The epistemological and philosophical situation of Mind Techno-Science

Alain-Marc Rieu

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1- The objective and the persective

My objective is to examine the philosophical relevance of Mind Techno-Science (MTS), why philosophy finds itself in a paradoxical situation where it cannot ignore this new field of knowledge and at the same time has to reinvent itself outside its realm. In order to reach this objective, it is necessary to clarify the present interactions between artificial intelligence (AI), cognitive sciences (CS), virtual reality (VR), the Humanities, their present conjuncture (post-modernism) and other issues that will be progressively conceptualized. The reasons for the connection of these different fields of research seem obvious, but are in fact less than clear: the form and content of this connection raise questions that cannot be answered in any one of these fields alone. To deal with this general problem does not only require to find the proper information and methodology, it requires an understanding of the *epistemic conjuncture* at its core[1]. The questions are many, all more or less confused: in what sort of epistemic conjuncture post-modernism finds itself, why are AI and CS in a situation beyond the reach of their actual practice but at the same time cannot afford to ignore this, because it concerns their epistemic and academic environment[2].

I hear already the protests from many readers: French fog. Indeed my perspective will appear at first non-analytical, even anti-analytical. But the overplayed opposition between the two traditions, in this precise case, takes a distinctly different aspect: it is between clarifying the already largely debated problems and questioning these very problems through an analysis of their presuppositions. The risk is fully accepted: my view concerns the forest more than the trees. It concerns the forms of argumentation at the root of these problems and the way to deal with them. A two layers reading scheme is herewith proposed; the first at the level of the global argument, the second at the level of the various problems crossed by the first one and usually

discussed by cognitive and AI scientists and philosophers. This perspective asserts that this first level has its own relative autonomy, that it can be analyzed with a rigor which, regarding its intrinsic intricacies, satisfies the minimal standards of an analytic tradition. If some parts of the argument do not seem satisfactory, I hope they can be rectified to open the way to a proper knowledge. Philosophy in any case cannot pretend to deliver much more.

2- The situation of the Humanities today

My starting point is a common sense question: how can one assert that the various sub-disciplines covered by the notions of AI and CS are generating knowledge which can be transferred to the Humanities in order to provide knowledge of what is called *mind* in this field? Is the transfer able to preserve the knowledge value of what is being exported from one field to another?

According to present research in philosophy and historical epistemology, in the field called *Humanities*, mind is not a substance; it is a *function* within a symbolic order. This order is constituted by a hierarchy of different disciplines that has been relatively stable during a certain period of time, till the end of the 19th century. Indeed, since the 1850's and 1870's, successive mutations in logic, physics, mathematics have deconstructed this symbolic order to an extent which seems (at least to me) till today not fully evaluated[3]. The function at the core of the symbolic order had been hypostatized by the philosophical tradition in a conception of the mind, of its capacities (faculties), of its assignments in society, culture and/or civilization. In any case, the historical hypostatization of this function cannot be taken for a knowledge of the mind, but it has effectively opened the possibility of transforming the function of the mind into an object of science, even of experimental investigation from the mid-19th century on.

This function has imparted to the mind different roles, the most important of them being the origin[4] of knowledge through the different faculties the mind was endowed with in order to satisfy the function it was given within this symbolic order. So the mind came to be known and understood as the foundation of all sciences. The real sense of this is the following: in return, any development of sciences and the knowledge they produced are to be referred to the activities of the mind and herewith contribute both to its development (the historical unfolding of its virtual capacities) and to its own knowledge. Mind knows itself through the development of the different forms of knowledge it makes possible. In this symbolic order[5] centered on the function of the mind, the role of philosophy is essential: its role is to extract from sciences the knowledge of the mind they carry and to refer to the mind this progress as a *deepening*[6] of the knowledge of itself necessary to accomplish its assignment. This construction of the mind through its function within a symbolic order has produced since the 17th century a major ideology: the progress of sciences,

being a progress of the knowledge of the mind is a progress of all the individual minds and as such a progress of Humanity or Mankind. In his late works, Husserl has clearly expressed this idea and the consequences of its regression[7].

The Humanities are a set of disciplines at the core of a symbolic order, they are regulated by philosophy. These disciplines, developed in the intimacy of the modern mind, are supposed to be its closest expressions[8], the fulfilment of its powers, the medium of Humanity. The modern conception of Man is built up through the Humanities as the presence of the mind in the world[9]. Within the Humanities, philosophy is defined as the exercise of Reason. What is Reason? Reason is supposed to be anchored in the mind as the origin and canon of all its activities; it exhibits and actualizes itself when it extracts from the different fields of knowledge that which concerns the mind so that it recognizes itself in its own productions. Reason is the self-reflection of the mind, the mind in search of itself in its activities. Philosophy, as reason at work in the mind, is the mental process in which all the different *expressions* of the mind are related to each other in the understanding of their origin. Its duty is to associate (even integrate) each individual mind, their *constructs,* in the generic mind of Mankind. So philosophy constantly weaves the Humanities with their different historical patterns, it asserts their coherence within the concept of Man as origin and end of all knowledge.

In such a brief summary, the argument may appear slightly ridiculous, as strange as a summary of any myth of an ancient people in the ancient Near-East or Africa. But this mythology has been repeated for so long in Europe and America, it has produced such wide effects, that its failure at the end of the 19th century, its fast withdrawal mostly since the 1960's, leave a void and a nostalgia that the majority of philosophical research tend simply to fulfil, explicitly or not.

The Mind Techno-Science is reaching philosophy and the Humanities in this precise context. One idea is to be obtained by this approach *à la Foucault*. There is no doubt that AI and the CS are progressively building an effective knowledge of what they define as mind. But in no way can the inter-discipline emerging at their intersection satisfy the *modern* function of mind. Neither their programs, nor their results, nor their internal debates can be interpreted inside the modern symbolic order, within this hierarchical organisation of different disciplines that had an endogenic development from the European 16th century till the end of the 19th. This body of knowledge being effectively produced cannot be referred to the modern mind as being conceived as the origin of different faculties and at work in the knowledge gained from them. The Mind Techno-Science cannot have as its goal the deepening of the knowledge Man (the subject of the Humanities) has of himself as the origin and end of all human things. It cannot pretend to participate in the spiritual betterment of Humanity[10], to restore a vanished order.

The reason why is that the conditions of the formation and coherence of the modern Humanities are no longer satisfied. The traditional part played by the Humanities in culture and

society has vanished. The crisis of the Humanities is not only a fashionable theme in the Humanities departments of the industrial world universities. Since the end of the 19th century, this is a fact, an epistemic situation, the consequences of which are difficult to fully assess. The Humanities crisis is the most obvious consequence of a deeper transformation concerning the symbolic order aggregating inside one another the different fields of knowledge. Physics and mathematics dropped out in the 1880's, they did not refer to philosophy anymore and through it to the activities of a mind: they were building within themselves and by themselves their own foundations. This explains why the Humanities are nowadays mostly reduced to philosophy, and philosophy itself divided between a quest for a back seat in the sciences and literary theory.

AI and CS are rising in this very peculiar epistemic conjuncture. A place has been left vacant to be occupied. Professional philosophers are still being trained in the different modern schools. A reconstruction of the modern function of philosophy is possible, even anticipated and asked for: the roads are drawn, the problems are well known (mind/body, mind/brain, physical/physiological, natural/artificial, etc.). The philosopher E. Husserl even tried at the beginning of the 20th century to reconstruct the modern conception of philosophy: perhaps he failed because he did not have a proper conception of mind at his disposal! Now new answers from the Mind Techno-Science can be provided, they are able to justify the old questions of the philosophical tradition. A ground knowledge can be deciphered through the controversies of the scientists and engineers who are ignorant of philosophy. The grand program of a reconstruction of the Humanities can be designed. The present conjuncture is certainly an ambiguous opportunity for philosophy, but there is no such place to occupy, no such function to fulfil. The function has vanished. AI and CS are not coming to save the Humanities. Neither are they going either to take their place, because philosophy has failed to play its role. The Mind Techno-Science will not fulfil Husserl's utopia to transform philosophy into a science.

Because of its methodology, problems and criteria, the analytical tradition seems, for the moment, bound to reconstruct itself in the cognitive sciences: it feels itself independent from the epistemic conjuncture. Paradoxically, a style of philosophy, coming from research as diverse as M. Foucault or P. Bourdieu, have the potential to overcome the modern frame of philosophical problems and even to arrive at the rigor that it has been missing. The Mind Techno-Science emancipates philosophy from its modern function. This is why it belongs to the *post-modern* epistemic conjuncture. The Humanities cannot be revamped by the mind sciences, but only further deconstructed. Philosophy has to overcome its nostalgia and explore the virtualities of the present situation, the post-modern experience.

3- The epistemological problem

The epistemic conjuncture is more intricate. Even if AI et CS research is at a loss to provide the reconstruction of the Humanities, even if this historic mythology is forgotten, the sciences of the mind raise important epistemological questions. The French epistemological tradition[11] holds and shows that each science develops itself by the construction of its object. Through its concepts, formalisms and experimental procedures, a theory *filters* the phenomena and herewith generates a *quasi-object* reduced to a set of parameters that can be experimentally studied[12]. This quasi-object is not a mental construction, it grows within the development of a theory and its experimental basis; it indicates the type of properties an object has within a discipline or sub-discipline. It cannot be separated from the theory to which it is linked and from the instruments by which this theory develops the different experimentation by which it proves and disproves itself. Even sciences at a primitive stage of their development, when they are not yet clearly cut off from *folk knowledge,* are already constructing a quasi-object. The object of any science is always, as coined by Bruno Latour[13], a "hybrid," indistinctly natural *and* artificial.

This entails two major consequences. The first one is that it cannot be asserted that *reality* can be reduced to what is *known* by a science. The second is that there is no other way than science to know what reality is. So the Real (what is reality) cannot be called upon outside of science, through philosophy, any belief, intuition, theology or poetry. But in return, the different sciences are not providing societies with a unified or unanimous knowledge of what the reality they study is by itself. Scientific knowledge cannot be cut off from the methods through which it is produced: the objects, reality or levels of reality any science investigates is defined by a theory and its method of experimentation.

From this epistemological point of view, it follows that AI research cannot state what intelligence is by itself. But intelligence cannot be *known* outside of the different sciences that are being built. This is why *cognition* is the quasi-objet of the mind sciences. Cognition is not the object they are trying to know as if it existed by itself. Cognition is being *constructed* according to the development of these sciences and their interactions. It is a concept by which these different sciences give an operational name to the quasi-object they are producing. Intelligence, as the essence of the human mind, has not to be protected from Mind Techno-Science, neither is it necessary to prove and explain at length that intelligence is not what these sciences are studying. The epistemological explanation is a sufficient answer that should dry up many popular (and) philosophical debates rising from the ghost of the Humanities.

The epistemic conjuncture and its problems are much more complex. Indeed the present epistemological situation of the mind sciences is ambiguous and partly explains the philosophical temptations above denounced. As they are progressing from computer science models to the

connectionnist paradigm[14], they overcome the initial behaviorist model dictating the processes being studied: the initial models were simply falsified by the very processes they allowed to investigate and they had to be refined and new ones were slowly proposed. In this situation, the mind sciences are requiring a finer description of their quasi-object, based on more complex conceptual models. The filters have to change and they have been changing in the last fifteen years. But precisely because these sciences are investigating at the same time by experimentation and computer simulation, they are not, for the time being, able to define and construct by themselves this hybrid (cognition, intelligence and their different modalities) which is their quasi-object. Within their investigation, a type of cognition has to be so drastically reduced that mind sciences cannot pretend to explain what they are supposed to. At the same time they need a full conception of this object in order to reduce it to the parameters at their disposal. This is their present and temporary epistemological deficit[15].

So the mind sciences find themselves in the position of requiring a *pre-description* of their object[16]. They have to look for it outside, import it from outside, because they do not yet have the theoretical means to build the *filters* in which the effective cognitive or intelligent processes could be analyzed in related parameters, so that they could be reconstructed and tested. Of course, this is how hard mind sciences are progressing already, but they are still under the influence of folk psychology and the pre-description of cognitive behaviors. In any case, the problem is not that intelligence or cognition cannot become an object of science, but that the present reduction is too strong and requires to be related to different pre-descriptions outside the mind sciences.

But here philosophy enters the game: different historical schools amply provide for the time being such pre-descriptions, because their linguistic self-reflective methods based on the potentials of natural logic were the only ones available to describe basic mental processes such as belief, cognition, attention, perception, intention, etc. Phenomenology and its different trends provide an important more recent stock of relatively well refined descriptions of mental states and processes. These schools can provide these badly needed pre-descriptions and their specialists can revive them and position themselves in the very development of the mind sciences.

I think this is a false conception of the present situation of philosophy. It is just a way for *modern* philosophy to continue its routine and even pretend to provide (unexpected) *true* (scientific) answers to old problems. Everybody seems satisfied in this false association: modern philosophical inquiry seems justified instead of being disqualified, the mind scientists are gaining some ideological prestige they do not even need. Indeed, if the epistemic conjuncture concerns the global organisation of knowledge, the epistemological situation concerns the state of development of a discipline or of a theory. The epistemological situation of Mind Techno-

Science explains why it is so concerned with philosophy issues, but it also explains why some philosophical schools find so much *interest* in them: they can recycle their presuppositions with fresh data, launch debates and even provide guidelines or orientations. Epistemology teaches that the present situation is only a temporary step. The next one is all the more easy to predict, because it has already happened: the formation of the *connectionist* paradigm shows how the mind sciences are becoming able to provide the *filters* for their own descriptions of the cognitive processes they are investigating. They are in the process of reducing their dependence on linguistic self-descriptions provided by philosophy and folk cognitive psychology. Connectionism attests the emergence of mind sciences as this autonomous inter-discipline I have been calling *Mind Techno-Science*[17]. A decisive step has been reached.

4- The situation of philosophy in this conjuncture

In such a situation, the domain of modern philosophy is even further contested. The problem is not at all that the mind has become a proper object of science, that has been the case since the 1850's. The problem is that the mind sciences have become able to construct themselves outside of the conception of philosophy which pretends to decide what mind is or is not, if the knowledge to be gained is possible or not, valid or not. Mind Techno-Science, by becoming autonomous, implicitly shows that even the analytical approach is neutral regarding its development. Just as physics and mathematics had become autonomous in the late 19th century, a science and a technology of the mind have become possible. This Mind Techno-Science cannot even become a substitute for the Humanities, a ground knowledge: the positivist dream is no longer feasible, simply because the order of knowledge (the web of interactions between fields of knowledge and practices) is no longer organized in a way to make it possible. The exercise of philosophy has become external to the knowledge of mind. Philosophy cannot pretend any longer that mind is its sanctuary, a strange object appearing to itself when it is described and analyzed by this peculiar use of language called philosophy. Philosophy finds itself outside the mind, the mind of the philosophers as well as the mind of Humanity or Mankind. In fact it seems (for the moment at least) nowhere and everywhere.

This final uprooting of philosophy needs not to be dramatized. In the present situation, the task of philosophy is certainly difficult to perform but it is at the same time quite obvious. First it is necessary to avoid any pretended fear or anxiety of (re)constructed mind, virtual (parallel) reality, artificial (non-natural) intelligence, as if we were waiting for a new Frankenstein under the cover of a Heideggerian conception of *technè*. Any form of post-modern blues or pathos (the end of all things modern, the philosopher as guru) is quite superfluous and rhetorical. The path is

actually predictable. Philosophy has to learn from the Mind Techno-Science what mind is, not what it is outside of them but how it is constructed, debated, investigated in the formation and development of this inter-discipline. Philosophers of the mind have to internalize their investigations within the mind sciences: they will probably have to become mind scientists in order to become their epistemologists. There is one obvious reason to justify this tentative assertion: many mind scientists have de facto become the epistemologists of their discipline and this work inside their own practice has played a major role in the various developments of their field. Regarding language, as there is a para-psychology, philosophers have been able in the past to play the role of para-linguists: they pretended for a long time they were producing some knowledge of language, even if it was and still is difficult to establish its clear status. Somehow this prospect seems doomed regarding Mind Techno-Science: its epistemology is already at work.

This is the reason why I think modern philosophy has no regeneration to expect from the formation of a Mind Techno-Science. It is just another proof of the need and opportunity for philosophy to reinvent itself as it always did throughout its history. But the present conjuncture cannot be compared with the 1920's, when the young Heidegger understood that the programme of his master, Edmund Husserl, was impossible to fulfil and had become an utopia. The modern philosophy of the subject could not be reconstructed in order to save the role of Reason as well as the function of philosophy in the European civilization. The epistemic conjoncture was a dramatic philosophical situation: if this reconstruction could not be properly accomplished, it meant that the new sciences of the late 19th and early 20th centuries could not improve the knowledge of the mind required for the progress of Humanity. Certainly Heidegger's solution has been worse than what he denounced as impossible. But his thought has been thoroughly developed, studied and enough understood. Who can pretend nowadays that philosophy can discover what it was before (and therefore after) it was linked to science, the individual subject, modern society, etc.? The Heideggerian solution is *achieved*, as well as its peudo-scientific opposites. Philosophy cannot ignore the development of Mind Techno-Science.

Still, even if he provided the wrong answer, Heidegger has left us with the right question. The question of thought is indeed the relevant one, as long as thought knows how to invent and discover what it could be by experimenting with its position and relevance within the different fields of knowledge. At present, philosophy seems only possible as thought producing itself in an order of knowledge that nobody knows but that everybody practices in his research. Indeed, thought is concerned by the mind sciences, but neither to be digested by them as their epistemology, nor to ignore them and express its own possibility as fiction (fabula) or as a form of literature (d'*écriture*).

So the role of philosophy is not to *reflect* upon the mind sciences, but to *think* how thought is concerned by the development of Mind Techno-Science, because it investigates what is thought and what is thinking in a mind. This problem is made possible at the interaction between Mind Techno-Science (AI, CS, neuro-physiology, etc.) and the practice of thought. What becomes thinking when the various operations that have been traditionally defining *thought as cognition* are being simulated and mechanized, i.e. become reproducible by artefacts and machines, even if these artefacts are very abstract and formal ones? Then a non-modern distinction between thought and intelligence becomes necessary, because in the present situation, the problem not only concerns what is an intelligent behavior, but the very intelligence of thought. *Intelligence* indeed has many forms and many levels, but it can only be known or investigated as a type of response to some change in an environment so that the said intelligent subject or entity reaches, through this *intelligent* process, a better (or new) adaptation to its environment and/or is capable of preserving or developing its autonomy[18]. Thought, to be intelligible/intelligent, requires to be treated as a behavior or process. This very situation changes the relation between intelligence and thought, it forces thought to gain a new intelligence of intelligence[19] and it is profoundly transformed by this situation. This experience seems to me one of the most radical questions for philosophy at present.

This proves that the situation of thought and intelligence is at the core of Mind Techno-Science, not only does it guide its development but it presides over the progressive association of the different fields of research composing it today. It is basically a technological question since the 1940's and an analysis of this *technology* is able to clarify the question and situation of thinking today, as well as some problems raised by the relations between AI, CS, virtual reality, etc. I will call it *Intelligence Technology* (IT) in order to exhibit that it is not a technique as means to realize some goals under the guidance of some ideal (Man, reason, spirit, etc.) or under the power of some interest (economical, etc.). This technology generates within itself its conception of thought and makes possible at its border another conception of thinking. As already shown, the Humanities, either as a modern ideal or as academic institutions, are not directly concerned by this question, except through the very possibility and relevance of philosophy.

5- A philosophical response

My question is: what is intelligence in Intelligence Technology? The answer is the opening of another thought that can only be proved in action. This interaction within thinking, between thought and its intelligence, is the question: no theory can be made, it has just to be tried out. But

I certainly do not intend to take a heroic stand and enunciate what is thinking today. On the contrary, the situation needs not to be dramatized, because it already occurred in the history of philosophy, even if the problems to raise and the answers to provide have to be original. Indeed in the early 17th century, Descartes saw that analytic geometry was introducing new ways of organizing thinking, a new form of intelligence. It did not concern the mind itself but its conception, not cognitive behaviors as the spontaneous activities of this mind, but a conception of knowledge and thought overimposed on the mind. A *new* mind was not constructed, but a new image of the mind in its act of thinking was constructed and a new definition of Man became possible. This is what Descartes called *method* and he formulated its basic rules, not for them to be simply applied and followed, but to exhibit that a new organization and practice of thought were possible, that they could be explored and that the results of the exploration could transform the different fields of knowledge, and even open up new ones. His work was very dependant on the order of knowledge that he was at the same time contributing to establish. This "method" could be called today a *model of rationality*[20].

I probably have proven by now that I am no Descartes, but the situation of philosophy in *his* epistemic conjuncture is quite similar to ours. IT is offering a new method and its basic rules or steps can be formulated; they have been born in computer science and information technology and my objective is to show that they play a major role in Mind Techno-Science. The description of these rules will not teach anything new to anybody working in these fields, but this is precisely the reason why it is so important to exhibit them[21].

The form of what is given (investigated) is a behavior, a process or the function of a process. So the function always supposes a process and every process expresses a function. The first step of the method is the description of the process, i.e. its analysis in order to discern its different phases, the elementary functions composing it. This analysis is the uncovering of the structure of the process or of a function in a process. Structure can be symbolic or, according to the connectionnist paradigm, *subsymbolic*. Indeed, the concept of structure designates a level in the analysis of phenomena and not a specific type of formal theory. What is here investigated are the properties of this level and this requires the development of original descriptive and explanatory hypotheses. The key point in IT is the relation between this structure and the process from which it was exhibited.

The second step is the expression of this structure in a formal language. It was traditionally a mathematical one, but in IT the problem is not only the formal language itself, but the language in which this structure adequately formalized can be programmed so that it can be reproduced and therefore the function itself simulated. The very stake of this second step is the decisive character of IT: once a structure is *expressed* (in the biotechnological sense) in a formal language,

it can be programmed so that it becomes possible to interfere with it, to introduce variations in order to better satisfy the function or to act eventually upon the function itself. This potential action within the structure on the function raises fundamental questions. IT makes it possible to express structures *by* interfering with them, to simulate or develop new versions of any function or new functions that have in common a structure or some elements of one. To be able to analyze the structure of a function in order to act upon it and so to find within this very structure variations of the function or new functions is what is at stake and has to be *thought*. Functions have in fact become virtual modalities of structures within a technology. In IT, structures are neutral regarding the functions they have been gathered from. The consequences of this fact are innumerable and effectively bring Humanity (the Human community) into a new age of its evolution.

The third step is to select the *medium* capable of expressing the structure and its virtualities in order to fulfil the function. The medium is the *carrier* of the structure, it can, for instance, transmit it, introduce it into an *artefact* (any object, machine, etc.), etc. It *actualizes* the structure in an artefact, in a given environment and for a certain task. Strictly speaking, the medium does not carry or embody the structure itself but the structure being programmed to perform a function or a set of functions. The carrier is somehow the matter in the Aristotelian sense, programmed or programmable. The decisive point is that in IT the medium is neutral regarding the structure it expresses, as the structure is neutral regarding the function. The same medium can carry different structures and, more important for our objective, the same structure can be expressed by different media.

To follow Descartes' suit, the fourth step is to program the function in a medium in order to perform the function, reproduce its various steps and their order. The fifth step is to test the program to make sure that every moment of the initial or intended process is adequately satisfied.

This is the effective situation of thought today and many points could now be clarified. The first one concerns some aspects of what *virtual reality* means. IT brings in a radical new conception of structure. Since the Greeks, it has been conceived as an autonomous and formal level of determination in reality, expressed and treated by mathematics. Now structure is not only the form of an object, of an entity or a process, it has become the *intelligence* of a process. This technology manipulates the structure it analyzes and installs in it the results of these manipulations. So in IT, a structure includes its virtualities and the analysis of a process generates the virtualities of this process. This initial or actual process is to be conceived as the existing actualization of a set of virtualities internal to the structure and constituting it. This is made possible because the structure is programmable in a medium (or carrier) which *overdetermines* the object, is *overimposed* to it, so as to reconstruct it and make an artefact out of it.

The *management* of structures has become effective within *their* objects, entities or processes. It opens a radical transformation of our conceptions of any being. From now on, any being includes in itself its other modalities as part to its own being. Heidegger explained that things had become *objects* for *subjects* who were perceiving them and reducing them to what they appeared to them[22]. Now the objects are becoming artefacts: what the subject perceives is only one modality of an artefact whose structure includes other modalities that exist only through IT. The individuality of an artefact comprehends virtualities which can be actualized by a technology. So *virtual reality* is not another reality, it is *the* reality. Reality has become virtual. This does not mean that what is virtual is not real and that in post-modernity reality vanishes in the realm of artefacts. It is another experience of reality: the actual or existing reality contains its virtuals, other types of actualization. The object and the subject are overlapping.

Has therefore the substance of the subject become its structure which includes its potentials? Yes, if this means that the subject is not any longer closed within one's self, some master of his own being. But since Heidegger, philosophy has exhausted this interpretation. The answer is to be found in the negative one: according to a model of rationality derived from IT, the structure cannot be reduced to the form or the *dunamis* in Aristotle or to a program in genetics. The reason is, according to the form of the given, that the analysis of structures in IT has as a purpose the knowledge of functions or processes. IT transforms the conception of *knowledge* in a virtual action inside the process on the functions it satisfies: the knowledge of the process is a virtual action on the function[23]. So the clear objective of this type of knowledge is not to study pre-programmed potentials already inscribed in a code or in the substance of a subject in order to make or let it happen. It is not a return or a reconstruction of an Aristotelian paradigm. On the contrary, the stake seems to be the opening of the structure, the introduction into it, through a given technology, of virtualities that have to be interpreted and decided upon according to the functions they are supposed to accomplish. In short, IT is not a study of what is already there but of what can happen within what there is. One reaches the most controversial point of this paper, it needs to be justified or falsified: the function sets the limit of the technology. IT seems to be a technology that constructs its limit into itself.

The second point to be clarified is central to Mind Techno-Science and concerns the relation between mind, brain, computer science, physics, neurology, etc. My remarks will be strictly philosophical and do not pretend to have any practical epistemological relevance, they just follow from the argumentation being built up[24]. My assumption is that Mind Techno-Science is presently overdetermined by the model of rationality at the core of IT. It explains why mind is conceived as cognition and that cognition is in its turn reduced to various cognitive behaviors or processes like problem solving, belief, attention, perception, etc. In fact what falls under cognition is an analysis of different cognitive structures. This examination can only be achieved

in IT, at a symbolic or subsymbolic level, by their modelization in the field of computer science. Therefore the problem is not that mind is or is not a computer, nor what sort of computer a mind is. Certainly mind is not a computer, but computer science is at present the analysis of the structure of cognitive processes. To understand this fact and not to fall into the trap of endless controversies, one has to remember that Mind Techno-Science cannot be thought as the present and future substitute of philosophy or of Humanities. The whole (false) problem simply mixes the level of the structure and the level of the medium.

It was just argued that the level of the structure is neutral regarding the level of the medium, that a structure can be expressed by different carriers. From the point of view of IT, brain is a carrier of cognitive structures and in this respect it is similar to any physical system, for instance a machine, a computer or anything else which could perform the function described by the structure. A medium can be physical, neurological, etc., and this does not *matter* at all. The questions of the relation between minds and machines, brains and computers are often wrongly formulated, because they ignore the level of the structure. So the relations between the different fields of research in the Mind Techno-Science can be clarified if one acknowledges that this inter-discipline is organized by a model of rationality having its source in IT. This is why I said at the beginning that philosophy has not much to say, but that it was necessary to reduce some false problems and let an epistemology of the Mind Techno-Science develop. Certainly philosophy has a lot to learn from its development, but at present its main task is to learn how to stop asking the wrong questions. I hope I have not made the situation worse.

6- Individuals, artefacts, societies

To end this paper, it is necessary to examine some of its limits and consequences. Is there something alarming in these new virtualities offered to the power of Humanity or in-Humanity? Yes, if one thinks the IT paradigm according to biological and genetic research, in reference to the integrity of life or of the living being. In this case, epistemology is badly needed to explain the differences and the limits of such a paradigm according to the different fields where it is introduced and interferes. An epistemology proves its relevance when it is anchored in the very evolution of a field of knowledge, articulated to the internal and external questioning of scientists at work. Instead of deploring the end of the Humanities or to surreptitiously reconstruct them, it would be more relevant to study why epistemology is incapable of providing the knowledge of the sciences that our societies so badly need to understand themselves, their past as well as what they are becoming [25]. So to mingle the model of rationality provided by IT and the specific

problems of molecular biology is false, as Descartes was wrong to assert that animals or bodies were machines.

Indeed this problem forces us to return to the question of the *order of knowledge* in which Intelligence Technology is developing. Mind Techno-Science is not the substitute of the Humanities and IT is not a technology taking the place of Reason! At this point philosophy is radically involved. This can be introduced by further developing the end of the difference between subject and object which was one of the main features of the modern symbolic order. Such a difference does not concern artefacts. Artefacts are no longer objects, they require to be known from the inside, by distinguishing their structure and its virtualities, the medium expressing it and, most of all, the functions they satisfy. Objects have become artefacts. The subject is within the artefact, at the connection between the function and the structure. The artefact as it is used in everyday practice by an individual is *designed*. Certainly the design of an artefact is what *appears* to a subject, but it is conceived strictly according to the function and it does not express either the structure, or even the carrier. The design is neutral regarding the medium and the structure: the matter (which is not the medium!) of an artefact is selected according to the function[26].

The modern industrial conception of the object, "Form follows function", is taking a completely different meaning, because form is not any longer the structure. Form simply concerns the design. Artefacts are designed not for a substantive subject, knowing who he is or what he wants, but for a subject who explores its virtualities in the discovery and practices of artefacts. Individuals are not any longer in front of objects but in the middle of artefacts with which they interact, which they use as parts of what they are. So what *they* are is the uses, dispositions and practices they develop, exchange, adapt and invent: artefacts are the virtualities of individuals and individuals develop virtual artefacts. The object has lost the substance that was provided for it by the subject who was in front of it. Now objects are functions for virtual individuals. A world of artefacts is an age when functions, uses, practices are what matters and not substance and identity.

IT and its key concepts (structure, medium, design, function) are one of the main nodes in the present order of knowledge. But the striking feature is the primacy of function. The technology which is reducing the object to an artefact by managing its structure finds within itself its own limit: function is the beginning and the end. Function is no longer dictated by the production, the form by the matter, the structure by the form, because the manipulation of structures includes in them virtualities which are in the end decided by social practices. The relation between technology and society is radically transformed. I do not fall into a post-modern utopia of uses and customs rising and overtaking technology by the people for the people, of a Humanity free from the power of technology. I just explain that the future of IT lies not within IT but outside of

it, in the social and cultural practices. The core feature of IT is that what is outside of it finds itself introduced inside of it: its internal finality is what is external to it. To reach that point, structures had to become flexible, transformable, manageable. They had to include virtualities. In the end virtualities exist only according to the capacity of individuals to make them happen by actualizing some of them. IT supposes a world of events, chance, opportunities and, of course, accidents.

Urgently, structures have to be differently thought. Apparently, economists have been explaining this for the last twenty years: human capital is the main resource of high-technology societies. But they have a restricted view of this *capital* when it is reduced to techno-scientific skills, to the different competencies required by an industrial system based on information technology. Information is not intelligence. The virtuality of IT is that structures do not govern any longer but are governed by the functions they have the potentials to fulfil. Once again, function is the beginning and the end of IT. So the development of IT in societies, throughout their different sectors, is closely determined by the capacity of the individuals to develop and experience new and different behaviors, attitudes. These individual and collective innovations diversify social functions, desires, needs and demands. IT is the capacity to analyze them. The consequences are innumerable: in the end, these functions are the basis of what is produced and sold. But in North America, Europe and Japan, we see today a strong process of concentration in information industries. Of course this trend might be necessary to meet the level of investment required to implement *globally* information technology. But the objective and/or result of this very concentration, making the headlines, is the control of the demand by the strong structuring of the offer. To me, it seems to contradict the potentials of IT and conflict with the expected social and economical consequences of information technology. A bad philosophy and a poor epistemology might have today serious consequences.

The development of IT is determined by the capacity of our societies to offer to people a higher degree of autonomy, of individual and collective freedom. This requires, of course, a strong insistence on education, but more deeply it requires that our societies develop the knowledge, the epistemology and philosophy that change them. This may not be any longer the mission of the Humanities, but it is the task of the University. Ethical as well as political freedom has a direct effect on the capacity of societies to change according to the rise of IT. The paradox of Intelligence Technology is that it cannot submit society to its logic and requires freedom to develop its virtualities. The future of IT is political, but such a political and social philosophy requires to be based on a proper analysis of the order of knowledge. At the age of IT, the main question of philosophy is political.

7- Conclusion

This paper evolved from the conceptualization of Mind Techno-Science to a broader, more abstract and more intricate problem at the core of our societies, of our capacities to understand them and ourselves. Intelligence Technology is not a revolutionary technology, but a technology in a revolutionary sense. I said earlier that philosophy was nowhere and everywhere, because it is no longer localized in a subject, inside the mind, based on reason. I tried to show how philosophy was uprooted and therefore free from a function that was so deeply rooted in its tradition that since the end of the 19th century philosophy kept up the hope to modernize itself, i.e. to rebuild its modern paradigm. In the end, it always turned out a failure. Post-modernism has been nothing more but the way modern philosophy met its own limits, explored its presuppositions and finally predicted its own end as its only way to survive.

    To reconstruct the end of modern philosophy helps to understand the fascination surrounding Mind Techno-Science. But it also opens up new possibilities. As thought cannot be separated from intelligent behaviors, the knowledge (CS), technologization (AI) and industrialization (R&D on artefacts, Intelligent Manufacturing, etc) of intelligence transform the relation between thought and intelligence. Thought is changing because the emergence of MTS is dissolving the dominant internal relation between thought and intelligent behaviors. Thought is thus emancipated from a conception of intelligence which is becoming a techno-science. This mutation and the resulting evolution of thought shape the present situation of philosophy. But for that matter philosophy is not strictly, exclusively determined by MTS. Of course, philosophy cannot ignore its rise and development, but it should not be reduced to an epistemology of mind sciences. Neither has philosophy to prove (in vain) that thought has nothing to do with MTS, that its sanctuary lies in literature, in Heidegger, etc. Each scientific revolution, till now, has offered philosophy a possibility to reinvent itself. Once again it has become our common task[27].

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[1]   An *epistemic conjuncture* is the state of development of different disciplines and the internal and external interactions of these disciplines at this precise state.

[2] The intersection between the fields of artificial intelligence, computer science, neuro-physiology and cognitive science generates the inter-discipline here called *Mind Techno-Science*.

[3] Since the 1960's, *Post-modernism* has been an overall experience of this deconstruction.

[4] not the source, i.e. the senses. But there can be no source without an origin.

[5] It is in fact an architecture of disciplines: this *order* is constituted by the relations between statements (*énoncés*, not propositions in the traditional analytical sense), argumentations and concepts taken from different disciplines and intertwined in a *mind* located in a generic subject called Man.

[6] Mind was supposed to be deep, because new layers could indefinitely be excavated as long as sciences were diversifying and progressing.

[7] "Die Philosophie in der Krisis der europäischen Menscheit" (1935). French translation: "La crise de l'humanité européenne et la philosophie", appendice à *La crise des sciences européennes et la phénoménologie transcendantale*; trad. G. Granel; Paris: Gallimard, 1976.

[8] from language and the different expressions of *thought* to art as the way Man expresses its *spirit*. The sciences do not belong to the Humanities because they have historically developed their own methodology, they have

constructed the mind outside of itself. But there is nothing to fear: philosophy refers these methods to the faculties of a mind. Because philosophy is *the* inside of the Humanities, the sciences are outside of them.

[9] The world is not nature; it is the set of what can be and is *humanized*, i.e. comprized in a mind and comprehended by it.

[10] This program was explicitly articulated by Franz Brentano, *Psychologie vom empirischen Standpunkt*, Introduction. French translation: *La psychologie d'un point de vue empirique*; Paris: Aubier 1944, in particular, pp 42-46.

[11] i.e. J. Cavaillès (*Sur la logique et la théorie de la science*; Paris: P.U.F., 1960) - G. Bachelard (*Le nouvel esprit scientifique*; Paris: P.U.F. 1934) - J.T. Desanti (*Les idéalités mathématiques*; Paris: P.U.F., 1968).

[12] The standard presentation of this conception is G. Bachelard (1934), Introduction.

[13] *Nous n'avons jamais été modernes*, Paris, La découverte, 1991.

[14] The connectionnist paradigm can be summarized as the development of intelligent processes by the conception of networks connecting large numbers of elementary processors which are able to work in parallel, i.e. not consecutively. They herewith form a sort of *brain*. Parallel Distributed Processing opened in the late 1970's many new fields of research. Connectionnism is a proper paradigm because its methodology indicates which processes can be simulated and how to achieve this. It explicitly constructs *intelligence* as a quasi-object which does not have to be refered to any folk or intuitive conception of intelligence. The typical connectionnist question is not "can this intelligent process be simulated? "but "how intelligent is this network of processors? What does it perform?". My argumentation here is greatly indebted to the development of Paul Smolensky's work. For a definition of the connectionnist paradigm, see for instance his article "Connectionnism" in W. Bright (ed.); *The international Encyclopedia of Linguistics*; Oxford University Press, 1991, pp 294-297.

[15] The examples could be multiplied. A strict causality cannot be established in the phenomena being studied, because the causal models available cannot describe and explain the occurences and consecutions. A cognitive behavior like belief has to be reduced to such minimal parameters that it can hardly be called a belief in the common or philosophical use of the word.

[16] See Jean-Luc Petit, "Phénoménologie et sciences cognitives" in *Revue de l'Institut Catholique de Paris*, n° 35, July-September 1990, pp 113-134.

[17] Modern philosophy will have played (is playing) in CS a role similar to the *phlogisticon* in the rise of modern chemistry.

[18] This is why Mind Techno-Science is closely related to the epistemology of self-organizing systems and of neo-evolutionary theory, as shown by the work of Jean Gayon and Francisco Varela.

[19] both a new knowledge and a different conception of intelligence.

[20] There is never at any given period only one model of rationality available. The order of knowledge is conditioned by competing models. Descartes is only an example. On the concept of rationality model, see A-M Rieu "De la structure au système dans la théorie sociale" in *Systèmes naturels/systèmes artificials*; Seyssel: Champ Vallon 1991, pp 212-225, in particular pp 214-218.

[21] Concerning these rules, see A-M Rieu "Entretien avec G. Metzger" and "Penser l'informatique et pensée informatique" in *La techno-science en question*; Seyssel: Champ Vallon, 1990. Such an approach finds its roots in A. Newell, "The knowledge level", *Artificial Intelligence* n° 18, 1982, pp 87-127.

[22] "Das Ding" (1950), in *Vorträge und Aufsätze* (1954). French translation: "La chose" in *Essais et conférences*; Paris: Gallimard 1958, pp 194-223, in particular pp 198-202.

[23] This is why we have entered the age of *techno-science*.

[24] For a different philosophical clarification, see Pierre Jacob, "Le problème du rapport du corps et de l'esprit aujourd'hui. Essai sur les forces et les faiblesses du fonctionnalisme." in D. Andler (ed.); *Introduction aux sciences cognitives*; Paris: Gallimard 1992, pp 313-351.

[25] A key point in so-called post-modernism is the obvious failure of modern epistemology since the 1960's and the slow formation of an inter-discipline (associating sociology, economics, philosophy, etc) studying the development and organisation of sciences and technologies in societies. For the formation of a concept of science pertinent to such an interdiscipline, see my article "Science" in *Encyclopédie philosophique universelle*; volume 2: Les notions; Paris: P.U.F., 1990.

[26] Present architecture theoretical research calls this trend the *dematerialization* of the object.

[27] Acknowledgement: I wish to thank Pierre Morizet-Mahoudeaux (professor of AI at the University of Compiègne, he co-directs with me the *Science, technology, contemporary societies* program at the Maison franco-japonaise, Tokyo) for attracting my attention to the Stanford Humanities Review project, for pushing me to write this article and for his generous advice. So I am glad to dedicate this work to his newly born son Aurélien.