

Abstraction from Matter

NOTES ON ST. THOMAS'S PROLOGUE TO THE *PHYSICS* *

In the prologue¹ to his exposition of Aristotle's *Physics*, St. Thomas shows [i] what is the mode of definition that is proper to the science of nature, [ii] what the science is about, and, finally, [iii] what is the order of its parts. The first paragraph might be translated as follows :

Since the treatise called the *Physics*, which it is our purpose to explain, is also the one that comes first in the study of nature, we must show, at its very beginning, what natural science is about — viz. its matter and subject. To this end, we should point out, on the one hand, that inasmuch as every science is in the intellect, and since a thing becomes intelligible in act insofar as it is more or less abstracted from matter, things, according as they are diversely related to matter, are the concern of different sciences. Again, since science is obtained by demonstration, and the middle term of demonstration is the definition, it follows, of necessity, that the sciences will be distinguished according to a difference in their mode of definition.

In the very first sentence of the paragraph just quoted, several terms are used whose meanings differ widely from the current ones. Our present intention is confined to showing, as best we can, what they meant to the author of the *Physics* as well as to the commentator, and why they said what they did in using those words — whatever the truth of what they held in using them. There can of course be no question of taking up the problem of what scientific knowledge is, as if we were presenting an exposition of the *Posterior Analytics*. We intend to have recourse to that treatise only to the extent required for the clarification of the above text.

* These pages, which are based on a course of lectures (given at the University of Notre Dame, 1957), aim to provide a general introduction to a philosophy of nature ancient by more than two thousand years. It is hoped that even readers whose interest in the subject is only historical, or who seek to show where the Philosopher was wrong in his general conception of science and of the study of nature, will find these notes of value. Although the reader will not long remain in doubt as to the persuasion of the author himself, still it is the latter's purpose merely to set forth what Aristotle had in mind as St. Thomas understood it. A growing interest in the subject may now be seen, not so much among professional philosophers, who often prefer to soar off on wings by no means fully fledged, into the realms of metaphysics, but among scientists (especially in Germany) who are coming to see that their own knowledge, in its inception as well as in its further development, forms in fact part of the philosophy of nature, and that this truth is an important one for the progress of their understanding of what they achieve.

1. In the Leonine edition of *In Octo Libros Physicorum Aristotelis Expositio*, nn.1 to 4 inclusive, lectio 1. Notes on the second paragraph of this prologue, in which the sciences are distinguished according to their different modes of definition, and named, will appear in the next issue of this review.

I. WHAT IS GENERALLY MEANT BY THE NAME 'SCIENCE'
IN THE PRESENT CONTEXT

1. *Not every kind of knowledge is called science*

Because the word science is frequently used to signify widely different kinds of knowledge, and since St. Thomas, in this context, has in mind a definite kind, we must first point out what this is. The expression 'natural science,' as generally understood today, refers to a type of knowledge that differs, nearly beyond recognition, from the kind of knowledge intended by 'natural science' in this paragraph. When the same word is commonly used to mean different things, and the relation between them is not clear at first sight, it sometimes helps to point out something which pertains to the same genus, but is manifestly not an instance of any of its recognized meanings. Now science is a type of knowledge. Let us therefore consider a kind of knowledge that we do not commonly call science, e.g., the knowledge that Socrates is now standing at that corner of this street. This fact may be very certain to him or to someone else who sees him there, but we are not in the habit of calling this kind of awareness 'science.' The reason seems to be not that it is knowledge of a mere individual fact, but that this fact has not been established by some mediating term. When a historical fact — e.g. that Aristotle was not the author of the *Liber de causis* — has been ascertained as the result of an orderly approach, complying with definite rules, we are wont to call this knowledge 'scientific.' And we all know what is meant when one historian is called 'more scientific' than another who is willing to receive hearsay as fact. It is futile to quarrel over the use of the word 'science' in connection with such knowledge and far better to enquire why it came to be so used. Again, of the observed relationship between the tides and the phases of the moon or between the behaviour of people and the weather, we say that they are scientifically certain. When the makers of some product assure the consumer that their brand has been 'scientifically tested,' they refer to a process of examination performed according to accepted rules. "Any mode of investigation by which scientific or other impartial and systematic knowledge is acquired" is the description of Scientific Method found in an article under this heading in the *Encyclopaedia Britannica*. All this suggests that the term 'science' still has to do with knowledge obtained by some recognized means or process emphasized as impartial. It is implied that anyone who can grasp the means or understand the process ought to agree that what is so discovered or so proved deserves his assent.

Among the studies called sciences, mathematical physics is often presented as so ideal in method and standards that the other depart-

ments of the study of nature are called scientific only in the measure that they approach its exactness. Now, what we must notice is that, if mathematical physics is called the most exact, it is because it attains more closely to the precision of mathematics itself, which is undoubtedly more rigorous than any other science. For mathematics proceeds, more than any other science, "in the mode of discipline,"¹ where we give the reason for a proposition that is not self-evident. In fact, when Aristotle mentions the 'disciplines' without qualification, he means mathematics.² The reader must realize that we take the term 'mathematics' in the traditional sense, which is not quite what it means today.

To show what is meant by 'science' in our strict sense of this term, we will therefore consider in illustration some examples of scientific knowledge in mathematics.

2. *Illustration from Mathematics: demonstration of existence.*

The geometer accepts the meaning of the word 'triangle'; but he also proves that there *is* such a thing, as when, on the basis of the radius of a circle, he constructs an equilateral triangle. The expression 'a plane figure having its three sides equal' has meaning, but from this alone it does not follow that there can be such a thing.³ The name 'centaur' refers to 'half man and half horse,' but the fact that the term has meaning does not suppose that there is such a being, nor that there could be. 'The diagonal of a square, commensurate with the side,' has meaning, too; yet no such thing can be.⁴

To show, concerning the equilateral triangle, *that it is*, it is not sufficient to point to a figure on the blackboard, so carefully drawn that to our eyes its three sides are indistinguishable in length; for

1. Cf. ST. THOMAS, *In Boethium de Trinitate*, q.6, a.1.

2. It may be noted, however, that if we refused to consider as subjects of investigation those not amenable to the exactness of mathematics, we would have to renounce even mathematical physics, if only because of its dependence upon sense experience. Cf. ARISTOTLE, *Metaphysics*, II, chap.3, 995 a; ST. THOMAS, *ibid.*, lect.5, nn.334-337.

3. On the difference between the interpretation or the definition of the *meaning* of a word, and the definition of *what a thing is*, see *Post. Anal.*, II, chap.7; ST. THOMAS, *ibid.*, lect.5-6.

4. The question 'Can it be?' is not the same as 'Can it be in nature?' *Being* is understood here of what is true; not of what is or can be in reality. In the present context, "'to be' and 'is' mean that a thing is true, and 'not to be' that it is false. Similarly too in affirmation and negation, e.g. in 'Socrates is cultured,' 'is' means that this is true, or in 'Socrates is not-pale' that this is true; but in 'the diagonal [of the square] is not commensurate with the side' 'is not' means that it is false to say it is." (*Metaph.*, V, chap.7, 1017 a 30. Cf. ST. THOMAS, *ibid.*, lect.9, nn.895-896; *Quodl. IX*, a.3, c. and ad 4). If someone said that the word 'horse' stands for a certain kind of vegetable, his account would not be true. Nor can we know whether a proposition is true or false unless we first grasp its true meaning.

no amount of physical measurement could verify the exactness of 'equal sides.' To designate an actual horse would be enough to show that the name 'horse' stands for something that is; this does not hold for the subjects of mathematics. While the geometer assumes the continuum as 'what is divisible without end,' according to one or more dimensions, any subject of which he demonstrates some property, e.g. of 'triangle,' must first be established by way of a construction to show that there is such a thing. Demonstrations by way of construction are called 'quasi operational.'¹ Every attempt at proof by experience that 'the equilateral triangle' is (in the sense of 'true'), must prove hopeless. How, then, can we know of what we define as 'a plane figure having its three sides equal,' that it also is — in the sense of true? Euclid provides the following proof:

[i] On a given finite straight line to construct an equilateral triangle.

Let AB be the given finite straight line.

Thus it is required to construct an equilateral triangle on the straight line AB .

With centre A and distance AB let the circle BCD be described;

[Post. 3]

again, with centre B and distance BA let the circle ACE be described;

[Post. 3]

and from the point C , in which the circles cut one another, to the points A , B , let the straight lines CA , CB be joined.

[Post. 1]

Now, since the point A is the centre of the circle CDB , AC is equal to AB .

[Def. 15]

Again, since the point B is the centre of the circle CAE , BC is equal to BA .

[Def. 15]

But CA was also proved equal to AB ;

therefore each of the straight lines CA , CB is equal to AB .

And things which are equal to the same thing are also equal to one another;

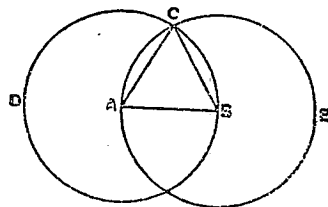
[C.N.I.].

Therefore CA is also equal to CB .

Therefore the three straight lines CA , AB , BC , are equal to one another.

Therefore the triangle ABC is equilateral; and it has been constructed on the given finite straight line AB .

(Being) what it was required to do.²



This demonstration by way of construction shows that there is 'a triangle whose three sides are equal,' and that this is indeed a definition of 'what it is to be such a triangle,' — not just an interpretation of the expression 'equilateral triangle,' nor even a definition by a property. This kind of proof makes us discover and establishes, by means of the construction, that there is such a subject, and it is by means of the definition of the latter that any of its properties will have to be demonstrated. So much for demonstration of existence in mathematics.

3. Demonstration of a property.

We must now turn to the kind of demonstration which establishes a commensurately universal property following with necessity from 'what its subject is.' Let us take in illustration another proposition from Euclid: *In any triangle, if one of the sides be produced, the exterior angle is equal to the two interior and opposite angles, and the three interior angles of the triangle are equal to two right angles.* This statement is not self-evident. That 'the sum of the angles of the triangle equals two right angles' is a proposition requiring proof: it follows from something other than itself, from a reason already known. How is this reason known, and how does it lead to such a proposition? Assuming certain demonstrations already provided, we quote the proof from Euclid:

[ii] Let ABC be a triangle, and let one side of it BC be produced to D ;

I say that the exterior angle ACD is equal to the two interior and opposite angles CAB , ABC , and the three interior angles of the triangle ABC , BCA , CAB are equal to two right angles.

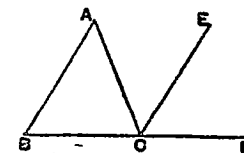
For let CE be drawn through the point C parallel to the straight line AB .

[I, 31]

Then, since AB is parallel to CE , and AC has fallen upon them, the alternate angles BAC , ACE are equal to one another.

[I, 29]

Again, since AB is parallel to CE ,



and the straight line BD has fallen upon them, the exterior angle ECD is equal to the interior and opposite angle ABC .

[I, 29]

But the angle ACE was also proved equal to the angle BAC ;

therefore the whole angle ACD is equal to the two interior and opposite angles BAC , ABC .

Let the angle ACB be added to each;

therefore the angles ACD , ACB are equal to the three angles ABC , BCA , CAB .

1. ST. THOMAS, *In I Post. Anal.*, lect.2, n.5. In this, the mathematical disciplines somewhat resemble the productive sciences. To construct a subject, e.g., a house, is the very purpose of the latter. They remain radically distinct, however, inasmuch as the construction of a subject is the very purpose of the latter, whereas in mathematics the construction is a means of discovery (*ibid.*, lect.41, n.7).

2. Book I, Proposition 1. *The Thirteen Books of Euclid's Elements*, translated by SIR THOMAS HEATH, Cambridge University Press, 1926, 3 vol., Vol. I, pp.241-242. Cf. ST. THOMAS, *In II Post. Anal.*, lect.6, n.4.

But the angles ACD , ACB are equal to two right angles ;
[I, 13]

therefore the angles ABC , BCA , CAB are also equal to two right angles.

Therefore . . . etc.

Q.E.D.¹

What is the exact reason from which this property is inferred? It is none other than the definition of the subject (triangle) to which, in the conclusion, we attribute the property 'to have the sum of its angles equal to two right angles.' Now the definition which, in this demonstration, is the middle term and contains the proper principles of the property is not just 'a figure enclosed by three straight lines,' but, as the first part of the proposition states, it is such a figure inasmuch as it has its "exterior angle equal to the two interior and opposite angles." It is in this exact respect, brought out, 'made actual,' by means of a construction ("if one of the sides be produced"),² that the triangle is both the subject and reason of the property 'to have its three interior angles equal to two right angles.'³

4. *A posteriori science*

Knowledge of a necessary, universal and commensurate property derived from the definition of its subject, is science in the fullest sense, because it follows from what is actually, on the part of the known, the proper principle of that property. In the case of mathematics, this principle or formal cause is also first known by us. (We would never say: 'This figure is a triangle because it has its angles equal to two right angles,' for this would be to put the cart before the horse.) Such knowledge, then, was called science in the most rigorous sense of the word.

But in actual usage the name 'science,' like the adjective 'scientific,' is not reserved to such knowledge alone. For although in science proper we cannot acquire knowledge of the unknown except through the mediation of something else already and better known, not everything that is first and better known to us is also prior in itself as in geometry. Hence it can happen that things better known in the

1. Book I, Proposition 32, HEATH, *ibid.*, pp.316-317.

2. ARISTOTLE, *Metaph.*, IX, chap.9, 1051 a 20: "Geometrical constructions, too, are discovered by an actualization, because it is by dividing that we discover them. If the division were already done, they would be obvious; but as it is, the division is only there potentially. Why is the sum of the interior angles of a triangle equal to two right angles? Because the angles about one point [in a straight line] are equal to two right angles. If the line parallel to the side had been already drawn, the answer would have been obvious at sight." Cf. ST. THOMAS, *ibid.*, lect.10, n.1888ff.

3. Cf. ST. THOMAS, *In II Post. Anal.*, lect.1, n.9.

sense of more intelligible in themselves, which would be the proper means of a perfect demonstration, cannot at once be reached or used, because what we know first is not always what actually comes first on the part of the thing known, taken in itself.

Now, when the only knowledge accessible to us is not a proper means of proof, unlike the definitions of mathematics, which are such proper means, our only resource is to look backwards, doing our best to find our way from properties to definition, instead of from definition to properties. In the study of nature this is usually the only way in which we can make progress. For example, we know the alternation of day and night before we know the reason for it — a reason which it took some time to discover. To know that this phenomenon has always taken place, in all recorded experience, is one thing; to know why it takes place, is another; and the expression of the observed regularity, as a general proposition reached by induction, becomes the substitute for the definition required by science in the strict sense.

5. *Induction of self-evident principles from sense perception and imagination*

It has just been stated that very often in the study of nature, not having definitions to serve as a basis of reasoning as we have in mathematics, we must make do with propositions reached by provisional induction. This term induction is another which we must now consider if we are to understand the import of St. Thomas's preface. By induction, in general, is meant thinking our way from particulars to universals. The main thing to notice in the beginning is that there are two basically different types of induction: a distinction which is made, not with regard to the form of inductive reasoning, but on the basis of its matter. One of them passes unnoticed in ordinary life, because it goes on as unceasingly and unconsciously as breathing. It would be difficult to say just when we first suddenly understood that 'it is impossible to be and not be at the same time and in the same respect,' or that 'nothing can be a whole and a part in the same respect,' or that 'every whole number is either odd or even' (which we gather by mathematical induction.¹) But the fact is that knowledge

1. "Ipsa autem principia non eodem modo manifestantur. Sed quaedam considerantur *inductione*, quae est ex particularibus imaginariis, utputa quod omnis numerus est par aut impar. Quedam vero accipiuntur *sensu*, sicut in naturalibus; puta quod omne quod vivit indiget nutrimento. Quedam vero *consuetudine*, sicut in moralibus, utpote quod concupiscentiae diminuantur si eis non obediamus" (St. Thomas, *In I Ethicor.* lect. 11). The term induction in this passage is reserved to mathematics because here it is the most accomplished and least ambiguous. That every living thing stands in need of food is not that obvious. Even the principle of contradiction, the most certain of all, is difficult to express without confusion; we must qualify what is meant by 'to be' and 'not to be,' 'at the same time' and 'in the same respect.' Further proof of this can be seen in the

of the most general principles, presupposed as it is to all reasoning,¹ is preceded by an induction, so natural that it passes unobserved.

The other kind of induction, which, now spontaneously, now deliberately, considers the particular cases within reach and concludes from them to a general proposition,² is familiar to us as the typical procedure of the arts and crafts as well as of experimental science in general. These propositions are made to serve as principles, but they are not the reason for the regularities which they enounce.

In comparing these two sorts of induction, it must be noted that they differ, not merely in the frequency or ease with which they are carried on, but more fundamentally in the role assigned to the enumeration of particular instances and in the certitude finally achieved. It may sound surprising, but an induction may lead to complete certitude without all instances having been covered, as in the case of first, self-evident principles; and, on the other hand, may cover all instances without yielding a sufficient reason. The first and basic type of induction, whereby the mind moves from sense perception towards general, self-evident principles, is nothing like a complete enumeration, nor do we need one. Indeed, a principle like 'it is impossible to be and not to be' etc., or 'any two things which, in the same respect, are like to a third, are in that respect like to one another,' could hardly be the result of an examination of all the cases, since these are innumerable. In the primordial process of acquiring knowledge, propositions such as these are consequent upon sensation, memory and experience; yet, once we grasp them, we see that they must hold good in all possible instances. In other words, it is characteristic of this first type of induction that no attempt is made to offer the survey of the particular cases as the proper reason for the truth of the universal proposition.³

fact that the primacy of this principle is forever in debate. As to the part-whole principle, it is extremely ambiguous, for there are wholes which are identical with each of their parts, namely the logical wholes with their subjective parts; besides, any part of a line is not less divisible *ad infinitum* than the whole, and there are wholes that are not composed of the parts into which they can be divided, such as a circle.

1. Most modern writers on philosophy of science assume that by first, self-evident principles of a science, ARISTOTLE meant what he called 'common principles', from which, he showed (*Post. Anal.*, I, chap.9 and 10), there can be no demonstration, although demonstration depends upon their truth.

2. This type of induction is analysed in *Priora Analytica*, II, chap.23, 68 b 5. See also ALBERTUS MAGNUS, *ibid.*, Tract.VII, chap.4. The text of this important exposition of the *Priora* has been transcribed from the Borgnet edition, long out of print, and made available in mimeograph by Michel Doyon, 1215-1223, chemin Sainte-Foy, Québec 6, Canada, 1951.

3. See *Post. Anal.*, II, chap.19, 99 b 15. Cf. ST. THOMAS, *ibid.*, lect.20. — (On the distinction between sense-perception, memory and experience, see also *Metaphysics*, I, chap.1, 980 b 20 — 981 a 30. ST. THOMAS, *ibid.*, lect.1). — Of this universality ARISTOTLE says that it is "at rest in the mind" inasmuch as it is eventually and suddenly perceived as independent of the particular, variable, instances; although it could not be achieved without

Cases may be referred to by way of illustration, but the reason for the truth of the proposition is nothing else but what we intuit in any single instance — once the proposition has been achieved.

Since the kind of induction just described never offers the number of particular instances as the reason for accepting the strictly universal proposition, it is not knowledge acquired through prior principles and can be called science only in a loose sense. That it does nevertheless have some claim to the title is clear, since it enjoys great certitude and is a necessary preliminary to all science.¹

6. *Not even complete enumeration is the same as to provide the scientific reason*

We must now turn our attention to the second type of induction, where the multiplicity and similarity of the particular cases are actually given as the reason for a general statement offered as a conclusion. In this way of reasoning from particular to universal, the enumeration of the cases may be either complete or incomplete. By 'complete' is meant an enumeration which exhausts all possible cases, implying, of course, that they are clearly limited in number. Now, even when complete enumeration is possible, so that the property x is shown to be true of every possible instance, the inductive argument may still fail to provide a proper, universal reason for a general statement which is nevertheless certain.²

sensation of some instances, without memory and comparison of the instances retained, the results of which is experience. If we had no such knowledge, no word we use could have any meaning beyond that of vocal sounds as produced by beasts, i.e., signs of a state of passion, as the dog's bark or the lion's roar. For this type of induction, modern logicians still refer to ARISTOTLE, and call it "immediate" or "intuitive induction." (See, e.g., W. E. JOHNSON, *Logic*, Part II, chap.VIII, Cambridge, 1922, pp.188ff.; MORRIS COHEN and ERNEST NAGEL, *An Introduction to Logic and Scientific Method*, Harcourt, Brace and Company, New-York, chap.XIV, pp.273ff.). "Intuitive induction" is perhaps not a very happy expression for the reason that this induction and the intuition that follows it are not one thing. The "seeing" or intuition consequent upon the induction is not the proper effect of the induction itself.

1. Traditional philosophy accounts for this use of the word science. Cf. *Post. Anal.*, I, chap.31, 88 a 5. ST. THOMAS, *ibid.*, lect.42, n.9; and *In VI Ethicor.*, lect.3, n.1145.

2. "An error of this kind is similar to the error into which we fall concerning particulars: e.g. if A belongs to all B, and B to all C, A will belong to all C. If then a man knows that A belongs to everything to which B belongs, he knows that A belongs to C. But nothing prevents his being ignorant that C exists; e.g. let A stand for two right angles, B for triangle, C for a particular diagram of a triangle. A man might think that C did not exist, though he knew that every triangle contains two right angles; consequently he will know and not know the same thing at the same time. For the expression 'to know that every triangle has its angles equal to two right angles' is ambiguous, meaning to have the knowledge either of the universal or of the particulars. Thus then he knows that C contains two right angles with a knowledge of the universal, but not with a knowledge of the particulars; consequently his knowledge will not be contrary to his ignorance" (*Priora Anal.*, II, chap.20, 67 a 5-20).

An example using the materials of geometry will show what is meant by a complete enumeration failing to reach the proper reason for the proposition enounced by way of a conclusion. Suppose one established that 'the sum of the angles of any triangle is two right angles' by way of induction, that is, by verifying this property in each of the three kinds of triangle, "first in the equilateral, again in the isosceles, and afterwards in the scalene triangle."¹ Seeing that a rectilinear three-sided figure either has its three sides equal, only two of its sides equal, or its three sides unequal, and that there is no other possibility, the general statement will be quite certain: 'In every kind of triangle, the sum of the angles is two right angles.' Yet the verification of the general statement by enumeration of all the possible kinds of triangle does not provide the commensurately one and universal reason why it is true of each kind.

... Even if one prove of each kind of triangle that it has its angles together equal to two right angles, whether by means of the same or different proofs; still, as long as one treats separately equilateral, scalene, and isosceles, one does not yet know, except sophistically, that *triangle* has its angles equal to two right angles, nor does one yet know that triangle universally has this property, even if there is no other species of triangle but these. For one does not know that triangle as such has this property, nor even that every triangle has it, except in a numerical sense; nor does one know it according to the species [triangle] universally, though there be no kind [of triangle] in which one does not recognize this property.²

In the study of nature, too, an induction is judged complete when some general proposition is taken as true because it has been verified of each member of an adequate division; as when it is said that "irritability (the power of responding to a stimulus) is the general property of living beings" because it is true of both animals and plants.³

1. On whether or not ARISTOTLE's mention of such proofs (*Post. Anal.*, I., chap.5, 74 a15-35) refers to a historical development of the theorem, see HEATH, *op. cit.*, Vol. I, pp.317ff.

2. *Post. Anal.*, I, chap.5, 74 a 25-35. Cf. ST. THOMAS, *ibid.*, lect. 11-12. — Inasmuch as 'triangle' and other types of plane figure, such as circle, divide the genus 'plane figure,' triangle is a species which, with regard to the kinds of triangle that in turn divide triangle into species, has the nature of genus. Figure is called the 'remote genus,' triangle 'proximate genus.'

3. Even this so-called complete induction is only hypothetical, since it must assume that the terms of the division have been verified. Such tentative or dialectical use of the 'dici de omni' provides a universality that was formerly qualified as '*ut nunc*, as of now,' i.e. valid in all the cases actually known. Cf. ST. THOMAS, *In I Post. Anal.*, lect.9, n.4. — Many philosophers of science nowadays are shy of, or even categorically reject, all so-called first, self-evident, necessary principles, both general and proper. To their mind, all principles must be stated in hypothetical form, qualified by 'if.' We may mention three points that appear to be in their favour: (a) The consequences of reasoning are at least materially the same. E.g., 'If the exterior angle of a triangle is equal to the two opposite interior angles, its three angles are equal to two right angles.' If you remove the

However, although this may be the reason why we believe the property to be common, it is not a commensurately universal reason, which must be one and adequate to all possible cases. The same judgment should be passed on an argument showing that all mobile beings are bodies because both animate and inanimate things — an adequate division of mobile beings — reveal three spatial dimensions. This is far from being the commensurate universal reason why anything that can be in movement must be a body. A genuine demonstration would have to show that 'to be *per se* in movement' belongs primarily to body as such.

* More often, however, the induction used in the study of nature cannot be made complete. We say, for instance, that 'every man is mortal.' Yet, if this proposition is considered to be general merely because no man has been known to survive, its basis is an induction that is necessarily incomplete. For all practical purposes, the proposition is sound, though based on an incomplete induction and universal only *ut nunc*; but as such, it does not offer the reason why man is mortal. The observed fact 'no man has been known to survive' is not the natural reason why 'every man is mortal.' If the sun rises tomorrow, it is not because, in all human experience, it has always happened before.¹ So long as we cannot find the reason why they

"if" and make the statement categorical, the conclusion will be materially the same, but you will not know whether it is true or not. (b) Most universal terms and enunciations are no more than what we call universal *ut nunc*, that is, provisional, and must be taken as posits subject to change. There was a time when 'All swans are white' was valid. (c) It is possible to say that 'All statements are uncertain, including this one' an enunciation which is grammatically correct. — This retreat from truth retains all the same a logical structure similar, in some respects, to that concerned with true knowledge acquired by induction and demonstration. A logical positivist such as Hans Reichenbach will be satisfied with knowledge, whether it be true or not, so long as it is an instrument of action, and we can readily produce examples where this is true. A speculative theory need not be true to ensure results that are in practice true. The ancient hypothesis that malaria was caused by the evening miasms of swamps produced results for those who followed the advice to stay away from them. The explosion of the Bomb did not depend upon the speculative truth of Einstein's theory. But it proved nonetheless that the theory is at least on the right track. In most departments of natural science, no matter how great our desire for ultimate truth, we never get beyond universality *ut nunc*.

1. ARISTOTLE's famous hypothesis of a radical difference between the phenomena on our planet and those on an astronomical scale is a case in point. He assumed that the latter were entirely uniform, unaging and unalterable, from which he concluded that they could not be subject to contrary states, such as hot and cold, so that the heavenly bodies, e.g. the sun, were actually incorruptible. — "The mere evidence of the senses [he said] is enough to convince us of this, at least according to human belief. For in the whole range of time past, so far as our inherited records reach, no change appears to have taken place either in the whole scheme of the outermost heaven or in any of its proper parts" (*De Caelo*, I, chap.3, 270 b 10). "Nevertheless [ST. THOMAS adds, in his commentary, lect.7, n.6] this is not necessary, but only probable. For the more a thing is lasting, the more time is required to observe its change; for instance, the change that over a period of two or three years takes place in a man is not as readily observed as that which affects a dog, or some

occur, the regularities observed in nature (such as the eventual death of every animate thing) will by themselves provide no strictly universal proposition. The proper, universal reason why man, as well as any other animate thing, is mortal must be found in what is inseparable from being an animate thing, and therefore from being a man.

7. The 'universal' of demonstration is not the same as
'to be said of all' — or "dici de omni"

The universal property, as understood in strict science or demonstration — of which an example is 'to have its three angles equal to two right angles' — must show the following characteristics : [a] it must be true of all instances that are under it (e.g., of each and every triangle) ; [b] its subject must belong to the very definition of the property (e.g., 'to have ~~three~~ angles equal to two right angles' implies triangle as having an exterior angle equal to the two opposite interior angles, viz. the *per se* subject of this property which follows from it with necessity) ; [c] it is primarily in that of which it is said (i.e. primarily in triangle as such, and not primarily in this and that of its species).¹

To assume that one has demonstrated that the triangle as such has the sum of its angles equal to two right angles by showing it to be true primarily of each one of its kinds, this is to be satisfied with the mere appearance of a reason. In fact the statement : 'In every kind of triangle the sum of the angles is two right angles,' when it is understood as the result of an induction by complete enumeration, is not a demonstrative conclusion at all, but a mere restatement of something already known, viz. [a] that any triangle is either *e*, *i*, or *s* ; [b] that *e*, *i*, and *s* each has its angles equal to two right angles.

What we are trying to show is that to establish something by induction as true of a class of things is not to prove anything about the nature of the thing in itself. Such inductions, however exhaustive, will always suffer from this limitation. The reason is that a class, as such, is never the same thing as a universal. A class, or collection, may be no more than an incidental whole, a grouping which supposes something held in common by many objects, but not necessarily something pertaining to what they are in themselves. If, instead of meaning 'a rectilinear figure contained by three sides,' which is one in notion, the term 'triangle' were used to stand primarily and immediately

other shorter-lived animal, during a time of equal length. Hence one could say that while the heaven is naturally corruptible, it is so long-lasting that the whole span of time which memory can record is not enough to observe its change." — Thus, according to both ARISTOTLE and ST. THOMAS their whole theory about celestial bodies was no more than a hypothesis.

1. *Post. Anal.*, I, chap.4 and 5, 73 a 20-74 b 5. ST. THOMAS, *ibid.*, lect.9-12.

for the class of each and all triangles, 'triangle' would lose its true universal meaning ; it could be said of no triangle whatsoever, neither of a kind nor of an instance of a kind. Where the term 'triangle' is intended to mean a class of things, to say triangle of equilateral, or of *this* particular one, would mean that 'equilateral' is the class of all triangles, whether equilateral or no. Likewise,¹ if we interpreted 'man' to mean primarily and immediately the class 'men' (that is, all of the subjective parts of the universal nature 'man,' viz. all beings of which 'man' can be predicated), then, to say 'man' of Socrates would mean that he is each and every man : Socrates and all men who are not Socrates, viz. all who have been, are, shall be, might have been, and even all possible men. Actually, a collection, as such, like an individual, can be predicated only of itself, viz. in a proposition of identity, 'A is A,' 'Socrates is Socrates,' or 'All Greeks are Greeks.'

If 'triangle' meant primarily and no more than the class of all triangles, the 'equilateral' could not even be called 'triangle' since this would imply that the class of all triangles is in the same respect both equal and unequal to only part of itself. It would be false to say : 'A surface enclosed by three straight lines is a figure,' or that 'it is a rectilinear figure,' or 'a rectilinear figure that has three sides.' For all these terms ('figure,' 'rectilinear figure,' etc.), when used to signify collections *qua* collections, are equivalent to symbols, viz. the kind of arbitrary signs that must be distinguished from names.

II. THE OBJECT AND SUBJECT OF A SCIENCE

St. Thomas said, in the passage quoted at the head of these pages, that "we must show, at its very beginning, what natural science is about, viz., its matter and subject." A well-known sentence from A. N. Whitehead's *Introduction to Mathematics* seems to advance the contrary opinion : "the last thing to be discovered in any science is what the science is really about."² Yet, towards the beginning of the same *Introduction* he had said that students should know "from the very beginning of their course . . . what the science is about."³ That there is no contradiction here can be made plain by first pointing out what is meant by 'the object of a science,' as distinguished from its subject, for the object includes the subject.

1. Cf. JOHN OF ST. THOMAS, *Cursus Philosophicus*, Logica, P. I, lib. II, chap.10-12 ; *Quaest. disput.*, q.6, (edit. Reiser, T.I, pp.29-35 ; pp.166-182).

2. P.223.

3. P.8. — We do not aim to show what WHITEHEAD actually means by 'science.' We have pointed out elsewhere (*Random Reflections on Science and Calculation*, dans *Laval théologique et philosophique*, 1956, Vol.XII, n.1) that what he calls 'mathematics' is what the ancients had named *logismos*, i.e. the art of calculation.

By the *object* of a science, in the strict sense of the term science, we mean knowledge acquired as the result of demonstration, e.g., that 'the plane triangle has its angles equal to two right angles.' The *object* of science is therefore nothing other than the conclusion, in which something (e.g., 'to have its angles equal to two right angles') is said about something (viz., 'triangle').¹ This object, then, is something complex: a composition of subject and predicate, which in perfect science follows from the definition of the subject (e.g., to be a triangle is 'to have an exterior angle equal to...'), or in other instances, from the substitute for a definition. By the *subject* of a science, we mean that *about which* we have knowledge by demonstration, viz., the very subject of the conclusion or 'that about which' (e.g., 'triangle') something is asserted by means of demonstration (e.g., the property 'to have the sum of its angles equal to...').

Now the subject about which we assert something in the object or conclusion of the demonstration does not of course make its first appearance in the conclusion. Something has already been predicated of that same subject in the principles or premises of the demonstration. For example, of the *triangle* we said that 'it has its exterior angle equal to the two interior and opposite angles,' and it is in virtue of this that the conclusion follows, viz., that 'the *triangle* has its three angles equal to...'. In other words, the subject of scientific knowledge is both [i] what is first known, viz., that about which we seek science,² and [ii] what is last known, viz., this same subject *qua* known to possess such or such a property. The subject, considered in the latter respect, is called the 'term' of the science.³ There is, then, no contradiction in saying, on the one hand, that students should know "from the very beginning of their course... what the science is about," and, on the other hand, that "the last thing to be discovered in any science is what the science is really about."

III. THE DISTINCTION AND RESPECTIVE UNITY OF THE SCIENCES, IN GENERAL

Although every demonstration produces scientific knowledge, a particular demonstration, obviously, does not constitute a science all by itself, since, if it did, there would be as many sciences as there are particular demonstrations. Rather, a single science, such as geometry, embraces many objects or conclusions, e.g., that 'the sum of the angles

1. In *I Post Anal.*, lect.10, n.8.

2. In geometry, that which is first known and about which we seek scientific knowledge is magnitude; whereas the particular subjects are known, we say, by way of construction. These, in turn, are known before the demonstration of their properties. In *I Post Anal.*, lect.2, n.5.

3. In *I Post Anal.*, lect.41, n.7.

of a triangle is two right angles'; that 'the angle in a semi-circle is a right angle'; etc. And these form what is called the *material object* of a science. Now what is it that gathers such objects into a single science? Why do certain conclusions belong to mathematics and not to the science of nature? This will be what is called the *formal object* of the science.

We have noted that the means by which we acquire scientific knowledge are none other than the definitions, since the definition is the proper principle of the conclusion or object of science. What, we might ask, do the definitions of geometry have in common? To make this point briefly, we propose the question: how could we show that *in nature* there is such a thing as an equilateral triangle? By what method could we verify that this triangle cut in bronze has its three sides equal, or that its exterior angle is equal to the two opposite and interior angles? Or by what means could we demonstrate that the angles of the metal triangle are equal to two right angles? The only possibility is measurement by means of some standard or 'measure.' By a 'measure' we mean 'that by which the quantity of a thing is known primarily.' If the measurement is to be perfectly exact, the measure must be indivisible. Now, 'to be quite indivisible' is true only of the 'one' that is the principle of number, and not of magnitude; of the things, in nature, that are continuous, there can be no exact measure. The reason for this will become clearer if it is noted, that, as Aristotle said,

the measure is always homogeneous with the measured: the measure of magnitudes is a magnitude, and in particular that of length is a length, that of breadth, a breadth, that of articulate sound articulate sound, that of weight a weight, that of units a unit. (For we must state the matter so, and not say that the measure of numbers is a number; we ought indeed to say this if we were to use the corresponding form of words, but the claim does not really correspond — it is as if one claimed that the measure of units is units, and not a unit; number is a plurality of *units*.)¹

But at the same time, since the measure of a magnitude is itself a magnitude, and every magnitude *qua* continuous is divisible without end, the measure itself must be indefinitely divisible. Hence, to be entirely exact, the standard of length would have to be length without length, both divisible and indivisible. That is why, for practical purposes, some length, chosen by convention, like the yard or the metre, simply must be declared the correct standard.² The subdivisions

1. *Metaph.*, X, chap.1, 1053 a 25.

2. Cf. ARISTOTLE, *Metaph.*, X, chap. 1, 1052 a 15-1053 b 8. ST. THOMAS, *ibid.*, lect.1 and 2 — SIR ARTHUR EDDINGTON, *Space, Time and Gravitation*, Prologue, pp.1-16. Of the standard of length SIR ARTHUR says that "it has no length." This paradox may prove helpful to call attention to the difference between (a) length as 'what is extended according to one dimension' and (b) length as 'what is known by means of the measure of length.'

of such a standard make possible some improvement in precision,¹ but can never attain the exactness of mathematics, nor permit the demonstration of a theorem.

The reason why complete exactness is possible in geometry is that the definitions we use are formally independent of, and have no reference to, the order of sense experience, and the conclusions are established as following from such definitions with necessity. Yet by means of a construction² geometry can demonstrate that there is a triangle whose sides are equal, and that the angles of any triangle are equal to two right angles. Why cannot the same be done for a metal triangle? Why should the object of sense experience offer such hindrance to exactness? The answer to this difficulty, and the reason for the distinction between the 'matter' and the 'subject' of a science, lie in the quotation from St. Thomas, "a thing becomes intelligible in act insofar as it is more or less abstracted from matter."

Now the word 'matter' in 'abstraction from matter' and in 'the matter of a science' does not mean quite the same thing. Let us begin with 'abstraction from matter.' What is this 'matter' from which we must prescind as an essential condition of science?

IV. WHAT IS MEANT BY 'MATTER' IN 'ABSTRACTION FROM MATTER'?

In our scientific age the student of nature would, on the whole, show little concern for a doctrine such as that of 'abstraction from matter,' and apparently one can do well without it. Some might even suggest, since we know so little about 'matter,' except, for instance, that it is convertible with 'energy,' that the question of abstraction from matter refers either to some outdated theory or to a knowledge not yet had. Fortunately, some recognized authors, especially in the field of mathematics and physics, still make very definite statements which show that a theory of abstraction is even now of no less consequence than it has been in the past. On the other hand, the reader may be willing to bear with us if we promise to show how the question

The measure itself must have length in the first sense; but it cannot have length in the second sense since, by definition, the standard of length cannot be measured (except *per accidens*, as when we express the ratio between the standard of one system of measurement, e.g., the meter, in terms of the standard of another system, e.g., the English or the U.S. 'yard,' where in either case, the measured ceases to be taken as a standard.

1. The meter, although of considerable magnitude, may be called the 'minimum of length,' provided we mean 'the material object whose variations owing, e.g., to changes in temperature, can be more precisely controlled; while the variations in a smaller object would be less noticeable.' This more readily controllable exactness is presupposed to the subdivisions of the standard.

2. Such proofs are called "quasi operational demonstrations." In *I Post. Anal.*, lect.2, n.5.

of abstraction from matter as a condition of the sciences and of their distinction arose in the mind of some ancient philosophers whose terminology is still in use. This may prove the best means to decide whether or not such a doctrine is still relevant. To this end, it will not be enough to point out what these philosophers intended when using such words as 'matter' and 'abstraction.' All this is bound to still another doctrine, a general, more basic one concerning the use of words and their various impositions.

Both the Greek word *ύλη* and the Latin *materia* originally meant 'timber,' and then what we call 'lumber'; they were further extended to mean any 'building material,' including stone as well as lumber, bricks, cement, etc.; finally they were extended to mean 'that of which' anything is composed, even though this might be as various as the *vapor* of a cloud, the *sides* of a triangle, or the *terms* of a syllogism.¹

1. Original meanings of words and new impositions

Now a word may have some original meaning which it is well to know if its later impositions are to be understood.² That is, whenever the latter apply to things which cannot be known nor, therefore, named, without reference to something earlier and more known to us. For, since words are signs of our concepts, and concepts are the mental images of things, words can refer to things only through the medium of the mind's conception of them.³ The way in which words signify does not depend immediately on the way in which the things that they stand for are in themselves, but on the way they become known to us and are present in the mind. And hence it is that we can name a thing only as we know it, and that

in naming things we follow the progress of intellectual knowledge. Now our intellectual knowledge proceeds from the better known to the less known. Accordingly, we transfer names of things more known to signify things less

1. LIDDELL and SCOTT (*Greek-English Lexicon*) list the following meanings: I. *forest, woodland; forest-trees*. II. *wood cut down; firewood, fuel; brushwood; timber*. III. *the stuff of which a thing is made, material; generally, materials; in philosophy, matter, first in Aristotle, etc.*

2. The word *imposition* is here used in a scholastic sense, described by Webster as 'the application of a name to a thing.' Unlike mere vocal sounds, such as the growls and whimpers of animals, names do not have meanings by nature but by convention. It is man who deliberately confers or imposes their significance. Sometimes the term *application* may be used instead of *imposition*, but it should be borne in mind that not every application of a word constitutes an imposition of meaning, nor is every novel application a new imposition. Metaphors like "a heart of stone," "a huge ox of a man" do not change the original meaning of "stone" or "ox," but merely apply a word, in its first imposition, to an object which is in no proper sense what that first imposition designates. A new imposition would destroy the metaphorical force of the word.

3. ARISTOTLE, *Peri Hermeneias*, I, chap.1.

known to us. Hence it is that . . . the word *distance* has been transferred from things that are apart locally, to all contraries ; and in like manner words pertaining to local movement we use to signify the other kinds of movement [viz., according to quality or magnitude], because bodies, inasmuch as they are circumscribed by place, are better known to us.¹

That is why extended meanings of words indicate an order of progress in knowledge. St. Thomas illustrates this point in the following passage :

We can speak of a word in two ways : either according to its first imposition, or according to an extended use of it. This is shown in the word *sight*, which was originally imposed to mean the act of the sense of sight, and then, inasmuch as sight is the more excellent and trustworthy of our senses, according to common usage it extends to all knowledge obtained through the other senses. Thus we say : *see how it tastes, how it smells, or how warm it is*. Further [the word 'sight'] is extended to knowledge by the intellect, as in : *Blessed are the clean of heart, for they shall see God* [MATH., v, 8]. And thus it is with the word *light*. For it was first designed to mean that which makes manifest to the sense of sight. Afterwards it was extended to that which makes manifest according to knowledge of any kind.

And so we say things like : 'Let us look at this problem in the light of new evidence.' What, then, is the *proper* meaning of this word? St. Thomas goes on to make the following important distinction : "If, then, the word [light] is taken according to its first imposition, it is used metaphorically of spiritual things. But if taken according as by common usage it is extended to any sort of clarifying or making plain, then it is properly said of spiritual things."² If taken after this new imposition, which still refers to the original one as meaning what is better known to us, the word *light* is, in fact, used more properly of intellectual things — even though less known to us — since the light of science, for instance, has far more of the nature of 'what makes plain' than candlelight has.³ To the man unaware of this change of imposition, the 'light of new evidence' might seem no more than metaphor ; for him, nothing but the light which permits our eyes to see could be called light in any proper sense.⁴

2. Original meaning and etymology

Now concerning the word *matter*, the original meaning we have in mind should be distinguished from the word's origin or etymology,⁵ which is quite contingent.

1. *Ia IIae*, q.7, a.1, c.

2. *Ia Pars*, q.67, a.1, c.

3. *Q. D. de Potentia*, q.4, a.2, ad 3.

4. More specifically, unless the value of extended meaning is granted, most of the terms used in philosophy, and all metaphysical terms, will have to be taken as metaphors.

5. From the Greek *etymologia* : the real, true (*etymon*) or primitive meaning of a word.

The etymology of a word is one thing, its meaning is another. For its etymology shows that from which the word was taken for the purpose of signification [*id a quo imponitur nomen ad significandum*] : whereas the meaning of the word concerns that upon which the word is imposed for the purpose of signifying [*id ad quod significandum nomen imponitur*]. These things are not always the same : for the name *lapis* is taken from *laesio pedis*,¹ but this is not what it means ; else, iron, since it hurts the foot, would be a stone.²

Yet whatever the etymology of the word *lapis* — or of our own word *stone*, for that matter — the meaning we are concerned with here would be that of *lapis* as the name of this kind of object to which we can point a finger, and not with the name as drawn from the possibility of a stone affecting us in this way or that. A person may know the primary imposition of a word without knowing exactly how it came to get it in the etymological sense. For instance, the name *Metaphysics* came to mean what it does in a very casual way. Because of the place assigned to them — after the *Physics* — by an early compiler of Aristotle's works, certain treatises were called *Metaphysics* : *μετά τὰ φυσικά*. This provides us with the etymology of the name, i.e., 'that whence the name was taken' ; whereas the primary imposition of *metaphysica* as a single word refers to treatises which, in the proper order of learning, are to be studied after those on nature. Eventually, by a new imposition, going beyond yet embracing the previous one, *metaphysica*, as Boethius (*cir.* 480-524) employed this term, referred to the science which Aristotle himself had called *First Philosophy* and *Theology* — 'First' by reason of its principles, 'Theology' because of its principal term, viz., knowledge of what is divine.³

Of course, 'that from which the signification of the word is drawn' or 'that whence the name is imposed,' and 'that which the word signifies' are sometimes the same, viz. in the case of words conveying what is immediately known to our senses, such as *hot*, *cold*, *hard*, *white*, — words which are verified directly by reference to sense experience, and which are in no other way verifiable. The reason for this resides in the fact that even of the things which are present to our senses, and at any rate first and more known to us, we do not know directly what they are in themselves ; this we can approach only through something extrinsic to their nature, viz., some sensible effect or quality.⁴ What we first discern of a horse, for example, is

1. This etymology, reported by ST. ISIDOR OF SEVILLE (*cir.* 570-636), is in fact incorrect.

2. *IIa IIae*, q.92, a.1, ad 2 ; *Q. D. de Potentia*, q.9, a.3, ad 1.

3. Outside the aristotelian tradition, for centuries now the name *metaphysics* (as the adjective *metaphysical*) has had almost as many different meanings as there have been authors to use it, its etymology being the only common aspect of the word to survive.

4. *Ia Pars*, q.13, a.6, c.

what appears to the senses and allows us to tell it from a cow, or pig, etc. These colours, textures, sounds, we can name at once, and, in such instances, 'that from which the signification is drawn' does not differ from 'what the name is intended to mean,' although that to which these qualities belong is still not truly known as to what it is in itself absolutely.¹

But it is perhaps well to point out that these qualities or operations which lead to a first attempt at naming a thing like a horse are not to be confused with the distinctive properties which truly set a horse apart from other things. Further knowledge may oblige us to change our minds about what constitute real differences. We may become acquainted with an animal like the zebra, let us say, possessing all the traits we had assigned as peculiar to the horse, and yet endowed with a few more of its own. What was thought to characterize a horse would now appear to be only something it has in common with certain other animals. In other words, if we assumed that we knew a given substance, e.g. a woodpecker, as to what sets it apart from all other things absolutely, just because we knew the word 'woodpecker' in its derivation from some other words previously formed to signify a substance and operations or effects of what we call a woodpecker, we would be like a man who, understanding that *bluefish* is derived from *blue* plus *fish*, insisted that every blue fish ought to be a bluefish, and all bluefish, blue. — Such examples may seem somewhat outlandish, yet the confusion they illustrate is widespread among philosophers and even among their critics.² To cling to first impositions as the only valid ones may be just as foolish as to lose oneself in vague, extended meanings without comprehending the basic imposition to which these may owe their force.

3. Names that are not taken from other things

It should be noted, however, that names signifying substances, such as *man*, *horse*, *tree*, *stone*, etc., can never have the immediate meanings of words like *noise*, *smell*, *sweet*, *pain*, *large*, *smooth*, *inside*, *feel*, *move*, etc. Terms like these are the most basic in any language. Whatever their philological origin, they are not named from other things: *that which* they mean is the same as *that from which* their signification is drawn. Now the fact that this identity holds only in

the case of objects immediately known by our senses¹ should make us aware of how important it is to take into account what happens in the knower between his apprehension of a thing and his naming of it. Different words are intended to signify different things. But the differences indicated by variations in names are seldom the proper differences which set the things themselves apart from one another. If the knower, who imposes a meaning upon a word, does not actually attain the essential differences between the things named, he may in his naming of them, refer to some trait which, though admittedly not the essential difference, is used instead of it — as in the name *rattlesnake*. If we assumed that the warning sound referred to in this name, which is that whence it was imposed, was actually *what* the name meant, we would imply, gratuitously, that this sound was the essential difference of *that which* we name.² To sum up, if the essential differences between things were grasped at once, the differences of names would be taken from them: *that whence* they signify would be *that which* they signify — the specific differences of the things themselves. The whole relevance of the distinction between the specific difference of the thing itself and the trait from which the thing's name is taken derives from the fact that we do not know outright the essential differences of things, and that we can name things only as we know them.³

1. As we shall see in Part II, chap. 3, there is a notable difference between interpreting a word like *horse* by pointing to such an animal, and interpreting the word *white* by designating a white horse. What we call *white* is something sensible *per se*, whereas a white horse, as a substance, is sensible only *per accidens* — as we shall explain further on.

2. The word *rattlesnake* may, as a composite name, be used to confirm the distinction between etymology and signification. For, that which this name signifies, is not the two things called *rattle* and *snake*, these being only that 'from which' the name has been imposed. The components of this name can signify separately, but they cease to do so when taken together as one name. "The reason is that a single name is imposed to signify a simple concept; for, that whence the name is imposed to signify is not the same as that which the name signifies; as *lapis* from *laesio pedis*, which is not what the name signifies: for it was imposed to mean the concept of a thing. Hence it is that a part of the composite name imposed to signify a simple concept, does not signify part of the composite conception from which the name was imposed to signify. An expression [e.g., 'pale man'] signifies the composite conception itself: hence a part of the expression signifies a part of the composite conception" (St. THOMAS, *In I Perih.*, lect. 4, n. 9).

3. "That a name is said to be imposed 'from something' can be taken [a] either on the part of the one who imposes it, or [b] on the part of the thing upon which it is imposed. In the latter case, a name is said to be imposed from that which completes the notion of the thing it signifies, viz., the specific difference of the thing [i.e. that which sets it apart from other things]. However, since the essential differences are unknown to us, we sometimes use accidents or effects in their stead... and name the things accordingly. And thus it is that, whatever is used to take the place of the essential difference is also that whence the name is imposed, considered on the part of the one who imposes the meaning: as when *lapis* is imposed from an effect, *laedere pedem*. And this need not be that which the word is intended to mean before all; the word means that instead of which we use the effect [viz., *laedere pedem*]" (St. THOMAS, *Q. D. de Veritate*, q. 4, a. 1, ad 8).

1. Obvious examples of substance-names taken from a perceptible quality or action already named would be *quicksilver* or *rattlesnake*; they do not signify the fluidity of mercury or the rattle of a certain type of snake. The word *snake* is another example, being kin to *sneak*, as well as to the Old German *snachan*, to creep.

2. The criticisms leveled against philosophical jargon by the 'logical positivists' are only too often well taken and should be turned to advantage.

However, though the relationship between meaning and etymology should not be confused with the dependence of a new and extended imposition upon a prior meaning, it must not be thought that knowledge of a word's origin is of importance only to the philologist. Etymology, providing as it does a kind of reason why a given word was formed and used to signify this or that, has the advantage of referring us to something known even before the first imposition of that word. For instance, the verb 'to manifest' — meaning 'to show plainly,' 'to make to appear distinctly,' 'to put beyond question or doubt' — comes from the Latin *manifestare* which was originally taken from *manus*, hand, and *fendere*, to seize; *fur manifestus* meant 'a thief caught in the act.' This word, then, referred originally to the most basic of our external senses: to touch, and to the palpable.

4. The relevance of names signifying things first known to us

Many of the so-called technical terms of philosophy look forbidding (if not pedantic) because they are borrowed from another language, like the word 'philosophy' itself. And they appear all the more remote because they are usually taken according to later, more abstract impositions which had become theirs in that language. Such is the case with the words 'syllogism' and 'abstraction,' for example. Even in Latin, the adverb *sylogistice* (used by Cicero), or the Low Latin noun *sylogismus*, refer immediately to an extended meaning of the Greek *συλλογισμός* used by Aristotle in logic. The word derives from *συν* (with, together) and *λογίζομαι* (to count, to calculate, and finally, to reason). So, in Latin, French, and English dictionaries, the very first meaning of 'syllogism' is 'a term of logic,' and reference is made to Aristotle. Actually, the word was once used by the man in the street who knew nothing about its extended meaning, and he would have been puzzled if told that the 'syllogism' was the invention, or discovery, of the founder of the Lyceum — as we are at times led to believe. Yet the passage from the meaning of the word in common use to its extended meaning can be followed as easily as the transition from 'light,' as in 'sunlight,' to 'enlighten,' as in 'enlighten me on this subject of geometry.' Both in French and in English, the disparaging remark 'What does reasoning have to do with syllogisms?' may well draw applause from the gallery. Such a reaction is only natural when the borrowed term is used outright to signify something which, without reference to something more known or more knowable to us, can be understood only with difficulty, or not at all. Such a reference must be provided either by an earlier imposition, or, if they are not the same, by the etymology which helps us to grasp that previous meaning. Failing this verification, such so-called technical terms take on an air of fraudulence which calls for exposure so long as one is presumed to know just what they mean.

The same holds for the word 'abstraction.' Both in French and in English it means, first and immediately, something far removed from what is more known to us: viz., a certain operation of the mind, or the status of something related to thought as distinguished from mere sensation. The original Latin (just like the Greek *ἀφαίρεσις*) conveyed 'the act of drawing or separating from,' a meaning very near to the etymology: *ab*, *abs* (from) and *trahere* (to draw, pull, take away). The sculptor, hewing away stone from stone, performs an abstraction in that primitive sense of the word. (This meaning was retained in the English adjective 'abstract,' but is now archaic.) Present-day discussions on the nature of abstraction show how bewildering are the consequences of using words intended to mean, from the first, something which can be properly known only by dependence upon something of which we are immediately aware.

The need to lead extended meanings back to those that can be verified of things more known and unquestioned would not arise if, with Descartes, we could assume that what is most knowable in itself can be equated with what is most knowable to us — which is indeed the case in mathematics. To him, the words 'God' and 'soul' meant something first and most clearly known to us by intuition.¹ He believed that he was using the word 'soul' according to the sense in which Aristotle uses the word *ψυχή* (originally 'breath of life') in Book III of *De Anima*, i. e., intellective soul. We do not mean that Descartes had nothing in mind when he used this word, but only that he nowhere provided a means of verification. Nor would he need to do so if we enjoyed the kind of intuitions with which he credits us.² Actually, many later impositions of words depend upon a process of reasoning based, in the last resort, upon sense experience. For we can name things only insofar as we know them. Hence the very words we use to signify things that we can never know except by discourse, could not otherwise obtain such a particular meaning for us. Any statement containing, for instance, the word 'soul,' taken in a sense far removed from experience, yet with the assumption that this could, or should be its first imposition — like that of words for things immediately known, such as *hot*, *white*, *breath* — is going to be like any other enunciation made in terms not sufficiently grasped by its author. The neglect of primitive meanings opens the way to a philosophical jargon that all can repeat but no one understands.

5. Philosophical terminology

It has been observed that the original meanings of words have to do with things of rudimentary sense experience and practical life.

1. *Discours de la méthode*, part. IV; also *Méditation II*.

2. Note that we are not speaking of propositions, but simply of the meaning of the words.

For instance, the Greek for 'soul' ($\psi\chi\eta$, whence our psyche, psychic, psychology, psychiatry, etc.) first meant the *breath of life*; while the Latin *anima* was used for *air*, a *current of air*, a *breeze*; and we saw that the adjective 'manifest' meant *seized by the hand*. For this reason, many believe that to recognize the simplest words of common speech (although the whole of Aristotle's vocabulary, however awesome it may have come to look in modern languages, was derived from them) as relevant to philosophy, is to condemn the latter as a science and abandon it to anthropomorphism. This is a denial of the progress of knowledge from more to less known. Rather than surrender to words in common use, some suggest that the philosopher should create his own vocabulary, out of nothing, so to speak, and employ only 'technical' terms divorced from usual meanings; much as the mathematical physicist, who must have recourse to symbols from the very start.

If this position were correct, it would imply that philosophy is a body of knowledge unrelated to what is actually more known to us; that it is based, perhaps, on some intuitions that are the privilege of a few, the only ones to have the right of calling themselves philosophers; or that the science is based on intuitions proper to some particular school. In effect, the reason why one does not understand the technical terms would be the lack of the proper intuitions. This position, which is rather widely held, implies that progress from the more commonly known to the less known, as well as the new impositions of words that attend it, cannot be achieved. Thus a word whose more original meaning referred to something practical, like 'manifest', to *seize with the hand*, could never be used to signify, in a proper sense, anything but that; or even 'symbol,' which meant the sign of a convention or contract, such as a wedding-ring, could not be reasonably extended to mean the sign of a collection that cannot be named.¹ So that once a word has been used to refer to something in the order of sensation or in that of action or of making, it should never be employed to mean anything else in any proper sense. If such were the case, we admit that philosophy could not name anything. And the reason is that there would be nothing known to require a name.

V. A NEW IMPOSITION OF THE NAME 'MATTER'

What is meant by 'matter' in the statement that a thing is intelligible in act only insofar as it is abstracted from matter? (We will pay no attention for the moment to what 'intelligible in act' may mean). It is also said that a thing is knowable only by reason of its 'form.' In treatises of philosophy these terms are often used with-

1. ST. THOMAS, *IIa IIae*, q.1, a.9.

out apology in a sense far removed from the meaning we know best. Let us here try to identify their meaning by taking an example from something well known, which leads us to a primitive meaning of 'matter,' viz., timber, the stuff that is used to make houses, tables, broomsticks, etc. 'Form,' on the other hand, originally meant the contour, shape or figure of a thing, e.g., the form of a bowling-pin.¹

1. 'Matter' as a connotative term

'Timber' happens to be a good example of a connotative term, since it does not mean just wood, but wood with reference to something to be made of it. Now, none of the class of things that are made of wood will be sufficiently described by 'made of wood' or 'wooden,' since a table, an oar, a toothpick or a house may all be equally wooden. They are distinguished by their shape or the arrangement of their parts, i.e., by their form. With respect to all these kinds of wooden objects, timber is a material still to be formed; and it is only when the timber is 'that of which this kind of thing is made,' or when the timber has taken on such a shape, that we have 'that for the sake of which' timber is. If this should be a table, it will not be primarily because it is made of wood — for it might still be a table even if made of metal or plastic — but primarily by reason of its shape or the disposition of its parts. In short, it is by reason of its form that this object is identified as a table and distinguishable from a bowling-pin.

2. Shape or form and matter are both principles of differences

At first sight, it might appear that, since a bowling-pin differs from a broomstick by its shape, we may, in defining or describing it, ignore the matter and give our attention only to the form. It is clearly the form of the bowling-pins which explains how they can be put up and knocked down in such a fashion as to make sport for the players. Yet, it should also be clear that we cannot afford to neglect the matter. The material must be wood or something like it.

Of wooden objects, the form is the principle of difference. Yet, when we want to distinguish wooden from non-wooden objects, we see that the matter too is a differentiating principle, though not at all in the same respect. That which a thing is made of is essential to it as the subject of the form; since the thing could not be what it is

1. The emphasis which we are placing upon the original meaning of a word is not intended to suggest that this same meaning is to be identified with its subsequent uses; but rather that to neglect original meanings entirely could lead to confusion with respect to later meanings. Etymology, in the historical and philological sense, can be the key to more abstract meanings of the same word. The principle involved is that even today, a word must be made to refer first of all to something more known to us, before we apply it to something less known. We always have to know what we are talking about.

without some kind of subject. Plainly, then, from the definition of bowling-pin matter may not be excluded. The matter that is thus part of the definition is called 'part of the species,' i.e., part of the kind of thing we are speaking of.

Notice, however, that the matter we put into the definition is not the matter of *this* bowling-pin, but only the *kind* of matter that the whole set of pins is made of, viz., wood. 'Wood' is never '*this* wood.' If it were, the wood of *this* bowling-pin would be all the wood there is, and there could be no other wood nor any more bowling-pins. 'To be a bowling-pin' is not the same as 'to be *this* bowling-pin.' Bowling-pin can be said of any one, while *this* bowling-pin can be said of only one. Hence, when we say *what* an individual thing is, the *what* compares to the individual thing as form to matter. For example, when we call a certain tool a saw, 'saw' is to this single tool as form to matter. It should therefore be clear that even the matter which enters into the definition (as steel in the definition of saw) has the nature of form if related to a single specimen of the thing defined (as steel in general has the nature of form as regards this particular saw). Thus we have a new imposition of the words 'matter' and 'form.' To return to our bowling-pin, 'matter' now will be individual bowling-pins as instances of 'bowling-pin.' It is in this sense that 'rational' and 'irrational' are called the subjective parts or matter of the predicable universal 'animal.'

3. When 'matter' refers to a principle of sheer numerical difference

'Matter' is used in still another sense, this time as a principle of difference. The bowling-pins of our set all have the same shape and are made of the same material. The same definition applies to each one of them. Yet they differ numerically: *this* one *here*, is not *that* one *there*. How can we account for this purely numerical difference? Of course we might argue that *this* particular pin differs from the others because it has been placed at the apex of the triangular grouping. But this position does not alter its shape nor the stuff of which it is made, and any other pin might just as easily have been set in its place. In short, the fact that it is a bowling-pin does not require that it be *this* one, *here* and *now* at the apex of the triangle; in other words, no amount of description of *this* bowling-pin considered by itself can account for its distinction from the others. When we identify it as the one closest to the player, we say nothing of what it is in itself. The shape and material that enter into the definition of bowling-pin do not account for *this* particular one qua *this*. 'That which' we define (the *definitum*), as well as the definition itself, can be said or predicated of any particular bowling-pin, and any and every pin is a *this*; yet both *definitum* and definition 'abstract' from each and every individual bowling-pin as a *this*.

4. 'Matter' as a principle of sheer numerical difference must imply 'amount' of matter

Although apparently not differentiated in shape, size, and type of matter, our bowling-pins are actually not so much the same. Actual measurement would show them not exactly the same in form and size, and careful analysis would be sure to find structural differences in the grain of the wood, and even between its individual cells. But none of this expert information is needed to realize that *this* pin is not *that* one. And even if we did take into account the hidden differences in these pieces of wood, cut from the same tree, we would never hold such differences to be the reason why *this* pin is not *that* one. We are never going to maintain that, if the pins were actually as similar as circles of the same radius, they would lapse into a single pin; or that, if all electrons were quite equal in charge — a basic supposition of the physicist — there could be only a single one. And even though we did grant of real objects, that any single thing in the real universe, or any single part of such a thing, must differ from every other single thing or part of such a thing by reason of the 'what it is' expressed in its definition, we would still be left with those individual circles of equal radius that are used in Geometry. They give rise to much the same problem.

Perhaps we can narrow down the problem by asking why it is that we can have a whole set, and even many sets of wooden bowling-pins, apparently all the same so far as the maker and user of them are concerned. The answer might simply be 'because we have enough of the right kind of wood — and we could have as many as you please, so long as there is the wood to make them.' This seems to place the burden of sheer multiplication of individuals upon the stuff that our bowling-pins are made of, upon their matter. Yet not on the wood alone, but upon the *amount* of it; or, to put it otherwise: upon how much wood there is available. Whatever that *amount* is, it must be an amount of *wood*. The same amount of water would not do. Nor can the amount or quantity be indeterminate when we realize that the size of each of our pins is the same. The same problem arises concerning the many, when these are the same size: how can they be many while similar in every other respect? ¹ Size will distinguish one pin

1. At this point some reader may begin to wonder what it can matter, since we know that there are such individual things; and so to conclude that the whole problem had better be thrown out. But this will be like arguing: who cares what horses are, so long as we know that they exist? and, if they truly exist, why question their possibility? It has been maintained that the principle of individuation is precisely that incommunicable existence realized only in the individual. Now, we do not question the fact that only singulars exist in reality. Our problem concerns a special type of real individuals, those all of one kind. To assert that they are individuals because of their existence is like saying that they are apart because they are not together. What we want to know is simply this:

from the next no more effectively than shape, colour, or quality of wood. Or to put it in another way, the quantity or size of the pins calls for individuation no less than the wood of which it is the size. It is not 'fifteen inches high' that makes it *this* pin, or even *this* height, for all the others are the same in this regard. It is not quantity as size that plays the essential role in individuation. A thing may have its own quantity for so long as it exists, and that same quantity may vary in size at different times. The dimensions of Socrates were his own throughout his life no matter how much they varied in size. This is what is meant by the distinction between quantity as *dividing*, and quantity as *informing*, *ordering* the parts of the whole and terminating it. It is the former that has to do with individuation.

5. *Things differing no more than by number are indefinable*

It is not our purpose to define here what the principle of individuation is. Our aim, for the moment, is merely to point out that things which are many, yet indistinguishable in kind, cannot be accounted for in their numerical distinction by defining or describing *what* they are. The reason for their distinction must be something other than what is expressed in a definition or a description. Whatever it may be, it has something to do with *this* matter of *this* quantity, something that can be designated in sensation, a something here and now. In other words, if an individual of a particular type can be neither defined nor described as an individual, the reason must be something extrinsic, foreign to what we can know of it by the definition or description; and it must be something irrational, since it allows a thing to be *this* without any discernible differentiation from *that*. In the definition of a bowling-pin, by itself, there is nothing to limit the number of individual pins; such a limit will be determined by the available wood and the powers of *these* craftsmen. Similarly, that the individuating principle is something irrational is clear because none of these individual things can be known to us except in the act of sensation. It can be true to say "this is a bowling-pin," and truth is in the intellect; but

how can they be distinct in existence when, in every other respect, they are the same? The answer: 'Because they exist distinct from one another,' is something we already know. Some have also held that the principle of individuation is precisely the 'thisness' of the thing that is 'this.' But such a reply merely indicates what the question is about, leaving us still with the task of discovering what gives rise to it. To say that a thing is 'this' because of its thisness is pretty much the same as saying that a horse is a horse because of its 'horseness,' and does not help much if our aim is to learn something about horses. We have still got to find out what 'horseness' is, and no amount of mere designation can shed any light on the matter. This kind of verbalism became popular and was made fun of by MOLIÈRE, when he had the doctors pronounce that opium causes sleep "because there is in it a sleep-inducing power whose nature it is to lull the senses — *opium facit dormire quia est in eo virtus dormitiva cujus est natura sensus assoupire.*"

intellect does not hold this truth, except with reference to the thing actually sensed.

The act of reason alone, apart from sensation, does not attain to *this* thing here. Of course we know this kind of truth by our intellect — e.g., that this object is a man — but only with dependence on a particular sensation here and now. However, this truth is not attained by the kind of knowledge which proceeds by way of definition and demonstration: it is not reached by science, if the term science is taken strictly. While whatever is true of man can always be said of *this* man, the truth of 'this man is mortal' depends upon an act of sensation. Such a proposition of course adds nothing to science, even though science can exist only in individual men, and they alone can contribute to it.

6. *In what sense science cannot be concerned with the individual*

The doctrine that science cannot be concerned with the individual is frequently misunderstood and interpreted as haughty indifference to reality. Small wonder if the reader's indignation is aroused when he learns that he is of no interest to science unless, for example, he displays some exceptional endowment, or even disease; and that even this distinction is merely incidental to him, since anybody else with the same peculiarity would do just as well. But the point is that speculative science does not pretend to replace every kind of knowledge. It is only one kind — that which is pursued for the sake of knowing, insofar as 'to know' can be sought for its own sake. And it remains true not only that the individual of sensation lies at the source of all knowledge, even of the most abstract, but also that science can never be indifferent to the qualitative varieties between individuals. Unless we know that human nature can assume widely different types, we know it very imperfectly indeed. When it is asserted that the individual is of no concern to science, the meaning is merely that the same thing over and over is of no concern to science; while this individual, this duplicate of his fellow, remains of the first importance in the domain of action.¹

1. The doctrine applies with equal truth to emperor and clown. For as soon as we realize that the emperor could have been another man, indistinguishable in character, ability and motives, so that the substitution of one for the other would leave the course of history unaltered, we see that the actual historical personage is unique only as a matter of bare fact. His case is comparable to that of a given equilateral triangle, let us say, compared to another exactly like it. To argue that the perfection of speculative science is to be sought in such knowledge of the individual would be like holding that the aim of geometry is to contemplate, one after the other, all possible equilateral triangles of one size. There could be no end to this sort of thing. Wherever it began, and in whatever direction it proceeded, science could meet with nothing but frustration. To put the same idea in different words, the mere individual can never be pinned down except by designation through an act of the senses — *this, here and now*. No amount of description ever touches

Such is the 'individual matter' that science abstracts from, and which cannot be its subject, though the subject can be said of any individual of its kind. Of course, individuals are *used* in the study of nature, and the more one wishes to learn about man, the more one must turn to individuals. Yet while learning from them, they themselves are not 'what' is learned from them. Because of the real existence of *this* or *that* individual, we know that 'man' exists in the sense of being true; but from true propositions about man — e.g., that man is mortal — we cannot infer the existence of an individual, like Socrates, who can be known only through an actual sensation, or through the report of such an awareness. — It is in a somewhat similar way that we imagine and use a particular straight line, designated by 'AB,' to demonstrate by way of a construction that there actually is a kind of triangle whose sides are equal. Yet, from the existence of that kind of triangle — 'existence' being taken here in the sense of truth — we cannot infer that such a triangle exists in the way that Socrates does.

VI. 'A THING BECOMES INTELLIGIBLE IN ACT INSOFAR AS IT IS SOMEHOW ABSTRACTED FROM MATTER'

1. *An illustration of what it is to make something intelligible in act*

What do we mean by 'intelligible in act'? It is by making them actual that geometrical constructions are discovered, e.g., by actually dividing or protracting a line which was only potentially divided or protracted.

If the figures had been already divided, the constructions would have been obvious; but as it is they are present only potentially. Why are the angles of the triangle equal to two right angles? Because the angles about one point are equal to two right angles. If, then, the line parallel to the side had been already drawn upwards, the reason would have been evident to any one as soon as he saw the figure.¹

In other words, it is by making actual that which was only potential, that we come to know it. And the reason is that thinking is an actuality. We would never know this property of the triangle if its base were not actually protracted.

the individual. To assume that it can is to assume that there could never possibly be another like this one. As we describe Alexander the Great in all that made him different from every other figure of history, we might still be talking about somebody else. And this is what is meant by the statement that the individual is ineffable: all that can be done is to point him out.

1. ARISTOTLE, *Metaph.*, IX, chap.9, 1051 a 23.

The instance of a geometrical construction was chosen because it is more obviously a case of making something actually knowable than will be any example of the kind of actualisation which we perform when we make the things of sensation intelligible in act.

2. *The sheer individual cannot be rendered intelligible in act qua individual*

If by 'intellect' we mean the power of our mind to define and to demonstrate, and by 'intelligible,' that about which there can be such an activity, then, as we have already pointed out, the individuals of sensation cannot be attained by the intellect directly, but only with reference to sensation of a *this, here and now*.¹ But how do we get hold of that which the intellect properly attains, and about which there is demonstration? It is enough to realize, here, that we do form propositions like 'Socrates is a man,' 'Plato is a man,' and that, while the subjects of these propositions stand for different individuals, their predicate is common, signifying one and the same kind of thing attributed to both subjects in the same way. Neither this individual, Socrates, nor that one, Plato, can be said of anything else, whereas 'man' can be said of every individual man. Now we can define man and describe him in such a way as to set him apart from any other kind of thing. But, as we saw, we could not do as much for the individual thing attainable only by the designation *this, here and now*. We can say *what* this individual is, namely, 'a man,' or 'the kind of animal that makes automobiles, constructs theories about the universe,' and so forth; but it remains clear that 'what it is to be a man' is not the same as 'to be *this* man.' To put the thing a little differently, when speaking of this individual thing, we have got to distinguish between '*what kind*,' meaning of what it is an instance, and 'which one,' meaning which instance of it this is. Only the *kind* of thing it is is definable, and demonstration can concern only the *kind* of thing it is. That is what we mean by saying that 'man' is 'intelligible in act,' whereas Socrates is not. There is no science about 'what it is to be this individual who is Socrates.'

There remains of course a sense in which the individual is a remote principle of science, viz., in the enumeration of particular instances leading by induction to a universal. But note, again, that even here any one of these individuals might have been replaced by another. There is also the sense in which individuals of the same kind may be severally a term of the science, viz., when we apply what is scientifically

1. The question of the distinction between intellect and sense: whether they are distinct faculties, or constitute one and the same power of knowledge, does not concern us here. It is enough, for the moment, to recognize that to know what a thing is, even if only confusedly, to define it or to prove something about it, are not the same kind of activity as to feel warm or cold, to see red, to hear a noise, and so on.

known to *this* that we designate in sensation (the universality of the demonstration implies that such an application must be valid).¹ But what can never be is a science having Socrates as its proper subject ; for, if such a science could exist, 'what it is to be *this kind of individual*' and 'to be *this man Socrates*' would have to be utterly identical, so that nothing else could be an individual of his kind. Further, 'what the science is about' would be in every respect as variable, as contingent, as what we know in actual sensation ; in other words, 'what it is to be a man of *this kind*' could have existence, in the sense of truth, only so long as Socrates himself existed, and only for so long as we had actual sensation of him — whether he really continued to be or not.

3. Knowledge of the individual could not be the aim of speculative science

Again, if 'to know' is that for the sake of which this kind of science is pursued — as distinguished from knowledge sought for the purpose of learning how to make something, or how to behave — and if, at the same time, the essential function of the science were to apply what is known to this individual and that, of the same kind, then the aim of such science could be achieved only through a process of designating successively and unceasingly, not merely distinct individuals of the same kind, but even the very same individual, over and over again ; for, this individual thing is knowable qua *this, here and now*, only for so long as it exists, and could be known in this manner only for so long as we would be in the act of designating it — a process which must be constantly renewed, subject as it is to the passage of time. In short, 'this thing here and now,' owing its individuation to the kind of principle pointed out above, can never possess the intelligibility and necessity essential to the subject and principles of science in the strict sense of the word.

The individual is to the true subject of science as the potential to the actual ; and even when it is spoken of as 'made intelligible in act' the meaning is not that the individual can be rendered intelligible in act qua individual. It is not *this* thing qua *this* that our mind makes to be intelligible ; it is only 'what it is an instance of' — that which it has in common with things the same as itself — that can be actualised and understood. It is the 'what' of *this*, and not the *this, here and now*, that is called actually intelligible.

4. The contingency of the individual is another reason why there can be no science of it

Still another aspect of the potentiality that keeps the individual beyond the immediate grasp of science is revealed when we consider

1. ST. THOMAS, In *Boethium de Trinitate*, q.5, a.2.

that Socrates may now stand, then be seated, or even cease to be at all, without affecting the 'what it is to be a man' which is the concern of science. Change affecting individuals does not oblige the notion of change to change. Even when science is about what is variable or what ceases to be altogether, 'what it is to be variable' or 'what variation is,' remains invariable. Thus, 'what movement is' is not in movement, and 'what it is to be contingent' is not contingent : the right definitions of movement and contingency are changeless and necessary — unless we hold that all attempts at definition are equally good, or that things are as anyone chooses to have them. It may be objected that, in the pursuit of science about nature, most definitions are provisional and subject to revision ; but this is only because they belong to an order of research in which we ourselves are subject to change and contingency. It goes without saying that to be on the way towards a goal is not the same as to have already reached that goal ; but, if there were no goal, the pursuit of it would be meaningless. Nor are the things that we try to know in a scientific way other than they are when we do not know them ; nor do they cease to be what they are when we do not actually consider them. The one who possesses scientific knowledge may be subject to change, he may forget, or die, but the mutability of the scientist does not destroy the subject of the science and its properties.

5. The ultimate aim of the science of nature cannot be to know this universe qua "this," but to know what it is in kind

In conclusion, the science of nature cannot be science about this universe of ours qua *this*. The physicist assumes that the laws governing the universe, which he seeks to know by gradual approximation, progressing by hypotheses and provisional theory, would apply in every universe of the same kind as ours. So far as science is concerned, there might be another universe, governed by the same laws, quite indistinguishable from the present one in every respect. The only difference would be one of number. The numerical difference we can bring home to ourselves by reflecting that *this* universe is the one that we are alive in ; we feel ourselves alive in it when we touch, taste, smell, hear or see, conscious of this awareness, *here and now*. For no one else can be myself, no matter how like me in every respect. Similarly, although another universe can be wholly like the present one, none can be *this* one, since our incommunicable selves are part of it qua *this* universe (even though we, as *these* individuals, are not part of it as to its kind). *This* universe of ours is a matter of history, not of the kind of science we are invited to study here.

... In all formations and products whether of nature or of art we can distinguish the shape in itself and the shape in combination with matter.

For instance the form of the sphere is one thing and the gold or bronze sphere another; the shape of the circle again is one thing, the bronze or wooden circle another. For when, of sphere or circle, we state 'what it is' we do not include in the definition gold or bronze, because they do not belong to what those things are, but if we are speaking of the copper or gold sphere we do include them. We still make the distinction even if we cannot conceive or apprehend any other example beside the particular thing. This may, of course, sometimes be the case: it might be, for instance, that only one circle could be found; yet nonetheless the difference will remain between the being of circle and of this particular circle, the one being form, the other form in matter, i.e. a singular. Now since the universe is perceptible it must be regarded as a singular; for everything that is perceptible subsists, as we know, in matter. But if it is a singular, there will be a distinction between the being of 'this universe' and of 'universe' unqualified. There is a difference, then, between 'this universe' and simply, 'universe'; . . .¹

6. *A new imposition of the name matter, to signify a part of the definition of natural things, viz., "sensible matter"*

To return to our old example, the name 'bowling-pin' can be accounted for by pointing out this particular bowling-pin. But if we are asked 'what a bowling-pin is,' it will not be enough merely to state its purpose and describe its form; we shall also have to show 'what it is made of.' A bowling-pin, of course, is only an artifact, but the things that surround us in nature are like it in this respect: the matter or 'what they are made of' should enter into their definition. No man is a man without bone, muscle and nerve of some special quality, arranged in some manner peculiar to man. 'What it is to be a man' is not indifferent to the kind of matter that belongs to what he is.

So bone, muscle and nerve, the matter of man, must be considered by any genuine science of man. It should be clear, however, that this does not mean the bone, muscle and nerve of Socrates the individual, although our scientific findings are going to apply to his matter truly enough. What science does, then, is to abstract from individual sensible matter, but not from common sensible matter. But now a question arises: if science abstracts from the individual sensible matter attained in sensation, why, in speaking of the bones and flesh that are essential to man as such considered apart from this or that particular man, do we still use the qualification 'sensible'? The matter that enters into the definition cannot possibly fall under the senses as does that of Socrates; bones and flesh, when they are those of 'man' as defined by science, produce no alteration in the

1. ARISTOTLE, *De Coelo*, I, chap. 8, 277 b 30. (ST. THOMAS, *ibid.*, lect. 19).

senses. Why, then, retain the adjective *sensible* to describe an abstract matter which cannot be actually sensed?

Philosophies of experimental science are so distrustful of our senses in the study of nature that they are quick to make objections to the argument that sensible matter must be included in scientific definitions. Some of these objections must be faced now, even though this will oblige us to anticipate a few points of doctrine to be made later, *ex professo*, in that part of natural science which is studied in the treatise *On the Soul*. The need to explain what is meant by the archaic phrase 'common sensible matter' might perhaps be made to seem less acute by substituting for it the more conveniently vague and non-committal 'reference to sense-experience.' But this would merely be to evade a problem basic to an understanding of what natural science is about in each and everyone of its parts. Moreover, in our day, we have an obvious reason for continuing to use the old, candid and exact expression, a reason better than any the ancient philosophers could have dreamt of. The present knowledge of anatomy, physiology and, more especially, of the chemistry and physics these involve, have made us realize that the very organs of our senses can never be described adequately in terms of what we know first in sensation. Knowledge of the ultimate constituents of these organs, whatever they may be, would presumably lead us far away from anything that can be rendered in terms of sensible qualities like hard and soft, wet and dry, warm and cold, or in terms of taste, smell, sound and colour. So it is more important than it ever was to bear in mind that these sensible qualities are what we know first and best and that, no matter how far investigation may lead us away from this familiar realm, it continues to be the indispensable starting-point of all our knowledge about nature, and one to which we must always return. Unless anchored in sense experience, the study of nature can never keep to the right track, nor lead towards the truth.

If such a beginning and end in sensation are necessary, and if it is the 'sensible individual' matter that this science must abstract from while not abstracting from the 'sensible matter' that enters into the definition of natural things, we will first have to look more closely into what is meant by 'sensible' in this context.

7. *'To be sensed' is not a property of sensible things*

It is sometimes assumed, quite wrongly, that to call an object sensible is to assert its 'sensitivity in act' as a property really inherent in it. But 'to be sensed' or 'to be sensible in act,' when applied to the things of nature, is manifestly a mere extrinsic denomination borrowed from the sense faculty of the animal. Things that we sense do not depend upon sensation to be what they are; even if there were no faculty to sense them, they would hold themselves unchanged. 'To

be actually sensed' cannot alter the state of the thing that produces the sensation, except incidentally, as when the temperature of my hand affects the temperature of the thing I touch. This sort of alteration is not sensation, and a piece of inorganic matter, if brought into contact with the object, could produce the same result.

The act of that which is sensible in act, as such, can only be in the sense. If 'to be actually sensed' were something of the object sensed, no object could be what it is unless actually sensed; so that if there were no animal to sense it, a thing could not exist nor be what it is in itself. Further, since the actuality of being sensed is essentially in the knower, 'to be sensible in act in itself' would imply that the thing must be in the act of sensing itself. To put it still another way: to be sensed, the thing that we sense must have an actuality of its own, but this actuality that it has apart from the knower and because of which it acts upon the sense, can hardly be the actuality of being sensed. The actuality of what is sensible in act arises in the knower and can in no way be said of the external agent that produces it; nor is this actuality one in nature with the actuality that produces it.

... The view that [if there were no faculty of sense] neither the sensible qualities nor the sensations would exist is doubtless true (for they are affections of the perceiver), but that the substrata which cause the sensation should not exist even apart from sensation is impossible. For sensation is surely not sensation of itself, but there is something beyond the sensation; for that which moves is prior in nature to that which is moved, and if they are correlative terms, this is no less the case.¹

When 'sensible' and 'sense' are said to be correlatives, the true reason for referring the one to the other is to be found on the part of the sense-faculty: the thing is called sensible because the sense refers to it.²

Hence the matter in our definitions of natural things is called sensible inasmuch as it may cause sensation, not because it is sensed. This shows, too, that the sensible matter of definitions is not confined to those things of which we can have an actual sensation, like a tree. Anything that is one in genus with what we can actually sense will be defined as made of sensible matter. When we call bones and flesh sensible matter, we make this denomination with reference to the sense faculty that is its foundation. And while it is true to say that things external to the percipient are sensible in potency, this potency is not to be understood as one that can be brought to an actuality inherent in what is sensible in potency. The actuality of the potentially sensible is still what it is even if, *per impossibile*, there could be no sensation.³

1. ARISTOTLE, *Metaph.* IV, chap.5, 1010 b 30. ST. THOMAS, lect.14, nn.706-707. Cf. *De Anima*, III, chap.2. (ST. THOMAS, lect. 2, nn. 596-597.)

2. ARISTOTLE, *Metaph.*, V, chap.15, 1021 b. (ST. THOMAS, lect.17, nn. 1026-1029.)

3. ST. THOMAS, *In IV Physic.*, lect. 23, n.5.

But there is more to it than this. If by 'sensible matter' we meant something that can be a *per se* object of sense, like warmth, colour, shape or size, then sensible matter, for example, bone and flesh, would not be sensible at all and, if it were, it would not be 'matter'. To show how this is true, we will have to distinguish the various realities which may be called sensible.

VII. THE DIVISION OF WHAT IS CALLED 'SENSIBLE'

Aristotle, in the *De Anima*, presents the following division:

In dealing with each of the senses we shall have first to speak of the objects which are perceptible by each. The term 'object of sense' covers three kinds of objects, two kinds of which are, in our language, directly perceptible, while the remaining one is only incidentally perceptible. Of the first two kinds one [a] consists of what is perceptible by a single sense, the other [b] of what is perceptible by any and all of the senses. I call by the name of proper object of this or that sense that which cannot be perceived by any other sense than one and in respect of which no error is possible; in this sense colour is the proper object of sight, sound of hearing, flavour of taste. Touch, indeed, discriminates more than one set of different qualities. Each sense has one kind of object which it discerns, and never errs in reporting that which is before it is colour or sound (though it may err as to what it is that is coloured or where that is, or what it is that is sounding or where that is). Such objects are what we propose to call the proper objects of this or that sense.

'Common sensibles' are movement, rest, number, figure, magnitude; these are not peculiar to any one sense, but are common to all. There are at any rate certain kinds of movement which are perceptible both by touch and by sight.

We speak of an incidental object of sense where, e.g., the white object which we see is the son of Diares; here, because 'being the son of Diares' is incidental to the directly visible white patch, we speak of the son of Diares as being (incidentally) perceived or seen by us. Because this is only incidentally an object of sense, it in no way as such affects the senses. Of the two former kinds, both of which are in their own nature perceptible by sense, the first kind — that of proper objects of the several senses — constitute the objects of sense in the strictest sense of the term and it is to them that in the nature of things the structure of each several sense is adapted.¹

1. Special or Proper Sensibles

We must observe that, when asked what is meant by 'warm,' we can only convey our meaning by inviting the questioner to share our experience of warmth. Actually we can do no more than interpret the word by designating an instance of a special object or proper

1. Bk.II, chap.6.

sensible ; in so doing, we refer to a particular kind of experience which the other must be able to share if he is to know what the word stands for. To a man born blind, it will never be possible to convey what is meant by the proper sensible 'colour.'

2. *Common sensibles do not have the ineffable immediacy of the proper sensible, and are communicable*

'Common' does not mean that they can be perceived by each and every sense, but that they are not the exclusive object of one sense as colour is — though actually they appeal mainly to sight. Note that they are either quantity (like number and magnitude), modalities of quantity (figure, movement, rest), or reducible to quantity or to a modality of it (as time is to movement, and *situs*, i.e. position or order of parts in place, to external figure). The mind can collate and express them in terms of measure, without particular reference to a single kind of sensation. Even the person born blind can know what is meant by 'three marbles,' viz., their shape, size and number. Though blind and deaf, he might be led to an understanding of a phrase like 'the clatter of three, green, cold marbles,' without reference even to the feeling of cold. For, if by 'clatter' is meant the measurable intensity of a certain kind of vibration ; by 'green' a colour defined, not with reference to sight, but to the angle of refraction in a prism ; and by cold that which is expressed on a thermometer ; all these — clatter, green, cold — could be conveyed to him by mere resistance to his touch. It is upon such a basis that mathematical physics proceeds.

Later philosophers called the proper sensibles 'secondary qualities,' and the common sensibles 'primary qualities.' Part of the reason may be that quantity is more basic than quality, inasmuch as a certain division or extension are presupposed to anything that is a proper sensible, as number to octave, or surface to colour. But while this may explain why the common sensibles came to be judged primary, it does not explain how they can be called qualities. Figure is, indeed, a quality of a quantity ; but number and magnitude are quantities pure and simple. That is why we prefer the old division in terms of 'sensibles,' allowing as it does for both quality and quantity. But there can be no objection to qualifying the proper sensibles as secondary qualities, provided it be remembered that they are primary in the order of perception, since we cannot perceive a common sensible independently of some proper sensible. By this I mean that, when seeing the size of something, I perceive it through seeing something coloured ; or when feeling the size, I perceive it because of some resistance to the touch. This dependence in perception of the common sensibles upon the proper is perhaps being acknowledged when the former are called, not merely primary, but primary qualities.

3. *Sensible "per accidens"*

There are two basically different ways in which anything can be sensed *per accidens*.

(i) The *per se* object of one sense may be a *per accidens* sensible with respect to another sense, as when sweetness is called visible inasmuch as a white thing may in fact be sweet, the sweetness being *per se* perceptible to taste ; or when the cube, whose shape is a common sensible, is called sweet. An object, incidentally sensible in this manner, remains within the domain of what is sensible *per se*.

(ii) 'To be a sense object *per accidens*' can also mean something quite different. It may be observed, for instance, that Socrates is a *per accidens* sense object, whereas his whiteness or his figure are *per se* sensible. It is *per accidens* that the white thing, sensed *per se* as white, should be a man. For white man does not act upon the sense *qua* man, but *qua* white. 'Incidentally' or *per accidens* qualifies the connection between what is *per se* sensible and what is not so to the sense itself. So far as the sense faculties are concerned, any other white thing, though not a man, would act upon the same sense in the same way. Socrates does not act upon or modify the sense of sight by being a man, but by being of such a colour. Yet, if Socrates is to be called sensible *per accidens*, he himself must be perceived somehow by the one who is sensing. If he were connected with the object that is *per se* sensible without himself being perceived, he could not be said to be sensed *per accidens*.

So, when someone says 'I met Socrates this morning, and he talked to me,' he means that he actually met the man named Socrates and heard *him* talk ; not merely that he perceived a colour pattern and heard a series of sounds, nor that what he met was only incidentally Socrates. And this implies that, while not perceived *per se* by any of the senses, Socrates is known *per se* nevertheless by the one who senses ; though not sensed *per se*, Socrates is yet somehow apprehended *per se* by the one who senses him *per accidens*.

It does not follow, however, that anything thus knowable *per se* should be called incidentally sensible, but only that which is at once apprehended so soon as a *per se* sense experience occurs. Thus, as soon as I see anyone talking or moving himself, my mind perceives him as living, and I can say that I see him live. This shows us that 'to know' or 'to apprehend' does not always mean the same as to have an external sensation. That some faculty other than the external senses is coming into play here ought not to surprise us, realizing as we do that to understand his speech is not quite the same as to hear the sounds that convey what Socrates is talking about. But just what it is to know in this fashion, or what is the power or faculty of the mind by which we have such knowledge is not our immediate concern.

Knowledge of an incidentally sensible object of this kind must accompany every sensation, since all *per se* sensibles are at once perceived as belonging to something that is not *per se* sensed; and this something, unlike the things we sense *per se*, is never attributable to anything else. When we see that Socrates is white, or hear him talking, we are aware that whiteness is in him, and talking one of his activities, but Socrates himself we do not attribute to anything else.

Notice also that, when it is asserted that Socrates is *per se* known to the mind and only *per accidens* to the senses, this should not be interpreted to mean that *per se* sensibles are only *per accidens* attained by mind. The mind extends *per se* both to what is *per se* sensible to the senses and to what is sensed by them *per accidens*, grasping both one and the other as connected *per se*, for it is not *per accidens* that Socrates has shape and colour. In a similar way the mind apprehends speech both as a series of sounds and as possessed of meaning.

4. *New imposition of the name 'subject' used with regard to what is sensible "per accidens"*

Observe that, in using the word 'subject' with reference to the thing incidentally sensed while apprehending what is *per se* sensible of the man Socrates, we imply a meaning that goes beyond the original and more known one exemplified by 'the floor beneath, and subject to, the table.' The new imposition would also apply to the wood that the bowling-pin is made of, as subject of its figure or form. In this second example, the word 'subject' is obviously not intended to suggest that the matter, viz. wood, is beneath or subjected to colour and figure in the same way in which the floor is beneath the table. The subject of the figure, colour, hardness of the bowling-pin is what we called its sensible matter, viz., the wood. Now, just as the wood, compared to all that is *per se* sensible in the bowling-pin, is the sensible matter of this object, so bones and flesh, compared to all that is *per se* sensible of Socrates, are his sensible matter, viz., the matter of the man as *per se* subject of whatever is known of him by sensation of quality, quantity and modes of quantity. It follows that what we call the sensible matter of Socrates, is sensible only in the manner that Socrates himself is, that is, *per accidens*. When we term his matter-sensible, we do not imply that it is convertible with the subject in every respect, as if Socrates were no more than his sensible matter; we mean Socrates precisely as the subject of what is *per se* sensible in him, and this subject will be that which, in him, is sensible *per accidens*.

Someone may suggest at this point that what we are calling sensible matter seems very like 'substance.' The term substance, however, has so many meanings, most of which are irrelevant to what is intended here, that we may avoid using it until we meet a problem requiring its explanation. For the present let it suffice that 'sensible matter'

refers to that which a thing is made of, like the wood of the bowling-pin, or the bones and flesh of man.

5. *Not every subject of "per se" sensible objects is to be called sensible "per accidens"*

Note further that not everything having the nature of subject with regard to the *per se* sensible is therefore merely sensible *per accidens*. With respect to its colour, for example, the surface of the bowling-pin is a subject, and yet it is sensible *per se*. Sensible matter, on the other hand, is perceived as subject of each and all *per se* sensible objects. But this raises an obvious difficulty. If sensible matter is what a thing is made of, like wood, and if, in its turn, the wood which we designate by means of its qualities and structure is made of something else not called wood — the cells that the fibers are made of and the molecules making up the cells — which do we intend by 'sensible matter?' Here is a problem which would be quite insoluble if the reason for the qualification 'sensible' were forgotten.

The point is that, when we call wood 'sensible matter,' all that we do is to refer to a subject as apprehended in the act of sensing these qualities and structure which are our only means of identifying wood. We have no sense perception of the nature of wood, nor is there any question of an insight into 'what wood is' absolutely. To grant that we can be aware of sensible matter is not to grant more than this: first, that, in perceiving sensible objects, if we can distinguish one from another, in number or in kind, it can only be to the extent that differences in the *per se* sensible objects (like number or figure) may be signs of different subjects (as one man is distinct from another, or from a horse); secondly, that we never sense any object without being made aware of some background, incidentally sensible, about which we know only that it has shape, colour, resistance or absence of resistance, and so on. This is the only way in which the incidentally sensible is known while the act of sensation is going on. Even though we may call the matter wood, rather than glass, let us say, the name chosen does not — at least in the beginning — refer to what the nature of the matter is in itself. And when we learn that the wood is made of cells, the cells of molecules, and the molecules of electrical charges, we may qualify these as sensible matter, inasmuch as they are held to be constituents of what is primarily apprehended as sensible matter. For it is surely what we apprehend as wood, and so name, that is made up of those things.

6. *Sensible matter is only "per accidens" sensible*

This shows how important it is to find the reason why that which is known to us in sensation as matter must be termed sensible. Al-

though it must be maintained that sensible matter is known *per se* to the mind, and to the senses only incidentally, this should not be interpreted to mean that the mind thereby knows 'what the matter is' absolutely. When the physicist points to the atom as an instance of matter, and then proceeds to show that it is convertible into energy, hinting, finally, that perhaps there is no matter there at all, he does not use the word as we intend it in the phrase 'sensible matter.' Whether sensible matter turns out to be a swarm of electrical charges or not does not affect what we mean when naming it; bone and flesh are not less bone and flesh for having an inner structure far more intricate and hidden than was dreamed of when man first knew and named them. And to make reference to what is thus called sensible matter is absolutely necessary for, if this reference be withheld or denied, there will be no way of knowing whether what science is elaborating upon has anything at all to do with the reality first attained by us in sense experience.¹

VIII. THE TERMS OF THIS DIVISION IN POINT OF CERTITUDE

In one way or another, all our knowledge depends on the senses. It should also be clear that all the definitions of natural science — whether they are definitions in the strict sense or not — must be in terms of sensible matter. Nevertheless, the physicist in particular feels obliged, from the start, to exclude sense-impressions as leading to confusion. It seems our duty, therefore, to examine what our sense-impressions actually bring us, and in what measure they are to be trusted.

1. *Errors with regard to proper sensibles*

In the text quoted on page 169, Aristotle observed that the proper object of each sense is one about which there is no mistake, as sight is not mistaken about colour; hearing, about sound; taste, about flavour; whereas, concerning the common sensibles, error is normal, as when the size of the sun appears to be about that of a dinner-plate, or when touch reports two objects when we cross our fingers over a single marble. But in that department of natural science called mathematical physics, where only the measurable aspect of things is considered, and in which there is plainly more exactness, the proper sensibles seem to have lost their favoured position. For instance, this water may seem warm to my right hand but cold to my left. What is the water,

1. A further subject of investigation would be the relations between real things, and how these are known to us. We would find that, although their foundations may be sensible *per se*, the relations themselves are only sensible *per accidens*. But this is a question too involved for full discussion at this juncture.

then, warm or cold? The trouble is, of course, that my two hands were at very different temperatures when I plunged them into the water. But no such problem arises when a thermometer is used to measure the temperature. Even sight, a more detached sense, does not entirely escape such relativity: I have the impression that this surface is red, while another may see it as a shade of grey; and the surface which, to the naked eye, appears white becomes a shade of green when I wear green glasses. The first difference is explained, to some extent, when it is learned that the man who sees only a shade of grey is colour-blind; but the second example shows that any colour we spontaneously attribute to a thing may also have something to do with the structure of the normal organ of sight in such a way that we always misjudge when in an absolute way we attribute the colour as we see it, to the thing to which our sight refers us. This relativity of sensation is something from which there is no escape.

After remarking that "each particular sense can discern these proper objects without deception; thus sight errs not as to colour, nor hearing as to sound," Aristotle qualifies this statement by adding: "though it might err about *what* is coloured, or *where* it is, or *what* it is that is sounding or where it is." What is meant by this qualification St. Thomas explains when he distinguishes¹ between the sense as a *thing* reporting to the mind how it is *itself* affected, and that same sense as one thing indicating *another* thing; as 'I have a bitter taste in my mouth while eating this apple', as opposed to 'the apple has a bitter taste.' As a thing reporting on itself, the sense does not err; but when indicating something else it may be responsible for a mistaken judgment. One might object that the apple is actually sweet, but tastes bitter when the tongue is coated by illness. However, even when this difference in taste is accounted for by the unusual disposition of the organ — which gave rise to an incidental error concerning what the apple *normally* tastes like — we still deceive ourselves if we attribute the quality perceived as belonging to the other thing (the apple) in the way in which the sense reports it, even when normally disposed. Spontaneously we do believe that the taste of an apple is wholly in the apple; yet in believing this we go beyond what the sense reports as its own affection. In other words, if my judgment goes like this: 'I sense things *as if* the quality which I perceive were present in the thing itself as my sense refers to it,' then my judgment is unassailably true. And there is surely some quite determinate reason why the sense reports the other thing in that way. How the apple and my sense of taste contrive to produce this kind of sensation is not revealed in sensation. The knowledge which allows me to verify the word 'taste' throws no light on this.

1. *Q. D. de Veritate*, q.1, a.11.

No matter what the conditions of sensation may be, I cannot doubt, when I see a surface as green, that I truly see green, nor doubt that I see it as being in that surface. But whether it is there in the way in which my sight reports it is another matter. In fact, the more we learn about sensation the better we realize that qualities are not simply *there* as we sense them. But this does not change the really relevant fact that we do perceive qualities, that the perception of them is real, and that the term 'reality' refers first of all to the kind of being attained in actual and external sensation.

Hence it would be idle to suppose that the senses could be detached from things sensed to the point where they would be as faithful in reporting on these things as they are in reporting their own affections. To put such a demand upon them would destroy their very nature as senses inasmuch as some kind of physical union of the organ with the object, occurring in a way which sensation does not convey, is a prerequisite of sense knowledge. What and how the things which sense refers to are out there simply cannot be known by the senses themselves when, by their very nature, they are organic faculties, operating by, and inseparable from, instruments entitatively part of material reality.¹ Even the organ of our most detached external sense, sight, is being physically affected when we see. Not that the mere physical affection is the act of knowing, but the sensation cannot take place without it.

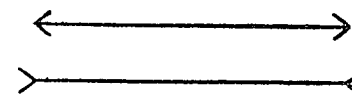
To put it briefly, error with regard to proper sensibles is incidental to them in two ways: (a) the typical examples are the colour-blind who believe that the way they see colours is the way in which all or most people see them; or the sick, who attribute the bad taste to the food. Such errors consist in deciding what is normal by means of sense equipment that is abnormal, so that a difference which is only incidental is ascribed to the things the sense refers to. (b) When *any* quality is judged to belong to the thing indicated by the sense, as an absolute property of that thing in exactly the way the sense is affected by it.

Must we conclude from this that there is nothing in things themselves which could rightly be called sensible quality, or even, mere quality, to the point where the external cause of sensation would be of a different nature altogether, like quantity? We will come back to this question after discussing sensation with respect to certitude.

1. 'Organon' means tool or instrument. 'Organized body,' which the definition of the soul refers to, means a body equipped with tools, namely, physical instruments of the kind of operations which are characteristic of living beings in nature. ARISTOTLE, *De Anima*, II, chap. 1, 412 b. Cf. CHARLES DE KONINCK, *Introduction à l'étude de l'âme*, dans *Laval théologique et philosophique*, 1947, Vol. III, n. 1, pp. 9 et sq.

2. Error with regard to common sensibles

Mistakes in judgment about the common sensibles are normal. The illusion illustrated here is a familiar example:



When two horizontal lines of equal length are made to terminate, one in arrow heads, the other in feather heads, the second will appear longer than the first. Of course, there is error only so long as we judge the things to be as they appear in sensation, and this example has exactly the value of that used by Aristotle, of the sun appearing to be only the size of a dinner-plate.

In our estimates of common sensibles we inevitably commit ourselves far more as to the status of the things 'out there,' although on the other hand, our mistaken judgment can be corrected by measurement. It is partly because of this possibility of verification by measure, that the common sensibles are accorded a more objective status than the proper ones. But it should be noted that the process of measuring involves a certain operation, namely, the collation and comparison of measure and measured, as in counting or in determining a length; and that this operation is performed by the mind, though on the basis of, and together with, external sensation.

There is another way in which common sensibles lead to error in judgment. A process of mathematical abstraction is going on unceasingly as we receive perceptions of quantity and of quantitative modes. A line can be drawn so thin that it yields no distinct perception of width, and its parts in length are made to appear so fused that they give an impression of uninterrupted continuity. The result is that we assimilate the sensible line to the one generated in imagination by a point in motion. Both to touch and to sight the bowling-ball has the appearance of a true sphere. Actually, any visible or tangible line or sphere can offer no more than the appearance of true continuity and regularity. For it is only when we consider a line apart from any sensible example that we can be sure that it is a line; and only when we consider a sphere apart from a sensible one can we know that it is a finite solid having every point on its surface equidistant from a point within called the center. When we project this exactness into the objects of sensation, we commit an error. It is only by prescinding from *per se* sensible objects that we achieve such rigour. To proceed as if ideal and real object were the same, as when a star is taken as a point, is an example of the kind of fiction needed by mathematical physics.

It is again a mistake to believe that proper sensibles can be expressed in terms of quantity or of quantitative modes, for example,

that the definition of a colour by its angle of refraction is a definition of colour as a proper sensible. If it were, we could know exactly what it is to perceive colour without possessing the power of vision at all.

3. *Errors with regard to the incidentally sensible*

Whenever sensation occurs, we also attain a *per accidens* sensible subject. Our natural inclination is to believe that this subject is just what it appears to be to the senses. An example, based on experience of certain qualities, would be the judgment that a certain liquid is honey, because it looks like honey, whereas actually it is bile. In this instance the error could be corrected by perception of some other sensible quality, like odour, or taste. Again, we distinguish the various kinds of animals, and of plants too, mainly by their difference in figure. Then we take the further step of thinking that difference in figure is identical with the difference that makes this thing to be the kind of thing it is, whereas figure is only an external sign (in plants and in animals a fairly proximate one, to be sure) of difference in kind.

As regards quantity, errors concerning the subject are also very frequent. It is easy to fall into the habit of thinking that a fluid, like water, is a continuous homogeneous mass, comparable to the three-dimensional continuum of geometry, so that no matter how long we might keep on halving it, we would always have water. The sun appears to revolve around the earth. The propagation of light seems instantaneous. Misjudgments like these concerning the subject of the common sensibles are so natural that scientific correction of them is of recent date, and the means of correction remain very remote from direct sense-perception.

But the thing to notice is that the difference in subject is always grasped at indirectly, through differences in what is *per se* sensible. Our judgment in all such cases would be quite correct if it confined itself to what appears to be. It is true that to sight this fluid appears to be honey. It is true that the body of water appears to be a continuous mass. In short, it all comes to this, that "regarding the nature of truth, we must maintain that not everything which appears is true; firstly, because even if sensation — at least of the object that is proper to a given sense — is not false, still imagination is not the same as sensation."¹

Those who are disturbed by so frank an acknowledgment of our propensity to err in these things, or who are made uncomfortable by the contrast between the stern requirements of truth and an easy adaptation to appearances, should be reminded that "error is a state more natural to the animals than the truth, and in which the mind spends the

1. ARISTOTLE, *Metaph.*, IV, chap.5, 1010 b; ST. THOMAS, lect. 14. Cf. *De Anima*, III, chap.3, 427 b 15; ST. THOMAS, lect.4.

greater part of its time."¹ The thing we can never afford to forget is the vast difference between the kind of certitude about nature required for making, and the far higher certitude demanded by that knowledge of nature which is purely for the sake of knowing: between knowing what stone is for the purpose of building, or what wheat is for the purpose of baking, and knowledge of what stone and wheat are for the sake of knowing just what they are in themselves quite apart from what they may be used for. Lack of mineralogy and botany did not prevent the Greeks from erecting fine buildings, or making a nourishing bread. Certitude is achieved in practical life when we know a thing as suitable to the end we have in view, whereas in speculative science, our aim is to make the mind conform to what things are absolutely.

IX. DIVISION OF 'DEMONSTRATION TO SENSE,' TO CORRESPOND WITH THAT OF SENSIBLE OBJECTS

We have frequently been using the demonstrative pronoun 'this' to express designation of something individual. Such designation to sense is also called *demonstratio ad sensum*, where 'demonstration' is taken in the original sense of that showing of a thing, that setting it apart from other things by pointing it out, which occurs first of all in the order of sense experience. Now that the general division of sensible objects has been established, there is a parallel division of demonstration to sense to be explained. That various modes of demonstration to sense must be distinguished is clear from the fact that 'this' in 'this sensation of warmth,' 'this figure,' 'this stone' or 'this man,' is not of one kind. The failure to observe the distinction, and the common enough insistence that the only valid designation is one in the mode of the common sensibles, are the consequence of a tacit assumption that only common sensibles are real.

1. 'Demonstration to sense' in the order of proper sensibles

When asked to convey what 'warmth' stands for, as the name of a proper sense-object, we define the word by referring to an experience that another must be able to share, e.g., by approaching the fire, or by putting his hand in this water that feels warm to me — provided his hand has approximately the temperature of my own. In doing this we are not 'pointing out' the warmth as we would a

1. ARISTOTLE, *De Anima*, III, chap.3, 427 b. ST. THOMAS's exposition reads as follows: "For error seems to be more natural to animals, as they actually are, than knowledge. For experience proves that people easily deceive and delude themselves, whilst to come to true knowledge they need to be taught by others. Again, the mind is involved in error for a longer time than it spends in knowing truth, for we barely attain to knowledge of truth even after a long course of study" (*Ibid.*, lect.4, n.624).

number or a figure. The warmth I point out is not 'there' in exactly the way the figure of the billiard-ball is 'there.' It is because tangible qualities and tastes cannot be pointed out as common sensibles are pointed out, that they are sometimes held to be at least less real. Yet it is not possible to doubt the reality of this sensation of warmth, not only as a sensation, but precisely as a sensation of warmth; for the sensation is not received as the sensation of a sensation, but as the sensation of a warmth as real as anything else that I am aware of; nor can I doubt that this water that I now feel to be warm really has something to do with this sensation of mine. However, this does not imply that I believe the warmth to be in the water in the way I feel it: the sensible warmth in act is the sense in act, and not the water, which is never more than sensible in potency. Taste is another case in point. I have no doubt about the reality of the taste of this apple as I eat it. However, to assert that the taste of this apple is real does not mean that the apple tastes good when no one is tasting it. Nor may I doubt that the apple has something to do with the real taste I have, although this real taste is not, nor could be, in the apple in the way it really is in me as I sense it.

The names of tangible qualities, of tastes and of smells are ambiguous, as can be seen from the expressions: 'the water feels warm,' 'the apple tastes good,' 'the milk smells sour,' — as if the feeling, the tasting, and the smelling were in the things themselves; as if the sensation were in them. But common usage is merely bringing out the fact that the share of our physical organs in sensation cannot be divorced from the share of the thing that acts upon them. Both are involved. It would be just as naive to put the whole responsibility for *what* is sensed on the one who senses, as to put it all in the thing our sense refers to. The temperature of the water can be raised until the sense finds it unbearable; and apple-growers can improve the taste of apples. These changes take place in the water and in the apples.

'The taste of an apple,' can mean two things, then, the particular kind of sensation of quality that I have when eating an apple, or that, in the apple, which produces (or co-produces with my sense organ) such a sensation. I can designate neither of these meanings to sense in the way that I can point out a billiard ball. And it should be noted particularly that there is more than the 'taste in the apple,' i.e., the share of the apple in causing sensation, that is 'outside the mind'; even my tasting is outside the mind as the taste I have is here and now as this individual sense experience, a thing which I cannot help while eating. But to designate this individual experience in the way I designate the shape of the apple is not in my power.

... The sense objects which actuate sensitive activities — the visible, the audible, etc. — exist outside the mind; the reason being that actual sensation attains to the individual things, which are outside the mind; whereas

science is of universals which exist somehow within the mind. Whence it is clear that the man who already has scientific knowledge does not need to seek the objects outside himself; he already possesses them inwardly, and is able, unless prevented for some incidental reason, to reflect on them whenever he pleases. But a man cannot sense whenever he pleases; for he does not possess the sense objects in himself, but they must be present to him externally. And as with the operation of the senses, so with the sciences of sensible things; for the sensible things themselves are among those which are singulars, and which exist outside the mind. Therefore a man cannot consider scientifically whatever sensible things he pleases, but only those which he perceives by the senses.¹

2. *Demonstration to sense of the common sensibles*

To point out common sensibles, like numbers or shapes, is apparently something far more simple than to point out proper sense-objects. We verify the meaning of a sensible 'two' when we point out two billiard-balls, and the meaning of 'spherical' by indicating their shape, and of 'where' by showing where one is with respect to the other. Again the word 'warmth' no longer signifies the proper sensible, when used with reference to the measure-number obtained by using a thermometer. The result is conveyed without reference to the sensation of warmth, and the word no longer means specifically the tangible quality nor, in any clear way, even the real quality in the thing which causes the feeling of warmth upon contact with the organ of touch. As regards the thermometer, then, the term warmth stands indirectly for no more than the measurable aspect of the quality. Between degrees of temperature defined by means of a thermometer and what we sense as warmth there exists no doubt a relation, but the relation is hardly clear. Of course we observe that to a rise of the measurable temperature of the water, there corresponds a more intense sensation of warmth; and from the fact that this rise can be carried to a point which entails destruction of the organ it is plain that there is indeed a connection between what is expressed by the measure-number and what we feel as warmth. But, when the temperature of the water is eventually defined as the kinetic energy of its molecules, we are given no reason why temperature should produce in us a sensation of that kind.

It should now be apparent that temperature, defined in terms of a common sensible, can be demonstrated to sense as 'out there,' in a way that is impossible for proper sensible objects. In connection with common sensibles, 'out there' takes on a special meaning, and so does the expression 'outside the knower.' What is said to be 'out there' can be verified by a process of measurement; while 'outside the

1. ST. THOMAS, *In II de Anima*, lect.12, nn.375-6.

knower' now conveys a spatial meaning, that is, the known is outside the knower as this billiard-ball lies outside that one. It is often assumed that 'outside the knower' must always convey this kind of outsideness; but the assumption is unwarranted, for the independent reality of what is known in sensation of proper objects is not diminished by the fact that I cannot point it out as I can the figure of the billiard-ball. Nor is the reality of the known lessened in any way in the case where it is something of the knower in his own physical nature; as when I feel warmth in my brow, that warmth is not less external to the mind than the warmth I feel when putting my hand in that water out there. No matter where the irritation takes place in the man who feels pain in an amputated leg, it is still an awareness of reality. Were I the only being making up a world, feeling and comparing only parts of myself, that world would be no less objective, outside myself as knower, and real, than a world made up of many individuals and of other knowing selves.

In fact, the 'real' status of common sensibles, or of whatever is defined in terms of them, is genuine only to the degree that we attain real sensation of proper sensibles. If there is no value in the designation of the proper sensibles, then there is assuredly none in the designation of the common sensibles. If the so-called secondary qualities be no more than "mind-spinning," the real status of the primary ones will be carried off with them. Sir Arthur Eddington recalls that "When Dr. Johnson felt himself getting tied up in argument over 'Bishop Berkeley's ingenious sophistry to prove the non-existence of matter, and that everything in the universe is merely ideal,'" he answered, "striking his foot with mighty force against a large stone, till he rebounded from it,—'I refute it *thus*.'" Eddington adds: "Just what that action assured him of is not very obvious; but apparently he found it comforting."¹ But what Dr. Johnson's understanding of Berkeley's idealism was is less important here than what he claimed to be sure of in that action. And Sir Arthur himself makes it obvious enough in another of his books:

But although we try to make a clean start, rejecting instinctive or traditional interpretations of experience and accepting only the kind of knowledge which can be inferred by strictly scientific methods, we cannot cut ourselves loose altogether from the familiar story teller. We lay down the principle that he is always to be mistrusted; but we cannot do without him in science. What I mean is this: we rig up some delicate physical experiment with galvanometers, micrometers, etc., specially designed to eliminate the fallibility of human perceptions; but in the end we must trust to our perceptions to tell us the result of the experiment. Even if the apparatus is self-recording we employ our senses to read the records.²

1. *The Nature of the Physical World*, chap. XV, p. 326.

2. *New Pathways in Science*, chap. I, p. 2.

Here is a frank admission that sensation cannot be dispensed with, and must be trusted somewhere, if we are to have any trust in the physical basis of mathematical physics. The proper sensibles may not appear in the definitions with which this branch of natural science begins—as we have seen, some time is spent in getting rid of them¹—nor need they be defined or explained when the inevitable return is made to them. Thermodynamics does not give the proper reason why a certain amount of disorderly movement of molecules should be accompanied in us by a sensation of warmth, nor does optics tell us why light of a given wave-length should make us see red. There is no way of getting behind this kind of sensation, whereas we can proceed to do something about the common sensibles, for example, the operation of measuring them. Yet even here, as we choose a standard of length and then apply it, we remain bound to a proper sensible of one kind or another, which cannot be rendered in terms of number or magnitude. Although our definitions may appear detached from the proper sensible to a considerable degree, they can never be wrested wholly free of it. Definitions bearing no relation to proper sensibles would have lost all contact with that reality which our senses seize, with no clear awareness of its nature perhaps, but with utter sureness. We may grant that physics, in order to make headway, must ignore our feeling of weight; but at the same time we ourselves must surely be subject to the gravity that it talks about.

3. *Demonstration to sense of what is sensible "per accidens"*

To point out 'this man Socrates' is still another kind of demonstration to sense as widely different from the two preceding types as the incidentally sensible is from *per se* sensible objects. In pointing out Socrates we demonstrate something to sense which is attained *per se* by the mind and *per accidens* by the senses.

It is noteworthy that, in choosing an instance of what is meant by an individual demonstrable to sense, we fix upon a man, or upon some familiar animal, like a horse, but not so readily upon a point on the blackboard, nor even a stone. The reason is that we have internal

1. MAX PLANCK, *Theoretical Physics*: "While originally, . . . the fundamental ideas of physics were taken from the specific sense perceptions of man, the latter are today in large number excluded from physical acoustics, optics, and the theory of heat. The physical definitions of tone, color, and of temperature are today in no wise derived from perception through the corresponding senses . . ." — "The result is nothing more than the attainment of unity and compactness in our system of theoretical physics, and, in fact, the unity of the system, not only in relation to all of its details, but also in relation to physicists of all places, all times, all peoples, all cultures . . . To sum up, we may say that the characteristic feature of the actual development of the system of theoretical physics is an ever extending emancipation from the anthropomorphic elements, which has for its object the most complete separation possible of the system of physics and the individual personality of the physicist. One may call this the objectiveness of the system of physics" (pp. 4-7).

experience of numerical unity, exhibited in our sensations, in our conscious activities of thinking, doing and making, as belonging to one and the same self. Of the visible point on the blackboard we know that it is just particles of chalk; and of the stone, that while it may have the tangible and visible appearance of an individual like an individual man, it might still be many individuals. That a stone is an instance of individuality in some fashion is beyond doubt — there is nothing universal about this particular stone — but the individuality could be like that of a single crowd, or of the individual sun. We do not think this of a horse.

Though in sensing we are always referred to something that is *per accidens* sensible, we can rarely be sure that this something is a single individual in the way that a man is. For a man is unmistakably an integral whole, notwithstanding the many respects in which he is a composite, an assemblage. There is, to be sure, a way of referring to him as a collection. To the mathematical physicist, Socrates is a swarm of electric charges, sparsely scattered in an emptiness so out of proportion with what remains in him of bulk that the latter amounts to less than one billionth of the total of Socrates himself. To the anatomist, he may be an assemblage of head, arms, legs, liver, etc.; and to the physiologist, a compact of various kinds of fibers each made up of certain types of cells, etc. The psychologist reveals in him another set of parts, like intellect, will, and various kinds of internal and external senses. And yet, when we point out Socrates, we are confident that he nevertheless makes one single individual; nor could we possibly treat him like a crowd or a mere bundle of events. But the physicist, to whom he may be no more than a bundle of events, could not possibly point him out in any other way; his roundabout way of demonstrating to sense can never terminate anywhere but in the domain to which he had to confine himself from the start: the domain of common sensibles.

What would happen to Socrates if only the second type of demonstration to sense were recognized as valid? if he were singled out only by means of his common sensibles? Although substance as such is not our present concern, yet it may be helpful to watch what Socrates (or Mr. Smith) becomes when Bertrand Russell attempts to reject substance, both in notion and reality, by assuming that there is no other way of denoting than that permissible to the physicist:

"Substance," in fact, is merely a convenient way of collecting events into bundles. What can we know about Mr. Smith? When we look at him, we see a pattern of colours; when we listen to him talking, we hear a series of sounds. We believe that, like us, he has thoughts and feelings. But what is Mr. Smith apart from all these occurrences? A mere imaginary hook, from which the occurrences are supposed to hang. They have in fact no need of a hook, any more than the earth needs an elephant to rest upon. Any one can see, in the analogous case of a geographical region,

that such a word as "France" (say) is only a linguistic convenience, and that there is not a *thing* called "France" over and above its various parts. The same holds of "Mr. Smith"; it is a collective name for a number of occurrences. If we take it as anything more, it denotes something completely unknowable, and therefore not needed for the expression of what we know.¹

It is surely very odd, though, that even as we are dismissing him as a mere collection of events, we do not seem able to avoid denoting this incidentally sensible *him*, Mr. Smith. If we can rest satisfied with this sort of verbal twist, it is because we accept the supposition that there is only one adequate way of denoting to sense. Yet, as the example proves, we are also assuming the third mode and actually using it to establish the second: that which we call a mere series of sounds and pattern of colour is the man we see and hear, Mr. Smith. In fact, even the first mode is involved here (and hence all three): for we cannot see him without seeing colour, nor hear him without hearing sound. Observe, too, that, in the example as it is stated, the second mode, to which the other two are intended to yield, is actually least in evidence. For it is not made clear that the colour pattern and the series of sounds are meant to be understood as the physicist defines them, not as we see and hear them. The implied reduction to measure-numbers would have been somewhat more awkward had the figure of Mr. Smith or the arrangement of his members been selected as samples of the experiences he occasions in us.

Required as we are to disregard the third mode of designation, we shall also logically be compelled to overlook *what* Mr. Smith is saying here and now, for what he intends to convey by his series of sounds is not present in them as spherical shape is in the billiard-ball, and hence must escape the scientific filter through which Russell is passing him. And if we choose to call Mr. Smith a man, and to explain 'man' by 'rational animal,' we will certainly be forced to abandon 'rational' as not susceptible of designation to sense. In fact, even 'animal' must escape us, if by 'animal' is meant 'a body apt to have sensation,' since we cannot point out a sensation as we can a common sensible.

In short, when we declare Mr. Smith to be no more than a collection of events, we imply that he is only something that the physicist can express in terms of measure-numbers. But, in mathematical physics, when names are used — and they seem to be needed at times — they stand for one or more measure-numbers and theoretical constructions properly expressed by symbols that are not names. By rigid scientific standards, then, once we really know Mr. Smith we should not name him at all; for he is not the kind of individual

1. *A History of Western Philosophy*, pp. 201-202.

he seems to be, and to give him a collective name would only oblige us to face a collection of quasi-hims, things and aspects of things like those which 'France' is intended to convey.

X. THE ATTEMPT TO DIVORCE OURSELVES FROM DEPENDENCE UPON SENSE OBJECTS

We have already said that to attribute to ourselves or, more exactly, to our sensations alone, the qualities we sense, would be just as naive as to put the burden of *what* we sense upon something designatable in the fashion of a common sensible. The clear impossibility of doing so has inclined many to reject 'secondary' qualities as unreal, as mere projections of the imagination. Now, what explains this attempt to shake off what is actually first in knowledge and without which nothing else can be known? For, just as we could not know what a sensation is without having a real one, so we could not know anything real without having a sensation.

What seems to instigate the typical objections to the validity of proper sensibles is the half-conscious hope of finding out how things would appear, and what essential properties they would have, if they could be reached by some avenue other than that avenue of proper sensation which is our first and last means of approach to them. "When an external object raps on the door at the extremity of a nerve, you cannot put your head outside to see what is rapping,"¹ but you cannot help wishing that you could. What should be observed is that the things our senses refer us to act upon us physically even before awareness is aroused — 'before' meaning at least by priority of nature. When I feel warmth, something happens to the temperature of my hand, thanks to a difference in temperature between the organ and that which is affecting it. The sensation of course does not consist simply in this physical change, for then stones ought to feel warmth when heated. But the point is that there is no sense-knowledge without some physical alteration, and it is this which makes all the difference between reason and sense, however much the former may depend upon the latter. A relatively high or low temperature is sufficient to destroy the sense of touch; while rational knowledge of a temperature, no matter how extreme, does not destroy reason. When we ourselves are so entitatively and obscurely involved in the very act of sensation, it follows that we can hardly hope for a detachment like that of reason in mathematics. There is detachment in sensation itself to the extent that there is knowledge, but it remains knowledge essentially bound to a physical organ involved in the act of knowing. And since sensation continues in one way or another to

1. EDDINGTON, *New Pathways in Science*, p.6.

be a condition of every kind of knowledge we can acquire, we have simply got to learn how to live with it, while keeping it in its place.

It is noteworthy that difficulties concerning the status of proper sensibles have been raised chiefly with regard to tangible qualities, and that these have been, in one breath, called fictitious and, in the next, invoked as the chief basis for our confidence in reality. It is indeed a paradox that touch may be considered the least objective of our senses, while at the same time it is in feeling resistance to touch that we are first and most vividly aware of what is 'outside the mind.' This is quite understandable when we realize that touch, as compared to sight, is, on the one hand, so coarse, so poor in representation, since its organ is so inextricably entangled with whatever is touched; while, on the other hand, it is in the feel of being buffeted by reality in resistance to our touch¹ that we have the most vivid experience of existence. It is the sense, the touchstone, upon which the most elaborate theories of mathematical physics must continue to rely. Without it we could not reach even existence in the sense of truth that is essential to every science. Yet if there were not this unmistakeable entitative involvement² between touch and touched, if the organ itself were divested of the contraries of hard and soft, warm and cold, wet and dry, it could not bring us that assurance, admittedly gross, which it is normal to expect from it — the assurance sought by the doubting Thomas in all of us. The eye never conveys that assurance so strikingly, except when in pain from excessive light, and even this must be attributed to touch lying at its base.

XI. THE MEANING OF SENSIBLE MATTER WITH REGARD TO THE DEFINITIONS OF MATHEMATICAL PHYSICS

In order to understand the precise relationship of sensible matter to the definitions of mathematical physics, it will be necessary to

1. It is a universal experience that, whenever man wants certainty about the real existence of a sense object, he will try to verify it by touch. It is for this reason especially that touch is called the sense of certitude, while sight is the sense of distinction, of clarity, and of representation. Where the brute fact of physical existence is concerned, sight, notwithstanding its accuracy of discernment and its certitude of distinction, yields less assurance than touch. The words "phantom" or "ghost" usually stand for things visual, yet unreal and intangible; we compare them to the kind of representations we have in our dreams. Even when not doubting the things we see but cannot touch, we somehow feel more at home when they are brought within our reach, as is proved by the large numbers of people in this century ready to face any risk in order to set foot on the moon.

2. Let it be repeated that sensation cannot, of course, consist in this mere entitative involvement. The material change by itself is no more than a prerequisite, during which the sense power is still only in potency to true sensation. Sensation as knowledge is a change of a radically different kind. This is a subject for rational psychology, taken up by ARISTOTLE in the *De Anima*, Book II, chap.5 and 12 (St. THOMAS's Commentary, lect.11, 12 and 24); Book III, chap.7 (lect.12).

determine three things : first, what the common sensibles have to do with these definitions — a question easily enough answered ; secondly, to what extent the measure-numbers of this science are independent of proper sensibles ; thirdly, in what sense the incidentally sensible subject called 'sensible matter' enters into the statements of the physicist.

1. *The case of common sensibles*

Even the common sensibles, while dependent upon some proper sensible for our perception of them, are *per se* sensible, since they too produce a modification in our senses. By this is meant that they produce a physical change, as well as the change involved in knowing ; as the shape of a coin is imprinted on the hand that squeezes it ; or as the contour of the desk is successively registered on the fingers run along its edge, along with the sensation of movement ; and as a change takes place in the organ of sight while watching this shape and this movement. Even though a common sensible, like the actual size of the sun, for example, may lie beyond the scope of sensation, its physical reality remains beyond question ; nor is physics obliged to limit its investigations to those which can be established by the senses working through the tape-measure.

But when the physicist puts down the diameter of the sun, he cannot mean diameter quite as in geometry, where diameters are as intangible as points or lines. There is indeed even a connection with proper sensibles involved here insofar as the size of the sun is inseparable from its temperature. The fact is that, when he determines real size, no matter how far beyond the range of actually sensible magnitude, he still defines size in terms of how we measure it within the narrow scope of actual sensation, by means of a standard agreed upon — like the meter. He can claim knowledge of that which lies beyond the immediate reach of our senses — in remote stellar space, or deep in our very organs of sensation — only on this basic assumption : that the realities far beyond the scope of sensation to which he is applying numbers, magnitudes and quantitative modes are yet one in nature with those we can actually sense.

2. *Reference to proper sensibles*

Now let us turn to the *proper sensibles*. Apparently they are never expressed in an equation ; yet no equation can be called physical without reference to one or another of them. Until recently, scientists failed to realize the extent to which measure-numbers are inseparable from the basic standard of length, from scales, clocks, thermometers, and so on, as well as from the operations performed in using them. Measure-numbers are not gathered freely like the numbers and magni-

tudes of mathematics. 'What is extended in one dimension' gives us length, but nothing like a standard of length ; the latter cannot be made known by this type of definition at all. We can tell what we mean by 'the meter.' We call it a measure (in Latin *mensura*, in Greek *μέτρον*) which we define as 'that by which the quantity of a thing is first known' ; but this definition does not tell us what the meter is, to which the merchant or the physicist actually refers. The meter happens to be an individual thing, kept in a certain place and even in its designation, bound to a particular time : "The meter as now defined is the distance between two lines on a certain platinum-iridium bar kept at the International Bureau of Weights and Measures in Paris, when this bar is at 0°C. or 32°F. Copies of this bar are kept elsewhere" (Webster's). How much this ties us to the ineffable singular is plain from the fact that the graduated scale of the very instrument used to measure the temperature of the meter is divided by lines which are measured by the meter.

All will concede that to look at this bar is to see a colour, thanks to which there can be perceived lines and a certain distance between them. All will concede that the bar is hard and cold to touch ; that the lines could also be detected by the finger-tips, and the intervening distances by moving the finger-tips from one to the next. But, it will be argued, what we are really interested in is the bar as our standard of length, not the qualities which allow us to perceive it. But this is not the whole truth. If we abstracted from every sensible quality by means of which the thing becomes known to us as a physical thing decreed to be the standard of measure, what would meter mean ? What the physical property of length would be to an intellect which needs neither sensation nor any practical operation to know it would be something fascinating for us to guess at ; but our concern is with ourselves ; how do we know a physical length ? Aristotle faces this problem with the well-known example of the snub-nose. If our definition conveys the curve alone, prescind from bone and flesh, will our definition of such an object still be a physical one ? If we call it physical, we are assuming that there are curves in nature apart from curved subjects like a nose, or a moon, or the orbit of a moon. The curve defined without sensible matter, the mathematically abstract curve, has a simplicity nowhere matched in experience, and can no more be identified with the shape of a nose or a planet than a mathematical point can be identified with a star. Now, when we divorce our common sensibles from all sensible qualities, we are making them into such mathematical entities, which are not even sensible ; we are then faced with a curvature, for example, so absolutely exact that it can no longer be verified with exactness in experience.

It should now be clear that the incidentally sensed subject, which we called sensible matter, does appear in the definitions of the physicist. To abstract from that subject always means to be left

with something which is not the business of the physicist as such. Besides, if definitions are of universals, the definition of the meter to which the mathematical physicist refers, is not a definition in that sense ; it is a nominal definition or interpretation of a name.

X. IN WHAT MANNER THE DEFINITIONS OF MATHEMATICAL PHYSICS CONTAIN SENSIBLE MATTER

It is one thing to establish that the physicist must define with sensible matter, and another to show just how he takes account of it. The common impression that his statements disregard sensible matter entirely is not without justification, to say the least ; for he certainly appears to confine himself to the order of common sensibles, that is, to sensible numbers, magnitudes and modes of quantity, and soon arrives at entities and structures beyond the reach of actual sensation. It is therefore our duty to explain exactly how, even in the mathematical science of nature, the law governing all natural science applies, namely, that contact with, and dependence upon, the material reality upon which we lay our fingers is the ultimate test of validity.

1. *Whether what lies beyond the threshold of sensation can still be called sensible*

Let us begin with the following observation. The limens or thresholds of sensation are very narrow. The range between extreme cold and extreme warmth, perceptible to human touch, is but a minute fraction in the scale of measurable temperature. The heat at which the sense organ itself would be destroyed is very near the bottom of a scale that runs to millions of degrees. In terms of the proper sensibles, then, what can be meant by the heat inside the sun ? If sensible matter is so called because of its sensible qualities, it seems a likely conclusion that sensible matter is nowhere to be found beyond the narrow thresholds of sense awareness, — not for the physicist, at any rate, since he seems not even to mention matter, nor to be inconvenienced by the absence of it. But, if we stop to think, we must realize that what he can never forsake or ignore is 'that of which we have sense experience.' Our question therefore is always the old one : what is it that we do have sense-experience of ?

In his famous illustration of how the physicist treats the elephant sliding down a grassy hillside, Eddington makes plain that he is concerned only with pointer readings — like weight, bulk, friction, etc. — obtained by measurement applied to the elephant. Now the weighing-machine is of course quite indifferent to what it is that is being weighed : enough coal would provide the same measure-number of two tons. As the student puts down the elements needed to solve

the problem of how long it will take the elephant to reach the bottom of the hill, the elephant himself fades out of the picture ; i.e., what it is that slid down the hill has left the scene and that which the student retains can only be described as a bundle of pointer readings. To the mathematical physicist, the only man to handle such problems, it is precisely the "connectivity of pointer readings, expressed by physical laws, which supplies the continuous background that any realistic problem [in physics] demands."¹ And so "we have dismissed all preconception as to the background of our pointer readings, and for the most part we can discover nothing as to its nature."²

This kind of information does not of course pretend to teach us what it is to be an elephant. But it does tell us that, when something (whatever it may be) of a given bulk and weight slides down a slope of such a degree, it takes so much time to reach the bottom. Yet the point is that no matter how indifferent is the specific nature of the thing thus described, however irrelevant, once the pointer readings are obtained, something remains that is not a pointer reading. When the physicist considers a curve, it may be quite indifferent to the problem at hand whether it is the curve of a snub-nose or the curvature of the moon. But it must be the curvature of something or other, something demonstrable as 'this,' and which is not the curvature itself. Otherwise, what would be the difference between the form of a wave of liquid and its vaguely corresponding geometrical form ? The reply need not grant so much as that the first is the form of a 'material mass,' but it must admit that it is the form of something conveyed to us through the senses even though in itself it could never actually be sensed *per se*. This much is certain, anyhow, the wave is not a wave of matter in the sense which the physicist intends when he distinguishes between 'matter' and 'energy.' The latter words are used by him as linguistic devices in lieu of the symbols that are the true means of expressing what he has in mind.

2. *Sensible matter and Eddington's 'knowability of matter'*

The sensible matter that we are talking about is not to be identified with what Eddington calls "the background of the pointer readings," but rather with what he calls matter as "knowable to mind," to mind as distinguished from mere sensation. What we term 'sensible matter,' i.e., sensible *per accidens* and intelligible *per se*, is indeed a kind of background, too. But we are not requested to picture this 'background' as we do an elephant or an ocean wave ; it is not to be thought of as standing behind a measure-number as a tree might stand behind Mr. Smith. The background which makes

1. *The Nature of the Physical World*, p.255.

2. *Ibid.*, p.259.

the curve a physical one does not hold it up as Lord Russell's elephant might support the earth. In what relation to the pointer readings does it stand? Eddington moves a step or two nearer to the character of this 'background' when he observes that "physics treats of what is knowable to mind," and the fact that matter is knowable must be set down as one of the fundamental attributes of matter.

[... And this] potentiality of the whole physical world for awakening impressions in consciousness is an attribute not to be ignored when we compare the actual world with worlds which, we fancy, *might* have been created... We recognize the actuality of a particular world because it is that world alone with which consciousness interacts. However much the theoretical physicist may dislike a reference to consciousness, the experimental physicist uses freely this touchstone of actuality. He would perhaps prefer to believe that his instruments and observations are certified as actual by his material sense-organs... Each of us is armed with this touchstone of actuality; by applying it we decide that this sorry world of ours is actual and Utopia is a dream...

From a broader point of view than that of elaborating the physical scheme of law we cannot treat the connection with mind as merely an incident in a self-existent inorganic world. In saying that the differentiation of the actual from the non-actual is only expressible by reference to mind I do not mean to imply that a universe without conscious mind would have no more status than Utopia. But its property of actuality would be indefinable since the one approach to a definition is cut off. The actuality of Nature is like the beauty of Nature. We can scarcely describe the beauty of a landscape as non-existent when there is no conscious being to witness it; but it is through consciousness that we can attribute a meaning to it. And so it is with the actuality of the world. If actuality means "known to mind" then it is a purely subjective character of the world; to make it objective we must substitute "knowable to mind." The less stress we lay on the accident of parts of the world being known at the present era to particular minds, the more stress we must lay on the *potentiality* of being known to mind as a fundamental objective property of matter, giving it the status of actuality whether individual consciousness is taking note of it or not.¹

"Knowable to mind" we interpret as 'sensible matter.' For it is acknowledged that there is reference to the actuality in question by the material sense organs, while Eddington goes on to explain (in a passage omitted above) that the "final guarantor is the mind that comes to know the indications of the material organs." These statements account well enough for what we call "sensible matter," insofar as it is *per se* knowable to the mind while only incidentally sensed; — a kind of actuality and knowability that we demonstrate to sense according to the third mode.

¹ *Op. cit.*, pp.264-267.

Hence, the particular domain of mathematical physics shows "a definitely selective action of the mind; and since physics treats of what is knowable to mind its subject matter has undergone, and indeed retains evidences of, this process of selection. [...] The sphere of the differential equations of physics is the metrical cyclic scheme extracted out of the broader reality. However much the ramifications of the cycles may be extended by further scientific discovery, they cannot from their very nature trench on the background in which they have their being — their actuality."¹ The whole point is, however, that while the sensible matter to which the pointer readings refer the mind, is not brought to the fore, the actuality of the metrical world of physics is guaranteed only by the actuality of that background as perceived by the mind thanks to sensation. Eddington pointedly says "knowable to mind"; and he distinguishes "the actuality of being known" from "the potentiality of being known," just as we distinguished 'to be sensed in act,' which is on the part of the knower, from 'sensible in potency,' which is the actuality of what there is sensation of.

3. *Mathematical physics implies all three modes of demonstration to sense*

From this it is plain that mathematical physics actually depends upon all three modes of demonstration to sense, and that Eddington's philosophy of science implies this. (i) It confines itself to the metrical aspect of nature, first revealed as common sensibles (or primary qualities), and to which we must always return. (ii) The common sensibles are not perceived independently of some proper sensible or other. (iii) The mind cannot help but refer the metrical structure to a background which we call sensible matter.

This matter is not *per se* sensible; nor is it something merely intelligible. It is an object which the mind attains to as the proper subject of what is *per se* sensed. It can be known *per se* neither by external sense nor by imagination. In fact, it is our unwarranted attempt to imagine that subject which creates the need of an elephant for the earth to rest upon.

XIII. IN WHAT SENSE THE OPERATIONAL DEFINITIONS OF PHYSICS ARE DEFINITIONS

By showing that the mathematical physicist, as well as any other student of nature, defines with sensible matter we have actually done more than that: we have found on the one hand that measure-numbers are symbols interpreted by describing certain contrivances and the

¹ *Op. cit.*, p.264, 282.

operations by which these contrivances are put to use in order to reach a certain quantity ; we have seen how, in every instance, the standard of length is basic to all the other measurements, as is clear from the graduated scales of clocks, weighing machines, thermometers, and so on ; and that this basic standard is a certain platinum-iridium bar kept in Paris at a certain temperature. In other words, it is not enough to refer to 'some' individual thing : it must be the individual thing now in Paris.

1. *These definitions are interpretations of symbols*

Now this is not at all like the reply to "What is meant by the word 'man'?" which may consist in pointing out any man who happens along ; or like the answer to "What is intended by an 'equilateral triangle'?" which consists in making a particular construction. In physics it is as if the interpretation of the word man always implied reference to the particular individual called Socrates now living at such an address ; so that if any other man were pointed out, the reference would be valid only inasmuch as the other man were, not just another instance of man, but a reasonably faithful copy of the one named Socrates. It is as if, in the case of the 'equilateral triangle,' we had to refer to a construction made in the mind of Socrates, on the first of July, at such an address, with the help of a piece of chalk and the kitchen floor. An instance of the meter is never to be understood like an instance of 'man' or an instance of 'equilateral triangle.' An instance of a meter is a copy of 'the meter,' a particular object at a particular place, time, and temperature. The definitions of mathematical physics are therefore a very special type of interpretation : one which ultimately amounts to the designation of an individual something that will be the unique standard until a new convention is made. If we made the historical 'Socrates' equivalent to 'philosopher,' meaning that no one is a philosopher except in the degree that he is a duplicate of Socrates, we would be following a parallel usage.

Such definitions, then, cannot be definitions in the sense of expressing what a thing is ; they are simply interpretations of what the names or the symbols stand for. The definitions of mathematical physics are not even 'nominal' definitions and should not be confused with them. The physicist does not use descriptions, like "two-legged featherless animal" as interpreting the name 'man.' For the physicist as such does not use names, but operational symbols as distinguished from names. When he uses words like 'matter,' 'body,' 'movement,' or 'time,' he employs them merely as convenient linguistic substitutes for what should actually be expressed by measure-numbers. If he used them in any other way, he would be making them stand for something which, as a mathematical physi-

cist he cannot know, and hence cannot express. Further, unlike the symbols of mathematics, the symbols of physics can be interpreted only by referring to the kind of real individual described above.

2. *Although its interpretations must continue to refer to the individual sensible matter of the standard of measure, the aim of the science remains universal*

This last point seems to imply that the mathematical physicist is not concerned with the kind of universality that we saw as essential to science in the strict sense of this term. Yet, we have already insisted that even the physicist is not concerned with this universe *qua this*. And this view is still adhered to by men who are held to be authorities. Thus Whitehead declares that "to see what is general in what is particular and what is permanent in what is transitory is the aim of scientific thought."¹ Lord Russell agrees, for he speaks of "that essence of individuality which always eludes words and baffles description, but which, for that very reason, is irrelevant to science."² Henri Poincaré held, on the other hand, that "every generalisation is an hypothesis."³ The implication of this last remark is that, while the physicist does not pretend to have achieved any definitive generalisation, nevertheless, he seeks for his hypothesis the kind of confirmation by experiment that will assure him of being at least on the road towards strict generality. To attain this limit is out of the question, of course. No science can hope to formulate laws that apply everywhere and always when, by the very nature of the method which it employs, it is held bound to that standard of measure which alone gives meaning to its symbols.

If the day should dawn when the mathematical physicist could abstract from this particular standard to know the general laws of nature, he would find himself contemplating the universe from outside it, free from the limitations imposed on us by our dependence upon sensation. Individual sensible matter would no longer be a principle, neither *qua* individual nor *qua* sensible. In the meantime, he can only go on proposing tentative generalisations, on the general assumption of a similarity in structure between, on the one hand, the measure-numbers he obtains and the generalisations he makes from them, and, on the other hand, the absolute condition of the world, that is, the world as it is apart from how we get to know about it. Eddington put it this way :

But the physicist is not generally content to believe that the quantity he arrives at is something whose nature is inseparable from the kind of opera-

1. *Introduction to Mathematics*, p.11.

2. *Introduction to Mathematical Philosophy*, p.61.

3. *La Science et l'hypothèse*, p.178.

tions which led to it ; he has an idea that if he could become a god contemplating the external world, he would see his manufactured physical quantity forming a distinct feature of the picture. By finding that he can lay x unit measuring-rods in a line between two points he has manufactured the quantity x which he calls the distance between the points ; but he believes that that distance x is something already existing in the picture of the world — a gulf which would be apprehended by a superior intelligence as existing in itself without reference to the notion of operations with measuring-rods.

.....
The study of physical quantities, although they are the results of our own operations (actual or potential), gives us some kind of knowledge of the world conditions, since the same operations will give different results in different world conditions. It seems that this indirect knowledge is all that we can ever attain, and that it is only through its influences on such operations that we can represent to ourselves a 'condition of the world.' Any attempt to describe a condition of the world otherwise is either mathematical symbolism or meaningless jargon.¹

It would be entirely facetious to insist that this most exact of the sciences of nature cannot really claim to be a science at all in the strict sense of the term 'science.' Mathematical physics is the only means we have to extract a certain kind of knowledge about nature, and to grasp its aim and how near it can approach to truth is not less important than to expose its limitations.

We must never forget that our nature is that of the animal, to whom error is more natural than truth. And the most unfailing error of this animal is perhaps the premature confidence that he has the truth, that universal terms and propositions are as readily plucked from nature as cherries from a tree. Even when it is granted a background of centuries, the human mind "is involved in error for a longer time than it spends in knowing the truth."² This was plainly the case of Descartes, and of his followers into the XIXth Century, believing as they did that, from what turns out to be no more than imaginary 'matter and movement,' man could construct the universe in all that it is.

Charles DE KONINCK.

(To be continued)

1. *The Mathematical Theory of Relativity*, pp.1, 3.

2. Cf. ST. THOMAS, *In Boethium de Trinitate*, q.3, a.1, ad 4 : "...Etsi demonstratione numquam falsum concludatur, tamen frequenter in hoc homo fallitur, quod putat esse demonstrationem quod non est."

Marie dans le gouvernement de l'Église

CHAPITRE DEUXIÈME *

LA CAUSALITÉ INSTRUMENTALE PHYSIQUE DE MARIE

I. DIFFICULTÉ DE LOCALISER CETTE CAUSALITÉ

Le chapitre précédent n'avait d'autre fin que d'introduire celui-ci. Si la grâce, en effet, n'est pas le terme immédiat d'une activité créatrice, il n'y a plus d'impossibilité pour la créature de concourir à la production de la grâce, à titre de cause instrumentale. De fait, nous avons vu comment il est bien dans le mode d'agir de Dieu de se servir de ses créatures, même dans l'ordre surnaturel, comme il le fait avec l'Humanité sainte, des ministres et des sacrements. Or à tous ces instruments il faut attribuer une causalité physique.

Il est reconnu que Marie a certains rapports avec la collation de la grâce aux âmes. La première partie de ce travail a rapporté les opinions des théologiens à ce sujet. Mais est-il possible de voir dans ces rapports de Marie avec la grâce une véritable causalité instrumentale dans le sens des instruments mentionnés ci-haut ? C'est le problème qu'il nous reste à considérer.

Le rapport de Marie avec la grâce n'est, et ne peut être, ni celui de l'Humanité sainte, ni celui des sacrements, ni celui des ministres.

Le rapport de l'Humanité sainte à la grâce est celui d'un instrument conjoint de la divinité.

Par son union personnelle au Verbe, l'Humanité du Christ est en disponibilité immédiate et constante à l'égard de la divinité, comme le corps vis-à-vis de l'âme,¹ ou la main pour le corps.²

Il est évident qu'un tel rapport ne saurait exister pour Marie. N'étant pas unie à Dieu hypostatiquement, elle ne peut être que dans la catégorie des instruments séparés.

L'instrument séparé est extrinsèque à celui qui s'en sert : « unum quidem separatum, ut baculus. » C'est le cas du sacrement : « sac-

* La première partie de cet article est parue dans le numéro précédent.

1. Ce rapprochement que fait SAINT THOMAS (*IIIa*, q.8, a.2, c.), n'est pas en point identique, mais sous un rapport seulement. L'âme est forme du corps ; la divinité n'est pas forme de la nature humaine. C'est en tant que mue par l'âme que le corps est l'instrument ; c'est de même en tant que mue par la divinité que l'Humanité sainte est l'instrument.

2. « Est autem duplex instrumentum : unum quidem separatum, ut baculus ; alterum autem conjunctum, ut manus. » *IIIa*, q.62, a.5, c.

Notons tout d'abord que saint Thomas, à la fin de la même réponse poursuit ainsi : « Sed tamen sequens appetitum rationis in pluribus bene se habet, et non nisi in paucioribus male. »¹

Dans les *Sentences*², le saint Docteur nous fournit une doctrine plus détaillée concernant la fréquence du mal dans les diverses natures. Après avoir expliqué que le mal arrive « ut in paucioribus » dans les créatures irraisonnables et chez les anges, il envisage la nature humaine, essentiellement composée, selon deux aspects bien distincts : « vel secundum totam latitudinem speciei » ; il concède alors que le mal arrive « ut in pluribus » car la plupart vivent selon la vie sensible qui comporte un plus grand nombre d'opérations se rapportant à des biens plus proportionnés à l'homme. « Vel potest considerare aliquod individuum illius speciei » : entendu dans ce second sens, ce qui convient à la nature concrète, à tel individu, arrive le plus souvent.

En effet si le sujet singulier est vertueux il poursuit « ut in pluribus » le bien moral conforme à ses dispositions ; s'il est vicieux, attaché habituellement aux biens sensibles, auxquels il s'est inféodé et comme identifié par le poids de l'amour, il se porte vers eux, avec une certaine infaillibilité.

Ainsi, de toute façon, les déterminations qui ont leur siège dans l'appétit inclinent le sujet à agir avec une certitude analogue à celle qui régit le comportement des êtres naturels.

JASMIN BOULAY.

(À suivre.)

1. *De Potentia*, q.3, a.6, ad 5.

2. *II Sent.*, dist.1, q.1, a.1, ad 3.

Abstraction from Matter*

XIV. SOME MEANINGS OF THE WORD 'ABSTRACTION'

Having examined the word 'matter' in 'abstraction from matter' we must now turn to 'abstraction.' Like the Greek term *aphairesis*, the Latin *abstractio*, from *ab* and *trahere*, meant the process of drawing one thing away from another, as to pull an apple from a tree, or hew stone from stone.

1. 'Abstraction' is an analogous term

By extension, this term is applied to knowledge. I can taste an apple without seeing it, or see it without tasting. In reality the apple has both colour and flavour. To perceive the one without the other is to abstract. The same term acquires a new meaning again when applied to understanding. For of objects which in reality are together, one may be considered separately, so long as the understanding of one part or aspect of the thing is not essential to an understanding of the other. For instance, Socrates is stout, the husband of Xanthippe, and a player of the flute. In his particular case all these things go together, so that it would be false to say that he is stout but not a husband, stout and husband but not a player of the flute. Yet the mind can consider each of these attributes of Socrates, one apart from the other, for a man can possess one of them without the other. In other words, our mind can be brought to bear upon one of them, abstracting from the other, even though the latter be in fact conjoined to the former. If this were not so it would be false to say that Socrates is a husband without saying that he is stout, or that he lives in Athens, and so forth.

Now there is still another way the mind performs abstractions, namely, when something can be considered apart from something else because the one is prior to the other, even though in subject they be one and the same thing. For instance, I can consider man as an animal, abstracting from the fact that he is an animal of a very special kind ; and I can consider man without considering this one who is Socrates. But I cannot conceive man without conceiving animal, nor this man without conceiving man. Animal is prior to man inasmuch as an animal is not necessarily a man, even as a man is not necessarily Socrates. Both examples convey abstraction of universal from particular. In the first case we abstract a universal, animal, from a less universal, man ; in the second, the particular is a singular. It is likewise called abstraction of the whole from the subjects or 'subjective

* See the first part of this study in *Laval théologique et philosophique*, Vol. XIII, 1957, n° 2, pp.133-196.

parts' of which it can be said. (This term 'part' is an analogical term, for Socrates is not part of man in the sense that his head is part of the whole that is Socrates; nor is horse a part of animal in this early sense of part.)

The term 'abstraction,' then, is plainly an analogical one. It has a further meaning still in the special case of mathematics. Just as we can consider animal without man, and man without Socrates, we can also consider quantity without the qualities that attend it. This is seen in the fact that we grasp and define numbers, point, line, surface and volume without the sensible qualities that quantity is subject to in nature. The reason, already mentioned, is that quantity is prior to sensible quality, as surface is to colour. Now, although we may consider quantity apart from sensible quality, we do not mean that it can also be that way, in a state of separation from sensible matter, outside the mind.

At this juncture a question is raised concerning the value of such abstraction as to truth. For if in nature there is no such thing of which we can verify the exact kind of triangle we define in geometry, nor the kind of homogeneity and unity required by number theory, how can we say anything true of triangle when truth is defined by the conformity of mind with what is? If I say that Socrates is seated, and he is seated, what I say is true. But when I say that the plane triangle has its three angles equal to two right angles, how can this be true if a figure of that kind does not exist somewhere in the sense that Socrates exists?

2. Some Meanings of 'existence'

Two things are to be considered in connection with this problem. First, that the terms 'to be,' 'being,' and 'existence,' each have several meanings, as we noted on an earlier page. If we take 'being' for 'what is,' then both 'what' and 'is' each have several meanings. The single word 'what' can be used to stand for the diverse things that Socrates is, according to what is intended by the questions we may ask about him, such as 'What is he?' 'What is his size?' 'What is his disposition?' 'What is his civil status?' 'What is he doing?' and so forth. Accordingly, 'is' will not mean the same in the answers to these questions. 'What' will again mean diverse things in the following questions and their answers: 'What is a billiard ball?' 'What is it made of?' 'What is it for?' 'What made it?' The adequate and proper reply to the first of the questions must include the answers to all of them. Now, what a billiard ball is made of, what its shape is, what it is made for, and what made it are plainly far from being the same *what*.

The term 'is' or 'exists' has likewise different meanings in the statements: 'Socrates exists,' 'Man exists,' 'The equilateral triangle exists,' 'There is an equilateral triangle in the mind of Socrates,'

'There is a relation of reason called genus,' 'Some things are nothing at all,' 'Whatever is impossible is impossible,' etc. Accordingly, 'being' can be said of all these things; whether they be thing or not thing, for 'thing' too has a large number of meanings.

To make plain what is intended by existence in connection with the abstract subjects of mathematics it will do to single out only a few of these meanings. 'Socrates is,' i.e. 'exists,' means that an individual called Socrates is alive. 'Man is an animal' implies that this is true whether there be an individual instance of the kind or not. 'Man exists' will be true if there is at least one individual, such as Socrates, who 'exists' in the first sense. But in 'Man is an animal,' neither 'man' nor 'animal' stand for individuals, nor for collections of individuals; 'is' stands for a composition made by our mind and true, regardless of whether 'Man exists' be true or not. 'There is a triangle with three equal sides' means that we can construct such a triangle; it does not imply that such a triangle exists as in 'Socrates exists' or 'Man exists.' 'One centaur is faster than another' refers to something that cannot exist outside the imagination — a pure fiction. That there are fictions would be false if intended to mean that they are in the way 'Socrates is,' 'Man is,' or 'The equilateral triangle exists,' 'There is a logical relation of genus,' merely means that our mind, comparing terms such as 'animal' to 'man,' or 'plane figure' to 'triangle,' forms a relation of one to many, such that the more universal term can be said of things which differ in kind. Though remotely based upon what is outside the mind, such relations cannot be outside it. As in the case of mathematical subjects, 'existence' is here related to our way of understanding.¹ Finally, even negation, as in 'non-being is non-being,' has being in still another sense of this term.²

1. "... Ipsa conceptio intellectus tripliciter se habet ad rem quae est extra animam. [a] Aliquando enim hoc quod intellectus concipit, est similitudo rei existentis extra animam, sicut hoc quod concipitur de hoc nomine "homo"; et talis conceptio intellectus habet fundamentum in re immediate, in quantum res ipsa, ex sua conformitate ad intellectum, facit quod intellectus sit verus, et quod nomen significans illum intellectum proprie de re dicatur. [b] Aliquando autem hoc quod significat nomen non est similitudo rei existentis extra animam, sed est aliquid quod consequitur ex modo intelligendi rem quae est extra animam; [i] et hujusmodi sunt intentiones quas intellectus noster adinvenit; sicut significatum hujus nominis "genus" non est similitudo alicujus rei extra animam existentis; sed ex hoc quod intellectus intelligit animal ut in pluribus speciebus, attribuit ei intentionem generis et hujusmodi intentionis licet proximum fundamentum non sit in re, sed in intellectu, tamen remotum fundamentum est res ipsa. Unde intellectus non est falsus, qui has intentiones adinvenit. [ii] Et simile est de omnibus aliis qui consequuntur ex modo intelligendi, sicut est abstractio mathematicorum et hujusmodi. [c] Aliquando vero id quod significatur per nomen, non habet fundamentum in re, neque proximum, neque remotum, sicut conceptio chimerae: quia neque est similitudo alicujus rei extra animam, neque consequitur ex modo intelligendi rem aliquam vere: et ideo ista conceptio est falsa." *In I Sent.*, d.2, q.1, a.3, c.

2. "Unde dicimus quod non ens est non ens. Quod non diceretur nisi negationi aliquo modo esse competere." *In IV Metaph.*, lect.1.

Let us suppose for a moment that the word 'being' had no more than one meaning, as the Ancient Greek Philosophers assumed — a position to which nearly all moderns have unwittingly returned. The following would then be unimpeachable: 'Man is a predicable species, and Socrates is a man; he is therefore a predicable species, viz. predicable of any individual man; it follows that Socrates is Plato, Ion, and each of these is Socrates.' Seeing there is always one sense or another in which anything or nothing is, if the diverse meanings of 'to be,' or of 'being,' were one and the same, the worlds of nature, of logic, mathematics, fiction, absolute or relative negations would in their turn be utterly one and the same. Whatever is ineffable, as well as what is namable, would be in the way that 'Socrates exists;' and Socrates would be the way relations and negations exist.

Let us now revert to the existence of our abstract triangle. Like any other mathematical subject it is an *opus*, a work, in the broad sense of this term (*communiter loquendo*), yet at the same time a definable nature: 'what a triangle is' follows from our own, human mode of understanding. This *consequi modum intelligendi* does not imply that mathematical subjects are embedded in our mind in the way of *a priori* forms; we actually construct them, yet as a result we are faced with strictly definable natures. All the same, they differ from second intentions. These are formed by acts of comparing, which may likewise be called a 'making' in the wide sense of this term. But whereas in mathematics the purpose of making is for the sake of knowing the subjects made, in logic the works are produced to set order in our mind, but for the sake of knowing subjects other than these, such as those of mathematics and natural science, pursued for no other purpose than to know. Logic is strictly an *organon*, a tool. Mathematics is more than that, though it takes on the nature of means when applied to nature.¹ The term 'existence' as applied to relations of reason and mathematical subjects does not mean the same kind of existence, yet the same word is used because the existence of triangle, for instance, and that of genus are one in proportion.

We must now look more closely into the nature of mathematical abstraction as understood by Aristotle and St. Thomas.

1. An intellect which knows things independently of experience and whose means of knowing are prior to the things known, sees whatever truth which we possess in composing, dividing and demonstrative reasoning, but without composing or dividing or demonstrating. Such an intellect stands in no need of abstraction, and for this very reason it forms no second intentions, nor does it construct in order to know what we learn by construction in mathematics. Separated substances are neither logicians nor mathematicians.

XV. TO DEFINE WITHOUT SENSIBLE MATTER THINGS THAT CANNOT BE WITHOUT IT OUTSIDE THE MIND

We have seen, in a very general way, what is meant by things which cannot be defined without sensible matter. Let it be granted, for the moment, that they are what the science of nature is about. We already pointed out briefly that there is still another mode of defining, as when we define a number without any reference to a corresponding number of sensible things, or a figure without reference to the figure known to sense. This second type of definition differs radically from the first. The first was abstract in the sense that we left aside the individual sensible thing, like the bones and flesh of Socrates, but did retain bones and flesh; for, without these, man can neither be conceived nor exist. By 'exist' we mean that man could not exist even in the mere sense of truth; since 'what it is to be a man' is to be of bones and flesh, and no propositions about man as such are true which do not so consider him. The second is abstract in the sense that the definition disregards both individual sensible matter and common sensible matter. This, then, is a very different way of abstracting from matter.

1. Abstraction of form, i.e., of quantity from sensible matter¹

In the first type of abstraction, the initial step is from the individual Socrates, Plato, etc., to man in general. After this first step, it is an easy progress from man to animal, from animal to living being. It should be noted, however, that it is the first step which is crucial, for by it alone we pass from the potentially intelligible to the actually intelligible. The further transitions — from man to animal to living thing — take place on the same plane of actual intelligibility: man, animal, and living being still requiring sensible matter in their definitions (at least until some proof is advanced that there can be living things without sensible matter). Now, to appreciate how entirely different is the second kind of abstraction, we have only to consider the example of circle, viz., 'a closed plane curve such that its circumference is at every point equidistant from the point within called its center.' That the status of this thing is very different from that of a chalk-circle on a blackboard, or the circular path of a planet, is plain from the fact that we cannot possibly verify the definition in experience. Even though we may have started by drawing a circle with a compass, the definition is not of what we have drawn. The drawing is no more than a stepping-stone to the goal of the true circle, and one to which we cannot return, once the circle is constructed and defined, although we may appear able to do so. And the same holds for 'sphere' which abstracts, e.g., from 'bronze sphere.' That is why St. Thomas insists

1. Cf. In Boethium de Trinitate, q. 5, a.2.

that mathematical subjects are not similitudes of things outside the mind.

Now, of the abstract sphere, it is to be noted, not only that it is neither hard nor soft, cold nor warm, nor coloured, but that it is not even a common sensible like the shape of the bronze sphere. When considering 'sphere' in separation from everything *per se* or *per accidens* sensible, the mind confines itself to something that has the nature of form, not with regard to a matter incidentally sensible like the bronze of a bronze sphere, but with regard to a matter which is simply the three-dimensional continuum of the sphere. In the abstract sphere, the continuum is as the matter, and the shape is the form. In other words, in order to arrive at the true geometrical sphere, the mind must completely abandon that reality which requires sensible matter in its definition. That it has indeed done so is manifest from the fact that neither the definition of the mathematical sphere, nor any proofs or reasonings derived from that definition ever need to be confirmed by comparison with natural objects. If the statement 'a sphere is a three-dimensional continuum bounded by one surface which is at every point equidistant from a point within called its center' depended upon verification in experience for its truth, we could not know it to be true until we had made the verification. But the fact is that, in the very act of predicating the definition of the definitum, we see that the proposition is true: that there is such a body, that sphere *is* in the sense that we may form true propositions about it, whereas 'diagonal commensurate with its side' is not. This condition of things never applies to definitions or propositions about things that can be outside the mind, like man, or snubnose, for it is essential to the latter that there be possible instances of them in nature. Thus in the mathematical object we have an actual intelligibility of another kind, free from the limitations of sensible matter.

It is sometimes thought that mathematics is about common sensibles; but this is wholly wrong, for these, too, like the proper sensibles, are *per se* sensible. Mathematics is about forms as the mind has abstracted them by construction, and not about what may vaguely correspond to them in the order of common sensibles. Both the sensible *per se* and the sensible *per accidens* can serve as their source; it is abstraction as practised on individual or common sensible matter which leads by construction to the subjects of mathematics. Should we make our start from common sensibles, for example, from a triangle drawn on the blackboard, our science will still deal with what has been abstracted and not with what it has been abstracted from. The demonstration is not even about the *kind* of triangle that is drawn on the blackboard, for this is a white one, actually the shape of a mass of chalk hanging there, a *per se* sense object. There is indeed something about the chalk-lines that our mind can consider without them; but this 'without sensible lines and angles' is not understood to be in the

sensible lines and angles. If it had to be in them, it could only be so in the way in which a sensible triangle is a triangle, viz. in sensible matter and without any verifiable exactness.

There is, then, a separability to mind that is typical of quantity, of number or dimension. The reason is that, in the things of nature, quantity is prior to quality, as surface is prior to colour; and prior to the *per accidens* sensible subject of sensible quality as such.¹ So that, even if quantity cannot exist in reality without a sensible subject and without sensible quality, it can nevertheless be abstracted from them and considered in the way outlined above.

2. Whether there can be an abstraction of quality in the way that there is one of quantity

But there can be no abstraction of sensible quality in the way that there is of quantity. The best way to explain this will be by facing the objection that, when we abstract from sensible quality we ought still to have quality, just as when we abstract from sensible quantity we still have quantity. When we say 'Socrates is wise,' for example, wise is predicated as a quality that is not *per se* sensible. Why not a special science of quality, then, like that of quantity? Two things should be noted in this connection. First, that what we are examining here are the various modes of definition inasmuch as they distinguish the sciences in kind. Second, that the properties of things that are not some way or other in sensible matter are not positively known to us until they have been demonstrated; and if such a demonstration is possible, it will show that there is still another mode of definition. Further consideration of these two points will allow us to appreciate how unique is the case of quantity.

3. The formal distinction between sciences is not based *per se* upon degrees of generality

Regarding the first mode of defining, we must observe that the sciences are not distinguished according to each and every kind of abstraction. We noted that from the universal 'man' we can go on to 'animal,' which is more universal; and from here to 'living being,' and hence to 'being,' and then to 'whatever can have the nature of object' including even 'that which cannot be an object in any sense.' These are degrees of sheer generality, — specific, generic, or proportional — and the degrees lying within each are inexhaustible. If this sort of abstraction could distinguish the sciences, there would be as many sciences as there are degrees of generality. Besides, they who define metaphysics by nothing more than generality would find this generality superseded by a far greater one; for what could prevent us

1. In II Physic., lect. 3; In Boethium de Trinitate, q. 5, a. 3.

from saying 'let A stand for the subject of every such a science including that of metaphysics,' or 'let B stand for what is impossible as well as for its opposite.' The art that does not name anything at all, viz. logistics (*logistikè*: the art of calculation), would be queen. But to the true nature of science and its true mode of definition all this kind of thinking is totally irrelevant. A degree of generality is not more actually intelligible in the measure that it is more general, but in proportion as it is removed from matter. No definitions contain individual sensible matter; some contain common sensible matter; others, like those of mathematics, abstract from common sensible matter too, even though the defined could have no being in nature without it. And if there were definition without sensible matter of something that could also be in reality without it, we should have a third mode of defining, and therefore a third kind of principle of science, or degree of actual intelligibility. So soon as we establish that there are objects like spheres or equilateral triangles, we have shown that there is a peculiar mode of definition which deals with them. In the same way, if we could demonstrate that there exists a reality without sensible matter at all, we would know that there was a third mode of definition and that it held good for what is in the way of Socrates.

That a degree of generality does not carry with it more actual intelligibility can be seen from the fact that, in knowing man only as an animal, we do not know him distinctly as a man, for the elephant too is an animal. The general, here, is more potential and confused, whereas the perfection of knowledge lies not in the direction of the more general but rather in the direction of something less general which must include nonetheless the more general, in the way man includes animal.

Anything is best known when known according to its own kind, the kind which can no longer be divided into other definable kinds. And although the definition of animal ('a body able to sense') differs from the definition of man ('an animal able to reason'), as being more general, they do not differ as to mode of definition, for both are with sensible matter. This may perhaps become clearer if we notice that, even when we consider Socrates as *this man*, or as *this animal*, as *this living being*, or as *this thing*, our degree of generality is widening, but we are always pointing to the same individual matter as attained in sensation. Similarly, whether man be defined as man, or animal, or living being, common sensible matter enters into each definition.

XVI. THE TRUTH OF A THIRD MODE OF DEFINING IS NOT SELF-EVIDENT

Now regarding the second observation, that there is a definition of 'life' or of 'living being' which does not include sensible matter, could only be shown by an *a posteriori* demonstration (i.e. from effect

to cause). We would have to prove that there can or must be such a thing, a reality without sensible matter;¹ for there can be no way of learning that there is a reality of this kind except by a proof *that* it is, and that sensible matter does not pertain to what it is.² Hence, that there is a third mode of defining is a matter for demonstration. This is the peculiar condition of the third mode, if there is one.

1. Defining quality without sensible matter

If we did attempt to define quality without sensible matter, we could not succeed until we had also demonstrated that there must be quality of this kind. We actually do this when we demonstrate that there is a triangle whose three sides are equal, for the resulting figure is a quality. But it is a quality in abstract quantity, not a figure which is a common sensible; in other words, it is considered as a figure without sensible matter at all. And why is it that in abstraction from sensible matter we can obtain qualities like straight, circular, etc. whereas we obtain nothing of the kind concerning 'quality not in quantity,' and could not do so without first proving that quality without sensible matter exists in reality? In other words, why is it impossible to construct in the abstract a quality which would be related to proper sensibles in the way circle is related to the chalk-circle on the blackboard?

The reason is that quality simply cannot be abstracted from sensible quantity and sensible matter, whereas quantity is easily abstracted from both sensible quantity, quality and matter (though not from all matter — as we shall see further on). The latter abstraction is possible because, on the one hand, what we call sensible matter is only sensible because perceived as the proper subject of sensible quality, and sensible quantity too is so called because attained through perception of sensible quality; while, on the other hand, quantity is seen to be prior to quality: as surface is grasped as that in which colour is, or as three perceptible units, like three men, are known as that of which there are three (for each must be outside the other before this particular kind of order, known through perception of quality, can arise). Now, surface can be thought of apart from any sensible quality, such as hardness or colour, and defined as 'what is extended in two dimensions'; the number three, in its turn, is understood as the particular kind of order revealed by adding one to two, provided the elements are of the same nature. Prescinding in this way from sensible quality, we obviously prescind as well from quantity as sensible,

1. The mere fact that the possible expression 'a wholly immaterial substance' reveals no contradiction does not entail that there can be such a substance.

2. Only then might we change the imposition of 'living,' or of 'living being,' and make them analogical terms, as 'light' is used analogically of both candle-light and the light of mathematics.

though not from quantity as such ; for we still have something extended in two dimensions, and still have three units that are one three. But if we detached, or thought we could detach, quality from *sensible* quality, we would at once lose our sensible quantity and sensible matter and what would we have left ? What would the abstract quality be ? We would be left with a mere expression, whose meaning could be susceptible of no more than the logical verification conveyed by the question : 'Is there an *immaterial* quality ?' The point is that, though the question may have meaning, it does not answer itself. If the answer is to be that there does exist immaterial quality, such an answer calls for positive proof.

Unless we can demonstrate that there is quality apart from *sensible* quality, which would then be defined without sensible matter, we cannot know whether or not such a mode of defining is possible. When we speak of 'quality in the abstract,' we do not know exactly what we are talking about except logically. To hold for knowledge of anything more than the logical function of our term is to fall at once into a mental void. If, in the question 'what is man ?' for example, the 'what' were more than logical, the question would hold its own answer, and 'what man is' would have to be taken as undefinable. In this state of affairs, on the other hand, 'squarable circle' would be a definable nature for the simple reason that we can ask whether there is such a thing. To know how to ask a meaningful question would be the same as to know the answer, and the true meaning of the question would have to imply that that which the question is about must have more than a logical status and must *be*, at least in the sense of that of which there is more than a nominal definition.

2. Quantity compared to quality in point of definition

But none of this holds true for quantity considered apart from sensible quantity. First, quantity in the abstract, that is, quantity separated by the mind from all sensible qualities, can be so considered in separation no matter if it cannot actually be in this fashion ; nor does the act of abstracting it assert anything about its mode of existence in reality, because whatever we do affirm or deny of it never bears upon it except qua abstracted from sensible matter *in mind*, and never requires the supposition that it could have the kind of being that man has. And when we say 'in mind,' we do not mean that abstract quantity is of the mind exactly in the way in which the second intentions of logic, like the relations of universality, are formed by the mind.¹ The mind does not form the nature of equilateral triangle, although it forms a mental construction in order to reveal it. In

1. Although even here the mind does not form 'what it is to be a second intention', any more than Socrates becomes a *per se* cause of 'what it is to be a man' by generating one.

mathematical abstraction, the mind's only function is to make the separation, so that there is absolutely nothing to oblige the mind to maintain that what is thus separated in mind can, or should be, also separable in reality. When we demonstrate that there is a triangle whose sides are equal, we never imply that there is such a figure in reality, either with or without sensible matter. We merely show that there is such a definable subject in the sense of truth, and that whatever is demonstrated of it is true of it qua abstracted from all sensible matter.

But quality, we have seen, cannot be abstracted in this way. That the name 'quality' could never be extended to something that is not sensible, or that is not the quality of quantity, is certainly not self-evident. But the lack of evidence for this identification is not a reason from which we may infer that such an identification is possible, and that there is a quality without any matter whatsoever. Evidence to show that we might at least consider such a quality would depend upon a demonstration that there is a third mode of defining, which means proving that there is such a quality in reality in the way that man is in reality. It would be evidence leading not merely to what might be considered in separation, but to what is separate in reality.

The free development of mathematics in its independence from sense experience is guaranteed by the very nature of quantity inasmuch as it is basically no more than repetition of the same ; whereas quality is not. And while, even of quality, there may be more of the same, this will depend upon quantity : to have more redness of a given shade we need a greater surface. Now, repetition of the same gives rise to various new kinds of form without bringing in anything from outside that which is the same, like $1+1=2$, $2+1=3$, etc., each unity obtained by adding a unit, being different in kind ; by multiplying any number of the series by two, we reach the series of even numbers ; and we can then show the properties of odd and even, and the properties pertaining to certain of their kinds. So the forms of numbers (like two-ness) and of dimensions (like straightness) arise from the different types of order that can be reached — as we prove by constructions — so long as more of the same can be had. And this leads us to another basic notion which we must now make clear : that of intelligible matter.

XVII. THE NOTIONS OF INTELLIGIBLE MATTER

If we are to understand the nature of the abstraction that is proper to mathematics, viz., of arithmetic and geometry taken in the traditional sense, we must examine what Aristotle calls 'intelligible matter.'

1. *Metaph.*, VII, c.10 (St. THOMAS, lect.9-11) ; *De Anima* III, c.4 (St. THOMAS, lect.8) ; *Ia Pars*, q.85, a.1, ad 2 ; *Q.D. de Veritate* q.2, a.6, ad 1. An elaborate study on intelligible matter will appear in the next issue of this periodical.

1. *Mathematical individuals and their matter*

Aristotle begins his explanation of intelligible matter by calling attention to the fact that, even in the world of mathematics, there can be individual objects, like the individual circles we describe to construct a triangle whose sides are equal. Now these circles do not differ by what they are; for one is as much a circle as the other, and they are even of the same in radius. The only difference between them is numerical. The same holds for numbers: we may have as many instances of the same number as we please. Now, 'what circle is' is not the same as to be 'this particular circle,' e.g. the one to the left of that other. If it were, there could be only one circle, and circle would be this single circle. The individual circles are not part of the definition of 'what circle is,' while the definition is verified in each and every one of them; nor are the instances of 'two' part of 'what two is.'¹

There is therefore something about a particular or given circle which has nothing to do with 'what circle is.' In fact, as particular or given, a circle cannot be defined any more than that real individual, as individual, which we discussed in an earlier chapter. *This* circle, as such, can only be designated; no name can be given to it, although it may be convenient to use a symbol in its place — as A might serve to distinguish this one from another, B. In other words, an individuating principle is here at work, a principle analogous to that already pointed out in our bowling pins. Of the pins, we concluded that we could have many of the same, because we had enough material. The possibility of 'many of the same' was to be attributed to *this* matter that the bowling pins were made of.

Now the ineffable individuals of mathematics, like those of physics, must require something extrinsic to 'what' they are to distinguish them from one another, some subject analogous to the designatable matter of the bowling pins. Yet there is a profound difference. In the first case it is *this* individual sensible matter. The latter too is a *this*, and in the nature of matter, but not sensible, for we neither can, nor need verify it in sense experience. The mind nevertheless does reach it, inasmuch as we are quite clear about 'two or more circles of the same radius,' even though we could never designate them to external sense. So we call the matter of these mathematical individuals 'intelligible', in the sense that it can be reached only by mind, and is not the individual matter of external sense experience.

1. Unless we interpreted the term 'circle' to mean the collection of all circles, as 'two' can be taken as the class of all couples. This would actually be an interpretation of the symbol 2, not a definition of 'what two is,' and therefore not even an interpretation of the name 'two.' What we have in mind rather is the number two, that "metaphysical entity" of Lord Russell's, "about which we can never feel sure that it exists or that we have tracked it down." *Introduction to Mathematical Philosophy*, p.18.

There is a further analogy between sensible and mathematical individuals. The first, like Socrates, are known in actual sensation in such a fashion that when the sensation ceases, they too, so far as the sense is concerned, cease to be. But, even when the man Socrates himself ceases to exist and sensation of him ceases to be possible, the mind's conception of man, 'what man is,' whether the knowledge be confused or distinct, remains unaffected. Indeed, of the conception it may be further asserted that even if no one were considering it, or if all minds capable of considering it were to perish, the notion, 'what man is,' would remain unaltered. While Socrates *is* in a sense in which 'what man is' is not, he could not be in the sense in which he *is* if it were not true that 'man *is* a rational animal.' It may be that something comparable takes place when I cease to consider *this* individual circle that I bore in mind while drawing a circular figure on the black-board. Whatever it may be when I no longer consider it, it never is in the way in which the circle is; for the circle is no less what it is when I cease to consider it.

2. *Why this individuating matter should be called intelligible*¹

But this does not make wholly clear why such individuating matter should be called intelligible, rather than 'mental,' or 'mind-stuff'; terms which would leave it conveniently vague, yet distinguish it sufficiently from sensible matter. Further, of the mathematical individuals Aristotle says that, when we do not actually consider them, "it is not clear whether they exist or no"; while St. Thomas, in his commentary, refers them to what Aristotle elsewhere calls the passive or 'corruptible intellect.'² Again, since individual real things are known only when actually sensed or actually in the imagination,³ it seems that we should call this individuating matter by a similar term, like 'imaginable,' for the imagination is what 'corruptible intellect' seems to mean. But while this last remark is certainly true, we believe that there is nevertheless good reason for the expression 'intelligible matter,' just as there is good reason for speaking of a corruptible intellect.

By intellect we mean the power which grasps what a thing is, like 'what circle is,' and the power which asserts what a thing is or what it is not — whether the knowledge be confused or distinct. Such acts belong to the intellect and to no other power. But, when intellect asserts that this man Socrates exists, to be in conformity with what *is* in the way Socrates is, intellect must depend upon an actual, external,

1. Cf. ST. THOMAS, *In Boethium de Trin.*, q.5, a.3, c., ad 3 et 4.

2. *Metaph.*, VII, c.10, 1036 a 5. *De Anima*, III, c.5, 430 a 25.

3. ST. THOMAS, *Metaph.*, *ibid.*, lect. 10, n.1495.

sense perception, for the reason that this kind of individual can only be attained with dependence upon external sense. Yet, though Socrates may now have left the place where we are and where we saw him, and though he may now even have ceased to exist, we still hold the individual image of him in imagination; this individual image can still be attained when Socrates is no more to be seen or heard. And there is something else about this image that is peculiar to it: it can be multiplied at will, to look somewhat like the series of images reflected when Socrates stands between two mirrors. We can imagine a crowd of individual Socrates even if there is no such crowd in fact. The crowd is made up of imagined individuals, imaged as individuals. In short, there is a freedom here that is not to be found in external sensation. Instead of Socrates, we might have chosen the instance of a circle drawn on the blackboard, to multiply in imagination as we will. Observe, however, that this image does not represent a mathematical individual, for it is the image of a visible white figure on the blackboard. Even though we may imagine as many white circles on the blackboard, or as many hard bronze spheres as we wish, we must remind ourselves that mathematical individuals, the individual circles or spheres which we use in mathematics, are neither white nor black, warm nor cold, hard nor soft; because nothing of what they are, nor of what we assert of them implies sensible matter. If it did, they could not be exact as we know them to be. In this respect, we know that they are not like the circles gathered in imagination from the blackboard. They are like them only in the respect that they, too, are many. But are they likewise seated in the imagination?

3. *Mathematics and the imagination*

When intellect asserts something about this circle A, e.g., that it is a circle — as circle is mathematically defined — and that its radius is equal to that of the circle B, intellect then refers to an individual owning something of the status of the imaged individual Socrates, except that this individual is not taken from external sense experience. (Note that even the image of Socrates that I now have in mind is a *this*, though not a *this* that I can point out to sense, while I could use this drawing of a circle on the blackboard to bring my thought to rest on the one I have in imagination.) Now, there are two things to be noted. First, when dealing with its proper object, intellect does not concern itself with the individual; but, secondly, intellect can make statements about the individual which are true. For example, in grasping what circle is, and in asserting whatever is true of circle, intellect does not attain an individual; but, of a given circle A, intellect may truly assert that it is a circle, and that its radius is equal to that of B. It follows, therefore, that in making statements like the last two, intellect must be depending upon a power of mind which

perceives individuals directly, as is done in the imagination — upon some internal sense.

Why should the individuating matter of mathematical objects sometimes be called 'imaginable,' sometimes 'intelligible'? Individual circles are in the imagination, and in it have their being as *this* circle and *that* circle, here and now, in *this* organic power, that is no less corruptible than the external senses like sight or hearing. However, they would not be at all if it were not for intellect which summons them; and this intellect could not do without the imagination — unless it acquired a completely new mode of knowing, one not natural to intellect as we know it. It is plain, then, in what sense we speak of 'corruptible intellect.' In no way does it imply that imagination is intellect, nor that the intellect itself is corruptible. It only means that, in the representation of mathematical individuals, imagination and intellect are interdependent. The two circles are summoned by and for the purpose of the intellect, viz. demonstration, and only the intellect can *verify* that they are circles. The imagination itself does not do this. On the other hand, if the imagination were destroyed the intellect would lose the exercise of its power to attain the individual; even as the imagination would be powerless to represent mathematical individuals if the defining intellect did not direct the representation.

4. *Mathematical universals and their matter*

The intelligible matter which we have so far considered is plainly not part of the definition of *what* the mathematical individuals are, e.g., of what a given circle is, for whatever is part of a definition is not an individual part. Nevertheless, what mathematical individuals are, and what they have in common cannot be defined without including something having the nature of matter, something proportional to the bronze or wood of a sensible sphere. For when we have abstracted sphere from sensible matter of whatever kind, the mind still retains something that is in the nature of matter, the matter of the abstract sphere, viz. the three-dimensional continuum of which sphericity is the form. No mathematical entity can be considered apart from a subject, like triangle apart from its lines, or the number three apart from the three units. The continuity of the line is the matter of the circle, and the figure of the line is its form. The three units are the matter of the number three, whereas the oneness that is peculiar to three as distinguishing it from any other whole number, is its form.¹

1. For the number three is not the same as three units or three ones. Number is a plurality measured by the unit, the indivisible 'one' which is the principle of number. Now the measure must be of the same nature as the measured: measure and what is measurable by it must be homogeneous; the standard of length is a length; of weight, a weight. There is, however, something peculiar to number, inasmuch as the measure of a plurality is not necessarily itself a number, viz. the indivisible 'one' which is a perfect

If, per impossibile, the figure we call 'equilateral triangle' were 'what it is' apart from the lines, that is, if it were definable without them, then 'to be an equilateral triangle' and 'to be this particular individual one' would be entirely the same. It would be 'what it is' in abstraction from all intelligible matter. The same would hold for man, if he were definable without sensible matter: what man is would be wholly the same as what the definition expresses only as form; so that if this thing so defined were to exist as Socrates does, 'to be man' would be incommunicable in such a fashion that there could be only one single individual man. The individual would exhaust the species, and any other individual would be different in kind.

In other words, whenever a thing owes what it is to something extrinsic to its form, then, to be what it is, is to be of matter and form, inseparably, such as triangle and straight lines, or three like units and one three. If three could be the one three that it is, without the three units which are its matter, the oneness peculiar to three would be destroyed.

5. *Mathematical science defines with intelligible matter*

Hence, both in mathematics and in nature, the 'thing' and 'that by reason of which' it differs from another in kind are not wholly the same. And this is because of the matter essential to their definition, i.e. to 'what they are.' If there were a thing which is 'what it is' irrespective of all matter, then the thing and what it is would be quite identical; it would be individuated by its form. Let us repeat, however, that whether there is such a thing existing as Socrates does, but in separation from matter, would have to be proved. Only then

measure in the sense that it is used to express exactly and completely that of which it is the measure. What is essential here is that the measure-unit should be wholly of the same nature as the elements of the measured. Otherwise a number would be no more than an aggregate, a collection; it would be all that it is in its matter alone. Now, from the viewpoint of calculation it is indeed no more; so that, if we define numbers by no more than the operations which can be performed on them, 1 and 0 are just as much numbers as two and three; and fractions, irrationals, and the rest, will be special instances of number, inasmuch as they are interpreted in terms of the properties of certain operations that can be performed on them, and which they share with the more familiar instances of mathematical entities. (Cf. COHEN and NAGEL, *An Introduction to Logic and Scientific Method*, chap.VII). For strict calculation, it is quite indifferent whether the units symbolized by 3 are of the same nature or not, that is, whether we refer our 3 to three bowling pins, or to the heterogeneous collection of 'a man, a centaur, and a logical intention of genus.' The art of calculation would indeed be very much restricted if it were to be no more than an instrument of mathematical demonstration. Fortunately it applies far beyond the limits of mathematical science, to things whose nature may be quite unknown, and applies as well to unknown operations, as in the theory of groups, where the operations are as unknown as the quantities they operate upon. (EDDINGTON, *New Pathways in Science*, chap.XII). Calculus, in the broad sense of this term, owes its effectiveness to the very indifference of abstraction by way of symbolic substitution.

could we know, in a positive way, that there is a mode of defining without even intelligible matter, because we would then know *that* there is that kind of thing.

There is, accordingly, a relation between the matter which is part of the definition, and the matter which is extrinsic to it; for if there is to be an individual, either in nature or in imagination, the individuality will owe itself to something extrinsic to what is expressed by the definition, viz., *this* sensible matter or *this* intelligible matter, making possible many things the same in kind. 'What man is' cannot be individuated by itself, but only in Socrates; and 'what circle is' only incidentally in the circle A. That which individuates here is matter as quantified and designated, either sensible or intelligible; and of this irrational principle there can be more and more without end.¹

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(To be continued.)

1. We might go on from here to distinguish the two kinds of universal intelligible matter, viz. that of number, and that which is the continuum, showing how they lie at the basis of the distinction between arithmetic and geometry. For geometry is less abstract than arithmetic in its very mode of defining, the continuum being intrinsically indefinite by reason of its unlimited divisibility, thus being more in the nature of matter than number is. But this would carry us beyond our present scope. (Cf. ST. THOMAS, *In II Post. Anal.*, lect.9, n.5.) On what is meant by the arithmetisation of the continuum and how it is to be understood, the reader may consult Herman WEYL, *Philosophy of Mathematics and Natural Science*, chap. II.

Abstraction from Matter*

XVIII. WHAT IS MEANT BY 'SCIENCE ABSTRACTS FROM MOVEMENT'

We have considered the sense in which there may be science proper insofar as abstraction is achieved only from individual sensible matter. It is also said that science must likewise abstract from movement inasmuch as "science is of necessary things . . . But every necessary thing, insofar as it is necessary, is immobile, since whatever is in motion, as such, may be or not be, either absolutely, or in some respect." ¹

1. *Science proper is of what is necessary*

The reason, then, why science requires abstraction from movement is that science concerns that which cannot be otherwise and is necessarily true, while whatever is in motion is unceasingly otherwise in the respect in which it is in motion. If science were of the thing that changes as changing, science could not remain true except by changing with the thing as it changed, so that what was true at one instant would be false at another. For that 'Socrates is walking' is true only so long as he is actually walking; so that, if there were a science of Socrates' walking, it would cease to be true and to be science when he halted. Such a science would share the conditions of sensation. Moreover, the truth achieved by such science would be of a baffling kind, since it would have to lapse over and over again even while Socrates *was* walking; for throughout the course of the walking itself there is a 'before' and an 'after' — divided by the indivisible of time, the instant — the before which is no longer and the after which is not yet. Now the truth about *this* movement (for there is no motion except in the existent singular) could not be achieved even in the evanescent instant that divides the past from the future, since there can be no movement in the indivisible of time, no more than there can be in a point, or in the *momentum* — the indivisible of motion. And this reminds us of those who

because they saw that all this world of nature is in movement, and that about that which changes no true statement can be made, they said that of course, regarding that which everywhere in every respect is changing,

* See the first parts of this study in *Laval théologique et philosophique*, Vol. XIII, 1957, n° 2, pp. 133-196, and Vol. XVI, 1960, n° 1, pp. 53-69.

1. ST. THOMAS, *In Boethium de Trinitate*, q.5, a.1, c. — St. Thomas here refers to Aristotle's *Post. Anal.*, I, c.6.

nothing could truly be affirmed. It was this belief that blossomed into the most extreme of the views above mentioned, that of the professed Heracliteans, such as was held by Cratylus, who finally did not think it right to say anything but only moved his finger, and criticized Heraclitus for saying that it is impossible to step twice into the same river; for *he* thought one could not do it even once.¹

2. Illustration from Mathematics

When discussing the necessity and immobility of the subject of science proper we may easily confuse this subject with a given instance of it, e.g., 'what movement in a straight line is' with 'this rectilinear one.' The latter is a given movement, the former is not. As mentioned before, 'what contingency is' is itself in no sense a contingent thing or event. A further difficulty arises from the fact that the mathematician may produce a line by the motion of a point, and is always making lines and figures rotate, as well as generating numbers of all kinds. But such 'motion' belongs either to the method he employs to get at a notion — for even point and line are made plain by construction — just as he uses rotation, the notion of which in no sense rotates. ('Motion,' 'rotation,' as well as 'potency' are in mathematics no more than metaphors.) For geometry would be destroyed if rotation should turn out to be forever something else and never just what it is; while a given rotation may well yield something new. There would be no geometry as a science if the plane triangle could cease to have its three angles equal to two right angles,² or if the diagonal could become commensurate with the side of its square. There would be no arithmetic if two plus two were equal, now to four, now to five, — or if the same integer were now odd, now even; the same number now rational, now surd.

Science, then, would be impossible if it had to bear directly upon subjects which can be other than they are: what we call science would be no more than history, i.e. narration. Movement is excluded from scientific knowledge inasmuch as it implies this kind of possibility. But this does not mean that there is no science about movable things,

1. ARISTOTLE, *Metaph.*, IV, c.5, 1010 a. Oxford transl.

2. It may be objected that when the triangle is bent over a sphere the angles become together greater than two right angles, so that this property of the triangle is variable. They who choose to see things in this way should logically hold that, since what is true of the spherical triangle is not true of the plane triangle, what was seen to be true of the latter has now come to be false of it. Furthermore, the spherical triangle is not arrived at by bending the flat one over a sphere, as if it were flexible, no more than a straight line becomes a curve when we draw a line that is the shortest distance between two points on the surface of a sphere, for this is a new kind of shortest distance between two points, just as the spherical triangle is a new kind of triangle that leaves the flat one unchanged. There would have been an error had we assumed that what is true of the plane triangle should also be true of the spherical one. As to wilting triangles, they can be handled by the application of calculus.

for, on the one hand, 'what it is to be movable' or 'what mobility is' or 'what movement is' is quite immobile, as we have already pointed out; while on the other hand this definition does apply to any given motion, just as 'rational animal' applies to Socrates.

One might nevertheless raise the question of a necessary movement. If there were such a movement, how could we still assign immobility as a condition of science? The answer is that there would still be immobility in the sense of necessary: it would be impossible not to be in movement.¹ Besides, it would be a given movement, a particular one as opposed to 'what necessary movement is,' and therefore not the direct subject of science.²

There is very little in the study of nature that meets this condition of science proper, and the ancients were quite aware of it.³ Still, some solutions are definitive, such as those of Zeno's paradoxes in *Physics* VI — which are *ad hominem* — and *Physics* VIII which, as Sir David Ross points out, no one interested in this problem seems to read.⁴

1. In *IX Metaph.*, lect. 9.

2. In *Boethium de Trinitate*, q.5, a.2, c. et ad 4.

3. Albertus Magnus, for instance, compares in this regard natural science and mathematics: "Constat autem ex his quae subtiliter in naturis considerata sunt, omnem diffinitionem aut rationem formarum physicarum conceptam esse cum materia, quae motui subjacet, aut mutationi, aut utrique: et ideo concipi oportet eam cum tempore secundum quod tempus est in re temporalis. Propter quod etiam id quod scitur de hujusmodi, *multum miscetur opinioni*, et pertingere non potest ad confirmatum constantem et necessarium scientiae habitum, sicut dicit Ptolemaeus. Ex his autem quae in quadivio bene probata sunt, scitur omnes scientias doctrinales medium suae demonstrationis accipere secundum rationem diffinitivam formae, quae licet esse habeat in physicis et extra physica non inveniatur, tamen rationem diffinitivam non habet conceptam cum materia physica, neque secundum principia essentialia dependet ad physicam materiam, sed extra eam accipit principia essentialia: et ideo in omni varietate physicorum inventa via in natura manet *univoca*, sicut circulus, et quadratum, et par et impar, et omnis proportio numeri et continui, et diapente, et diatesseron in musicis, et conjunctio et praeventio et omnis stellarum respectus, et quaecumque alia sunt hujusmodi. Et sicut ista stantes habent formas secundum principia essentialia motum et mutationem evadentes, ita stantem de se generant speculationem, nihil opinionis habentem, sed potius scientiam necessariam de se praebentem: et ideo tales habitus per speculativum intellectum *adeptae* verae scientiae nomen acceperunt, et doctrinales et disciplinales vocantur, ideo quia *ex principiis non mutantibus* quae discipulus a magistro non acceptat nisi per terminorum notitias, docentur, experientia non indigentes, ut dicit Aristoteles libro quarto, sed simplici demonstratione Doctoris constante intellectu discipuli: propter quod etiam juvenes inexperti ut plurimum magis excellunt in ipsis: quod nullo modo possibile fuit in physicis speculabilibus, *in quibus experientia multo plus confert quam doctrina per demonstrationem*. Speculationes autem istae gradus sunt et manuductiones ad speculationem divinam, sicut optime loquens dicit Maurus Albubacher in epistola quam de contemplatione scripsit. Haec enim speculatio intellectus nostri non existit in eo quod est humanus, sed in eo quod ut divinum quoddam existit in nobis." *Metaphysica*, I, c.1.

4. Even Bertrand Russell insists that there are difficulties about nature which have been solved once and for all. And so he might agree with us, at least in principle. However, as Sir David points out: "Lord Russell constantly assures us that [Georg Cantor and

3. *Science and the possible*

The teaching of Aristotle and St. Thomas¹ that there can be science only of what is necessary and immobile must appear curious to the modern reader. But however strange their thinking may now appear, it can be worth while to learn what they had in mind when they set forth this proposition. We may begin with the term 'necessary'. In order to grasp what it means we must see how it is opposed to a special meaning of the word 'possible.'²

Generally speaking, the term 'possible' has two meanings: one is opposed to what is impossible, the other to what is necessary. That the first meaning is not opposed to the necessary is plain from the fact that if what is necessary were impossible it could not possibly be necessary; hence, what is necessary must also be possible in the first sense. The other meaning of 'possible' is opposed to 'necessary,' namely, to that which cannot not be. Possibility in this second sense is described as *potentia simul contradictionis*, a potency or possibility to be excluded from the subject of science proper.

The phrase *potentia simul contradictionis* is used because this kind of potency is of things that can be *and* not be; 'to be' and 'not to be' are contradictories. For instance, if Socrates could only lie down and never stand or sit, it would be false to speak of his standing as possible, in either sense of the word 'possible.' But if lying down he *can* stand, the potency to stand coincides exactly with the actuality of lying down: the two contradictories, lying down and not lying down, are simultaneous. Anything of which no more may be asserted than that it *can* be is not possible in the second sense of this term; both contradictories must be verified at once.

'Socrates is mortal' would not be a true instance of this kind of possibility, for, as we will explain in a moment, if he lives and is mortal of necessity he must die. Yet the possibility we now have in mind rules the *mode* of his inescapable death, for he may die at any time, by poison, run down by a truck, of old age and so forth. That Socrates must inevitably cease to be is therefore not incompatible with the contingency of the way he can cease to be. — All this may sound trivial, yet many philosophers have missed the two meanings of 'possible,' while St. Thomas is not merely ready to expose them with painstaking care, but to do so over and

Dedekind] have finally settled all the difficulties about space, time, and movement, and in particular those raised by Zeno. But he never seems to succeed in showing just how they have done so." *Aristotle's Physics*, Oxford, 1936, p.84.

1. *Post. Anal.*, I, c.6 (ST. THOMAS, lect. 13-14).

2. Why Aristotle sometimes uses the words *dynamis*, *dynaton*, and *endachomenon* interchangeably (St. Thomas does the same with *potentia*, *possibile*, and *contingens*) will be discussed elsewhere.

over.¹ Leibniz did not see the point of the distinction, and even nowadays it is ignored in discussions about propositions regarding future contingent events.

If Socrates can die, why does it follow that he must? If he can die by poison, does it follow that he shall? Now, if he can die by poison or not die by poison, why should he not likewise be destructible yet never be destroyed? The point is that, if 'mortal' allowed that he might cease to be or not, that he might live forever or not live forever, we would be positing some intermediate to the contradictories 'to be forever' and 'not to be forever.'

A man has, it is true, the capacity at once of sitting and of standing, because when he possesses the one he also possesses the other; but it does not follow that he can at once sit and stand, only that at another time he can do the other also. But if a thing has for infinite time more than one capacity, another time is impossible and the times must coincide. Thus if anything which exists for infinite time is destructible, it will have the capacity of not being. Now if it exists for infinite time let this capacity be actualized; and it will be in actuality at once existent and non-existent... It is clear also on other grounds that it is impossible that the destructible should not at some time be destroyed. For otherwise it will always be at once destructible and in actuality indestructible, so that it will be at the same time capable of always existing and of not always existing. Thus the destructible is at some time actually destroyed.²

This is why *in perpetuis non differt contingere et esse*: in things that are forever there is no difference between 'to be possible' and 'to be in fact.'³

1. E.g., *Contra Gentiles* III, c.86: "Possibile enim quoddam est quod ad necessarium sequitur. Nam quod necesse est esse, possibile est esse: quod enim non possibile est esse, impossibile est esse; et quod impossibile est esse, necesse est non esse; igitur quod necesse est esse, necesse est non esse. Hoc autem est impossibile. Ergo impossibile est quod aliquid necesse sit esse, et tamen non sit possibile illud esse. Ergo possibile esse sequitur ad necesse esse... Sed possibile vel contingens quod opponitur necessario, hoc in sua ratione habet, quod non sit necesse illud fieri quando non est. Quod quidem est quia non de necessitate sequitur ex causa sua. Sic enim dicimus quod Sortem sessurum esse est contingens, ipsum autem esse moriturum est necessarium, quia secundum horum ex causa sua de necessitate sequitur, non autem primum." — *In IX Metaph.*, lect.3: "... Possibile dupliciter dicitur. Uno modo secundum quod dividitur contra necesse; sicut dicimus illa possibilia quae contingunt esse et non esse. Et sic accepto possibili, non habet locum quod hic dicitur. Nihil enim prohibet quod antecedens sit contingens esse et non esse, consequens tamen sit necessarium; sicut patet in hac conditionali, si Socrates ridet, est homo. Alio vero modo possibile dicitur secundum quod est commune ad ea quae sunt necessaria, et ad ea quae contingunt esse et non esse, prout possibile contra impossibile dividitur."

2. *De Coelo*, I, c.12, 281 b 15; 283 a 25, Oxford transl. (ST. THOMAS, lect. 26-29).

3. ST. THOMAS, *In III Physic.*, lect.7. Cf. *Contra Gentiles*, II, c.30.

XIX. EXCURSUS : A NEW MEANING OF 'SCIENCE AND THE POSSIBLE'¹

We must be made aware that the type-writing-monkeys hypothesis² has given new meaning to 'science and the possible.' For we are told that random groupings of the letters of the alphabet could produce all the works in the *Library of Congress*. There is of course no doubt that all extant writings are in fact one set of possible arrangements of the elements of speech. But the hypothesis in question is not content merely to observe this possibility, it is determined to make of it an explanation of the actuality : it appears that random permutations of these elements could produce a set of groupings entirely similar to the one at hand, and therefore equally meaningful. Those who take the possibility of such an event in earnest³ must of course maintain that anything produced by intellect or reason can be perfectly matched by a blind, purposeless agency in the way Socrates can meet his debtor not only by design but also by chance. Thus a man, as no more than one possible arrangement of electrical charges, could be the product of chance. Such reasoning seems to underlie at least one interpretation of evolution, namely, that new species are sufficiently accounted for by random mutations, 'selected' by irrational forces. Now, does this mean anything more than that new species arise because they are possible? On this basis the whole universe would be explained by stating that it is a possible one — as anyone can see from the fact that it exists.

1. This digression may help to show what Aristotle and Aquinas meant by the term 'possible' as related to science.

2. "Concevons qu'on ait dressé un million de singes à frapper au hasard sur les touches d'une machine à écrire et que, sous la surveillance de contremaitres illettrés, ces singes dactylographes travaillent avec ardeur dix heures par jour avec un million de machines à écrire de types variés. Les contremaitres illettrés rassembleraient les feuilles noircies et les relieraient en volumes. Et au bout d'un an, ces volumes se trouveraient renfermer la copie exacte des livres de toute nature et de toutes langues conservés dans les plus riches bibliothèques du monde. Telle est la probabilité pour qu'il se produise pendant un instant très court, dans le récipient A, un écart de l'ordre du cent-millième dans la composition du mélange gazeux. Supposer que cet écart ainsi produit subsistera pendant quelques secondes revient à admettre que, pendant plusieurs années, notre armée de singes dactylographes, travaillant toujours dans les mêmes conditions, fournira chaque jour la copie exacte de tous les imprimés, livres et journaux, qui paraîtront le jour correspondant de la semaine suivante sur toute la surface du globe et de toutes les paroles qui seront prononcées par tous les hommes en ce même jour. Il est plus simple de dire que ces écarts improbables sont purement impossibles." Émile BOREL, *Le hasard*, Paris, Alcan, 1938, pp.164-165.

3. Émile Borel was not one of them. The hypothesis is usually held by non-mathematicians who are unaware that within the limits of calculus itself there is nothing probable. They are like biologists who believe that in physics and chemistry all is entirely accessible to the human mind.

1. *Possibility and existence*

This view is an ancient one. It can be traced back to Democritus and Empedocles, and was given new form by Giordano Bruno, Spinoza, and Leibniz. Perhaps the latter states it most clearly, in his doctrine that all possible predicates are virtually contained in their subjects : "The notion of an individual substance contains once and for all everything that may ever happen to it (*enferme une fois pour toutes tout ce qui lui peut jamais arriver*) and, the contemplation of this notion can reveal all that may ever truly be asserted of it (*tout ce qui se pourra véritablement enoncer d'elle*) ; even as there may be seen in the nature of circle all the properties that can be inferred from it." In other words, contingency is only necessity in disguise. For, "God, seeing the individual notion or thisness (*hecceité*) of Alexander, sees in it at the same time the foundation and reason of all the predicates which can be truly said of him, as, for instance, whether he would conquer Darius and Porus, even to knowing *a priori* (and not by experience) whether he died a natural death or by poison, which we can know only by history."

Notice that it is not the mere possible substance and predicates that are the issue, but real substance and its actual history. The point Leibniz is trying to make is that adequate knowledge of the possible has got to mean knowledge of what has been, is, and shall be. Of course we agree that if Caesar crossed the Rubicon it must no doubt have been possible — in both senses of 'possible.' But he did not by necessity cross the Rubicon, and might have taken many other courses which in fact he did not take. Why, then, should contemplation of his other possible predicates enable one to behold him actually crossing the Rubicon? How dare we assert that knowledge of all that is possible is vision of all that in fact exists? What happens to that which might have been, but in fact did not occur? Where are these 'all possible predicates' going to end?

Spinoza held that whatever is possible comes to be, whereas Leibniz confined the realm of real possibility to the compossible, in such a way that existence follows analytically, so to speak, from whatever is compossible.¹ This qualification might lead one to believe,

1. Our example of impossibility would be "to stand and be seated at the same time," whereas to be standing in fact and to be able to sit down are compossible ; able to stand, and able to sit down are simultaneously compossible with lying down. No amount of intuiting this compossibility will make us see that the one who is capable of these diverse positions shall have them in fact. Nothing actually follows from this kind of compossibility : the fact that I can stand does not entail that I shall (although the fact that I am destructible entails that I shall be destroyed, which is necessary as opposed to possible). Leibniz's compossibility is of another kind, for he seems to mean that things which are not impossible must come to be. Bertrand Russell's account of why, according to Leibniz, some things exist and others, equally possible, do not, is substantially correct, though not compatible, nor does it aim to be, with all that Leibniz wrote. "According

erroneously, that Leibniz's qualification is reducible to Aristotle's conditions of real possibility — as distinguished from what is possible in logic or in mathematics, where 'possible' and 'potency' are metaphors. Real possibility, such as that of walking, contains many things. These are in fact innumerable, and any account of such possibility must be largely incomplete. An adequate account would have to draw upon the whole unwieldy universe. However complete our knowledge of the conditions of any man's walking, it could not make us see him striding along. "... Anything which is possible is something possible at some time and in some way, with all the other qualifications which must be present in the notion."¹ Aristotle then goes on to show how natural possibilities differ from the rational. In nature, provided the required conditions are satisfied, the really possible, the physical potency, becomes actual — at least for the most part. "For the non-rational potencies are all productive of one

to this view [Lord Russell says], everything that does not exist struggles to exist, but not all possibles can exist, because they are not all 'compossible.' It may be possible that A should exist, and also possible that B should exist, but not possible that both A and B should exist; in that case, A and B are not 'compossible.' Two or more things are only 'compossible' when it is possible for all of them to exist. Leibniz seems to have imagined a sort of war in the Limbo inhabited by essences all trying to exist; in this war, groups of compossibles combine, and the largest group of compossibles wins, like the largest pressure group in a political contest. Leibniz even uses this conception as a way of defining existence. He says: 'The existent may be defined as that which is compatible with more things than is anything incompatible with itself.' That is to say, if A is incompatible with B, while A is compatible with C and D and E, but B is only compatible with F and G, then A, but not B, exists by definition. 'The existent,' he says, 'is the being which is compatible with the most things.' — In this account, there is no mention of God, and apparently no act of creation. Nor is there need of anything but pure logic for determining what exists. The question whether A and B are compossible is, for Leibniz, a logical question, namely: Does the existence of both A and B involve a contradiction? It follows that, in theory, logic can decide the question what group of compossibles is the largest, and this group consequently will exist." *A History of Western Philosophy*, Simon and Schuster, New York, 1945, p.594. 'Struggle to exist' is of course a metaphor, since compossibility is the *raison suffisante* of what actually comes to be.

1. *Metaph.*, IX, c. 5, 1048 a. St. Thomas explains the passage as follows: "... In ratione possibilis oportet multa considerare. Non enim dicitur possibile respectu cuiusque, sed respectu alicuius determinati. Unde oportet possibile, esse aliquid possibile, ut puta ambulare vel sedere. Et similiter quod potest aliquid facere vel pati, non potest illud quocumque tempore facere aut pati; sicut arbor non potest fructificare nisi determinato tempore. Et ideo cum dicitur aliquid esse possibile, oportet determinare quando sit possibile. Et similiter oportet determinare quomodo sit possibile. Non enim possibile, quocumque modo potest agere aliquid vel pati; sicut aliquis sic potest ambulare, scilicet tarde, non autem velociter. Et simile est de aliis circumstantiis quae consueverunt determinari in definitionibus rerum; sicut quo instrumento, quo loco, et alia hujusmodi." — This may have been the reason why the Megarians could make their contention, that a thing is possible only when it actually is, appear likely. "There are some who say, as the Megaric school does, that a thing 'can' act only when it is acting, and when it is not acting it 'cannot' act, e.g. that he who is not building cannot build, but only he who is building; and so in all other cases." *Metaph.*, IX, c.3, 1046 b 25. Oxford transl.

effect each, but the rational produce contrary effects, so that if they produced their effects necessarily they would produce contrary effects at the same time; but this is impossible. There must then be something else that decides; I mean by this, desire or will."¹ In other words, rational powers are of contradiction, and determined to one of the opposites by will, for the doctor can use his skill or refuse to do so; or he can use it to heal but also to kill. Yet there is likewise a *potentia simul contradictionis* in nature, inasmuch as the powers of action or passion may be present or absent, as when an animal may lose its sight.² But this is precisely the kind of potency or possibility which Leibniz must deny.

Leibniz did not of course believe that we humans can achieve the adequate knowledge which he so confidently described. He thought nonetheless that we can approach it. Only the possible that is compossible with other things does in fact come to exist. (We would say 'can come to exist.') Adequate knowledge is approached as one discerns which possibilities are more favoured; and this is to be achieved by a "logique des probabilités" along with infinitesimal analysis. (Again, we would say that the application of this logic and analysis must presuppose a given existential situation.) All the same, Leibniz was aware that sheer compossibility can hardly account for what actually comes to be; he felt the need to posit some kind of *finalité*. But this finality has nothing to do with action for the sake of something; 'that for the sake of which' is not conceived as a cause,

1. *Ibid.* — Nature and reason are distinguished by the difference between contraries as in our knowing, and contraries as in fact. In fact a man cannot at the same time see and be blind; but in knowing blindness, he must simultaneously grasp what sight is. For sight is implicit in the very notion of blindness, just as any positive term is essential to its negation, and the perception of one term as contrary is dependent upon the representation of its opposite. This supposes a radical difference between the corresponding subjects of any contrariety. So, if the differences between contraries are held to be finally one and the same, the real, as distinguished from the rational, will involve contradiction (which is the way some people want it): just as one cannot conceive blindness without simultaneously conceiving sight, nor think death without thinking life, so one could not actually see without being actually blind, or be alive without being also dead. This impossibility cannot be escaped by anyone who refuses to allow a significant distinction between mind and nature. All the same, there are instances of simultaneous contrariety outside the mind — providing ample room for confusion. A plant, for instance, grows in contrary directions; and a thing becoming white is neither determinately white nor not-white. But these cases differ widely from that of the mind; the first involves parts that are quantitatively external to one another, while becoming remains this side of full actuality. — Cf. *Q. D. de Veritate*, q.23, a.1.

2. "... Aliae potentiae rerum mobiliū, de quibus supra determinatum est, omnes sunt contradictionis, e contrario rebus sempiternis, quae semper sunt in actu. Sed diversimode: nam potentiae rationales sunt contradictionis, eo quod possunt movere sic vel non sic, sicut supra dictum est. Potentiae vero irrationales operantur uno modo; sed et ipsae sunt contradictionis per hoc, quod possunt adesse, et non esse, sicut animal potest amittere potentiam visivam." In *IX Metaph.*, lect.9.

but as an end-result that follows from compossibility — the true cause of coming to be.

Such a position is easily reached by means of a threefold confusion: by identifying (a) the possible opposed to the necessary, with the possible opposed to the impossible; (b) and simultaneously the possible opposed to the impossible with the necessary, on the grounds that whatever is possible is necessarily possible; (c) the true and the possible, ignoring that something may be false, yet possible; or possible though not true — e.g., to say that Socrates is standing when he is in fact sitting down, is false, yet, though sitting down, it is possible that he stand. Thus, by a fallacy of equivocation, making univocal use of the term 'possible' we have ruled out all *potentia simul contradictionis*.¹ Now we understand the basic principle: "Principium meum est, quicquid existere potest, et aliis compatibile est, id existere." This plainly means that whatever is compatible, was, is, or shall come to be. Elephants came to be because they are compossible permutations of the stuff they are made of, and compossible with the rest of the world. We might have known as much, of course, but how does this explain the kind of beasts they are, or why they should be at all? It is difficult to see how Leibniz's theory — namely, that to be actual the possible must be of the compossible kind — could be anything more than mere tautology in disguise. The aim of his *Characteristica Universalis* was to replace thinking by calculation, i.e. by a mechanical concatenation of tautologies.²

The hypothesis referred to at the beginning of this section contains still another fallacy of equivocation, based upon univocal use of the term 'chance,' as if whatever happens at random happened by chance understood as an accidental cause. There was a further fallacy — one of *latius hos* — in concluding that a certain event may always be the product of chance because it may at one time be the effect of a *per se* cause and at another of an accidental one. Let us first face the ambiguity of 'What happens at random happens by chance.' I throw a pair of dice at random. Now, they are not thrown by chance, for it was by deliberate purpose that I threw them at random. Hence, if the expression 'good luck,' or 'good fortune,' is used when desirable numbers turn up, it is not being used in the sense that the accidental discovery of treasure by a man digging a well

1. The identification of 'possible' with the opposite of necessary would mean that this *potentia* holds sway over all; which leads in turn to the paradox that 'everything is contingent' except that everything is contingent; in other words, 'the necessary is impossible' — except that it is necessarily impossible.

2. Hobbes held a somewhat similar view of reasoning. "Per ratiocinationem . . . intelligo computationem. Computare vero est plurium rerum simul additarum summam colligere, vel una re ab alia detracta, cognoscere residuum. Ratiocinari igitur idem est quod addere et subtrahere." *Opera philosophica*, Wolesworth, 1839-1845, vol. I, p. 3.

is called good fortune. I mean that we have changed the imposition of the term on the basis of a certain similarity, in respect to uncertainty, between the result of a random cast and the casual or fortuitous event. But in obtaining a desirable pair of numbers on the dice no chance is involved in the true sense of this term — unless someone accidentally nudged me and thus favoured the shot. Because, as I throw the dice at random I am quite aware of the alternatives, so that no matter which sides turn up, I cannot normally ascribe the result to chance, unless the meaning of this term be extended — as in 'the laws of chance.' And it may be worth remarking that chance in this extended sense, becomes a very equivocal term indeed, since it now means 'degrees of probability,' whereas true chance is always highly improbable. Similarly, if I bring down a duck with shot, this event may not be attributed to chance because of the random distribution of the pellets. There may perhaps have been a good reason why this particular pellet struck the game, but my intention will not explain it, because my intention was not set upon this pellet. Many pellets were stuffed into my cartridge (at random) so that the 'chance' (probability) of striking the goal might be enhanced. Nature is doing much the same in producing huge amounts of spores or of sperm most of which will fortunately never reach fruition. Yet without such enormous calculated waste, all living species would soon be extinct. So that, though it be by chance that this spore germinates, there is very little 'chance' that germination will not take place somewhere.

2. Science and accidental cause

To show, in turn, how easily the term 'accidental cause' lends itself to fallacies of equivocation, we have only to examine several of its meanings.¹

1. In *V Metaph.*, lect. 3: "Sciendum autem est, quod aliquid potest dici causa per accidens alterius dupliciter. [a] Uno modo ex parte causae; quia scilicet illud quod accidit causae, dicitur causa per accidens, sicut si album dicatur causa domus. [b] Alio modo ex parte effectus; ut scilicet aliquid dicatur causa per accidens alicuius, quod accidit ei quod est effectus per se. Quod quidem potest esse tripliciter. [i] Uno modo, quia habet ordinem necessarium ad effectum, sicut remotio impedimenti habet ordinem necessarium ad effectum. Unde removens prohibens dicitur movens per accidens; sive illud accidens sit contrarium, sicut cholera prohibet frigiditatem, unde scamonaea dicitur frigidare per accidens, non quia causet frigiditatem, sed quia tollit impedimentum frigiditatis, quod est ei contrarium, scilicet choleram: sive etiam si non sit contrarium, sicut columna impedit motum lapidis, unde removens columnam dicitur per accidens movere lapidem superpositum. [ii] Alio modo, quando accidens habet ordinem ad effectum, non tamen necessarium, nec ut in pluribus, sed ut in paucioribus, sicut inventio thesauri ad fossionem in terra. Et hoc modo fortuna et casus dicuntur causae per accidens. [iii] Tertio, quando nullum ordinem habent, nisi forte secundum existimationem; sicut si aliquis dicat se esse causam terraemotus, quia eo intrante domum accidit terraemotus." Cf. *In II Physicorum*, lect. 8.

(a) 'The doctor builds' is an instance of accidental cause by reason of something accidentally connected with the *per se* cause (the builder as such) considered on the part of the cause itself. To be a doctor, red-headed, a husband, tall, walking, and so on, is incidental to the builder; it is nonetheless true to say that this doctor builds, if he does, or this red-headed fellow builds, etc. There is in fact no end to such possible incidentals, some of which arise unceasingly, such as the advancing age of the builder, or his growing baldness; that he be fifty years old today may be false tomorrow, for instance, or if false today, it may be true tomorrow or at some later time. However, not all accidental causes, so-called by reason of something connected with the *per se* cause, are accidental in quite the same sense. It is *per accidens* that a man builds a house, else he could not be a man unless a builder. But it is not *per accidens* that the builder is a man (unless building comprise nests, ant-hills, hives, beaver-dams, and so on), eventhough he is not a builder simply qua man. Similarly, any given builder must of necessity have some age, one that advances necessarily as he builds, for he and his building are measured by time. In the latter cases, accidental is not opposed to necessary. Notice how inescapable is this infinity of accidental causes related to any builder. In a sense, they comprise the whole universe, inasmuch as the builder is in fact at such a place and such a time, as well as constantly elsewhere and later; and he will be one of so many people unceasingly varying in number, or one of so many kinds of animals, of living beings, of beings, and so on. But if the range of this kind of accidental causality is infinite, not every instance of it is equally close to the *per se* cause. That the builder, for example, be a man is more immediate and necessary than that he must of necessity be an animal, or a mammal. To live at this address rather than at that one is more accidental to the builder than to have been trained by a man in his fifties rather than by one in his sixties; that he be a husband is less incidental than that he should be bald. This sort of accidental causality reveals a new infinity then, one of degrees of relationship to the *per se*. Now, because all incidentals, however near to or remote from the *per se* cause, no matter how necessary or contingent they may be, are always a reason why the *per se* cause (the builder), is also an accidental cause (the builder qua man or qua bald), some are inclined to put all incidentals on the same level — now concluding that all incidentals are equally necessary, now that all are equally contingent. In either case utter confusion and unintelligibility must result: something the Anaxagorean *Nous* might be called upon to unscramble. It is the old story. The incidentals are there, hence they have got to be there; or, the incidentals are plainly incidental, therefore they are all equally incidental. Aristotle never falls into such over-simplifications.

(b) From a quite different point of view a cause may be called accidental by reason of that which may occur to its effect, i.e. when

something happens to the *per se* effect of an agent. There are three different types of such accidental causality.

(i) When the additional effect is related to the *per se* effect by necessity. For example, if to reach a certain place I must walk a muddy path, the walking through mud is incidental though necessary; or, if I pull down a column and the stone on top of it falls to the ground, I will be called the moving, though incidental, cause of this inevitable fall. Another instance of *removens prohibens* would be the opening in a cloud which accounts for a shaft of sunlight reaching the earth at such or such a spot. Taken in this sense, the accidental cause is not, as such, opposed to a necessary one. My awareness or non-awareness that the stone must fall if I pull away the column will not make its fall less necessary; yet it remains accidental in this particular sense of accidental. Nowaways, 'cause' is mostly used in the sense of *removens prohibens*.

(ii) The second type of accidental causality, is so called by reason of an effect which merely occurs to the effect intended *per se*, with no trace of necessary connection. This type is confined to causes acting for a purpose. It is essential to it that whatever happens to the effect should happen neither necessarily, so far as the agent is concerned, nor for the most part, but so seldom that there can be no reason to expect it. For example, a man digs a well for water and discovers a treasure. Digging at this spot he cannot fail to discover the treasure; the discovery is nonetheless purely contingent to what he intended as he dug. He is an accidental cause of this piece of good luck, no matter how predictable it was to his neighbour who knew all the time there was a treasure at that spot and in fact suggested digging for water precisely there. Strange to say, the neighbour could thus become the *per se* cause of a strictly contingent event.¹ Notice how 'that for the sake of which' — namely, a good to be achieved or a harm to be avoided — is essential to this type of accidental cause, meaning that the treasure is a thing the man would have dug for had he known it was or might be there. Similarly, had Socrates intended or expected to meet his debtor in the market today, or thought he might be there, the encounter would no longer be fortuitous.² In other words, whatever happens by chance in this

1. *Contra Gentiles*, III, c.92: "Patet etiam quod etiam homo qui sciret thesaurum esse ibi, posset alium ignorantem mittere ad fodendum sepulcrum in loco eodem, ut praeter intentionem suam inveniret thesaurum."

2. *In II Physicorum*, lect.8: "Sed nunc hoc debet fieri manifestum, quod utrumque [scil. fortuna, quae est agens a proposito, et casus, qui est agens a natura] continetur in iis quae aguntur propter finem: sicut si aliquis sciret se recepturum pecuniam in foro, ivisset ad deportandum eam; sed si non venit propter hoc, per accidens est quod adventus eius fiat reportationis gratia, idest habeat effectum. Et sic patet quod fortuna est causa per accidens eorum quae sunt propter aliquid. Item, manifestum est quod est causa eorum quae sunt in minori parte; quia ista reportatio pecuniae dicitur fieri a fortuna, quando

sense of the word — the second meaning of accidental cause, taken from the effect — must be something which the agent would deliberately pursue or avoid ; if what occurs accidentally to an effect intended by the agent were indifferent to him, one would not speak of fortune or chance in the sense here described. It follows that if there are to be chance events in nature, i.e. outside human agency, they will suppose that nature too, in her own way, acts for the sake of something, namely, to achieve a good or to avoid harm.¹

(iii) Finally, a cause is termed 'accidental' when in fact there exists no connection at all between what are thought to be cause and effect — *nisi forte secundum existimationem*. These supposed connections may be mere fancies, like the delusion of the good wife who believed herself cause of an earthquake because it occurred just as she dropped her bucket of coal ; or who reversing the relationship between sunrise and her getting up, believed the sun ought to rise because she had got up. These examples, adapted from Aristotle, may seem trivial ; yet they help bring to light more subtle illusions of this kind. In fact science is in some measure an attempt to rid our minds of such delusive appearances of causality. An instance would be the age-long belief that man's abode ought to be at the geometrical center of the universe. Leibniz's belief that compossibility is the proper cause of whatever comes to be is another case not much less ludicrous ; nor does it appear that the idea of random mutations, by their very randomness causing the rise of good species, makes a much better showing. Such relations of causality are utterly fictitious, in the pejorative sense of this term. (In mathematical physics, agent and final causes are vain, cumbersome fictions ; and therefore chance as well, if taken in the second meaning of accidental cause in our last division.) Perhaps one might say that Hume believed all causality to be of this type.

reportat ad villam veniens neque ex necessitate neque frequenter. Item est in iis quae fiunt a proposito : quia reportatio pecuniae quae dicitur fieri a fortuna, est finis aliquarum causarum, non secundum seipsum sicut in iis quae fiunt a natura, sed est finis eorum quae fiunt secundum propositum et ab intellectu. Sed si aliquis hoc proposito iret ut pecuniam reportaret, vel semper aut frequenter reportaret quando venit, non diceretur esse a fortuna ; sicut si aliquis frequenter aut semper madefacit sibi pedes quando vadit ad locum lutosum, et hoc licet non intendat, tamen hoc non dicitur esse a fortuna." The latter would be a case of accidental cause in the sense of (b, i).

1. In the *Physics* (II, cc.4-6) where Aristotle treats of chance in nature, he nonetheless first analyses fortune. The reason is that the latter, occurring as it does in rational agents, is more obvious as to us ; whereas in nature, chance is more hidden, even as is final causality itself. Regarding this causality, though *causa causarum*, it comes last in the division of causes and required more proof than the other species of cause. St. Thomas explains why. "Et quia de fine videbatur minus quod esset causa, propter hoc quod est ultimum in esse, unde etiam ab aliis prioribus philosophis haec causa est praetermissa, ut in primo libro praehabuitur est, ideo specialiter probat de fine quod sit causa." In *V Metaph.*, lect.2.

It is interesting that even accidental causes are not always opposed to necessity. The above divisions make this clear. The first case (a), for instance, may be one of absolute necessity, for the builder of houses is necessarily a man ; or it may be one of hypothetical necessity, for this bald builder cannot now build without being bald — even though his baldness be purely incidental. Neither is the first instance (b, i) of a cause accidental by reason of the effect opposed to necessity, for if I pull away the column, the stone must fall, or, if the earth is exposed to the sun and there is a break in the clouds, more light will reach the surface of the earth. (However, we may not say that the clouds opened so that sunlight might reach the earth, though this may in fact be good or harmful for the crops. To make such a statement would be contrary to the rule that effects must be related to causes proportioned to these effects — *causis debent proportionaliter respondere effectus*.¹) Only in the second case (b, ii) is accidental cause opposed to necessity. Yet, even this one must be qualified. For if a man digs a well deep enough at the very spot where the treasure is buried, he must of necessity discover it. But if this occurred always or frequently, (b, ii) would become a case of (b, i). Such necessity makes some people believe that there is no difference between these various cases of accidental cause, namely, that (b) is reducible to (a) ; (b, ii) either to (b, i) or to (b, iii) : (b, ii) to (b, i) inasmuch as digging the well at this spot must result in discovery of the treasure already there ; (b, ii) would be reducible to (b, iii) inasmuch as the man who so discovers the treasure would believe it was there so that he might discover it, as if he were the *per se* cause of this good fortune — for the fortuitous character of good fortune is soon forgotten. There is nonetheless all the difference in the world between (i) the necessity of following a muddy path to reach a certain place ; (ii) to discover unexpectedly something worth while or harmful ; (iii) to believe that there is an order of effect to cause, *per se* or *per accidens*, where there is nothing of the kind.

Now notice what can result from an easy confusing of one type of accidental cause with another. If the accidental cause termed chance (b, ii) be identified with that called *removens prohibens* (b, i), the result will at once be a case of causality, *per se*, necessary, yet utterly fortuitous in the sense of (b, ii). If I draw your chair away just as you are about to seat yourself, yet by some sort of curious reasoning can maintain that, though I foresee the result quite clearly, I do not in the least intend it, then I become *per se* cause of your fall, necessary cause of it, yet chance cause of it. Democritus seems to be in this position, since he holds that a concourse of atoms formed the whole universe by chance and that all happens of necessity. It is

1. If we fail to obey this rule, the doctrine of final causality can be made to look grotesque, as Aristotle shows in *Physics*, II, c.8.

noteworthy that several pre-Socratics went so far as to see in chance (*automaton*) the supreme universal cause, yet felt no need to analyse its nature. There is of course a sense in which chance, being *ens per accidens*, has no nature and is undefinable. This may be the reason they failed to analyse the notion of chance which is definable. But to proceed in this way is to attempt explanation of the known in terms of the unknown, of *per se* in terms of *per accidens*. This is precisely what we do when we say that order is the *per se* effect of disorder, and reason of unreason. And so we reverse the adage 'whatever is *per accidens* must be reduced to something *per se*.' Notice how the reverse of this statement may follow logically from its misinterpretation. For most authors, ancient and modern, understand it to mean that in a proposition like this one, 'Socrates was accidentally (cf. *b, ii*) run down by a truck,' we are ignoring the *per se* causes of his death, namely, the mass and consistency of Socrates, his inattention, the weight and momentum of the truck, and so on, and that we thus overlook the fact that under these circumstances he could not fail to die. But this is a bad blunder. The term 'accidentally,' in our report of Socrates' fatal accident, overlooks nothing. Rather it acknowledges the truth that, in spite of the determinate reasons for his death, the fact remains that Socrates was unaware of what was about to happen as he crossed the street then and there. Any rational agent who cannot keep all circumstances under control is liable to be an accidental cause of the type (*b, ii*). The pseudo-explanation by means of no more than determinate causes rests on a twofold confusion. First, the accidental cause (*b, ii*) is identified with (*b, i*); second, it is assumed that whatever happens necessarily (e.g., *b, i*) is a *per se* effect, as if, in our first example, the wish to reach a certain spot (A) were quite the same as the willingness to walk through mud (B). The whole point is that (B) is not *per se* intended, though inevitable, and even *per se* connected with (A). The truck is not the cause of Socrates' unfortunate end, though his death necessarily follows when it strikes him. Nor is the driver the *per se* cause, though he could see that Socrates was done for a few seconds before the actual impact. And it is a blessing that traffic courts appreciate this better than writers on philosophy.

Now let us see how 'whatever is *per accidens* must be reduced to something *per se*' can logically be turned into its converse. It is by reading *per se* causality into what is in fact accidental. The sophism here is more subtle. To illustrate, let us return to an earlier example: Socrates goes to the market place for the sole purpose of buying vegetables; he there chances upon a debtor of his whom he had wanted to meet all along. The usual analysis of this event is as follows: both Socrates and his debtor were bound to reach the market at such a spot and time, no matter what their respective intentions; so how could they fail to meet? The fortuitous character of this

meeting seems swallowed up, as it were, by *per se* causes. But such an analysis is pointless, for it excludes exactly that which makes the meeting fortuitous (*b, ii*), namely, the different reasons why Socrates and his debtor go to that place at that time, and their desire to meet or avoid each other if they knew where or how, and the absence of all expectation on the part of each that the encounter would happen then and there. *Per se* agency is of course present. But the duty of reducing the *per accidens* to something *per se* does not mean that in the end *per se* must replace it. The agent and his express purpose are essential here, while something, which he would pursue or avoid if he had foreknowledge, happens unexpectedly to what he intends, or in lieu of what he intends, in this particular action. In other words, the fortuitous occurs (1) to a *per se* agent who (2) would have acted for the sake of, or would have sought to avoid, something which happens outside of his intention. The encounter may be quite expected and foreseen by a third person who knows the intentions of Socrates and his debtor, and to this third party, will therefore not be fortuitous; but if he did not know that they did not intend or expect either to meet or avoid one another on this particular occasion, the third person would be ignorant of the encounter qua fortuitous.

Now, how can the converse of our adage come to be stated as a logical conclusion? It is simple enough. To reduce accidental causality in the fashion described, is actually to identify the two. The *per se* is watered down to *per accidens*. Let us recall the impossible enthymeme mentioned on an earlier page: since Socrates can meet his debtor just as effectively by chance as by design, it follows that everything can be accounted for by chance. Now an application of Occam's razor will be made: but whatever can be accounted for by chance requires no other cause. Therefore the proposition 'whatever happens *per se* is reducible to what is *per accidens*' should be preferred to its converse. Now, 'random mutations' means the same as 'mutations produced by chance'; therefore chance can account for all there is in nature. But does it? And, if so, how? What would be thought of a christian science forever ready with the pious declaration that everything found its explanation in the fact that God made it or could make it?

3. Explanation and possibility

There is nonetheless a sense in which science does have the duty of showing that a thing is possible. In geometry, for instance, it is possible to construct an equilateral triangle, which therefore 'exists.' In mathematics, constructibility implies existence; if our triangle is possible, if it *can* be constructed, then it is by that very fact a valid object of mathematical science. For instance, having constructed a plane triangle, it will now be possible to extend its base, which reveals

that the exterior angle so produced is equal to the two opposite interior angles ; from which we can now demonstrate that the angles of any plane triangle are equal to two right angles. This property follows necessarily from what a plane triangle is. In nature, however, possibility will not be quite of this kind, and will never of itself provide a basis for profitable reasonings. Anyone can see that elephants are possible, for example, but this possibility is known by hind-sight and throws no further light on what an elephant is, or *how* he is possible. To show how the elephant is possible as we do the equilateral triangle, we would need to know its inner essential design and there perceive how such a beast can come to be. Even from such knowledge, which no doubt would need to draw upon the whole universe, we could never conclude that elephants do in fact exist. To achieve this conclusion we would have to show how, from previously existing things (A), elephants (B) necessarily proceed, on the assumption that if A, then B.

An analogy may clarify the distinction which I am trying to establish. There are two ways in which a man may know a motor-car. Without in the least understanding how it functions, he may own and drive one. He will then be quite aware that motor-cars are possible, for he has immediate experience of his own. But he will have knowledge of these machines in a very different sense, if he also knows how they function and how they are manufactured. Now the man who is satisfied with randomness without aim as sufficient explanation for the origin of species will be like a person who would find a sufficient reason for motor-cars in the simple fact that they exist. The latter individual may attempt to render his position more acceptable by arguing that no contradiction or impossibility is involved in the notion that random changes in ores might well result in the special metals and alloys needed for a motor-car ; that random scrambling of these metals could explain the formation of the proper parts ; and that further scrambling could result in the final assembly of this convenient means of transportation. But does this sort of elaboration really help ? Surely its only function is to camouflage a basic position which remains unchanged : motor-cars are possible, they *can* be, and this explains the fact that they are. It explains nothing of course. Actually it is a statement that explanations are not to be sought.

Now if we are right to reject a pseudo-theory of this sort as accounting for motor-cars, why are we not right to reject a similar tale offered as explanatory of the nature and origin of species ? Are the works of nature manifestly so much less intelligible than man's ? And if they were, shall we diminish their obscurity by denying purpose in them ? The fact is that to understand the simplest forms of life is harder for us than to grasp the structure and workings of our most complex machines, because there is in nature so much more to be known, so much more intelligibility than man can achieve. Natural Selection, as Darwin put it, " is a power incessantly ready for action,

and is immeasurably superior to man's feeble efforts, as the works of Nature are to those of Art." Perhaps we should ask ourselves if the very superiority of nature's works, and the consequent difficulty man must face in understanding them, have anything to do with tendencies to ruthless over-simplification, such as that which leads to a theory of unguided randomness as proper and sufficient cause of all natural things.

In fact, though, most knowledge of possibility in nature is of the hind-sight type, and even when we reach some understanding of concrete possibility we can never do away with the first. For instance, we know that there are planetary systems, and several hypotheses are in vogue to account for their formation. Now suppose we eventually learned how they in fact come to be, as we know why eclipses occur ; we would then understand how they are concretely possible, yet this possibility would not be the reason they exist, any more than the mere possibility of the universe can be the cause of its existence. Having shown that planetary systems are possible, we might see that they are necessarily possible — a possibility opposed to the impossible ; but this is as much as we could hope for. The study of nature may therefore be viewed as progress from what is known to be possible because it is there, like an oak tree, toward understanding of the proper reason of its possibility — which is the same as knowledge of its causes. Still, it must not be forgotten that the latter possibility will never account for the fact, no matter how exhaustive the knowledge of all that is required for its possibility. Planetary systems or elephants remain contingent things, no matter how clear it may become that they can exist. All of which goes to show how essential it is to distinguish the possible as opposed to the necessary, from the possible as opposed to the impossible — and how easily the one is taken for the other.

Let us return to our random mutations. There is an analogy between throwing dice at random and the way nature produces individuals and new species, an analogy like that Darwin saw between conscious and unconscious selection. We observe random distributions of spores, and very few of these come to fruition. Now, is there anything unscientific in observing that without this huge waste there would soon be no mushrooms ? Is it unreasonable to see that this is reasonable ? Must we refuse to see that if nature did not resort to random mutations, new species would not arise ? If nature's randomness is analogous to the sort we use on purpose, as in casting dice, we simply cannot identify it with accidental causality of the type (b, *ii*) without destroying the analogy. Both instances of the random, however, can be partly reduced to the accidental causality (b, *i*) inasmuch as no purpose determines which particular sperm will fecundate the ovum, or which pellet will strike the game — so far as my

intention is concerned, any pellet will do. Lavishness and waste are part of a method used by both art and nature to defeat uncertainty in the face of contrariety — *removens prohibens*. Like the average hunter, nature is simply not equipped to achieve results with economy. There is no reason in the world why randomness in nature should not be purposeful.

It is interesting to note that they who seek in aimless random mutations a principle of natural selection, appeal nonetheless to a prior principle, namely, the 'struggle for existence.' Why should living things 'struggle' to exist? And what is meant by 'favourable' mutations? If these expressions are mere metaphors, why does science use them at all? If more direct language is impossible, we may surely ask why. The reader will remember that to make intelligible Leibniz's compossibles as invested with power to lift themselves into existence, Lord Russell explained that "Leibniz seems to have imagined a sort of Limbo inhabited by essences all trying to exist; in this war, groups of compossibles combine, and the largest group of compossibles wins, like the largest group in a political contest." Empedocles too, though he taught that order in nature is the product both of necessity and chance, nonetheless had recourse to Love and Strife as basic principles, but, like the *Nous* of Anaxagoras, they amount to no more than a *deus ex machina*.

There is a type of mind averse to any intelligibility we may achieve by granting purpose in nature, by granting, for example, that eyes were produced for the sake of seeing. It is obviously more simple to say that we can see because we have eyes, or can walk because we have legs. If a man is satisfied with the latter type of reason, if he frowns upon 'eyes are for the sake of seeing and are produced for that reason,' there is little to be done about it. But there is nothing to prevent us from understanding why he can find such a choice possible, just as we can account for Descartes' faith in a clarity which turns out to be utterly obscure.

Finally, it would be unjust to imply that all scientists scorn the notion of purpose in nature as scientifically perverse. Very eminent biologists, such as Lucien Cuénot and C. H. Waddington, and even physicists, such as Niels Bohr, maintain that living things are unintelligible without purpose.

(To be continued.)

CHARLES DE KONINCK.

La vision philosophique d'Héraclite

Que penser d'Héraclite? « C'est, pour Schuster, un sensu et un empiriste; pour Lassalle, un rationaliste et un idéaliste. Le fondement de sa doctrine, Teichmüller le trouve dans sa physique; Zeller dans sa métaphysique, Pfleiderer dans sa religion. Pour Teichmüller et Tannery, sa théologie est venue d'Égypte; pour Lassalle de Zoroastre; pour Lassalle de l'Inde; pour Pfleiderer, des mythes grecs. Pour le même Pfleiderer, la doctrine héraclitéenne dérive des théories générales; pour Teichmüller, les théories générales dérivent de l'observation du *flux*. Pfleiderer fait d'Héraclite un optimiste, Mayer en fait un pessimiste; il est, pour Schuster, un zoïste; pour Zeller, panthéiste; pour Pfleiderer, panzoïste, pour Lassalle, panlogiste! » Depuis que M^{re} Diès effectuait ce sarcasme recensement, la liste s'est allongée: pour Macchioro, Héraclite est un prophète, un initié, un bacchant; pour Gigon, il est un *Aufklärer*; pour Kirk, une sorte de Victorien égaré dans la Grèce archaïque. J'en passe une foule d'autres.

On éprouve quelque répugnance à mêler sa voix à ce concert discordant. Il est de mode d'en rejeter la cause sur l'obscurité d'Héraclite lui-même. C'est là un des nombreux spectres dont l'histoire de la philosophie est encombrée et sur lequel les exorcismes les plus vigoureux n'ont aucune prise. Nous nous inscrivons en faux contre cette tradition morte. La pensée de l'Éphésien est limpide dans les documents dont nous disposons, abondants et incontestables. Parmi les Présocratiques, il n'est sans doute pas de philosophe dont les intentions soient plus manifestes: il suffit de lire l'œuvre avec les yeux ingénus qu'Héraclite se flattait d'avoir et de retrouver la vision originale du monde dont il s'enorgueillit à maintes reprises. Cette conception fut en effet beaucoup plus intuitive que discursive: c'est ce qu'établissent sans conteste les textes dont nous disposons. À l'encontre de Parménide qui presse sa conception au point d'en jaillir une intrépide série de raisonnements systématiques, Héraclite est un « voyant » pur: aucune argumentation n'affleure dans son œuvre. Ce n'est pas que l'Éphésien dédaigne la synthèse. Lui-même l'a faite! Mais sa pensée, pour être fortement synthétique, ne se ramène jamais dans le système.

Cette distinction entre synthèse et système est d'une extrême importance pour l'interprétation de la philosophie héraclitéenne. On pourrait exprimer leur différence en disant que la synthèse ramène au tronc et à la racine, tandis que le système ramifie. Leur déroulement fait appel à des logiques différentes. La synthèse est régressive et cherche le principe, le centre de perspective, le point de vue par