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# MODERN SCIENCE AND THE COEXISTENCE OF RATIONALITIES

History is familiar with great scientific traditions which have been substantial, effective, cumulative and progressive.* At the level of great eras of civilization, extensive and not episodic phenomena, very ancient Chinese science, Greek science and Arab science are objects of investigation for historical erudition, but also for the scientific historian and the philosopher of sciences. Many of the elements of these systems were the source of "modern science", as it is called, or are integral parts of this system of knowledge and practice which has been constructed over a little more than three centuries. Diachronically, the "scientific revolution" of the classical age in Europe does not signify a total break with what preceded it: Chinese astronomy, Arab algebra and the hospital organization of the Islamic world were used, even if the ideology of scientists

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when they wrote their own history, particularly from the 19th century onward, tends to make of modern science a purely European phenomenon.[1]

This failure to remember origins, analytically explicable if not justifiable, was accompanied by another history, that of the simultaneous expansionism of the great European and non-European powers—Japan, Russia—which drew their military and industrial strength from the use of data provided by modern science and technology and from the organization of scientific production for non-speculative ends. In short, the exporting of the European system of science was not accomplished simply by the strength of demonstrated truths. As Claude Lévi-Strauss says, "Adherence to the Occidental way of life, or to certain of its aspects, is far from being as spontaneous as Occidentals would like to think".[2] For this reason, the same person today can belong to his traditional culture *and* to the international scientific network, can leave his laboratory *and* return to an everyday environment marked with specific national cultural elements, even sometimes at the cost of painful distortions. For this reason, the same country can at the same time establish an Occidental hospital system, encourage high level biomedical research corresponding to criteria of international science *and* support traditional medicine with the assistance of the World Health Organization.

This modern science, whose nature is to be international and even worldwide, is first of all an *institution* in the two-fold sense of the term. It determines and manifests a new scientific object, theoretical or practical; it imposes and transmits for a time a body of teaching and techniques, which supposes a homogeneous scientific community; it is located in institutions and laboratories which are the seats of orthodoxy and innovation, as well as of financing and management; it is subject to the judgment of communities and institutions of an international if not neutral cast.[3]

[1] R. Rashed, "Science as a Western Phenomenon", *Fundamenta Scientiae*, vol. 1, No. 1, 1980, p. 7-21.

[2] C. Lévi-Strauss, *Race et Histoire*, Unesco, 1952, p. 31.

[3] See C. Salomon-Bayet, *L'Institution de la science et l'expérience du vivant, Méthode et expérience à l'Académie Royale des Sciences, 1666-1793*, Paris, Flammarion, 1978; and "Bacteriology and Nobel Prize Selections, 1901-1920", *Science, Technology and Society in the Time of Alfred Nobel*, London, Pergamon Press, 1982, p. 377-401.

## THE INSTITUTION OF SCIENCE

The institution of science refers to a culture which characteristically claims universality. We shall see a little later why this universality should be qualified and even called into question. It does not mean that the institution of science can be transferred anywhere at any time without fulfilling certain conditions. It is clear, in any case, that these conditions are not brought about by chance nor by the specific characteristics of a European, Arab or Chinese "nature".

The fundamental question always remains not so much why it was in Europe in the 16th and 17th centuries that the "scientific revolution" was born, but why this revolution, which led to the institution of science, found its home exclusively in Europe. From this point of view, Joseph Needham's comparison of the relations between science and society in China and in the West show well how necessary are explanations of a sociological nature in which are considered not only economic factors but also mentalities (language, religion, philosophy, theology, attitudes toward time and change, etc.).

But although these sociological explanations show that society has an influence on science, they cannot reduce this influence to strictly economic factors (a Marxist-type infrastructure) nor to a set of socio-cultural factors (the superstructure). It may seem easier to explain the birth of the development of industrial capitalism than the birth and development of modern science in Europe. For the former it is possible to do without an "internalist" history; with the second phenomenon, however, although the interactions of economic and political factors, scientific institutions, mentalities and practices are one of the keys to the process, this key (which is necessary) is not sufficient to explain the logic of discoveries nor the solidity of concepts.

This is one of the debts which the scientific historian owes to Alexandre Koyré who believed it "impossible to separate into sealed compartments the history of philosophical thought from that of the religious thinking in which the former is always immersed, either for its inspiration or as its point of opposition... likewise impossible to neglect study of the structure of scientific thinking". He thought it "essential to return the works studied to their

intellectual and spiritual context and to interpret them in terms of the mental habits, preferences and aversions of their authors". In sum, science is not neutral, whatever it might claim to be. "Any scientific method implies a metaphysical basis or at least some axioms on the nature of reality".[4]

As much as one might criticize Max Weber, it is not possible to explain the origins of industrial capitalism along with its "ideology" without reference to the "spirit of capitalism" associated with Protestantism—the saving of time. But the history of the City-States and particularly that of Florence, along with the rise of the bourgeoisie, does not explain Galileo any more than the social-economic context of the early 18th century can explain Newton. The analysis of the institution of science cannot be reduced to a sociological approach.

Within science, whose servants form, as we know, an international community, referring to the same paradigms, working within teaching and research institutions of the same type, the language and concepts are shared because their professional training and practice are shared. When specific national characteristics are cited—differences in institutional structures, methods of financing or simply ways of using the science which is being created—this is done to bring out effectiveness, performance, a particular rapidity in innovation *within* the scientific network. This is not meant to raise questions with regard to the nature and object of "science" or its place within cultures which cannot (except in a Utopian fashion) be defined exclusively by it. At the most it is to deplore the fact that certain societies, for reasons which, as Montesquieu would have said, are based "in the climate, in customs and in laws", are less apt than others to be party to cumulative and progressive scientific activity.

These standard (not to say trivial) themes require a few remarks. In the first place, the sharing of a language, here scientific language, whatever might be the structures which make its use possible and pertinent, does not define a *culture*, but a shared area of circulation and time of reference from which are excluded non-scientific facts and symbols (even if there is some borrowing). No doubt an

[4] A. Koyré, *Études d'histoire de la pensée scientifique*, Paris, P. U. F., 1966, p. 3-4 and 55.

individual can live for science and by science. But, just as no man is great in the eyes of his personal valet, there is no individual so purely scientific that his attachment to a given culture—bodily gestures, beliefs, affectivity, not to mention specific characteristics of national heritage—can be simply eliminated.

Another limitation can be added to this: science defines more spontaneously what it is not than what it is. It is similar to what rationality and language were for Greeks of the classical age. The latter sketched the portrait of a "barbarian"; the former defines the non-scientist, i.e. the person who cannot understand or be understood within the system and who is no doubt not even worthy to be understood. It is necessary to question this division of the world, and the first thing to ask is: *is it possible to conceive of a culture in which science is both a component and the whole?*

In the second place, the "science" of which we are speaking is implicitly that of developed countries—and the reference model for developing countries. It is made up of a set of phenomena which are known, dated and circumscribed. It draws its legitimacy from its effectiveness, to the point that the canonical expression of international institutions, "science and development", plays on ambivalence. It is possible to think of economic development for its own sake with all the repercussions which can "naturally" be derived (satisfying national needs as well as contributing to the progress of international science).

Science here is not what Aristotle defined as the fruit of the "desire to know", desire being the power of the desiring individual, the object of this desire being prudence as well as the cause and reason of things—or wisdom. Western science, with its eponymous heroes—Galileo, Descartes, Newton—cannot be dissociated from technique which is in turn struck with the seal of the same scientific rationality: mathematical science, which goes from the thread of algebra and geometry to measurement by experimentation and proof, phenomena which until now were recognized at best in a speculative manner. Upon completion of the application of measurement, which combines instrumental science and technique in the same project, the European economic-industrial enterprise achieved the triumph of technology.

## Science and Technique

This "desire to know"—for Greeks of the classical age as well as for Neolithic shepherds—by definition cannot be hostile or foreign to the "desire for power". But it does not identify itself therein any more than it identifies knowledge with power. Bacon's expression, "knowledge is Power", summarized and announced the nature of the scientific revolution in the European classical age and the scientific-industrial structures of the contemporary world which derived therefrom. The formula did not overlook desire. Pan's chase, metaphor for data and experiments as is every quest, is not absent from pleasure nor chance nor games. But the identification of knowledge with power leaves aside the possibility of a disparity. Appreciation of this disparity, (which allowed the experienced eye of Plato, for example, to distinguish the political sophist, the person who sought out wealthy young men to sell them the instruments of power, from the one who sought the proper ratio between the various elements of a human community), is the only means of distinguishing what, in the composite activity which is scientific research, is the true, the false, the useful, the efficient, the misleading. This disparity is the touchstone which allows distinguishing the multiple and different *finalities* of scientific activity, which is neither as "pure" as has been claimed nor as "impure" as some would have us believe. Likewise it is within the limits of this disparity between knowledge and power—however restricted these limits might be—that are set the problems of the relations between science and technique, between fundamental sciences and applications of science, between theoretical science and technical knowledge of engineers, builders, craftsmen.

Depending on the cultures, these problems are dealt with in tales, myths or historical-philosophical or psychosociological analyses: the tale of the one who tames fire, the myth of Prometheus, the distinction between *theoria* and *praxis*, between *episteme* and *techne*, along with the distribution of tasks between classes or castes. For the question of definition (what is technique, what is science?) there is substituted a question of origin: is there a common origin or not? A derivation of one from the other? The nature of the tale and of the myth is to speak of origins: cosmogony, the birth of fire and of metallurgy, the origin of rice paddies, the

harnessing of the horse, tales which are told and listened to, whether believed or not, which deal either with the birth of common techniques or with the reason for the order of the world—the heavens or the regular succession of days and seasons or the order of the empire.

A historical and philosophical analysis proceeds from a critique of the notion of origin. The "initial fact" is not the origin, but an identified trace of the phenomenon, a trace which every historian knows is temporarily initial, dependent on the "invention" of a new fact. There is no zero time in history. When philosophy borrows from history facts which mark beginnings—e. g., the beginnings of mechanization or of capitalism—it asks what made them possible, and its initial statement is in fact an analysis of the *conditions* for the appearance of the phenomena noted. The unique origin of the myth is replaced by an analysis of the multiple conditions, whether material or not, which define the *spirit* of the phenomenon in question, dated, noted, become an object of rigorous investigation.

I would ask that this disparity between power and knowledge be maintained, no matter how small it might be, for reasons of method at least. The question raised initially was that of the cultural, social, and philosophical roots of scientific traditions. I am returning to that question: what traditions and what sciences? Should this mean science *and* technique—knowledge and power—or should we recognize that in Europe before, as in certain developing countries today, science has not always controlled or led the development of tecnique?

Techniques are part of what Fernand Braudel calls material civilization. They can be completely integrated within the religious and social network of a given civilization with the distribution of technical roles identified with the distribution of social or religious roles. In a symmetric reversal, they can define a social group—globally a class—by the fact that it belongs to the same production process. This was the function of the guilds in the medieval West, the role of craftsmen in Islamic tradition, engraved in urban topography, the definition of the proletariat in the age of industrial mechanization. But prior to the second half of the 19th century, when relations between science and technique began to be closer and more ongoing, it is not possible to say that science and

technology worked together or were mutually helpful. In fact for quite a long time technical progress did not depend on the progress of scientific knowledge whereas science owed much to technique. For if techniques suggested to scholars subjects for their research and provided them with scientific instruments as new means for conducting their work, the development of tools, techniques and even of machines was for a long time the responsibility of craftsmen rather than scholars. There was no need for science to create telescopes, but science needed telescopes to demonstrate that the shift from the Ptolemaic system to the Copernican one to that of Kepler was correct.

There is no relation between the scientific activity of Antiquity, of the Middle Ages or even that of the Renaissance, and the technical advances of which each of these periods was able to boast. This is so true that, from a point of view of balance between the poles of technical progress, it is necessary to await the acceleration evident from the 18th century on, and especially in the 19th century, in order to speak of a break. In the Far East and in the West, techniques had attained comparable levels, and exchanges were actually taking place in both directions. This balance was to be upset with China stagnating and closing itself off from foreign penetration under the Manchu dynasty, while Europe (especially the North, open to the ocean) was to concentrate its power of technical innovation. Nothing less than the scientific and industrial revolutions were needed in order to transform the rhythm and direction of technical innovation into a movement of "cross fertilization", steady and deliberate. But this joining did not completely appear until the 19th century.

"Everything is technique", said Braudel admirably. "All those gestures which are the result of accumulated knowledge".[5] Everything is technique, certainly, but every tecnique is not *technology*.[6] For a century a new phenomenon has characterized the industrial world. Techniques prepare for a state of science at the same time as they are directly dependent in their progress on those who have

[5] F. Braudel, *Civilisation matérielle, économie et capitalisme*, Vol. 1, Paris, Armand Colin, 1979, p. 291.

[6] J.-J. Salomon, "What Is Technology? The Issue of its Origins and Definitions", *History and Technology*, 1983, vol. I, No. 2, p. 113-153.

scientific knowledge. Steam engines existed and functioned for more than eighty years before the scienctific foundations for their operations were identified, understood and thus "applied". But it was precisely with the formulation of the laws of thermodynamics that the industrial system was more and more closely associated with the scientific system.

In the history of modern science over the past three centuries, this reciprocity between science and technique is a recent arrival, to the point that it is astonishing to note their disjunction in the past. For example, in the Fifth century B. C., there is an astonishing contrast between the development of Greek mathematics and the stagnation of the technical civilization which was contemporary with it. "Why", asked A. Koyré, "did the inventors of *episteme* not apply it to *praxis*? Why, in other words, did Greek science not develop a technique the idea for which it had in fact formulated?"[7] This question reflects an illusion in retrospect: what has been the intent and rule since the 17th century, what became reality in the 19th century—the close connection between science and technique—was not a problem for the state of civilization, which thought of technique as an "efficient traditional act"[8] and science as a theoretical focusing on essences. Today the same question could be turned around: why do the users of modern techniques not apply them to science? In other words, why has Western technology not developed a science everywhere it has been implanted, where it has spread and been sold, a science which is supposed by this technology.

Here, too, the question involves an illusion: "The illusion of a universal democracy of science, due to the narrow international networks through which researchers, trained in the same institutions, speaking the same language and publishing in the same journals, discuss the same problems defined around the center in the hope of receiving the same rewards and of having access to the same resources."[9] Thus the expression "science and technique" is only ideally redundant. In actual fact the expression combines two

[7] A. Koyré, "Les philosophes et la machine", *Études d'histoire de la pensée philosophique*, Paris, Armand Colin, 1961, p. 308.

[8] M. Mauss, *Sociologie et anthropologie*, Paris, P. U. F., 1973.

[9] B. Latour, "Le Centre et la périphérie: à propos du transfert des technologies", *Prospective et Santé*, No. 24, winter 1982.

unconnected orders: the technical order, traditional or advanced, metamorphosed into technology or not, defines the material civilization of everyday living (the use of very ancient plowing techniques can coexist with transistors just as calculating with an abacus coexists alongside electronic calculators). But the scientific order defines its own reference system, practically autonomous, which has meaning and use only for those who have access to it through appropriate training. Our contemporary world allows juxtapositions, brutal or progressive, substitutions, imposed or desired, techniques based on traditional knowledge and techniques combined with international scientific (and industrial) networks. In countries which have long been industrialized and are scientifically advanced already, the technical modernity of everyday life—literacy, vaccinations, electricity, transportation, telephone and television, synthetic materials, etc.—is not understood as part of a scientific system except by a limited number of users, although this modernity is available to almost everyone.

To use the words of Gaston Bachelard, we are living applied rationalism and rational materialism without in any way being rationalists, an attitude of *consumers* of techniques and sciences combined which speaks of a limit to assimilation of accumulated knowledge. If knowledge means knowing how to repeat something, each of us must admit that we know only very little, to say nothing at all about what makes up our technical universe. For individuals a two-fold limit has taken the place of the limit imposed by the traditional secrets of production, by craftsmanship or specialized trades: the *complexity of economic and scientific systems* supposed by a single simple object, for example an electric-light bulb or a bottle of bacteriologically pure milk; the *extension of disciplines*, their multiplicity and their specialization, such as the theme of two cultures so dear to C. P. Snow, a theme which has been opened up and multiplied by the very diversity of the areas, disciplines and sub-disciplines to which today's exact and natural sicences bear witness.

The driver of a car who knows nothing at all about combustion engines and who periodically trusts his garage mechanic and the Polynesians who worship the Cargo plane god for the regularity of his landings have at least this much in common: they retain the structural unity of daily life which juxtaposes elements from

different technical systems and deriving from different rationalities. Both the driver and the Polynesian place their trust in something: in the mechanical functioning of the car, in the legal bond of the maintenance agreement together with the bond of personal confidence, and in the proximity of the sacred, all rationalities which refer to relationships with technology which are not simply an understanding of what composed that technology. *Here, however, man can do more than he knows.*

As Lévi-Strauss wrote a long time ago, "Man does not realize his nature in an abstract humanity but in traditional cultures".[10] Cultures are defined by values, social practices and by their belonging to a given technical system.[11] Science and technique theoretically have different ends. Depending on the culture, science can signify, and historically has signified, both knowledge of mathematical essences and demonstration (the Greeks in the classical age) as well as knowledge of the principles of government for setting up absolute order (Chinese law-makers of the Fourth century B.C.), whereas technique meant practice aimed at production rather than at knowledge. Today, as we said, these are two aspects of the same activity which no longer distinguishes production from the theoretical knowledge which nourished it, whence the formula science and development, making it all the more difficult to comprehend the diversity of cultures, their individual genius and their capacity to integrate and to reorient or even to refuse this determinant axis which presents itself as universal.

## The Universal and the Universalizable

Universal has two meanings: a logical meaning and another, geographical, meaning. A proposition or a phenomenon without exceptions is said to be universal. Universality is the criterion which, in the context of an ideal analysis, permits distinguishing natural ele-

[10] C. Lévi-Strauss, *op. cit.*, p. 13.

[11] We are using Bertrand Gille's concept of technical system, *Histoire des techniques*, Paris, Pléiade, Gallimard, 1978, p. 19-20. "All techniques are, to varying degrees, dependent on one another, and a certain consistency is required between them. This ensemble of consistency at different levels of all structures and all combinations and all components makes up what can be called a technical system".

ments from cultural elements which in turn are derived from the criterion of the norm, from the relative and the particular. Propositions and phenomena can be said to be universal if they can be extended to the entire universe. The geographical sense is *de jure* included in the logical sense. *De facto* this is not the case. Despite the "universal" constancy of a certain number of facts, propositions and techniques issuing from the scientific revolution of the last three centuries, invention in the sciences and in techniques remains limited to a certain number of developed countries which use the English language (whatever might be the local vernacular) and working in a cumulative and collective fashion. "It would be of no use", wrote Lévi-Strauss almost thirty years ago, "to want to defend the originality of human cultures from one another... [It is] extremely difficult for an enthnologist to evaluate properly a phenomenon such as the universalization of Western civilization."[12] There, where the ethnologist can only appreciate with hesitation the shock of civilizations, the stakes and the risks of confrontation between heterogeneous cultural systems, are not the philosopher and the scientific historian in a better position to judge in what way these systems can communicate among themselves, can interpenetrate and adopt rationalities which are foreign to them?

The question, "Are there cultures which are more or less receptive to Western (European) science?", nevertheless elicits a positive response. If the sources of this science are traced back to the mathematization of nature and to experimental proof, it is clear that any culture professing an order of natural phenomena in which mathematical rationality is not essential is hardly made to adopt the Western approach. This response does not signify that Western rationality challenges this culture as such; it simply defines it as *other*, and the difference of its practices does not at all mean that *they are not operational.* But this otherness does not claim to have a power of universal application there where Western rationality is only so when postulating an order—the constancy of the laws of the universe—of which mathematization and experimental proof take advantage to act universally on natural phenomena.

From Lucretius speaking of the laws of nature as contracts

[12] C. Lévi Strauss, *op. cit.*, p. 30.

(*foedera*) to Einstein proclaiming, "God is subtle, but he does not have a malicious nature", the postulate of this rationality is that the universe functions according to commands which are like decrees. In fact these would seem to be the decrees of a supra-rational legislator, decrees which the founders of modern science—Descartes, Kepler, Newton—thought to be "revealed" to the human spirit. This is what led Joseph Needham to demonstrate quite concretely the essential difference between the conception of the order of the world in traditional China and that in Europe of the Renaissance. In the latter, the laws of nature are valid for the earth and the heavens according to "orders" given by a rational legislator; in the former, there is not a superior authority instituting a system of causal relations, but an organic cooperation defining a cosmic reality: the law has no clear representation outside of human affairs so that the intelligibility of the world is never guaranteed.

Needham cited the example of medieval Europe, struggling against sorcery, where trials were held in which charges were brought against roosters who had laid eggs! These roosters were condemned to be burned alive because they had betrayed the divine order. Needham used every opportunity to show that Taoist China would never have dreamed of conducting similar trials. Such phenomena were considered to be "rebukes of heaven", "celestial misfortunes", and not a perversion of the order of the world guaranteed by God. Western science was developed and imposed itself by doing without the guarantee of a supreme legislator; nevertheless statistical regularities and their mathematical expressions are still guaranteed by the hypothesis of an "honored contract", of an order removed from the whims and arbitrary moods of either a magical or malicious intervention. It is by definition impossible to hold the rational functioning of natural phenomena in default. And hence the remark by Needham which marvelously locates the boundary between the cultures ready to adopt a Western rationality and those which are closed to it: "Perhaps the kind of spirit which could make of an egg-laying rooster a being to be persecuted by the law was necessary in a culture so that this same culture would later be capable of producing a Kepler?"[13]

[13] J. Needham, "La Loi humaine et les lois de la nature", *La Science chinoise et l'Occident*, Paris, Seuil, Point Sciences, 1969, p. 243.

The conception of the order of the world—Husserl's *Weltanschauung*—is global, determining a certain number of attitudes at the same time as being determined by them. Visions of the world and attitudes can attest to singular evolutions in cultures which are neverthless close, at a given moment, in terms of knowledge and technique. Until the 17th-18th centuries, once again, there was the same capital of knowledge between China and the West. The compass, gunpowder and printing were all "transfers of technology" from China to the West. The end of the 17th century marked a reciprocity of exchanges between the two civilizations in the common area of mathematics. "The Europeans at my Court have presided over mathematics for a long time already. During the civil wars they rendered an essential service to me with the cannon which they had cast", said the Edict of Tolerance of K'ang-hi in 1692.[14] And the "Chinese model" defined a good part of European literature during the entire 18th century.[15] We will overlook the following era which was one of quarrels and intolerance.

But it was from the 17th century on that the break was introduced. Economic and social structures in Europe prepared the way for the scientific and technical revolution, while in China the "celestial bureaucracy" refused the spirit of enterprise and change. Along with economic and social structures there came (some would say that they are dependent on them) moral attitudes, the definition of responsibility, the responsibility to be or to do. It is necessary to return to the question asked by Max Weber: what is it in the system of values and social practices of the Western world which favored the development of capitalism understood as the accumulation of wealth associated with a given form of scientific-technical rationality? The answer, as we know, has been examined, criticized, discussed and qualified, but it has never been denied: it was an *ethic*, a collection of moral values defining daily behavior and belief, the ethic of Protestantism born of the Reformation in the 16th century. From that point a *new measurement* has accompanied the plurality of cultures, creating hierarchies, adding value to

[14] Etiemble, *Les Jésuites en Chine—La querelle des rites, 1552-1773*, Julliard, Collection Archives, 1966, p. 41. And *Lettres édifiantes et curieuses de Chine par des missionnaires jésuites, 1702-1775*, Garnier-Flammarion, 1979.

[15] See D'Alembert and Diderot, *Encyclopédie*, under *Innoculation, Pékin, Porcelaine*.

that which makes a given culture capable of assimilating, along with Western rationality, a part of, if not all, the social, economic and bureaucratic structures needed to make it efficient.

This measurement is in fact an oblique one. Although it is possible to transport an object from one place to another—a simple material transfer—transfers of technology suppose more than just movement. They suppose the development of a structure for education and production capable of controlling the very production of knowledge and of know-how.[16] Does this structure have to be *identical* to the one which produced modern science in European countries? Not necessarily, as S. Nagayama has shown quite well with reference to Japan. The "Meiji revolution-restoration" adopted the European scientific and technical model as a successful "transplant" from a political desire. The control of scientific rationality was not presented as a betrayal of the specifically Japanese character, but as a form of its fulfillment. But, as Nagayama continues, although Japan did not suffer from the dichotomy between science and technique which characterized the Western approach up until industrial capitalism, this "transplant" took from the West a vision of scientific institution totally defined by its ability to lead to technologies rather than by its specifically scientific power of creation.[17] It is not impossible, moreover, that the *truth* of Western rationality, thus reduced to its instrumentality, be found in the adoption of this model rather than in the original model which continues to profess a difference between theory and practice, between pure knowledge and its applications.

If we leave behind the discussion which implicitly favors the form of rationality represented by modern science—with its three characteristics, which are also ideologies: autonomy, universality, universalization—no matter what the differences between societies, civilizations or technical knowledge, there is no criterion for determining what is preferable or better. The same is true for cultures as for Hegelian consciences: each one is no doubt pursuing the death of the other, but the stratagem of history is such that syncretism is often the source of the greatest successes.

[16] B. Latour, article cited.

[17] S. Nagayama, "The Transplantation of Modern Science to Japan", Unesco, comparative philosophical studies on the development of relations between science and society, Kingston Conference, 1983.

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To conclude, let us recognize that the universality and the universalization of science are *postulates* of scientific thinking as it was formed in the classical age and developed, particularly in the 19th century, in Europe. This postulate was adopted by non-universalist cultures for reasons which have less to do with the definition of scientific research than with the power of economic-military-industrial complexes which scientific and technical development has made possible. When scientific and technical thinking is questioned along pluralist lines, science appears as a form of rationality—the desire to know—combined with a manner of intervention in nature and in man. It is not possible to dissociate Descartes from Vico. The desire for knowledge is truly universal no matter what form the knowledge may take. But the universality of scientific knowledge in the Western sense affects only the networks formed and developed by the adoption of the model of scientific institution, from structures of instruction to structures of research, which was born in Europe.

What should be understood by pluralist axes? Ethnologists and anthropologists have instructed us in the diversity of cultures. Despite the prestige and the weight of the rationality which inspires Western culture, this diversity should be preserved by seeking to avoid the double pitfall consisting either in thinking of the difference in cultures in terms of conservation of rigidly fixed forms, or in eliminating them in the name of a sole and unique form of rationality. It is necessary to assume the risk, difficult and perhaps even impossible, to preserve and even promote the coexistence of forms of rationality to which the different cultures have given birth.

One of these axes derives from the history marking the changes in, confrontation between and borrowings of one culture from another. Think of the transformation of mentalities, of the veritable "intellectual transformation" which Europe experienced from the 17th to the 19th century, from the Counter-Reformation to scientism; or of the profound transformation in Japan from the Meiji Restoration to the "miracle" of this second half of the 20th century. The triumphant paths of rationality have never been linear or laid out in advance. Moreover, through synchrony, each of us is confronted, concretely or abstractly, with the "clash of

civilizations" and participates in several forms of rationality in our everyday activities. The sad thing would be to live from only a single one, even if from that one which we generally consider to be the most effective and generalizable, mathematical rationality.

Here we return to an old philosophical problem which is that of the one and the many. Let us leave aside the fundamental question of what is the one, for this would lead us astray. To raise up a sector of knowledge or a form of rationality as universal knowledge is intolerance, the intelectual form of which is both the worst and the least denounced. But not to constrain oneself to a discipline of reason is to impoverish discussion which says nothing or which serves other hidden ends. Modern science, at some moment in its history, between 1905 (the theory of relativity) and 1927 (the probabilist theory of the electron and Heisenberg's principle of indetermination), experienced a fundamental crisis and abandoned in part for a time the pride and intolerance which most often characterized the scientism of the late 19th century and which accompanied imperialism. This crisis prepared the way for minds to think more freely of the *pluralism of the systems of rationality*, since it was necessary to turn simultaneously to two reference systems in order to think of a single phenomenon and it was impossible to predict this latter other than in a probabilist manner.

A few signs of coexistence appeared within the institution of science, for example, the teaching of acupuncture, from Chinese tradition, in Western medical schools; or the work of the scientific historian Jean Gimpel who used models of Western technology dating from the Middle Ages or from the Renaissance to improve the efficiency of simple machines in use in developing countries, thereby spreading and instructing the use of techniques acceptable to traditional societies. But these examples are closer to what might be called "soft technologies" than the giant scientific complexes which are the mainstay of advanced physics and biology. The coexistence of different systems of rationality refers to institutions and practices from different levels.

At the same time, within industrialized countries, there was a newly perceived awareness of the "social costs" brought on by a too rapid rhythm of industrialization in developing countries over two decades and the inadequacy of transfers of technology made

without prior creation of an educational network prepared to be able to take full advantage of it. The power of diffusion of modern technical systems is thus limited by resistance to change within the social fabric, a protesting not so much of the rationality as of its evil or negative effects, when the rhythm and direction of technical change are no longer perceived as meeting the deep needs of a society. It is not wrong to think that such an awareness resulted, on the one hand, from the intellectual transformation caused by quantum physics and the theory of relativity and, on the other, from the moral and political crisis initiated by atomic physicists after World War II when they discovered, in Oppenheimer's famous phrase, sin and the end of innocence. The success today of molecular biology risks prolonging this crisis of the foundations of scientific rationality since it is within the scientific community itself that researchers are raising questions about the potential threats of bio-enineering. The coexistence of rationalities imposes reflection not only on the limits to knowledge which does not meet the criteria of scientific rationality, but also on the limits encountered by the very applicaton of this rationality. Even modern science, which based its pretensions to universality on the association of knowledge and power, is discovering that it is necessary to pay heed to the fact that there is gap between power and knowledge.

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