level of the eye which sees them on that side, excepting by means of the vertical plane which is the standard and guide of perspective. Let n be the eye, $e f$ the vertical plane above mentioned. Let $a b c d$ be the three divisions, one below the other; if the lines $a n$ and $c n$ are of a given length and the eye n is in the centre, then $a b$ will look as large as $b c$. $c d$ is lower and farther off from n , therefore it will look smaller. And the

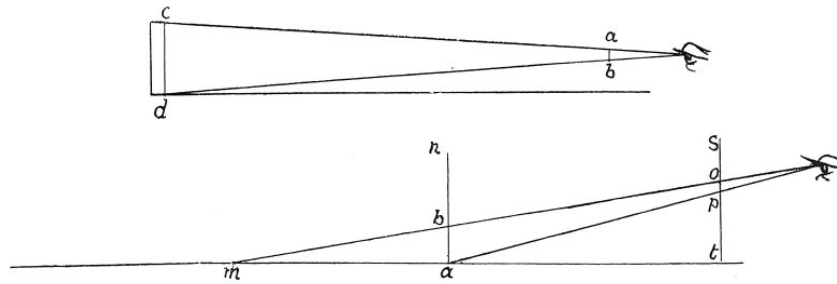
same effect will appear in the three divisions of a face when the eye of the painter who is drawing it is on a level with the eye of the person he is painting.

**54.
TO PROVE HOW OBJECTS REACH THE EYE.**

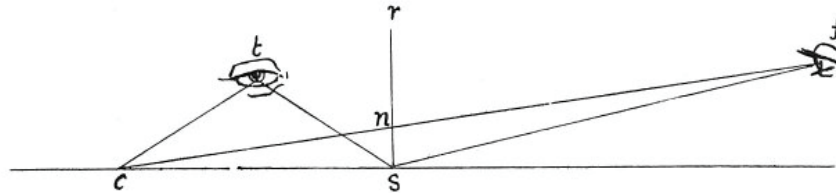
If you look at the sun or some other luminous body and then shut your eyes you will see it again inside your eye for a long time. This is evidence that images enter into the eye.

**55.
ELEMENTS OF PERSPECTIVE.**

All objects transmit their image to the eye in pyramids, and the nearer to the eye these pyramids are intersected the smaller



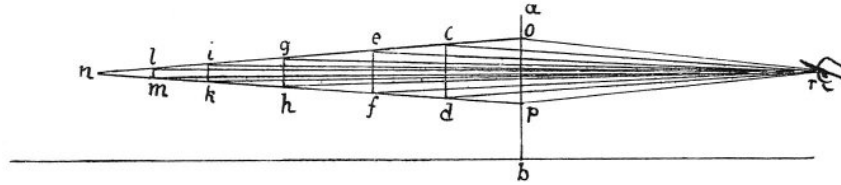
will the image appear of the objects which cause them. Therefore, you may intersect the pyramid with a vertical plane which reaches the base of the pyramid as is shown in the plane $a n$.



The eye f and the eye t are one and the same thing; but the eye f marks the distance, that is to say how far you are standing from the object; and the eye t shows you the direction of it; that is whether you are opposite, or on one side, or at an angle to the object you are looking at. And remember that the eye f and the eye t must always be kept on the same level. For example if you raise or lower the eye from the distance point f you must do the same with the direction point t . And if the point f shows how far the eye is distant from the square plane but does not show on which side it is placed--and, in the same way, the point t show s the direction and not the distance, in order to ascertain both you must use both points and they will be one and the same thing. If the eye f could see a perfect square of which all the sides were equal to the distance between s and c , and if at the nearest end of the side towards the eye a pole were placed, or some other straight object, set up by a perpendicular line as shown at $r s$ --then, I say, that if you were to look at the side of the square that is nearest to you it will appear at the bottom of the vertical plane $r s$, and then look at the farther side and it would appear to you at the height of the point n on the vertical plane. Thus, by this example, you can understand that if the eye is above a number of objects

all placed on the same level, one beyond another, the more remote they are the higher they will seem, up to the level of the eye, but no higher; because objects placed upon the level on which your feet stand, so long as it is flat--even if it be extended into infinity--would never be seen above the eye; since the eye has in itself the point towards which all the cones tend and converge which convey the images of the objects to the eye. And this point always coincides with the point of diminution which is the extreme of all we can see. And from the base line of the first pyramid as far as the diminishing point

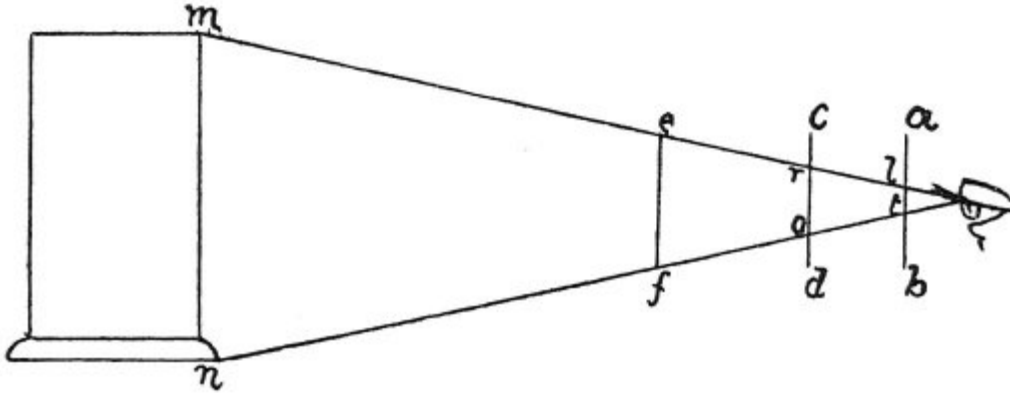
56.



there are only bases without pyramids which constantly diminish up to this point. And from the first base where the vertical plane is placed towards the point in the eye there will be only pyramids without bases; as shown in the example given above. Now, let ab be the said vertical plane and r the point of the pyramid terminating in the eye, and n the point of diminution which is always in a straight line opposite the eye and always moves as the eye moves--just as when a rod is moved its shadow moves, and moves with it, precisely as the shadow moves with a body. And each point is the apex of a pyramid, all having a common base with the intervening vertical plane. But although their bases are equal their angles are not equal, because the diminishing point is the termination of a smaller angle than that of the eye. If you ask me: "By what practical experience can you show me these points?" I reply--so far as concerns the diminishing point which moves with you --when you walk by a ploughed field look at the straight furrows which come down with their ends to the path where you are walking, and you will see that each pair of furrows will look as though they tried to get nearer and meet at the [farther] end.

57.

As regards the point in the eye; it is made more intelligible by this: If you look into the eye of another person you will see your own image. Now imagine 2 lines starting from your ears and going to the ears of that image which you see in the other man's eye; you will understand that these lines converge in such a way that they would meet in a point a little way beyond your own image mirrored in the eye. And if you want to measure the diminution of the pyramid in the air which occupies the space between the object seen and the eye, you must do it according to the diagram figured below. Let mn be a tower, and efa , a rod, which you must move backwards and forwards till its ends correspond with those of the tower; then bring it nearer to the eye, at cd and you will see that the image of the tower seems smaller, as at ro . Then [again] bring it closer to the eye and you will see the rod project far beyond the image of the tower



from *a* to *b* and from *t* to *b*, and so you will discern that, a little farther within, the lines must converge in a point.

58.
PERSPECTIVE.

The instant the atmosphere is illuminated it will be filled with an infinite number of images which are produced by the various bodies and colours assembled in it. And the eye is the target, a loadstone, of these images.

59.
The whole surface of opaque bodies displays its whole image in all the illuminated atmosphere which surrounds them on all sides.

60.
That the atmosphere attracts to itself, like a loadstone, all the images of the objects that exist in it, and not their forms merely but their nature may be clearly seen by the sun, which is a hot and luminous body. All the atmosphere, which is the all-pervading matter, absorbs light and heat, and reflects in itself the image of the source of that heat and splendour and, in each minutest portion, does the same. The Northpole does the same as the loadstone shows; and the moon and the other planets, without suffering any diminution, do the same. Among terrestrial things musk does the same and other perfumes.

61.
All bodies together, and each by itself, give off to the surrounding air an infinite number of images which are all-pervading and each complete, each conveying the nature, colour and form of the body which produces it.

It can clearly be shown that all bodies are, by their images, all-pervading in the surrounding atmosphere, and each complete in itself as to substance form and colour; this is seen by the images of the various bodies which are reproduced in one single perforation through which they transmit the objects by lines which intersect and cause reversed pyramids, from the objects, so that they are upside down on the dark plane where they are first reflected. The reason of this is--

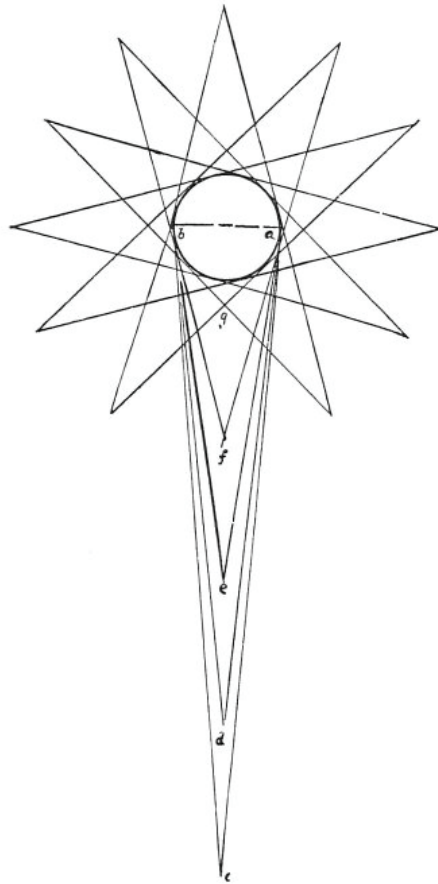
Translator's Footnotes

The text breaks off at line 8. The paragraph No.40 follows here in the original MS.

62.

Every point is the termination of an infinite number of lines, which diverge to form a base, and immediately, from the base the same lines converge to a pyramid [imaging] both the colour and form. No sooner is a form created or compounded than suddenly infinite lines and angles are produced from it; and these lines, distributing themselves and intersecting each other in the air, give rise to an infinite number of angles opposite to each other. Given a base, each opposite angle, will form a triangle having a form and proportion equal to the larger angle; and if the base goes twice into each of the 2 lines of the pyramid the smaller triangle will do the same.

63.



Every body in light and shade fills the surrounding air with infinite images of itself; and these, by infinite pyramids diffused in the air, represent this body throughout space and on every side. Each pyramid that is composed of a long assemblage of rays includes within itself an infinite number of pyramids and each has the same power as all, and all as each. A circle of equidistant pyramids of vision will give to their object angles of equal size; and an eye at each point will see the object of the same size. The body of the atmosphere is full of infinite pyramids composed of radiating straight lines, which are produced from the surface of the bodies in light and shade, existing in the air; and the farther they are from the object which produces them the more acute they become and although in their distribution they intersect and cross they never mingle together, but pass through

all the surrounding air, independently converging, spreading, and diffused. And they are all of equal power [and value]; all equal to each, and each equal to all. By these the images of objects are transmitted through all space and in every direction, and each pyramid, in itself, includes, in each minutest part, the whole form of the body causing it.

64.

The body of the atmosphere is full of infinite radiating pyramids produced by the objects existing in it. These intersect and cross each other with independent convergence without interfering with each other and pass through all the surrounding atmosphere; and are of equal force and value--all being equal to each, each to all. And by means of these, images of the body are transmitted everywhere and on all sides, and each receives in itself every minutest portion of the object that produces it.

Proof by experiment (65-66).

65.

PERSPECTIVE.

The air is filled with endless images of the objects distributed in it; and all are represented in all, and all in one, and all in each, whence it happens that if two mirrors are placed in such a manner as to face each other exactly, the first will be reflected in the second and the second in the first. The first being reflected in the second takes to it the image of itself with all the images represented in it, among which is the image of the second mirror, and so, image within image, they go on to infinity in such a manner as that each mirror has within it a mirror, each smaller than the last and one inside the other. Thus, by this example, it is clearly proved that every object sends its image to every spot whence the object itself can be seen; and the converse: That the same object may receive in itself all the images of the objects that are in front of it. Hence the eye transmits through the atmosphere its own image to all the objects that are in front of it and receives them into itself, that is to say on its surface, whence they are taken in by the common sense, which considers them and if they are pleasing commits them to the memory. Whence I am of opinion: That the invisible images in the eyes are produced towards the object, as the image of the object to the eye. That the images of the objects must be disseminated through the air. An instance may be seen in several mirrors placed in a circle, which will reflect each other endlessly. When one has reached the other it is returned to the object that produced it, and thence--being diminished--it is returned again to the object and then comes back once more, and this happens endlessly. If you put a light between two flat mirrors with a distance of 1 braccio between them you will see in each of them an infinite number of lights, one smaller than another, to the last. If at night you put a light between the walls of a room, all the parts of that wall will be tinted with the image of that light. And they will receive the light and the light will fall on them, mutually, that is to say, when there is no obstacle to interrupt the transmission of the images. This same example is seen in a greater degree in the distribution of the solar rays which all together, and each by itself, convey to the object the image of the body which causes it. That each body by itself alone fills with its images the atmosphere around it, and that the same air is able, at the same time, to receive the images of the endless other objects which are in it, this is clearly proved by these examples. And every object is everywhere visible in the whole of the atmosphere, and the whole in every smallest part of it; and all the objects in the whole, and all in each smallest part; each in all and all in every part.