Information technology and the transformation of mass societies. Information technology today

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1- Information society to-day

The potential impact of information technology on advanced industrial societies has been identified in Japan in the early 1960ies. The idea of a major technical, economical and social change has been expressed by the notion of "Information Society" (Joho Shakai). This proves that Japanese experts both in economics, social science and technology assessment were the first to understand that a new type of socio-economic system was emerging. Prof. Ito Youichi has shown how this notion was constructed in Japan and when the other industrial nations developed this inquiry to figure out the deep change in which they were drawn into[2]. A major report *Information Society and human life* was published by a Japanese agency in 1983[3]. The notion and the processes it designates have been extensively studied and still are.

It is interesting to evaluate the present situation, how the meaning of this notion changed, how the societies which diagnosed such a change have evolved. In these late 1990ies, the question is: where are we now? Great changes were predicted and 20 years later it is time and also necessary to evaluate the difference between the prediction and the reality. Some very important changes indeed have taken place and still do:
1- a new full industry is born on a world wide basis: it produces the components for information machinery (mainly chips and computers) as well as the software which these machines run. Japan plays a key role in the production of components and in the production of a wide range of goods (from manufacturing tools and to consumers products) integrating these components. The on going delocalization in East-Asia of the manufacturing industries integrating these components and the construction of factories producing these very components (mainly memories) by competitors like South-Korea are playing a great part in the hollowing of the Japanese manufacturing industry.
2- The information industry has accelerated the development of the service sector and deeply transformed it. In the 1950ies services were identified as the future major economic activity and source of employment. Information technology (IT) has intensified their development but also transformed its course by first diversifying its activities and then by introducing new norms of productivity. Three examples have to be given. The first one concerns the birth and

growth of a "financial industry" as a quasi autonomous economic sector. Computer networks played a major role in its evolution and will play an important in its incoming regulation. Secondly, banks and insurance companies have started to reduce the part of their staff which has become redundant because of the generalized use of computers. Thirdly, Research and Development centers in some industries (mainly in the automobile one) are also reducing their employees due to computer graphics. Therefore the social impact of IT is more ambiguous than foreseen and its impact is even further reinforced by the globalization of the economy.

3- This part of the service sector transformed by IT has started in the mid-1980ies to merge with the Information industry to form what is now called the "Communication industry". The Communication industry associates and even integrates within information technology many different activities, the hard-ware (products) and soft-ware (programs) that can be conceived and produced to satisfy a growing demand. "Multi-media technology" is the name which expresses the globalization of this technology which now reaches all the different aspects of our societies, from the way we work to the way we are entertained after work, from the way we are going to shop to the way we might be educated.

These changes are numerous and enormous indeed. ITO Youichi research studies their different stages and the present paper tries to answer some of the questions raised by him. It is an attempt to propose a concept of Information technology bridging the opposition between the engineering perspective and the socio-economic one. The idea is to find the level where a technology and a social system are intertwined.

From such an approach, the changes should not be exaggerated. It seems, at least to me, very difficult to pretend that life, our industrial societies in general have been radically transformed: they changed but they have not mutated. When the automobile was invented at the end of the 19th century, it was impossible to forecast that towns will be restructured to facilitate their circulation, that people would tend to live in the suburb and commute to their down town offices, that the automobile industry would play such a dominant role in the economic development, integrating all the major technologies, becoming a mass product and as such a major source of employment, that in the long term its full success would generate pollution and traffic jam to the point of becoming an obstacle to its very future. When the telephone was invented in the USA at the end of the 19° century also[4], it was thought to become the main form of communication for illiterate people and immigrants who could not yet speak and write English. It was not forecast that its development would mainly be in corporate America where the written word, the one which seals a discussion, which is the proof of an agreement would have to stay dominant. Concerning IT we have just invented the telephone. We are for the information technology at the situation of the automobile at the end of the 19°.

2- What is a technology?

Nobody knows what the future will be. This also holds for technology and, as will be argued, even more true for IT. This is the reason why there is such a concentration in the multi-media industry these days. The goal of the Time-Warner merger is for instance an attempt to make the technology predictable by controlling the offer. The objective of the people in charge of these companies is to be so powerful that they become able to dictate what the consumers want because they have no choice but to choose from what they are offered. This is also true of State bureaucracies whose main legitimacy was and still is to reduce and manage uncertainty, from technological development to natural disasters. Still the future is written nowhere. This is the main point of the present argument: when we collectively understand that the future of a technology is unpredictable, then we enter the real problem concerning our present common situation.

Why is the future of a technology unpredictable? What makes a technology unpredictable is not the technology itself but the social environment in which a technology grows and develops, takes shape in various products or goods. But still the social environment, the culture, the class structure and the state of the economy do not dictate what the technology will become. It *shapes* it but does not *dictate* its course. The English culture and society were not predetermined to deliver the industrial revolution. England had no special gene to generate it. Europe had not in itself, a spirit out of which industry was finally born. The industrial revolution was not programmed from eternity to happen in Europe and then spread to the rest of the world. This means that it is necessary to understand case by case the interaction between a technology and a social system, the different conditions involved. They develop inside one another, they are not separated but on the contrary very closely intertwined. A technology is always cultural, social, economic and no society can be understood outside or without its technology[5]. So we cannot separate men and machines, think them apart like two separate worlds. Men and machines make only one world in which they are fully integrated.

This raises many difficulties: what the word "technology" means when I say that there is no society without its technology? Obviously a society is composed of many different techniques to manufacture goods, to communicate, to organize work and administration, to raise children and educate them, even to make love as well to design houses, etc. But these techniques, these know-how, these practices are very different, some of them highly theorized in confirmed bodies of knowledge[6], others informal to the point of being defined as "implicit knowledge". These techniques are diverse and numerous, highly heterogeneous but at the same time they are related to each other and all of them form a network.

First of all they are related by the fact that they are learned and used by men and women, more generally by groups, communities which give them a meaning by the goals they try to achieve with them. Then we arrive once again to the idea that technology is shaped by the society in which it develops[7]. This is not enough. It prevents us from understanding the internal interaction between a technology and a social system. It gives the wrong impression that techniques are only utensils, tools, means for any human or social design. It opposes what has to be understand together. The wrong idea is that we are disconnected from machines, that we decide[8] on goals and then that we select the best machines to accomplish these goals.

In fact machines, tools, practices, techniques, fields of knowledge in general, are related within themselves and form a network. A technique cannot work by itself, it needs an enormous amount of other techniques in order to be conceived, to be manufactured and to operate[9]. It requires codified and theorized knowledge at a certain level of deployment as well as implicit knowledge. Techniques at any moment of a social system form a structure and this structure is the technical basis (infrastructure) of a society. The idea of a technical structure was first developed by a French historian of techniques, Bertrand Gille[10]. Two examples will explain this assertion.

Let first consider an ordinary car, not as the utensil we use everyday but from an anthropological point of view, like an artifact similar to any artifact from a distant civilization, for instance a stool or a door produced by the Dogon people of Mali in West-Africa. The vehicle becomes an incredibly complicated assemblage of techniques. Let's close the hood and sit in the car. One notices that among these elements, some of them commercially the most important, are human tastes, behaviors, life styles, all symbols related to social fashions as well as to human needs. These signs are not outside the machine, projected on it, but they are within the machines, inscribed in the shape of the board, in the styling of the body, in the color of the paint, etc. Automobile manufacturers, in Japan as well as in Europe or the USA tend to become "blind assembly lines": they just assemble a huge variety of elements delivered to them by outside contractors, manufacturers who themselves constantly develop by themselves their research. A car is today as much (in fact more) social semiotics as technology. This is the meaning of "design" in advanced societies.

The second example is more complex and interesting because it raises deeper, long term problems. It concerns the technical conditions during the late 16° and 17° centuries of the European industrial revolution of the late 18° and early 19° centuries. It tries to shortly describe the technical structure in which the industrial revolution was born. In the late Middle Ages (14 et 15° centuries), trade exploded in Europe and developed on a continental scale. This was the first globalization of the economy[11]. In order to satisfy this market, the demands it generated, new tools and machines were necessary. They had to become larger, more resistant and more reliable. The solution was clearly understood at that time: wooden components had to be systematically replaced by iron then steel parts. But in order to produce in large quantity good quality iron, it was necessary to procure not only bigger quantities of iron ore but also a better source of heat to melt and refine this ore. To reach this goal, coal was needed instead of wood. To extract coal and ore in such large quantities, larger and deeper mines had to be excavated. But the larger and deeper these mines were becoming, the more it was difficult to dry them and raise the coal and ore to the surface. To achieve this purpose, large, resistant and reliable machines were required in order to pump water and to lift the ore to the surface.

In fact to design and build these machines (pumps, elevators, etc.) required the new physics invented at the same moment, the science of mechanics. The scientist was also an engineer. The iron parts these machines were intended to help producing were in fact required to build them and make them work in the first place. But the story does not stop here: as these machines were progressively being built and becoming more reliable, it became clear that a new engine was needed: they could not be activated anymore by wind or water mills, even less by man power or even by horse power. This new engine will be slowly invented and manufactured from the end of the 17° till the end of the 18° centuries. It was the steam engine. To generalize its use required even larger quantities of coal to activate it and also to produce the different parts necessary to build it and use it with a high degree of reliability. Its characteristics (the laws of thermodynamics) have radically transformed physics during the 19° century.

Many lessons could be gathered from this example. The first one is the paradox of technical change: the end result, new reliable machines, was needed to conceive and manufacture them in the first place. The rationality of technological evolution is the management of this paradox. The constant incremental innovations should not hide that at an other level happen technological mutations which transform social systems. The second lesson directly concerns the idea of Information society. From a long term perspective, the technical European structure starts to change during the Renaissance, from the 15° century on but explicitly and strongly during the 17° and 18° century. This period is dominated by the mechanical technology. But the long term evolution required by the rise of mechanical technology relies actually on the production and distribution of energy which became during the 19° century the dominant technology, up until the end of the 20° century when IT and the communication industry started to merge in what is ambiguously called "multi-media", this code name of the globalization of IT.

In both cases, the third lesson to be remember is that the long term perspective was quite different from the short term one. The evolution was unpredictable because prediction was impossible due to the internal paradoxes of technical change which had to be overcome. This proves also how technology and society are closely intertwined. Our starting point is reached again. We now understand the vicious circle of technological change which makes its future unpredictable: it presupposes its end. This is why techniques are always linked together, dependent on one another. They are not assembled in a chain but form a network. This is finally why it is necessary to understand the technical structure or the technological basis of a society. But still it is not enough. There is one more step to take in order to understand what IT means, which level of development and understanding it has reached today.

We have just seen that a technical system (a network of various techniques in a relatively stable order for a certain period) is always organized around a technology which plays the major role because it determines the evolution of the technical structure itself. It was mechanics in the classical technical system (late 16° till early 19° centuries), energy technology in the modern technical system, from the 19° century till to-day, from the steam engine till nuclear or fusion energy, with electricity and hydro-carbons. Energy technology in fact still dominates the world politics and economics, from Hiroshima and Chernobyl to the Gulf war. The fourth lesson is that a technical system is always based on a *core technology* whose evolution determines the evolution of the technical structure which is itself in internal interaction with a social system. A technical structure is made of cars, engines, computers, factories and offices, consumer behaviors, etc., all of them linked by techniques used in them and for them. A core technology is more abstract, more basic and more generic because it encompasses many different fields, actual and potential applications. It concerns for instance the principles of mechanics, the knowledge on energy production, transformation and transportation, structures found in different machines, etc. But it also involves ways of conceiving, of thinking and of organizing which have a strong impact on the evolution of society. What is called philosophy in Europe from the 17° century on basically deals with this last problem.

Therefore, from the present point of view of epistemology and anthropology of knowledge, to talk of Information society is to designate not only the technical structure of such a society but also the core technology of this structure. This core technology has a deep impact on the evolution of the social system through the technical structure. This might seem slightly obscure but it is very important because even if the notion of Information society was constructed twenty years ago, only recently in the last ten years, has the technical structure really started to change. But we still are in a transition period because we are not free from the constraints of the energy core technology. This situation further reinforces the unpredictability of advanced industrial societies. One of the possible way to analyze such a conjuncture is to better understand IT as a core technology. It contributes to a better understanding of the evolution of advanced industrial societies.

The word "technology" means two very different things: 1- the components of the technical structure and 2- the core technology which acts upon its evolution. The technical structure is embedded in a social system from which it cannot be dissociated. But the core technology exercises specific constraints that have to be understood for themselves[12]. If a social system cannot adapt to these constraints, if it rejects them, then its technical structure will remain stagnant. Other social systems will evolve according of the potentials of the new core technology: their technical structure will be capable of exploring, experimenting and then producing new products, inventing new behaviors, ways of working, communicating, etc. This will create new needs which will be satisfied by newer products, all of them extracting the potentials of the core technology.

This is the frame of reference in which the present situation can be assessed. Of course a nation in the situation of the "late comer", in a "catch up process" as Japan has been for a long time, till the late 1970ies and 1980ies[13], is not directly confronted with these problems because it imports and adapts knowledge in a frame of reference which it does not have to produce by itself. But this period of the Japanese development has clearly been over for more than ten years and therefore Japan has reached the same level of problems and difficulties as the other advanced industrialized nations. The proof is that since the early 1990ies Japan finds itself not a simple conjectural crisis but in a structural one. In Japan like in Europe deep reforms are necessary. This change will not happen by itself, it has to be conceived, thought, imagined and negotiated on the basis of the knowledge we are able to acquire of our present situation, of what a technology is, of the potentials of the technology which has become the core of our social system[14].

3- What is information technology?

In the early 17th century, Descartes understood that analytic geometry was introducing new ways of organizing thought, a new form of intelligence. A different conception 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.

The situation of philosophy to-day is quite similar to the situation in which Descartes found himself. IT is offering a new method and its basic rules can be formulated. They have been born in computer science and they express how IT will progressively change the social system, even if the end result cannot be predicted. This indicates what is most important: how do we have to think, to reform our habits and our institutions in order to make sense of IT and transform our technical structure. Maybe the description of these rules will not teach anything new to anybody working in these fields, but their cognitive value and their consequences are vastly underestimated, even unseen.

There are five basic rules which, like in Descartes, are more three steps than rules, the first three ones being most important. These rules are based upon the distinction between the function (the meaning), the structure and the medium. The presupposition at the root of these rules concerns the form of what is given, what we are studying, of the problem we want to solve. In IT, what is given is analyzed as a behavior, a process or the function of a process, of an evolution. So the function always supposes a process and every process expresses a function. We are not studying objects or entities but processes, changes and evolutions which play a role, have a function in a system.

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. The concept of structure designates a level in the analysis of phenomena and not a specific type of formal theory. What is investigated are the properties of this level. The key point in IT is the relation between this structure and the process from which it was exhibited. So the first rule is to exhibit the structure of a process.

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, once 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 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 in IT. Functions have in fact become virtual modalities of structures within a technology. The consequences of this fact are innumerable and effectively bring Humanity 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 fulfill the function. The medium is the *carrier* of the structure, it can, for instance, transmit it, introduce it into an *artifact* (any object, machine, etc.), etc. It implements the structure in an artifact, in a given environment and for a certain task. Strictly speaking, the medium does not carry or embody the structure itself but it carries the structure being programmed to perform a function or a set of functions. The decisive point is that in IT the medium is neutral regarding the structure it expresses, as the structure is neutral regarding the function. Very different media can express the same structure in order to accomplish similar functions. The same medium can carry different structures and the same structure can be expressed by different media. This is the main mutation introduced by IT.

To follow Descartes' suit, the fourth step is to program the function in a medium in order to perform the function, to 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.

The example of the clock can clarify the relation between the structure and the medium. The structure of a clock, the way it is designed, the purpose of all its different parts and the way they are assembled is to count time, the flow of time per second, minute, hour and so on. The carrier is the mechanism of the clock, an association of springs, dented wheels clog wheels in order to perform this counting. For a very long time, from the late Middle-Age till recently, every expert in the field thought that these mechanisms had to be improved with the only goal of counting time with ever increasing reliability. The different uses determined the size of clocks and watches, the protection of the mechanism against shocks, humidity and changes of temperature, the quality of their look according to their customs. Some had to be a pieces of jewelry, others a tool or a piece of equipment.

So the technical development was actually concentrated on the carrier, on the production of the mechanism, of all the different sorts of wheels necessary to satisfy the required function. A very complex and highly developed technical sub-structure was needed to produce the best bronze then steel which would not rust and slow the mechanism, eventually stop it. To produce this bronze and steel, to manufacture all the different parts according to the different seizes and functions, to assemble the different clocks became a high technology industry which was the pride of many regions in Europe. In fact these clocks were working with a relative lack of precision, they remain fragile and sensitive to the environment mostly because of their complex structure.

The mutation came when one learned to dissociate the function (to give time) and the structure (to count time). This seems easy but it is in fact a major achievement. For centuries the structure and the medium were thought together because the carrier was the only way to put together the structure and make it work. By themselves, structures were reduced to mathematical objects (mostly geometrical) and to their mathematical expression. Nobody really knows who did it and how it was done but it is an historic breakthrough. Why? Because it became possible to look for a new medium, for carriers which had nothing to do neither with the structure, nor the function. They had to express the structure which was reduced to the simple fact of counting time. Anything which counts time with relative precision can therefore satisfy the function. Many carriers are able to do this: the circuit of the water in the clepsydre (water clock) in the ancient Greece, Rome and Arab world or a modern calculator.

So the decisive discovery was not technical, it was not a simple innovation, it is conceptual discovery. The discovery is that a clock is a calculator: to measure time is a calculus. The consequences are far ranging: a clock is a calculator, but a calculator is a computer. So any computer is also a clock and any clock which could be sophisticated enough as a calculator could be also a computer. As computer are also word processors, a clock could also be a word processor as well as a calculator. So why not design a wrist watch which is a computer. This computer designed as a watch could calculate, draw graphs and process words. Maybe this does not make sense because it does not satisfy any real function or need in our society but the virtual objects to be designed are all there. It is a question of design, of market, of needs and desires.

How to evaluate a change which occurred nearly without notice. Mechanical clocks are to-day only pieces of jewelry. The historical trend was geared toward an increasing specialization and finalization of the carriers according to the function to be satisfied. The numeric (or digital) revolution is therefore a reversal of a long historical trend: the medium has become neutral towards what it can express. It has become programmable. Even the matter is "designed" today: atoms are manipulated to produce specific materials. This is a profound change with such potential that it is impossible to predict today what the evolution of the technology and of our societies will be. So we have to be very careful to leave open all the potentials of such a change and not to restrain them because of our present social systems. This is why there is such a need of reforms, to open societies, not to foreign trade only but to new ideas, wherever they come from.

4- Knowledge and reality

Three connected points have to rapidly mentioned because they concern the interaction between reality and knowledge in an Information society from the point of view of its core technology.

The first one concerns what is reality, in fact 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 process is the actualization of a set of virtualities internal to the structure and constituting it. This actualization is made possible because the structure is programmable in a medium.

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 virtualities as part to its own identity. More than fifty years ago, Heidegger explained that in modern times things had become *objects* for *subjects* who were perceiving them and reducing them to what they appeared to them[15]. Now the objects are becoming artifacts: what the subject perceives is only one virtuality of an artifact whose structure includes other modalities that exist only through IT. The individuality of an artifact comprehends virtualities which can be actualized by a technology.

For instance the structure of a car, its organization, can be indefinitely modified by computer graphics because the whole car has been conceived through this technology: the actual car is just one virtuality of the structure which has been established. Structures have become manageable because IT develops a sub-structure as a product adapted for a certain demand or function, to fulfill a need or a simple desire in some social system. This is why flexible manufacturing is such an important field of study. The conception of engineering is fully transformed, from the conception to the production processes.

Virtual reality is not an other reality, a reality that surmises itself on the real one, like a dream or an illusion. It is *the* reality. Reality has become virtual, it contains potential versions of everything there is. This should not be dramatized as some kind of potential insanity or perversion of natural or common sense where one does not know what is real and what is not. It is more deeply an other experience of reality: we are not anymore surrounded by things which have a definite, substantial identity. The actual or existing reality contains its virtuals, other versions or types of actualization: the present one is not the only real one, it is only one example of the virtuals.

The second point is more important. It concerns knowledge, the distinction between objective and subjective, the way knowledge is said objective when it is supposed to seize a reality for what it is, even in itself, outside of the knowing subject or entity. The analysis of structures is the knowledge of functions or processes. In IT, knowledge is a virtual action inside the process on the functions it satisfies. The knowledge of the process is a virtual action on the function[16]. So the relation between science and technology are deeply transformed. The 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. 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.

The third point raises the question of the management of structures, of their manipulations. It can be elucidated by returning to the example of the clock. The manipulation of structures has any interest and meaning only if its results are interpreted according to the processes themselves, to the role they play in a social system, to what they bring to the practices individuals or groups develop with them. The virtualities make sense only when they find a goal and meet an objective in a social system. Without this they are just meaningless. It was always the case but it is all the more true with IT. Therefore the management of structures find at the same time its purpose and its limits in a given social system. The type of relation and the degree of interaction between IT and the social systems are very different and much more intense than preceding technologies.

This is what makes IT so different from previous core technologies which were not so *agile*, adaptable. They required huge and stable technical structures which dominated and still dominate our social systems. Imagine the social organization needed to produce cars and for their buyers to be able to use them. Let us consider the amount tax payers have to pay each year just to create and maintain the means to use the cars they buy. The automobile industry does not participate in the payment of the infrastructure their cars need in order to be sold. Societies build always more highways, bridges, tunnels and parking lots which in the end just increase the markets of the automobile industry. It is a fact that this industry creates an enormous amount of jobs. But this era has clearly reached its top. An other problem is that IT will not create the same amount of jobs.

Former basic technologies (specifically mechanical and energy technologies) were the core of technical structures which dominated whole social systems and strongly determined their development. IT is quite different: its potentials are as important but so diversified that its development and diffusion is very dependent on the social needs, uses and practices that each society can invent and express through it. IT is very dependent on its *market* but in a different sense of this word. The market is there not only to sell the products which are developed by companies but the market is equally necessary to conceive new products and adapt them to changing and diversified social needs. With IT the economic system will slowly but deeply change, from an industry where the offer dominate the demand to an industry in which the demand structures the offer. IT is much more society-oriented or society-dependent than the technical structure based on energy core technology. Many of our energy problems will indeed find their solution in IT.

5- Information Society in 1996?

It is finally necessary to examine some of the limits and consequences of IT. This can be introduced by further developing the difference between subject and object which played such an important role in modern thought. Heidegger explained how we had moved from the age of things to an age (modern) of objects. We are now moving from the age of objects to an age of artifacts. Artifacts are no longer objects in front of subjects, 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 artifacts. The subject is not any more outside of the objects he studies or uses, he is within the artifact, at the connection between the function and the structure. The artifact as it is used in everyday life by an individual is *designed*. Certainly the design of an artifact is what *appears* to a subject, but it is more and more conceived 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 artifact is selected according to the function[17].

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. Artifacts 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 artifacts. Individuals swim in an ocean of artifacts with which they interact, which they use as parts of what they are. What *they* are as subjects is the uses, dispositions and practices they develop, exchange, adapt and invent: artifacts are the virtualities of individuals and individuals develop virtual artifacts. 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 artifacts is an age when functions, uses, practices are what matters and not substance and identity.

The key concepts of IT are structure, medium, design, function. But the striking feature seems to be the primacy of function. Therefore the technology which is reducing the object to an artifact by the management of 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 and experiences. The relation between technology and society is herewith radically transformed.

This is not falling into a neo-modern utopia of people seizing upon technology in order to master their own destiny, of a Humanity free from the domination of technology which was forecast by post-modern thought as the final consequence of modernism. The present analysis shows that the future of IT lies not within IT but outside of it, in the social and cultural practices in which it develops. This is the core feature of IT: what is outside of it is 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 have to include virtualities. In the end virtualities exist only according to the capacity of individuals to make them happen by actualizing some of them, to give them sense in their daily lives. IT supposes a world of events, chance, experience, opportunities and, of course, accidents.

Urgently advanced industrial societies have to learn to think structures differently. 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 they reduced it to techno-scientific skills, to the different competencies required by the present industrial system based on information technology. Human capital cannot be reduced to problems of *formal* training and *explicit* education. The notion of *implicit knowledge* has to be extended to encompass social practices and institutions. The virtuality of IT is that structures do not govern any longer but are governed by the functions they have the potentials to fulfill. Function is therefore the beginning and the end of IT. So the development of IT in societies is closely determined by the capacity of the individuals to develop and experience new and different behaviors, attitudes, life styles, models of organization. These individual and collective innovations diversify social functions, desires, needs and demands. In fact we are moving from an Information society which never existed to a virtual Intelligence society which will emerged only if we are able to understand what it could mean[18]. In the end, these functions are the basis of what is produced and sold.

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* IT. 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. This seems to contradict the potentials of IT and conflict with its expected social and economical consequences. The development of IT is determined by the capacity of our societies to offer 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 opening for them to possibility of changing.

Ethical as well as political freedom have a direct effect on the capacity of societies to evolve according to the rise of IT. The paradox of IT is that it cannot submit society to its logic and requires more freedom to develop its virtualities. Then the future of IT is political, it is based on our capacity to reform our societies. IT will only fulfill its virtualities if we are capable of inventing a more democratic society, where people are even more differentiated, have the possibility of expressing their specific needs and of reaching their own goals or objectives. IT will only fully develop in the societies which will be able to create the basis and the rules of such an advancement of democracy. Democracy is the only way to deal with uncertainty. This is a challenge for everyone[19].

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[2] "Birth of Joho Shakai and Johoka concepts in Japan and their diffusion outside Japan". KEIO Communication Review N° 13, 1991: 3-12.
[3] (for the English translation). Tokyo, Social Policy Bureau, Economic Planning Agency of Japanese Government.
[4] DE SOLA POOL, I (1983). *Forecasting the telephone: a retrospective technology assessment*. Norwood, NJ, Ashley.
[5] For a Japanese version of the same idea, see YAMAMOTO Tetsuji (1994). "The epistemology of cultural technology". *Iichiko*, n° 6: 11-35.
[6] In this perspective it is necessary to distinguish "science" from what is called in Japan "scientific technology".
[7] See BIJKER W. & LAW J (eds.) (1992). *Shaping technology, building society*. Cambridge, MIT press.
[8] If and how we do it is a difficult question which according to the present argument is a false one.
[9] This refers to the notion of "milieu associé" (technical associated environment) developed by SIMONDON Gilbert (1969). *Du mode d'existence des objets techniques.* Paris, Aubier.
[10] GILLE Bertrand (1978). *Histoire des techniques*. Paris, Gallimard, Encyclopédie de la Pléiade. Introduction. He used the notion of "système technique" (technical system) which was in fact the structure associating different techniques.
[11] Europe was its center.
[12] This is the reason why core technology cannot be dissolved in social practices and institutions as sociologists of science are attempting to.
[13] That the notion of "Information society" was invented in Japan comes in fact as a proof of this.
[14] Some of these problems are developed in RIEU A.-M. (1990) *La techno-science en question*. Seyssel, Editions Champ Vallon.

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

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

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

[18] On the question of Intelligence versus Information society, see RIEU A-M (1995). "The epistemological and philosophical situation of Mind Techno-Science". *Stanford Humanities Review*, 4 (2). Special issue: *Constructions of the mind: Artificial Intelligence and the Humanities*: 267-284

[19] Author's note: This text was the basis of a lecture given at Keio University at Fujisawa on July 8th, 1996, at the invitation of Professor Ito Youichi who has been the impetus for me to write this text.