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METAPHOR AND INVENTION

In *La Nouvelle Héloïse* Rousseau states that everyone uses figurative expressions; he adds that only fools and geometricians express themselves without using metaphor. Can one allow even these two exceptions? It has become increasingly clear in the field of culture that metaphor can be used in a foolish manner: how many doctrines have a dominant analogy at the basis of their reasoning; how many metaphors have become dogmatic as the areas in which they may be applied increase? And if metaphor is central to faulty reasoning and foolish arguments, is it altogether absent from the geometrician's work? The geometrician's categories are certainly limiting in this respect, and it appears paradoxical to wonder whether geometrical concepts, such as a straight line or a point are not figurative expressions borrowed from other fields. However the problem becomes far less paradoxical when one moves from geometry to mathematical astronomy, mechanics and by degrees to the whole of physics. For in most fundamental categories, those which instigate a new field of knowledge, a metaphorical dimension, then become ap-

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parent. The further one descends Comte's ladder of science, the more the terminology retains the stamp of the transitional stage from which the concept originated. A straight line, a point, a circle are perhaps first concepts as regards expression and invention. But attraction, natural selection, physiological division of labour, or division of social work bear in their very names the mark of the intellectual transference through which they were formed. With the result that scientific invention does not use non-figurative concepts; it often finds its mode of expression through metaphor. Neither the fool nor the geometrician escape the metaphorical realm of thought, because it is the usual means of expression and conceptualisation. Because of this the metaphor used by the fool and that used by the geometrician link up, and it becomes possible with regard to certain predominating metaphors, to tackle the question of the quality of reasoning and the question of the discovery of knowledge, the study of argument and the study of conceptualisation, together: for beyond the general usage of metaphor, it is the expressive nature of speech itself with which we are primarily concerned.

An example may be used to illustrate the metaphorical aspect of conceptualisation, showing how a scientific representation is formulated by borrowing heterogeneous images. The example in question is an article by J. de Rosnay entitled "Matériaux et dynamique de la vie" published in the newspaper *Le Monde* on the 7 September 1967. Based on the idea of cell-regulation and on the research for which Professors Lwoff, Monod and Jacob received the Nobel Prize in 1965, this article explains to some extent the most recent state of the formulation of histological research. It was written at a time when the scientific results were beginning to receive the authority conferred on them by their recent official endorsement, though without as yet being widely known. Nobody disputes that they constitute scientific knowledge well on its way to becoming established, but they are not yet taught in school text-books. They are already accepted by the cultured, but are not yet well-known, not even in the sense that the theory of relativity can be said to be "known." These results have already received wide cultural acceptance, but have not as yet been assimilated. Hence the importance at this stage of the way in which the results are presented to the public.

This account of cell function certainly contains nothing which may not be found in modern histological text-books and specialist scientific publications except, precisely, its deliberately expressive nature. Since it is aimed at a generally cultured public this article fulfils a transitional function of high-level popularisation. It is question of making something not yet known comprehensible to a reader who considers himself ignorant, but who nevertheless wishes to obtain quickly a total and reasonably clear grasp of the problem. In short, for an article of this sort, it is a matter of communicating information relating to a piece of knowledge in a succinct and almost-immediate way. In order to do this, within this context, is there any other way except to guide the representation with the help of a constant interplay of verbal analogy? And yet these analogical comparisons which are for the most part discreetly used—in Romantic biology analogy has been used very differently in an ostentatious and aggressive manner—all these ultra-sober comparisons, concentrated in too large numbers in too short a space, give the article a quite astonishing metaphorical character. The account aims at giving a cultured public a rapid but complete and fairly accurate view of cell-life; it attempts to make a new concept intelligible: but in or through what terms? Borrowing what from the various areas of concrete and intellectual reality?

The *dynamic energy* of life, one reads, assumes a "vital minimum" which is, in essence "summed up as *energy, building material* and the necessary *information* for its assembly." In the cell nucleus of all living things is a particular kind of giant molecule *governing the manufacture* of all other molecules; it contains the molecular "'*plan*' necessary both for the ***functioning*** of the cell which is the *chemical* factory and the *manufacture* of identical sister-cells." The proteins are "*building-bloks* or *chemical agents* controlling cell activity." The *information* needed for their *assembly* and for reproduction of the cell is found in D.N.A. and R.N.A. To be classified as "living," an organism, however small, must be able to ensure the three functions of self-preservation (thanks to a *transformation of the energy* that is drawn from the outside world), of self-reproduction (*assembling* according to a "*plan*" the *units split off, manufactured* or borrowed by the organism), and of self-regulation ("per-

manently to *control* and regulate the *functioning* of all this *industry*, in such a way as to avoid both *deficiency* and *over-production*"). Firstly self-preservation: living organisms must act as real *transformers of energy connected* up to a source: the sun. Through photosynthesis, then respiration, solar energy is stored in the form of sugars which are "*burnt*" in the mitochondria, real *molecular furnaces* which both *release* and *stock up energy* in the form of A.T.P. Secondly self-reproduction: enzymes are the *catalysts* which *control* the main reactions involving energy; they *work in conveyor-belt fashion*, and their diversity depends on their various combinations. D.N.A., which contains (*memorises*) the *assembly-plans* of proteins, also includes the *stock-pile of information* required for its duplication. Thirdly self-regulation: how does life manage to *run itself*? The *control* is exercised through the agency of enzymes, whose presence or absence allows or forbids certain reactions; "but which part of the cell "*decides*" to set off or terminate the enzymic *assembly-line*, to set off or shut-down the synthesis of enzymes?" The enzymes *authorise the chain-production* of molecules which can stop *manufacturing* themselves, notably by *cutting off* the *flow of information* used for the synthesis of enzymes in the chain, by the interaction of a real *chemical "switch"*. "*A truly self-regulated cybernetic system*, the cell can thus at any given moment *balance its output* according to its needs and the energy available."

What strikes us first of all, in the compact account which has just been summarised, is the multiplicity of metaphorical languages which have been referred to. It borrows its ideas and terms from several sectors of reality, whose one common feature is that they belong to the world of technology. To call the mitochondria "real molecular furnaces" amounts to saying that blast-furnaces make respiration comprehensible.

Already at the beginning of the 17th century Harvey had explained the circulation of the blood in terms of suction pumps and force-pumps. Resorting to the technical as the model for explaining the non-technical, whether one is dealing with the animate or the inanimate, constitutes one of the most important constants of thought. In this respect, the mental universe of Western logic and that of Western civilisation coincide. Here one could attempt to retrace the separate developmental paths of

the phenomena to be explained in the various technological models of explanation. It would, for example, be possible to note that the functions of self-preservation are expressed rather more in the language of transformation of energy, the functions of self-reproduction more in the language of the assembly of separate pieces broken off according to a plan, the functions of self-regulation more in the language of the cybernetic control of a mechanised construction. But the brevity of the text in question leads us to prefer a different method of analysis. Let us say that all the technical expressions included in the account of cell function fall roughly into five different languages. Five different languages rather than five truly separate ones; they intermingle, overlap somewhat, but in any case are juxtaposed in a continuum of metaphors which is far too unstable for the imagination to stick rigidly to any of the pictures sketched in these terms. These five languages are those of administration and economics, of mechanical construction by assembly, of energetics, of information and electronics, and of the factory, i.e. relating to manufacture and industrial production. Certain terms belong to several languages; the word "plan" is common to all the languages, with the exception of energetics. The various languages intermingle; the language of administration and the factory meet in the expression of production-management; those of administration and information in decision and control; those of electronics and the factory in the expression of a total cybernetic installation aiming at self-regulated production; those of energetics and the factory culminate in the concept of "molecular furnaces" which release and store up energy in combustible form; finally the languages of electronics and assembly join in the combinatorial imagery. The nature and scope of the article do not permit any further attempt at systematisation of the technical complexes whose conception is heralded and evoked by the multiplicity of languages. What matters here is the plurality of the zones to which the metaphors refer, and which all belong to the world of industry and technology.

In another way the text is equally interesting from the point of view of the levels at which the borrowed terms are used. Indeed not all the metaphors are used in the same way, nor are the metaphorical uses of the vocabulary all equally obvious or

equally new. An infra-metaphorical level, a true metaphorical level and a supra-metaphorical level could be found. To the first type belong expressions assimilated and made banal by scientific usage, and which are hardly felt any longer to be analogical. Thus, in this text, to compare protein with a pearl necklace is to use a banal image as an aid to representation. Explaining that the giant D.N.A. molecule can split into two in reproduction because it is "composed of two threads coiled up in a helix" is a comparison derived from mathematics which now belongs to the conventional substratum of the current world of technology. One writes without inverted commas that enzymes are catalysts since frequent usage of the word catalyst has liberated the idea from its specific context; one no longer explains what a catalyst is, it is the catalyst which is used in explanations as typical of a mode of functioning.

But one speaks in inverted commas of a chemical "switch" because this electro-chemical term, which has not yet become commonplace, is felt to be daring. Wherever analogical comparisons are used in full awareness of the mental gulf between the zones of reality evoked, the formulation bears the mark of this awareness. We are told that living organisms act as *real* transformers of energy, that the flow of information is cut off by a *real* chemical "switch," that the cell is a *truly* self-regulated cybernetic system. This is the level of true functional metaphor. The use of an analogically justifiable adjective like *real*, or the abundant use of inverted commas, shows that the metaphorical fabric is still perceived as such, and is not yet integrated into the self-evident and commonplace equipment of scientific speech.

But on a higher level one almost goes beyond metaphor. Life "runs itself," the cell "decides": here it is the awareness of metaphor which prescribes the use of inverted commas; these are manners of speaking. On the other hand cell-regulation is written without inverted commas. It is no longer a metaphor but a concept; it is no longer a manner of speaking but a manner of thinking. Although it is obviously of metaphorical stock, the idea of regulation ends and justifies all the terminological gropings through which the representation, for which it is now the concept, sought expression. The idea of regulation applied to cell

life is a borrowing, a model transferred from one field to another. But once incorporated, i.e. once scientifically established, quantitatively assessed, elaborated, this borrowing becomes a new part of scientific thought. We can still see at first hand how the concept of cell regulation borrows its terms and formulation from a group of technological zones, how it uses all the languages in order to express a new conception of the cell. But this is how all new scientific concepts originate. In fact—and this is the problem we should like to pose here—has scientific thought ever been enriched by a new concept, whose formulation, and therefore logical model, has not been derived from metaphor?

The starting point of the epistemological problem posed by this article, is that we have in fact understood what we have read. Or that we are at least under the impression, justified or otherwise, of having understood; a coherent and clear representation of cell function has in reality been imparted to us. The problem starts from a statement of success. Suppose the reader is a layman not especially familiar with the workings of blast-furnaces, assembly-lines and cybernetic memories. He has a few ideas on the subject, some vaguer than others, but it is not on his ability in these fields that he relies for an understanding. The metaphors do not address themselves to the specialist or technician in him; what he does not know is not explained in terms of what he does: he knows that he could profit by fuller explanation and information about the vectorial relationship of the comparison. Or if the reader happens to be a specialist, this is not likely to promote acceptance and communication. His adherence to the implied reality is more likely to hinder his understanding of the logical entity; the metaphor "fits" less well. Why then does the layman understand what he reads? Of what order is his understanding?

The unknown has been explained to us in terms of another unknown with which we are more familiar, by a round about system of connotations and accepted references. What is the value of an explanation of this sort? Does it not, by giving us the illusion that we understand, plunge us into the most dangerous of confusions, the mental universe of the *doxa*? Would it not have been better, as far as contemporary cell theory is concerned, to have left us in self-acknowledged ignorance tather than to

create, between science and silence, the ambiguous impression that we understand? But we still have not reached the fundamental problem. We do of course realise that this page of information does not give us full command of a piece of knowledge. Something is presented to us and shared with us: but this does not automatically make us scientists. Despite having been able to read this dissertation we are unable to follow it up. But if this is the language in which the scientist can attempt to impart some rudimentary information this is because it is the language for the communication of scientific thought, and in a way, the language for its expression. It is not only in order to be comprehensible to the layman that the cell theory makes use of the ill-assorted keyboard of technical allusion. It is also in order to be comprehensible to itself.

What does this language mean to the scientist? Our journalistic exposé is not a scientific text, a text within scientific thought itself. Consistent with its aim, it presents a synthesis of the results separate from all experimental ground-work, all consideration of methodology, and all justification of perspective. So it is the language of end-results, which thus collated and boiled down, gives the impression of extreme concentration of metaphor. In genuine scientific work, the language of end-results is considerably more diluted, fragmented and cautious. The general impression is, as a result, usually less striking; a theory is established (in writing), of a certain length and in a certain number of words; it requires a book, not a sentence. The acquisition of a piece of knowledge requires a word-circuit; it may find a stunning formula, but the formula on its own is not knowledge gained, but only the felicitous expression of a developed statement, or at least a developable one. The invention of the formula becomes woven into the fabric of knowledge. A scientific theory discloses itself through the statement of its verifiable body of fact: observation, experiment and measurement. Whatever the quantitative importance of the speculative language, it does not thus appear isolated and reduced to its essentials. In a way, a synthesis of the results such as is given in this article only presents a caricature of the scientific theories it is reporting. What is conveyed is everything most peripheral to science: popularising scientific knowledge makes it dogmatic and consequently ruins it. What can be more

opposed to the scientific spirit than teaching results without methods? Thus the almost entirely metaphorical language of our article is a virtually caricatural language. Compared with the activity of research, this constitutes the topmost layer, which is the first to die and fall away. It is a ridge not to be isolated.

And yet it is the very language which must convey the sense. It is not only with the immediate aim of making himself understood that the scientist seeks his terms, it is primarily for himself. It is not just a question of terminology, it is essentially a question of conceptualisation. When he makes discoveries, when he breaks new ground, he must be able to put his thought into words. This is not an exterior obligation but an internal necessity of fruitful thought: a concept is not acquired until it is named. A few pages from Mauss's studies *Sociologie et Anthropologie*, illustrate this point very clearly. They relate to the opening pages of his study on "the body's techniques." Mauss telles us that he was for a long time in a state of confusion on this topic. He had the rudiments of the problem to be posed, he could glimpse an avenue to explore, but he was unable to establish the bounds of his subject or to explain it, because he lacked a term with which to describe it. "I could see how everthing could be described, but not how to get it into working order; I did not know what name or title to give it." Unable to formulate his intuition, he was also unable to conceive of it in a way which satisfied him. This was until the moment when the expression "the body's techniques" came to him: the idea was then able to work itself out around this expression. The name for and the contents of the field of knowledge, the research programme, the plan of the article, all suddenly fell into place. The expression "the body's techniques" is the concept. It is the expression which makes the acquisition of a new system and a new piece of knowledge possible.

This example from Mauss is unusual in that he relates what took place in his mind before he hit upon the concept, which is subsequently developed and elaborated in his work. These psychological preliminaries ("the conscious and unconscious steps") are a stage in the development more often found in autobiographies than learned publications; with this exception, the existence and awareness of this stage are in no way out of the ordinary. It is a characteristic feature of a whole area of invention. That area

in which the intuition of a problem or an intellectual possibility gropes its way and seeks to grasp itself; until the moment when the inspiration of a name determines it, illuminates it and it is assimilated into speech. In this respect scientific inspiration is very close to poetic inspiration. They have an area in common, narrow but deep, in which they are both verbal creations. Both would attract the same type of critical analysis of the moment (or mystery) when the right formula appears. Let us re-examine the plan of Mauss's account: a confused and blind intuition unable to express itself because it lacks a language with which it can identify, it must therefore invent one; it discovers a new term, and realises it is the right one. This is a perspective which itself calls for a Platonic formulation: how do we know that the formula which appears is correct and totally adequate to express the intuition?

The nature of the formula in question "the body's techniques" will become clearer when compared with another manner of invention. When Mauss, since we need look no further than him, in other studies of the same collection, elaborates the concept of *mana* or *potlatch*, his contribution is just as new and just as important, but his method is different. The phenomenon he is studying already has a name, but the name means nothing to us, it simply indicates a problem. At the outset it is not a concept but a sigla. These syllables are simply the characteristic symbol of the area to be studied. This noun, transposed as it stands, is untranslatable and remains a proper noun. It is the object of a work of investment and notional elaboration. Mauss, the ethnologist,—and ethnology has readily proceeded the same way with the concepts *taboo, totem* etc.—must establish in all its richness the network of meanings, images and new values for which this proper noun is the central reference point. He must analyse and elaborate the total system of allusions to which this noun refers. These are concepts of "investment": but compared with the idea of *mana*, the idea of "the body's techniques" is more of an initiatory concept. The phenomenon referred to is delineated and brought to intellectual being from the moment it is named. The question did not exist before its intellectual solution. Similarly the concept of cell regulation establishes the field for which it sets the boundaries and is the co-ordinator.

In the case of initiatory concepts, word-invention raises a distinct problem, quite separate from those relating to the scientific and theoretical justification of the new concept. It is here that the question of metaphorical function arises. Just like mythical thought, as analysed by Lévi-Strauss, rational thought is in this respect "inventive." That is to say that it takes its constructive elements where it finds them, around itself, from the strange world of everyday life, and still more from those sectors of intellectual life which seem privileged, and are obviously fashionable as well as being rationalistic to an exemplary degree.

But to say that a piece of knowledge or a theory in the process of becoming established creates its terminology by borrowing the rudiments of its vocabulary, still only leaves us on the threshold of the epistemological and cultural problem of metaphor. Firstly, it is obvious that borrowing words both indicates and is the convergent point of various forms of borrowing. In a very general way it would be possible to distinguish different levels of metaphorical borrowings: representational borrowings, methodological borrowing, the borrowing of models. But in a more precise and concrete way, it would be quite arbitrary to attempt to divide the concrete examples according to a rigid classification of types of borrowings. It appears even less possible to sort out the various levels according to a typological structure, since the same language often carries along with it, whether contiguous to it or superimposed on it, different analogical perspectives. It appears to be more relevant here to recognise the plurality of and differences between the various levels of borrowing without inserting the various discernible types of borrowings into rigid frameworks. It often happens within the same language and sometimes within the same mind, that a concept changes its place and use, a method moves to another field, intellectual perspectives and demands transfer from one area to another, logical diagrams refer to each other, the authority of results and successes coincides with the starting point of the evidence.

There exists therefore between the various branches of learning, to a greater or lesser degree, a real circulation of concepts. An historical and critical study of this circulation would in itself be a vast field of research. It may perhaps bring a rudimentary

answer to a question which until now has only arisen from the personal and as it were local attitude of the theoretician considering the problem: in these phenomena of intercommunicating fields, something passes from one area to another, but what is it in fact that passes? Is it the living kernel of the questions and methods, or their purely verbal shell, their most dogmatic and ephemeral part? For the whole field of scientific thought does this constitute a shoot, i.e. profit, expansion, increase: or is it mimicry, i.e. sterility and degradation? The epistemological status of the conceptual borrowings is obviously primarily a function of their level. Without setting up a rigid and exhaustive hierarchy, it will readily be agreed that although it may be stimulating to draw a model of intelligibility from another field of knowledge (and we know all that the first steps of the human sciences owe in this direction to natural science and more recently to mathematics), it is hardly advantageous to take the partial and dated terminology of an already existing discipline, as has happened with certain forms of organic sociology in relation to physiology, as the basis and horizon of an argument. Analogy can be used in a flat and superficial way just as much as in a profound, creative manner.

However the level of analogical references brought into play by the invention of the thought does not exhaust the problem of their status. From the idea of the circulation of concepts it follows that metaphorical activity becomes integrated into what might be called the nature of the thought. Between metaphorical conventions and conceptual borrowings, there is hardly a productive area of thought which does not crumble and reveal that it contains something which it is not. The circulation of concepts is also cyclical. If one looks back far enough, one can see the outline of a perpetual interchange of models between the various fields of knowledge, a sort of odyssey of ideas. One can say that there transferences are productive in so far as they are non-generative. The function of an analogical borrowing from one field to another, whether a metaphorical borrowing of terminology, or on a deeper level, the methodological borrowing of an intellectual method or the epistemological borrowing of an ideal requirement of learning, the function of the borrowing cannot be understood in etiological terms, like production or origin. Borrow-

ing only takes place where a problem already exists: where a powerful but open intellectual elaboration uses what it needs selectively. Analogy provides expressions, arguments, representations, models: it gives the thought imaginative and expressive support; but it does not produce the concept. When this happens, the domain of knowledge has been replaced by the domain of rhetoric. Or, to use Rousseau's expression once again, one has abandoned the geometrician's metaphor for the fool's.

Despite having no legitimate etiological function, analogy as an imaginative support nevertheless has a fruitful part to play; its role is very ambiguous but of undisputed historical importance. It may be called facilitatory. A new idea is more easily accepted when it is preceded by its formulation or outline, when analogy has linked it to a conceptual circuit which has already been worked out. Its facilitatory function does not consist entirely of the simple didactic necessity of linking the unknown to the known. For here expression cannot be separated from invention. One may perhaps make use of the image of a lazy thought which prefers to appropriate pre-established routes, a conservative thought which accepts the innovation so long as it can be recognised in terms of what has gone before. Its preliminary statements endow the concept with a certain force; an intellectual discipline which exists successfully gains value by this very fact, and gives value to everything connected with it. With reference to the entire scientific and cultural field at a given moment, this is translated in terms of the prestige and authority of the discipline which finds itself in a successful position; and because of this, the notions which may be linked with the conceptual elaboration of this discipline. When a concept or a method or the representation of an order of reality are over-estimated, all the statements related to it or using it as an authority share the same total framework of values, and feed this framework in return. Through its language the dominant discipline provides a model of intelligibility which can come to be considered in other fields of the knowable both as an ideal and a criterion. The metaphorical function guarantees the value of these phenomena of analogical facilitation by going back to established patterns. This is why it is the way used to express invention in culture.

Now the epistemological field covers the historical and cultural

fields. Our basic categories refer to each other and emancipate themselves from each other via the living dimension of the elaboration of the thought. Would it be possible to distinguish one area of knowledge which would be the ultimate basis to which the circulation of concepts refers? Could one locate the final analogue of invention? In a general way it seems that one could postulate that no level of reality and no individual piece of knowledge constitutes in this respect an absolutely justifiable analogue, a firm basis which is always the bearer and is never derived. If this were the case, analogies would no longer be metaphorical simply because they would be metaphysical. The transfer would no longer be a creative extension of knowledge but the application of a principle. The metaphorical aspect of conceptual borrowings is the ambiguous counterpart of the absence of metaphysics.

However, and this in no way contradicts what has gone before, among the diverse fields of reference of conceptual invention, the productive and innovatory periods had at least one privileged analogue. A whole range of conceptualisation forms itself around its particular characteristics, and at a given moment it may play the part of an absolute reference. But the analogue is a variable; thought has known several of them in succession; and when one believes one has found a model that was used several centuries ago, the representational contents and associated values will have changed. The implications of the model will not have remained the same, nor will the selective needs of the reasoning which draws its formulations and arguments from metaphor. Hence the methodological need here to subordinate all typological analysis to an historical approach. The more permanent and important the model, the more numerous, various and associated with their period its manifestations will be. If one accepts a perspective in which the systems of analogical valorization succeed each other and change in time, flourish and perish, a whole body of questions of a temporal order relating to the beginnings, the success, the persistence and the decline of the models becomes apparent. The models do not simply succeed each other, each model is a sequence in its own right, and its meaning is closely linked with its particular historical determinations. Our article on cell regulation mixes several technological languages which not only belong to different fields, but have also

existed for different lengths of time. The most recent system of language is obviously that of cybernetics. Cybernetics is the language of a successful field in which the functions of analogical facilitation are just beginning to be explored. Here the presence of the cybernetic analogue, its prestige and its availability (for it has not yet been as fully explored as it could be, and, at the moment, intellectually it is the object of fascinated mimesis rather than of real rational examination), the presence of the cybernetic analogue provokes and instigates its own theoretical elaboration. It opens up the possibility of a conceptual expansion of the explanatory models, of an increase in the field of logic through the acquisition of new categories and the new laws they bring with them. The conception of the cell as a "truly self-regulated cybernetic system" is an example of the increase in the models of informatics. But this was not the only reference used in this article. Assembly, chain-production, administration, blast-furnaces; several types of factory are evoked all together by these imported languages; or at least several images linked with various periods of industrial production. These technical models exist all together, just as they do moreover in reality; and the oldest are those mental networks best known because they have been forged the longest, until the time when they crumble from old age, and are therefore difficult. Moreover a gap easily occurs between the scientific or technological status of a reality and its facilitatory power. The latter sometimes gives it a secondary intellectual role unrelated to its true importance.

Thus a whole epistemological landscape takes shape beyond metaphorical activity. It includes a plurality of fields or disciplines of knowledge in an indefinite state of elaboration. It is linked with the moment of invention and conceptualisation, and stresses analogical transfers, borrowed ideas, images and models. On a temporal plane it deals with the history of thought from the perspective of the circulation of concepts, with special reference to an increase in values. The temporarily productive and overestimated field plays an undoubtedly remarkable epistemological and logical role. But the various types of knowledge use each other in turn as points of reference and none of them enjoys more than a brief position of privilege in

this respect. And considered in this perspective, the need to re-examine, in the light of the laws of the innovatory expression, the relationship between science and culture, learning and opinion, reason and thought, becomes obvious, A. Koyré, using Kepler's example, showed how a new, rigorous and valid concept could be arrived at within the depths of a cultural horizon, at the heart of the most dated and most hazardous speculation. He showed Kepler hesitating for a long while about whether to abandon the proven model of the sphere, before daring to use the neutral and unguaranteed model of the ellipse; trying the image of God the geometrician inscribing bodies into classically-behaved solids before finding the image of God the musician and co-ordinator of the harmony of the spheres; keeping for the sun, even in a universe ruled by the laws of rational cosmology, the Platonic over-estimations of the renaissance, and even its more esoteric functions as chariot and seat of the Deity. If it is striking that in Kepler's case knowledge is born of speculation, the same is also true of Newton, Lamarck and Geoffroy de Saint-Hilaire. Pure innovatory knowledge has as its basis the impurity and complexity of the established bounds of culture. In a way knowledge is acquired against culture; but in what sense? By an epistemological leap which opens up a new dimension, and not by preliminary all-embracing discipline. Its beginnings are not aseptic; inventive thought, when productive, is impure. And everything happens as if metaphor had centred upon itself all the ambiguity of fecundity.