Science and the Humanities — [inédit] — (6)

lect. 3 — 23 pp. dactyl. ~~secret~~ autre copie — 17 pp. dactyl.
lect 4 — 25 pp. dactyl. " " 21 pp. "

Conf. corrigées par Mgr Arthaud Durand et Th. D. Kozmick en vue de la publication de The Divine Synthesis, 1968.

Non publiées.

Lecture # 3

We have been explaining how it is so valuable, and indeed vital never to forget, to stick to ordinary words, and ordinary language in all our thinking and discussions. Everyday speech is rooted in reality, and the thinker who abandons it may soon find himself floating in a void, cut off from both reality and his fellowmen. Now, to put this in other words, there are certain common conceptions, that is, ideas shared by all men, which, if we are to discover, our surest method is simply the examination of language shared by all men. I do not mean to suggest that all common conceptions are always to be trusted. But it can be stated firmly that the most primary and basic of them will never contain error. This we may assert with confidence, and easily verify. And we can furthermore see that if we were mistaken about all of our so-called common conceptions, then all our subsequent knowledge and science would be vitiated; we would find ourselves doomed to a condition of uncertainty so total that we could not even tell what uncertainty is. Because to know what uncertainty is, one must know what certainty is. And the investigation of certainty will most assuredly involve us in the study of absolutely primary conceptions.

It should be noted that these utterly primordial notions, with which all thinking must begin, are first attained through induction. Take our initial vague conception of man. That we do have such a primary conception is proved by the fact that we ask what man is; and this we could not ask if we did not already possess at least enough knowledge of man to put the question. Without some knowledge of what we were talking about, no matter how vague and unsatisfactory, the question would become utterly meaningless. However, though the knowledge be admittedly vague, it is quite certain. We are in no doubt that man exists. But this is very far from enabling us to explain, reveal, distinguish, exactly what it is to be a man. Were we required to convey exact knowledge, our first step would be to make a division; to observe that man is an animal. Animal is something better known to us. Indeed, man simply as animal is something we know before we identify this animal as a man. In short, we know what he shares in common with other things before we know what makes him different from other things. Yet, as we acquaint ourselves with man, we appreciate that he must be described as something more than the mere animal. And thus we are driven to making a division.

Proceeding with our investigation, we next observe that man is a creature who has developed certain skills. He makes tools. He talks. In each of these types of behaviour he exhibits ~~skill~~ a kind of infinity; ~~And each of these domains is possible as we readily observe.~~ Born the most helpless of animals, or, as the zoologist would put it, the most unspecialized of animals, requiring to be fed in a special way, needing shelter, ~~provided by~~ ~~neither~~ none of ~~those~~ things which are provided by nature, he must himself find that which will make him complete.

just as his hand is able to make, at various removes, an infinity of tools — from the axe to the computer to the missile and Saturn rocket. What else — so can his tongue say an infinity of things. tools, conventional signs like words, etc.

Now the things which will fill him out, which will enable him to be what he is, must be provided by himself. And these are the objects of his art. Of course, by art I do not here mean fine art, but rather the crafts, the skills enabling him to make clothing, shoes, huts or houses, and weapons for defence, to name but the most primitive. It is only by deliberate attempts at fabricating these things, by work, that man can achieve shelter and protection against the rest of nature, and against the worst of his enemies who are, of course, ~~simply~~ other men. So much we know by simple observation.

In providing for his needs or satifying them, man proceeds from one thing to another through something which stands between. And this he does quite consciously. For instance he needs shelter.

Stones and wood lie about him. But the wood must become timber and the stones must be gathered and shaped if they are to serve his end. These materials in more or less refined form become the intermediary term. This kind of procedure, as it goes on in the mind, we call discourse; the rational moving from one thing to another for the sake of a third, and finally for the sake of the ultimate goal. Such discourse we may call reasoning, and it is characteristic of man.

The evolving of shelters by man goes on, let us carefully observe, in all directions. For unlike the other creatures, he not only builds his shelter, but builds shelters of every kinds. The same animal, and often enough in identical conditions, will build shelters of great variety. Those he built a long time ago are quite different from those he builds now, and so on. So that, here again, a kind of infinity is exhibited.

You see how we are making progress. An animal might be defined, as I think I did the other day, as a body endowed with sensations, and thus distinguished from a plant and from other living things. Now what we have established is that, among animals, there is one which possesses this curious power of discourse. It is the discursive animal; or what may be termed the rational animal. You see how we have just made a division,

and, consequent upon the division, a composition. For we have put together animal and rational. The effect is a knowledge of man more distinct than before. Heaven knows it remains vague, but it is less vague than that primary knowledge with which we began.

May I also beg you to remark that I have persisted in giving examples that are rather practical. I have proposed man as a craftsman; homo faber, rather than homo sapiens. Why? Because the former is more readily verifiable. The homo sapiens who functions in the fine arts, and in the sciences, surely exhibits a greater perfection of man, in other words, that which is more truly man, yet it is nonetheless more difficult to recognize in the beginning than that aspect of man which we have been pointing out.

But I must recall to your minds the fundamental principle that more distinct knowledge has no meaning unless it be knowledge more distinct of something which already was known vaguely. In our example, first there comes man as the confused whole which is simply apprehended. Later by division and by composition we come to know with a knowledge much more distinct. But if this distinct knowledge were not of something at first vaguely apprehended, of what would it be knowledge? If the more perfect knowledge did not depend upon the less perfect, how could we know what it is

that we are defining? For it is not our definition that posits the thing being defined. Rather it is the other way round; we must first have something to define before we can arrive at a definition.

Here I must open a new and somewhat difficult line of inquiry, because there do exist good definitions which posit the thing defined. It is in mathematics that we find so many of these. What I mean is that you set down your definition and this now becomes the thing that you are talking about. However we had better set aside this matter for the present; so far as things of nature are concerned, we depend utterly upon our early vague knowledge of them. All of our distinct knowledge rests upon our vague knowledge; and this vague knowledge remains the matter of what we come to know more distinctly.

May I next beg you to observe that, though our later knowledge may be more distinct, it is less sure than our earlier vague knowledge. It will not be surprising if you think me a little slippery here. But I am urging you to notice that distinctness and certainty are very far from being synonymous: we may know something clearly and in detail yet remain quite unsure of what we know. For example, if we go back over the simple thinking which led us to make our

division of animal and rational, in view of a definition, it should be plain that in such divisions a mistake ~~is easily~~ could be made. The wrong division might be selected. Or we might apply it to something quite incidental, which does not really set man apart perhaps from other animals. Again in the act of composition, in the framing of the definition, there could be error. Although this knowledge is more distinct, then, it need not be anything like so sure. Here is a vital principle and the rest of what we have to say will hinge upon it.

To develop this a little farther, let us notice that almost any definition is debatable. But if we consider that vague knowledge of man with which all thinking of him must begin, that primordial apprehension of this creature which all men share, that absolutely basic and common awareness of his existence, appearance, and activity, about all this, there can be no debate. If doubt and discussion concerning man are to arise at all, we must step outside this utterly universal acquaintance with him, that is, we must take the first steps towards more distinct knowledge.

Perhaps an example or two may be of value. When we assert that man is an animal capable of discourse of reason, and has evidence proposed the works of his hands, the objection might always be made: "Well, what about birds? What about the social insects? What about animals like beavers? Do they not construct their own shelters and

nests?" Where lies the difference between man and these other creatures. Similar objections, difficulties of all kinds, could be brought in, and will be brought in until doomsday, though some people will become confident that rationality is typical of this animal. But I am insisting upon the debatable character of even the first distinct knowledge that we achieve, especially as concerns things of nature.

Now both in the order of division and of composition, between the definitum as yet undefined, and its definition, there lies a considerable margin of error. As an example, a rather spectacular example, of the kind of error which can be made here, I will choose the man who perhaps deserves the title of prince of the late scholastics. Cardinal Cajetan was an authentic genius, yet in the area of which we are speaking, he was capable of a glaring mistake. And perhaps his chief error lies in this: he maintained that our first grasp of the nature of sensible things (prima apprehensio) was not only true but also exact, and he held further that our apprehension of the proper sensibles in the domain of mere sensation was a parallel in its lack of error.

But the fact is that we can, and do, go wrong in apprehending the proper sensibles, while we can be still more easily mistaken regarding the common sensibles. For instance, when I see the colour red, I am sure I see red, and whether redness be there or not makes no difference. A person who is colour-blind will be as assured of what his erroneous vision tells him as the man with normal eyes. As for the common sensibles, you are familiar with the great number of optical illusions which are possible. I could draw a line on the blackboard, for example, then divide it in a certain fashion and ask you to judge which part was the longer. If you obeyed your power of

vision, you would inevitably choose the wrong half . In the same fashion, the sun, though much larger than our planet, appears to our power of vision, no bigger than a dinner plate. Indeed, most of the time, we are making mistakes in the use of our senses. To you this desk may feel warm; to me it feels cold. We can dispute the matter and settle it with a thermometer. But the thermometer is only a quantitative measure. It feels neither warmth nor cold; it can only offer us a number. So we are just chock-full of all the materials needed to make error upon error. In his commentary on the De Anima of Aristotle, St. Thomas reminds us that man is more prone to error than any of the other animals.

Now Cajetan maintained that in the order of simple apprehension, we enjoy the same kind of certitude. What he did not distinguish within the very limits of our initial apprehension of the nature of a thing, is the passage from confused to distinct knowledge. And it is in this process, if it may be so-called, that the first margin of error lies, and our mind needs direction. For we do need artificial direction in order to pass from confused to distinct knowledge. A special branch of logic exists which governs the process of dividing which is carried on by our minds in order to achieve definition. And there exists a treatise on this branch of logic which lays down the rules for composing terms that have been so divided or distinguished.

Now, if certitude could be made identical with exactness, as Descartes maintained, there would be no need for this type of logic. Descartes is a true child of the worst type of scholasticism. But you must not think that I am setting Cardinal Cajetan among the worst scholastics. We owe him too much for that. Nevertheless he did go run concerning these simple matters, as he went wrong about analogy.

How did Descartes reason in this matter? He was convinced that things which we first apprehend, for the very reason that they are apprehended with great certitude, are also apprehended with complete exactitude. His examples would be realities like body, motion, place and time. Now, that there are bodies, we are certain. Here I stand. My hereness is not the place, but what I here occupy. I begin at the crown of my head and I end down there at my feet, varying as I turn about. Anyhow, this is my place: the place that no one else holds, nor can hold. And, of all this, I am certain. Then there is time. We need not say exactly what it is. But it assuredly is. And, though we make no attempt to define it, we use the word "time" significantly. Of all these things we are quite certain. To turn to the example of motion, by it I might mean that Socrates is blushing, that he is walking. He is changing, and by a kind of motion. Or I might mean that this tree is growing. You remember it ten years ago? Look at what has happened to it since. And this would be undeniably motion, though

of a quite different kind. Very good. Upon all this we agree. But, now that we have agreed upon the name of this peculiar thing, we must ask what it is. What do I mean? I mean that up to the present, we possess only a nominal definition of motion, and must still inquire what it is? But this dreadful question plunges us at once into obscurity. The fact that motion is so familiar, that we are sure of its existence, in no sense reveals what it is. And when we seek this distinct knowledge of it, that is, the knowledge which would be conveyed by its definition, we shall find that it is one of the most obscure things known. In this respect, Descartes was quite a novelty in the history of philosophy. All the Greek philosophers without exception thought that motion was the most hidden and mysterious thing in our experience, to the point indeed where some denied its existence altogether. For these last, the question was how could a thing so obscure be real. Others maintained that there is so much motion going on throughout the entire universe that science of anything is out of the question. Everything is forever being something else all the time. No sooner have you made a statement about a thing, then it is no longer true because the thing is now other than it was. Nevertheless both of the extreme groups, the Parmenidians, and the followers of Heraclitus, would agree in this, namely, that motion is desperately obscure. This profound obscurity leads one school to exclude motion altogether, and leads the other to

allow everything to be engulfed by this obscurity. Yet to Descartes, suddenly all of this becomes clear and distinct, because motion is his prime example of clarity and distinctness. He holds that the same is true for place, and for time. In his Regulae ad directionem ingenii, r. 12, you can find this for yourselves.

In this rule 12, he makes fun of Aristotle's definition of motion because it is so obscure, whereas the thing defined is obvious to any sense. But this he can do only because he is confusing certitude, which sometimes means firmness of adhesion to a proposition or to a notion, and certitude, (if the word may be so used at all), in the sense of exactness. But the two are plainly not the same. To us, as we think nature should be studied, they are inversely proportional. Though it would take us a long time, we could show how it is that the more certitude our knowledge enjoys, the less exact it must be; and the more exactness our knowledge enjoys, the less certain it must be. Let me recall the example of man known merely as a moving object, so to speak, and man known as a rational animal.

Now it is with every reason that the history of philosophy speaks of the Cartesian revolution. His attitude of mind does indeed turn the world upside down. From a philosophical point of view, he is making the most radical break with all previous philosophy — and this break was actually prepared for, unwittingly, by the late scholastics themselves.

The revolutionary step is to identify what is most knowable to us with what is most knowable in the order of nature. Let me ask you to observe that Descartes might find some pretext for identifying certain knowledge with distinct knowledge. In the limited sphere of mathematics, for example, this principle would hold: that which is most knowable in itself being also most knowable to us. But only in mathematics.

What is it that is characteristic of mathematics as compared with other sciences? Mathematics is constructive through and through. We construct even our subject. Take any given subject of geometry, such as a triangle. How do you get your triangle ? You fabricate your own. You begin by constructing an equilateral one, and then define all others by comparison. But that first one you construct and, having constructed it, you maintain that the equilateral triangle exists. Now, from any triangle, you can infer a certain property. Such as that they have their three angles equal to two right angles. It is from your construction that all this follows. I am not asserting that we are responsible for what it is to be an equilateral triangle, for its very nature, so to speak, but merely that we cannot attain such knowledge without the kind of construction of which I have spoken. The example just given is one of a figure, but the same will hold for even the very elements of geometry, like the point, line, surface and

volume. Even these elementary notions are arrived at by construction. It is not enough merely to put a point on the blackboard; you have to say exactly what you mean by one. And this obliges you to some sort of construction. Draw a line, for example, then divide this line. The actual division is a point, the location of the cut. Or take the extremity of the line — there again we find our point. Similarly, if you wish to build a line, to make clear what a line is, you must have recourse to a point at the end of it. You might perhaps situate two points and then join them. Or, more simply, and after the example of the Platonists, you might conceive of your point in motion, and allow its trail to be the line. Now, make your line roll along, and the trail of this becomes the surface. Allow the surface to sink , and you construct a volume.

These elements, I grant you, are a little difficult to make clear. If you would like some notion of how hard it is to define point, line, surface, and so on, read Sir Thomas Heath's Introduction to the Elements of Euclid. It is long and most interesting. ~~But,~~ Still, if these matters are so troublesome, it is because they are not the business of the mathematicians. These definitions must be taken from somewhere else. Where they do come from is something which we may discuss later on. But the mathematicians quite properly

takes them simply for granted.

Yet once he has entered into possession of these elements, he can move on freely in almost all directions by further construction. Of course, everything he does must be exact and clear. And this is possible so long as the foundation, the ultimate elements, are assumed. But if discussion begins about these, then the greatest difficulties will be encountered.

May I ask you also to notice that mathematics, because of the construction going on in it, is in a sense artificial. It is not just a science but also an art. Again, mathematics is the most human of the sciences — not the most humane, to be sure, but the most human. I freely admit that there is something frightening and unfeeling about mathematics but, at the same time, it is by this science that we achieve our most exact knowledge: a knowledge entirely proportioned to the human mind because, to be a mathematician, one must not only possess reason, but human reason. Although they know mathematics better than we ever shall , neither the angels, nor God, are mathematician. (3) They are not logicians either. God never reasons. An angel needs no logic. Both logic and mathematics are typical of human reason.

I am barely touching upon matters of great difficulty,

but will beg you to agree with me about them if only for the purpose of further discussion. May I next ask you to observe that mathematics can provide an extraordinary tool for the investigation of the non-mathematical world. This tool has become more powerful and efficient as time goes on. As applied to the study of nature, mathematics gives rise to what we call mathematical physics: a science which was present in a primitive form even among the early Greeks. The Pythagorians possess it in a quite confused form. But, by the time of Aristotle, the understanding of this science has become quite clear and definite. And this persists through Archimedes and the rest. If I mention this fact, it is to establish, against certain historians of science who are not too well up on their subject, that mathematical physics was not a creation of the Renaissance, much less of Galileo. The essence or notion of mathematical physics is quite ancient. But the tremendous power of the mathematical tool is indeed relatively new. I mean the awareness of what this tool can do.

Little by little, thanks to the Arabs, another extremely powerful tool came to birth, first of all in the form of algebra. Here was an extraordinary discovery. And it is largely founded on symbolization. The Arabs seem to possess a genius for symbols. Before them, both Greeks and Romans were floundering about, victims of their own clumsy symbols. Try multiplying twenty-five by eighteen in roman numerals.

It is an extremely simple piece of calculation, and yet becomes quite difficult if the only symbols we have for our numbers are those which were used throughout the old Roman empire. Back in those days, it took experts a long time to make a calculation which a six year old could now perform quite quickly.

Of course this business of calculation, and the means of calculation, is not strictly mathematical. But thanks to Descartes, the application of algebra to geometry, gave us analytical geometry, and eventually made possible the work of Newton and Leibniz. I am not sure in which order we must report them: whether Leibniz precedes Newton, or Newton, Leibniz. There was great controversy about this order of precedence, and whether the matter has been settled I do not know. What I am talking about is calculus: differential calculus, infinitesimal calculus. And calculus is an extraordinary tool. For what reason? Because it permits us to make an approach indefinitely more and more exact to exactness. And thus we meet the rough edges of nature. What I mean is that nature is full of irregularity, of penumbras, of incalculables, and these can somehow be overcome, or in some measure dominated, as the infinite of calculus is approached more and more nearly.

But the important thing is that, among the sciences, it is the most human which permits the most spectacular achievements. The achievements we cannot deny. Without mathematics, without these last mentioned types

of mathematics, we could never send our complicated pieces of hardware into space. Without mathematics, we could not ride around comfortably in our automobiles. Nevertheless, nature does not grow out of our mathematical heads. In other words, nature can never be regarded as the term of a process of mathematical reasoning, as every mathematician and physicist is aware. There is always that fact, or object, out there in the real world which has to be met, and accounted for. By mathematics it can never be adequately accounted for. I mean that the real world is not an existing thing which can be fully explained by anything in the mathematical order. It is not a mathematical object become real. Let the mathematician calculate how many cows can stand erect on the surface of the earth, he is still helpless to set them there. The cows must be generated, and this is something beyond the power of mathematics. To multiply them in our heads, even to infinity, is as easy as you please. But it delivers not one single cow in fact. In nature there is something that resists mathematics.

~~But~~ To overcome this resistance, however, we do have a means of a sort. We can allow the mathematician to bridge the gulf between numbers and nature through another human device. And it is again something that grows out of our heads. What do we do? We convene mathematics with another tool of our own construction and, thanks to this arrangement, again draw closer to nature and make our knowledge of nature more probable. Because

it is never enough to see nature as an order of productivity, that is, of predictability. Those who reduce the science of nature to pure predictability have seized one aspect of the matter but only one. There is also the question of understanding. And to help us with this task of comprehension, what is it that we join to our mathematics, so that mathematics can achieve its full task. It is the machine. Now, what is a machine exactly? A tool, of course, but a complicated one. I say complicated because we would not call a saw, I mean a simple hand-saw, a machine. The same would be true of a simple hammer. But when the tool becomes complex and somehow automatic, then we begin to call it a machine. I make no attempt to determine exactly at what point the tool becomes a machine. About this we could not be exact. An automobile is clearly a machine. Some have argued that an ordinary wheelbarrow is also a machine. I am not sure. But there is no need to talk about difficult cases, not when there are so many easy ones.

What is typical, then, about a machine as compared to natural things? The machine is something that grew out of our heads. We are the makers of our machinery, and, as its makers we understand it. As the gears turn, and the pistons move up and down, connecting-rods push the crank-shaft, we know what is going on; we know what this

cog, or lever, is doing, and why it does it. Why? Because it is we ourselves who planned it so. The works of our hands we understand far better than the works of nature. And let me recall how all this began, with the example of lumber: lumber as lumber, far more intelligible than wood as wood. So soon as our reason has taken the initiative, and has imposed upon the raw material, some design out of our heads, we are at home. Now we know what we are doing. Machinery is essentially human.

~~Lecture # 3 (fin)~~

Let us attempt now to explain the relationship between machinery and nature. There comes to my mind a work by the late Professor Collingwood, "The Idea of Nature", which, when I first read it, in my student days, did not please me. What was the reason? It was because I was struck most of all by his statements concerning Aristotle's conception of nature which were largely mistaken. Much later, when a paper-back edition appeared, I examined the entire book and found in it some very fine things. You see, it is characteristic of the juvenile mind, to view all questions rather passionately: even in philosophy the young man is following a master, and when anybody opposes his master's doctrine, the youthful disciple is inclined to shoot him down. In later years, passions wane, and with advancing age one becomes inclined to say "perhaps", instead of "it is thus and so." Indeed so open can one's mind become as the years roll on, that one may end in that condition of old age which leaves a man completely sceptical (a type of senility). This stage I have not yet reached, not mentally, I trust. But the point made by Collingwood, and a correct one, is that the Greeks and Romans did not really know machinery. They possessed their catapults and

Quote the work by Bacon—

other large and clumsy devices, but these were not machines in our modern sense. They were not true examples of machinery because they were not automatic. Our machinery is self-propellent, as it were, and thus is truly a kind of automaton.

In our next lecture, machinery will be employed as a kind of example to make clear what nature is. But it will be always an easy error to talk of the machinery of nature as if nature herself were a machine. An easy error, and a fatal one. This we must do our best to avoid.

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Lecture # 4

Both mathematics and machinery come from within ourselves, which is to say that both are characteristically human. That this is true of mathematics is proved by the fact that this science is constructive. Machines too are complex tools constructed by ourselves, and thus growing out of our own minds. Any tool, as has been pointed out already, deserves the title of machine to the degree that it is self-operative, as it were, or self-propelling. Let us also recall, that we neither can, nor need, set the precise limit between the ordinary tool and the machine. At the upper limit we find the device which is as completely automated as man can make it; at the lower limit, a tool as crude as a sharpened stick, a mallet, or primitive knife.

The essential thing to grasp is that all these tools grow out of our heads, this being true even of the stick which we break off and shape so as to put it to our use. But such a device is not a machine. Nevertheless, I do insist that, as a tool, it grows out of the human mind.

Surely I need not explain to you how mathematics and machinery go together so extremely well: the machine becoming our means of mathematizing, as it were, the external world which we have not made. Now, I beg you to consider into what an error we would be falling if we

made these, namely, mathematics and machinery, the measure of all reality. This would be to humanize nature with a vengeance. It would be anthropomorphism pushed to the limit. For what we would be doing would be to impose mathematics on nature as if nature itself were mathematics: as if the non-man-made world were nothing more than the exteriorization of our mathematical conceptions. Having detected some basis of comparison between our machinery and certain workings of nature, we would then be leaping to the conclusion that these two were the same: from proportion we would be moving to identity. This would be making things human and degrading them in the process. For we would find ourselves rejecting as unintelligible, or valueless, anything which could not be caught in the web of our mathematical concepts, or which could not be duplicated by the mechanical constructs of our intellect.

But of course, though to apply mathematics to nature is always a kind of anthropomorphism, it need not be anthropomorphism in the bad sense. The reason is that the process can always be carried on with caution, and with full awareness of its limitations. And the same is true for the comparisons which we may make between mechanical and natural things. There is no good reason why we should not speak

of the mechanics of nature, provided that we do not identify nature with machinery.

Now a mechanical model, as we all know, can be a most effective means for the investigation of nature. As a matter of fact, especially in English physics, various mechanical models dominated the minds of the scientists for a long time. But such a model, as I have suggested above, yields us no more than an exemplum. And by an exemplum I mean something which, by reason of its similarity to another thing less known to us, can make clear what that other thing is. Our machines we can understand; how they work is clear to us. When we turn to nature, in certain obscure processes we can detect motions or functions comparable to those of our machines. A study of the machine, therefore, and the comparing of it to the natural process, leaves us better off than we were before. But we benefit by the comparison only to the degree that the comparison can be made. Between the mechanical motion, and the natural process, there is a proportion, but nothing more than a proportion. We must insist that proportion is to be distinguished from identity.

Need I digress on the various kinds of unity? There is, for example, numerical unity, as when we say that Socrates is Socrates. Then specific unity, as when we remark that Socrates and Plato are

the same kind of thing. Then generic unity; horse and man are of the same genus. Finally comes still another sort of unity which is very much neglected; this is unity of proportion, according to which things are only one in proportion. The famous old example is that unity which exists between health, medicine and urine. Health we say of the animal body. But medicine is also called healthy and so is urine . However, when healthy is said of the animal body we mean that this body is the subject of health; as used of urine we mean that here is a sign of health; medicine, finally, is a cause of health. Now there is something common, that is, some sort of oneness between these three. Yet we ~~there~~ dare not identify them and speak of all of them as healthy in the same way. What makes us bring them together is merely the proportion between them. This proportion suffices to yield a name that is one, though the things named are not entirely one. Our final acquisition, then, is a term which is the same, though it signifies more than one thing, and ~~thus~~ does so in a determinate order. This sort of name is called analogical.

Unity of proportion, consequently, meaning that kind which supports analogical terms, must be distinguished from all other kinds of unity. Where objects are specifically one, or generically one, what is true of a given specimen will be just as true of another.

But, where the oneness is only of proportion, the terms must be kept apart, though they do have a certain meaning in common. If properly understood, these terms are many and must remain so. In somewhat the same way, we shall be making a bad mistake if we identify nature and machinery.

May I repeat, therefore, that when we use artifacts as examples, we must be careful to notice the meaning of example in this context. An artifact can be used as an example, intended to teach us something about nature, only when by example we mean what the Latins meant by exemplum, or what the Greeks meant by paradeigma. What we cannot mean is example in a current English sense of the word which would stand for a sample of something, a true instance of a case. There is nothing to become alarmed about in this apparently elusive terminology. The word example is itself an analogical term, which has acquired this new meaning in English. The old meaning merely indicated something which, because of some resemblance, however inadequate, could be used to make clear, or clearer, the properties of something else. Actually, if we were to put the argument from an example into syllogistic form, the result would be a syllogism with four terms, and therefore no syllogism at all, neither dialectical nor demonstrative. But it does not follow that what the mind is doing, by means of this funny syllogism, so to speak, is without value.

Though nothing is demonstrative here, something is indeed brought to one's attention, namely, the proportion between these cases. So that one sees how what is true of A is somehow, though not quite in the same way, true also of B.

In the first two books of the Physics of Aristotle, many of the arguments are proposed as examples. Thus, a basic mystery of mature is that of absolute becoming: some years ago Socrates was not, now he is, in some years he shall no longer be. So a thing has become and will cease to be absolutely. For there is a big difference between Socrates becoming a man, and becoming pale. Where it is a case of merely becoming pale, it is the same fellow we have all the time. But where it is a case of change from non-Socrates to Socrates, then something absolute has occurred and the mystery is much more profound. So profound, indeed, that when we attempt to make sense of it, the best we can do is invite the mind to see a parallel between the simple and easily understood process of Socrates turning pale, and the deeply obscure transformation by which he becomes a man. When Socrates becomes pale, we identify three necessary principles. There is the subject Socrates, there is condition of no more redness, then the paleness towards which he moves. Redness disappears, and paleness takes its place, but the fellow who is subject to these two conditions remains the same. In fact, it is easy enough to show that

all becoming requires a permanent subject: that is, that in all change there must be that which does not change. Now, from this example, we pass to absolute change, and we argue that, if the conception and birth of Socrates are not pure creation, a coming to be from nothing at all, than underlying them there must be the unchanging subject. This is a simple case of a true example. There is a similarity between the two realities under consideration. Relative becoming, is somewhat like absolute becoming. Some basis for comparison exists. Another example might be that seen in the carving of a statue. The permanent subject is your block of material. You change its shape by grinding or chiselling . The final result is a new form, but a new form in the same material. First it was a stone-block, let us say, and now it is a stone-statue.

Another mystery of nature which can only be approached by means of examples in the old-fashioned sense is that of chance. Indeed it is not unfair to inquire if our term chance can truly be applied to any occurrence in nature. Is there in fact indeterminacy in nature? The difficulty is most obscure. And if any reply is to be made, we have no recourse except to begin with an instance, or example, where the presence of chance is comparatively clear. This means that we must turn to human events. Let us take an automobile accident. We

do call it an accident, a chance event. And this because, though it was not intended, it did nonetheless occur. Our purpose was to drive to the super-market. The other fellow had his heart set on reaching the bank. We collide at an intersection. Each of us finds himself in a situation which he did not intend: neither of us attains the situation which we did intend. Something non-deliberate has happened to something deliberate. Now are there such occurrences among the things of nature? This much at least should be clear, namely, that our example will help. It cannot prove that there is chance in nature, but it may help us to recognize it when it does occur. The cow walking across the meadow in order to obtain a drink from the brook may chance (as the phrase goes) to tread upon a nest of field mice, bringing to a sudden end the promise of these young lads . But this destructive act was plainly not intended by the cow, nor did the parent field mice ever expect their household to be eliminated in such a fashion.

The point of this entire discussion is that, in other circumstances, machinery may be used to play the same role. It will serve us as an example, but we must not be led to infer the presence of genuine identification. Just as we may never assert that chance in nature is exactly the same as chance in human events, because purpose in nature is not to be identified with purpose in human affairs; so we may not

declare that the behaviour of natural forces finds an exact parallel in the behaviour of one of our machines. Heraclitus was probably more light than he knew when he declared that nature likes to hide. We have learned to our cost how mysterious natural things really are. Now, in the face of mystery, we cannot give up. And if machinery will provide us with helpful examples, then machinery we shall employ. But we must not forget what we are doing. Mathematics offers a more profound case of the same sort of investigation. As a device it becomes a little more complex because nature does hold real quantity. Of course the quantity found in nature, and the quantity proper to true mathematics, are not quite the same. The quantity considered by the mathematician is abstract and, with the exception of numbers, the findings of mathematics can never be precisely verified in nature. The important thing to remember is that, when we use such devices, we must be aware of the fact that they are mere devices and no more. Max Planck, the great German physicist, admits all this in the fine statement that nature behaves mechanically only in our heads. Similarly, though he is often enough called a determinist, what he actually said about his position was something like this: "The determinism that I talk about is only in my head. Out there, I simply don't know. The determinism that I do know is that which man has devised as a means of

approaching nature. Not as nature itself." Max Planck deserves our respect and may I remark by the way that he enjoyed a classical formation, as did most of these great scientists.

The value of our own fabrications in order to learn something of those of nature arises from a proportion between the two, and from our better understanding of our own work. But unity of proportion, once again, is not identity. The two ~~poles~~ poles of our comparison stand far apart and so they must remain. With Descartes, they become identified. He is the supreme blunderer in this domain. What I mean is that thinking mechanically was so ingrained in his mind, that he actually identified the machine and the thing of nature, maintaining that all animals, even the higher animals, were mere machines in the exact sense that a clock is a machine. Even our own human bodies were mere mechanical devices being manipulated by our soul as ~~the~~ one manipulates an aeroplane or some such mechanical construction.

Notice how far Descartes has drifted from the conception of nature which was accepted by all the earlier philosophers. Now his mistake will become still more frequent and easy as man invents machines which are more and more self-propelling. Automation brings us many evils as well as many blessings. If living beings are defined as those which have the cause of their motion within themselves, how shall we distinguish between an automobile and a human being? Well,

it is not difficult to find philosophers who insist that there is no difference whatever. They too, appear to think that they are automobiles — and of course they are, in a primitive sense of the word. But the confusion would become more than curious if we took them to mean what they are saying.

Among the mechanical devices which truly deserve to be known as machines, those which are the most advanced are undoubtedly the computers. And it is a commonplace of our time that many a man who specializes in the making or operating of a computer, puts himself on a footing of equality with his electronic hardware, when indeed he does not give precedence to the fabrication of his mind and hand. I submit that the great reason why he tends to prefer the machine is that he can understand it so much better than he can understand himself. His brain does calculations. The machine seems to do calculations. But he does not know exactly how his brain is put together, nor how, nor why it functions as it does. The computer, though, is something which he does understand. Hence, ironical as this may sound, he develops for the computer a fellow feeling, which he cannot entertain towards human intelligence: the one seems to make more sense than he himself does. The other eludes and exasperates him. Many people may thus be said to detest themselves in the intellectual order because of their own inner obscurity.

It is so very hard to know precisely what the human intellect is. Indeed such knowledge as we do attain concerning it, comes to us by negative ways. And so we fight the darkness within us, we rebel against the inability of our own minds to grasp themselves.

Hence the dreadful vagueness of all self-understanding. ~~Pierre~~ Dare I say: "I understand myself(?)" How equivocal such a declaration would be. What I am sure of is that I do not understand myself. If anything is plain to me, this is. Because what would it mean to understand oneself? It would mean to enjoy a kind of intuitive vision of what we ourselves are, and this assuredly we do not possess. Descartes fancied that we did. Notice again how he must be thinking of us as a piece of machinery. Descartes maintained that we have complete intuitive knowledge of our own soul, and the first thing we really do know is the very essence of God. Yet, the same fellow declared that we are in the main, simple machinery.

To return to the computers, this nonsense which we hear about them represents, not so much confusion of mind, as confusion of speech. Because the man who declares that a computer is just as intelligent as a human being, and reasons in exactly the same way, cannot possibly mean what he says: I mean that, though he may state this clearly, he cannot think it clearly. And the confusion in

thought is often concealed because metaphors are taken, not as metaphors, but as literal statements. For example expressions like feeding into, and feed-back, or, best instance of all, the memory of the machine. Well, if an electronic device has a memory, then all the books in my library have a kind of memory too: because words have been stored in them and they will present these stored words to me whenever I open them. The computer, to be sure, does something different. It can actually open the page where we want it. However, like the book on the shelf, it can only present you with what is fixed there in some symbolic form or other. Now is this what is meant by memory in the true sense? Not at all. We must never confuse imagination with memory. The electronic computer deserves comparison with imagination rather than with memory because memory is the faculty of recognizing objects in the imagination as belonging to the past. Please note: as belonging to the past. Herein lies the real difference between memory and imagination. But the computer fanatics never trouble themselves about such distinctions, not delivered by their jet machines.) Their jet machines possess a "memory" and, this granted, they drew their conclusions.

Now the point is that the machines do not know that they are

remembering, nor that they are doing anything whatever. Indeed to make a still more primary objection, to speak of the machine as this, or this thing, is already somewhat doubtful . Because our word "this" must be taken in an analogical sense. This, used of a machine does not mean what it does in the phrase "this man" or "this horse". The computer is not somebody. The computer is not even someone thing. It is a whole host of things put together in a certain way: as a house is an assemblage of stone, mortar, wood, nails, shingles, and so on. Will it help you to understand this primary objection to the ridiculous claims made for our computers if I say of the machine that it cannot possibly think, because it is not even an it.

To make assertions like that to which we are objecting is to be guilty of anthropomorphism in the worst sense. But all the mighty achievements of science can be fully appreciated without this improper interpretation. And this is what I tried to show in the little book, The Hollow Universe. (1)

Now let us return to our chief subject. The Renaissance was characterized by still another type of humanism. That "humanism" which we have just been discussing began, let us say, with Nicholas of Cusa for its remote ancester, then descending through Giordano Bruno, took definite shape with Galileo and went on through Descartes. Its course did

(1) Oxford University Press 1960 ; published in France under the title [illegible] 1962

not finish with Descartes but he remains the high point of its evolution for reasons just given. However the second type of humanism is quite different from that of science. I now refer to the literae humaniores, and this phrase should bring to our minds the great literary figures of the Renaissance, and beside them the great artists of that time. But we shall concern ourselves especially with the men of letters.

It is often stated that the spirit of the Renaissance tended to desert the supernatural, and even the divine, in order to return to the purely human. The Renaissance, in this view, was centered on man. An instance of this interpretation, a typical one, is the article on the Renaissance in the Encyclopedia Britannica.

In my opinion, this is a superficial view of the matter. The men who pursued the more humane letters in Renaissance times were seeking those fundamental conceptions, those mental moorings about which we spoke the other day. Now if we ask why they did not succeed as well as we might have liked, the answer lies in historical circumstances which were beyond their control. The learned men of the late Middle Ages had lost contact with those common conceptions which man first knows and first expresses.

The thinkers of the early Renaissance, consequently, looked in vain for some contact between what the philosophers were talking about, and the things known to everybody.

May I digress for a moment to point out how sound was the thinking of Plato in this respect, if he is given and interpretation which the Renaissance could hardly be expected to assign to his thought. We all are familiar with his Myth of Reminiscence. Whether he considered this notion of reminiscence to be a mere myth, or something more, is of no interest at present. But if it be taken as a myth, it becomes something marvelous. For it is then Plato's way of saying that there are certain things we know, and know with utter certitude. These are our basic notions. All our thinking is founded upon them. Yet, our experience is so shifting and uncertain, the difficulties and objections which can be made are so many, that we often find ourselves incapable of justifying these basic positions of which we nonetheless remain so certain. So how did such knowledge arise in our minds? Not from experience, it would seem. And so, in this Myth of his - if it may be taken as a myth - our mind or soul is declared to have enjoyed a life prior to the present one, beyond the realm of matter, where it could contemplate the naked truth. Our private incarnation, our

entry into the body, has brought about the obscuring of this ultimate knowledge. Now, we must depend upon our senses, which can do no more for us than awaken the memory of a knowledge which once was immediate.

What a marvelous idea! As Aristotelians, in order to explain the same condition, we need only maintain that our mind holds a power independent of things, that is relatively prior to them and illuminates them. Our technical term for this power will be the agent intellect. But of course our theory is a little more involved. The Platonic myth makes a much easier beginning. A myth is of course a kind of lie: but there are good lies. — I mean in this order! A false example, as I explained in an earlier lecture, can sometimes do better work than a true one. A few of you have asked for an instance. Here is an extremely concrete one taken from Aristotle's Ethics. The philosopher has the duty of pointing out the difference between the happy mean in temperance, and the happy mean in justice. The happy mean in justice is a simple matter. The price of butter being 75¢, if you want a pound of butter you must pay 75¢. And this whether you like it pr not, for the price has nothing to do with your appetites. But in the case of temperance, in the consumption of food and drink, for example, where lies the happy mean? Is it to be found in these objects themselves? Obviously not. Our mean must be that of reason. It is to be based on the man who practices temperance, and this requires the taking into account of all sorts of

circumstances. What is his peculiar capacity for food? If his capacity is so much, and hence in order to recover the energy he needs, he has to eat so much each day, then temperance requires that he consume this amount. And now for the notorious Milo. Milo, Aristotle argues, was a temperate man, yet each day devoured a whole ox. Well, if Milo needed 900 pounds of beef every 24 hours he was not a ~~glutton if he ate~~ glutton for eating this enormous quantity. But of course there never was, nor could be, a man able to eat a whole ox every day. ~~Our example is a false one.~~ Yet the example ~~it~~ makes the point precisely. The principle which Aristotle is trying to teach is vividly illustrated by this ~~amusing and incredible~~ false example.

How wonderful then it was for the Renaissance men to be able to recover the languages, and the arts of language, which had achieved such perfection. What were they actually doing, or trying to do? They were trying to restore a lost human heritage of great value. They wanted to give back to men those magnificent writings in which ~~the~~ certain basic conceptions of which all men are sure had been beautifully expressed, first in poetry, and later in the writings of philosophers. What the great classic writers of the past had been able to do so splendidly was to talk sense, without pedantry, without false learning. And it was this power which had been lost in the late Middle Ages. But to return to simple truth, in splendid language, is not to desert

the divine. Indeed the great Renaissance writers were actually practising a kind of humility, inasmuch as they realized the need of recovering the simple things, of appreciating that great mysteries should not be approached ~~ed~~ head on, but gradually and indirectly. They sensed that man needed to be led by the hand in his most difficult investigations. And those who first do this for man are the poets. May I suggest an example? It is from Shakespeare's Antony and Cleopatra. Antony assures the lady that he loves her, and Cleopatra instantly demands; "Tell me how much." See ~~what is revealed in this simple statement~~ how typically feminine it is, what a glimpse of a woman's heart we are given in four simple monosyllables. She must be told that she is loved, and told it over and over.

Of course, I do not mean to deny that during the artistic Renaissance there were men who did want to return to the highly cultured paganism of Antiquity, and who did actually attempt this return. But even these writers and artists bear witness to what man needs as man. After all, we are first of all human beings. The supernatural is never intended to destroy our humanity. Grace does not bestow upon us a new intellect. That intellect which is going to see God is the old human intellect. Our Lord's work is not to destroy, but to fulfil. Even to know what faith is, you must understand

the words which express those mysteries which intellect cannot grasp. And, if we must have a mind, we need one that is well-formed. Grace, then, neither replaces mind, nor the sound and healthy training of a mind. As a matter of fact, in the order of theology, a man needs a mind well-trained, formed in grammar and logic, and in the natural sciences, if he is to respond to that sort of faith that seeks understanding.

Now the Renaissance seen in this light, is a splendid period of progress. The decadence of the late Middle Ages meant that everyone had begun to start half-way. It was necessary to go back to the sources. If one neglects beginnings, one can never safely reach the middle, much less the end.

First comes the world of ordinary experience with its vague but sure knowledge, knowledge which is not only thoroughly human but which, in the mind of a poetic genius, embraces death itself and achieves a kind of harmonious fulfilment. It is with these data, the daily experience of men and women facing the human condition, that nearly all great poets have worked. Dante, Goethe, and Milton are possible exceptions because these three use a tremendous amount of philosophy and theology in their images. That they should do so is splendid, of course, but the important

thing is that there have been great poets before and after these who composed great poems without the aid of this specialized knowledge. Shakespeare seems to have been a Christian, and knew a good deal of theological truth. He makes reference to such knowledge, and assuredly can be profound. But all he does is done in such a way that the average cultivated reader understands, though he may never have studied theology. We may presume that the poet picked up what he knew from his catechism, and then confirmed it in experience. Though he himself may never have been able to explain exactly why he believed what he did, he was always able to recognize truth. Robert Frost is quoted as declaring: "All a good poet needs is samples."

Our time is running out. I hope I have been able to show that the famous old Renaissance was humanistic in two different senses. I hope I have done something towards the higher and more essential purpose of these ~~meditations~~ lectures, which is to show that the positive elements, both in the mathematicism of a Galileo, and in the humanistic letters of an Erasmus, can be readily reconciled, and in fact do find their reconciliation in ~~his personal~~ fundamentally philosophy, though this word may be.

We can allow ourselves only a few more rapid and scattered remarks. The 19th Century we are obliged to pass over ~~without~~ with scarcely a comment. It was a strange century. By one writer it has been

termed le "stupide XIXème siècle." But of course this is far from being the whole truth. The scientific achievements of this age were not stupid, though the philosophical interpretations of them, in the main, do deserve this adjective. Also, this century held its great poets. Men like Mallarmé, Baudelaire, not to mention their English contemporaries, were authentic geniuses. The century also could boast of one or two very great poets. Among these I would unhesitatingly place John Keats.

As for that strange determinism with which the 19th Century was afflicted, it had grown out of previous centuries. First of all, it was an extrapolation of Newtonian mechanics, I mean the extending of Newtonian mechanics to the whole universe of being. A second curious fact is that the theory of evolution which saw its beginning in the 19th Century, that is, Darwinian evolution, seemed to turn in an utterly different direction, since it made the process an effect of natural selection and therefore of chance. Now everything seemed to be due to chance. So we have, on the one hand, a deterministic mechanism in physics, and in biology a theory which attributed everything to mere chance. Yet a kind of reconciliation is possible between even these two theories. The search for it would carry us all the way back to Democritus, who held that all things were simultaneously utterly determined, and attributable to random causes.

Nor is his position the absolute one which it appears to be. But time does not permit us to explain.

In our own generation, meantime, the scientific and the humanistic are not reconciled. However, there are encouraging signs of such a possibility in the near future. I think these signs are more vivid in the writings of our outstanding physicits, than in those of our great biologists. And for good reason, because physicists grasp the limitations of their science much more clearly than do their counterparts in biology who must study phenomena that, on the whole, are much more complex.

If there were time I would draw a general conclusion as to what could be done. From the very beginning, as I have repeatedly pointed out, our great trouble is that we start everything half-way. In grammar we do it. In mathematics we do it. We clutter the minds of little children, in their mathematics lessons, with bakers and butchers and candlestick makers, rather than with numbers. When my little ones come home with their problems in arithmetic, there is always a butcher involved, or more especially a plumber. In these cases I simply have to give up. Because you now have too many variables. You must calculate how much water there is in this tub: but how is this to be achieved without knowing the temperature of the water, the rate of evaporation, and so on. I am lost. And the question really has nothing

which I take from St Thomas.

to do with mathematics in the first place.

Since we have a blackboard I will leave you with a single word written upon it, The word is manuductio. Manifestly, the derivation is from manus and ducere —"to lead by the hand." A child is taken by the hand, even an adult if he does not know the way. To such persons we say: "take my hand, and I'll lead you there." In the case of the child, this means that we must stoop down, take this little hand as it is, and half carry the child to where it should be. But our beginning must be made with the child where he stands. We cannot urge him to leap over the early part of the distance. No, we must go all the way down, take the child's hand and lead him forward. Now, it is this term which St. Thomas uses in connection with the study of theology. If we drop the principle of manuductio, theology will be dead.

Why does a theologian use philosophy, then,? It is because the human mind is so feeble that it must have recourse to tools, instruments, orders of knowledge, that have more proportion to our mind. Philosophy is one of these. Philosophy is called an ancilla, and notice how this word means that philosophy is a kind of servant, or slave, But even though she be a slave, she can help us. When the truth we seek lies beyond our adequate grasp altogether, then it must be made known to us by means

proportionate to our minds, and these means are found in philosophy. Here is a point which needs emphasizing. Historically speaking, the theologian can easily be a proud man. Indeed it is among theologians/I have met with the greatest contempt for philosophy. Scientists sometimes reveal scorn for philosophical inquiry but ← it is nothing compared to what I have seen among theologians. One would think that they themselves were the Holy Spirit incarnate. Well may we all remember that theology needs philosophy, but that when we say this what we mean is theology as found in the human mind. There is no escape from it, our mind needs to be led by the hand. Someone must teach us to walk in theology, just as someone taught us to walk in our physical chilhood. In all true education this process must go on. It is with things more known to us, with things of daily experience, that we must start. Then we may move gradually and safely towards those matters which are much less attainable by us, however intelligible they may be in themselves. Should we attempt to begin with the things that are so far above us, we would be behaving as if we were angels. That we are not angels needs no proof.

END

SCIENCE EXPÉRIMENTALE

4 ff. dispersées, numérotées 4 à 7 –
8½ x 11

Cours 1937)

~~trouvé dans ch. 86~~

~~(1937)~~

D'autres ont exprimé cette même idée en disant que les concepts de la science expérimentale sont des concepts opérationnels, c'est-à-dire des concepts tirés des opérations par lesquelles nous définissons les propriétés expérimentales. Ainsi les concepts physiques de longueur, de température ou de couleur, les concepts biologiques de croissance ou d'hérédité, les concepts de mémoire ou de personnalité en psychologie expérimentale, doivent exprimer l'opération expérimentale que nous avons effectuée pour les connaître. Leur définition consiste dans la description de leur procédé de mesure.

Le sujet propre de la science expérimentale est par conséquent le résultat d'une opération concrète: les nombres-mesures définis par le procédé qui nous les fournit. Une photographie est chose très réelle et objective, mais par rapport au sujet qu'elle représente, elle n'est qu'un signe instrumental : le sujet propre de la science expérimenta n'est lui aussi qu'un signe instrumental, c'est-à-dire un signe que nous connaissons tout d'abord comme objet et qui cache ce qu'il représent Ce serait verser dans le subjectivisme que de prendre le signe instrumental pour le modèle auquel il se substitue. De son côté, le concept opérationnel est un signe formel de ce signe instrumental.( )

Si on se place à ce point de vue formel, si vraiment la science expérimentale a un objet formel propre, il faut dire que tout ce échappe à sa formalité doit être considéré comme irrationnel par rapport à cette formalité. Ainsi la couleur sensible propre est au point de vue physique un irrationnel : la physique définit la couleur d'une lumière par l'angle de

nous en avons — [illegible]

ne peut avoir la sensation d'une couleur. La matière, le mouvement, la nature, tels qu'étudiés en philosophie de la nature, sont autant ~~xxtxxx~~ d'irrationels en science expérimentale.

Parce que les sciences expérimentales s'appuient sur des nombres-mesures et sur des relations entre nombres-mesures, elles sont subalternées à la mathématique dont elles empruntent des principes pour expliquer les phénomènes, et non à la philosophie de la nature.( ) Cette subalternation se vérifie en psychologie expérimentale aussi bien qu'en physique. Une propriété qui n'est pas définie par la description de son procédé de mesure est une propriété mal définie ou étrangère à ces sciences.

La division des sciences expérimentales. A parler rigoureusemer les différentes sciences expérimentales ne sont que des parties d'une ~~même~~ même science. En effet, les sciences ne sont pas spécifiquement distinctes à cause de la diversité des choses traitées par elles, mais à raison de la diversité des objets formels. La philosophie de la nature étudie des sujets aussi divers que l'inorganique, la plante, l'animal et l'homme, et pourtant elle est une par son objet formel, à savoir la mobilité. Bien qu'on distingue en elle diverses parties selon les différents genres de mouvement — le mouvement local, l'altération et la croissance —, la raison formel reste la même. Or, ce qui est formel dans toute science expérimentale c'est la mensurabilité.

Mais alors, quel fondement peut-on assigner à la distincti des diverses parties de la science expérimentale ? Quelle différence y a-t-il entre la physique et la biologie expériment

A ce point de vue, la distinction entre les diverses parties de la science expérimentale est une distinction à postériori appuyée sur le caractère irréductible de certaines propriétés expérimentalement définies. Ainsi, l'accroissement des cristaux et la croissance vitale sont des propriétés irréductibles par ceci qu'un organisme peut croître au depens de matériaux plus ou moins différents de ceux ~~xxxxxxx xxxxxxx~~ de l'organisme lui-même; sa croissance se fait par voie d'assimilation active, et non pas par accroissement purement passif; elle mène en outre vers une reproduction, car une croissance continuée précipiterait l'organisme dans un état d'instabilité, etc. Cette propriété est appelée biologique parce qu'on ne peut pas la déduire de l'accroissemen des cristaux. La vie est définie par un ensemble de propriétés que l'on ne peut pas déduire des propriétés physiques ou chimiques connues. Il importe d'insister sur le caractère a posteriori de cette distinction: elle reste provisoire. La croissance telle qu'on la définissait autrefois ne différait pas de l'accroissement des cristaux, d'où l'on pouvait légitimement conclure que la croissance, telle qu'on l'avait définie, n'était pas une propriété vitale. Si on avait assimilé la définition philosophique de la croissance à la définition expérimentale, il aurait fallu en conclure que les cristaux étaient des vivants, ou bien que la croissance (au sens philosophique) n'était pas une propriété des vivants. La manière dont la plupart des psychologues définissent aujourd'hui l'intelligence est si vague qu'on peut l'appliquer aux animaux aussi bien qu'aux hommes. Il faut que le savant découvre les distinctions selon sa méthode à lui, il ne peut pas les recevoir d'autrui en tant qu'il est savant. ~~L'ignorance~~

Si au point de vue philosophique l'intelligence est absolument distincte de la connaissance sensible, cela ne veut pas dire qu'à son point de vue à lui le savant a déja reussi à trouver et à définir une distinction analogue. Cette ignorance ne devient insensée que lorsqu'elle nous pousse à nier ce qui est etabli à d'autres points de vue.

Lorsque deux groupes de propriétés sont irréductibles les unes aux autres, nous disons qu'ils sont séparés par un irrationnel. Il importe de distinguer cet irrationel expérimental que l'on rencontre à l'intérieur même du développement de la science, de l'irrationnel qui est imposé a priori par le caractère restreint de l'objet formel. L'irrationnel expérimental admet des degrés. Il existe une distinction globale assez nette entre la biologie et la physique. Mais il n'en est plus de même lorsqu'il s'agit de distinguer la physique et la chimie. Autrefois on réservait à la chimie les différentes combinaisons des atomes et l'arrangement des atomes dans une molécule, tandis qu'on assignait à la physique l'étude des changements d'état et les mouvements des molécules, mais aujourd'hui cette distinction ne peut plus être soutenue. La distinction est commode pour les traités, mais il serait malaisé de lui assigner un fondement experimental.

En pratique le savant doit tenter d'atténuer autant que possible cette irréductibilité des propriété