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SCIENCE AND ART: THE NEW GOLEM

FROM THE TRANSDISCIPLINARY TO AN ULTRA-DISCIPLINARY EPISTEMOLOGY

It is to an over-all situation based upon the complex play of political, social, economic and scientific factors, along with technological and mass media factors unique to our own era, that we owe the general trend toward multi-pluri-inter-trans-disciplinary questions so generally prevalent in our world today.

The crucial point is not to discuss differences in meaning that may occur on the occasion of these linguistic grafts but to bring to light a phenomenon affecting all aspects of our behavior, most particularly over the most recent decades. Schematically this means that for a certain fact, specified by a substantive guaranteeing its coherence and duration, prefixes (and sometimes suffixes or compound words as well) attest to terminological changes in progress. This phenomenon, which today can be found at work in all languages, for the most part reflects "work" done in and by language in order to adjust our means of thinking and com-

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municating to the technical changes that are ever more numerous and accelerated in our contemporary society. Thus we are dealing with a phenomenon that goes beyond the linguistic level and even the epistemological level to become an element of civilization. We are not dealing merely with new terminology, any more than with a new means of appropriating knowledge. Indeed, this represents a new world standing at the threshold of the new millennium; its outline, at the ontological level, is taking shape before our eyes.

NON-CLASSICAL FORMS OF LOGIC

What "responses" are suggested by these delineations? The word "response", we should note in passing, does not mean a statement made in answer to a question; it designates in a broader sense an activity through which an organism adjusts its equilibrium following a stimulus or perturbation. (We have here the Freudian problematic combined with a touch of cybernetics.)

Every discipline, every body of knowledge, every discrete mass of learning constitutes a system, that is an ensemble of elements whose interactions produce cohesion and stability to distinguish it from all others. Every system is thus based on an inner logic that guarantees its identity as well as its structure and functioning. In the broadest sense, we can speak of "logic" as soon as there is evidence of a certain succession in ideas or behavior patterns, a certain regularity in the sequence of phenomena. Thus there is the logic of the marketplace, of business, of political systems and parties; there is also the logic of Egyptian art, of Chinese art, of fashion, of culinary customs, of climates. Many of these aspects have long been studied by anthropologists and ethnologists who have shown us that, no matter how surprising such "logic" may be, each one shares the common desire to maintain a certain order. Having said this, the margin is wide between the logic of the heart ("The heart has its reasons that reason does not know": Pascal) and of advertising ("France Télécom: the future in advance"), both at odds with "good sense", and logic in the strict sense of an organization of thought applied to reasoning, the forms and applications of which, even though they might

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vary depending on places, cultures and eras, all attest to the same desire for rigor.[1] Numerous other forms of logic developed alongside classical logic based on the Aristotelian model, which introduced the revolutionary principle of variables, wherein a concrete proposition is replaced by a purely formal schema ("Socrates is mortal" is replaced by "A is B"), and which underlies all syllogistic reasoning with three principles: 1. the principle of identity ("A is A"); 2. the principle of non-contradiction ("A is not non-A"; 3. the principle of the excluded middle ("X cannot be both A and non-A").[2] Here it is possible to provide but a very limited glimpse at these other forms. Among "non-classical" forms of logic, let us point out multivalent forms of logic, with more than two values, such as the "fuzzy logic" of L. A. Zadeh, which attempts to establish a gradual transition between the true, the undetermined and the false; deontic logic, which attempts to formalize statements including expressions such as "it is permitted", "it is obligatory", "it is forbidden", "it is optional"; epistemic logic, which attempts to formalize statements by considering both the concept of "believing" and that of "knowing"; modal logic, which envisages the necessary, the possible, the impossible, the contingent as different modalities of the true; or also non-monotonous logic, which attempts to draw a conclusion from data that do not deductively imply one; temporal logic, which formalizes statements referring to dated events, past or future, and which even succeeds, in its chronological version, in taking into account the true at the moment in which it is stated. This survey[3] shows in any case that, unlike classical logic (a-temporal, a-spatial, in short, absolute), non-classical systems of logic are similar to the complexity of modes of thinking and expression that abound in our standard behavior and that reflect natural language, often with the aid of adverbs, adjectives, expressions, similar in short to all that could be called the existential side of our experience.

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[1] Robert Blanché, *La Logique et son histoire*, Paris, Armand Colin, 1970.
[2] Cf. Jean-Blaise Grize in *Intellectica*, Review of the Association for Cognitive Research, vol. 1, No. 4, 1987; and Claire Rémy, *L'Intelligence et son miroir, Voyage autour de l'intelligence artificielle*, Lausanne, Éd. Iderive, 1990.
[3] Jean Dubucs gives a synthesis of this in the latest edition of the *Encyclopaedia Universalis*, 1989, article "Logiques non classiques", pp. 977-992.

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The problematic raised by Western logic offers often disturbing analogies with extra-European logical systems, in particular those from India, that have been studied in great depth over the last half century. Classical Nyaya, for example, establishes the form of a syllogism in five parts: 1. proposition to be demonstrated: "this mountain contains fire"; 2. reason: "because there is smoke"; 3. proposition by example: "whatever smokes is on fire, as in the kitchen"; 4. application: "as is the case here"; 5. conclusion: "therefore this mountain contains fire". We could also note, without examining it further, the logic developed by Jainism based on the complementarity between immediate knowledge, provided by our senses, and mediate knowledge drawn from tradition.

This has been amply illustrated by ethnologists, linguists and anthropologists. Benjamin Lee Whorf, for example, in his classic essay on the Hopi Indians, shows that every language is both modeling and interactivity, depending on its original "assemblies". Unlike a "temporal" language such as English or French, the language spoken by the Hopi is a-temporal; their verbs "do not indicate a difference between the past, present and future of an event, but must always express the type of validity the speaker intends to express".[4]

The quintessence of the phenomenon perhaps is found in the profound remark of a native as reported by Lévi-Strauss. "Every sacred thing must be in its place"; and the anthropologist adds, no less profoundly, "It could even be said that that is what makes it sacred, since if this thing were eliminated, even in thought, the entire order of the universe would be destroyed; thus it contributes to maintaining this universal order by occupying the place intended for it".[5] In this way logic, all logic, is linked to the principle of order that, at its ultimate level, attains the dimension of the sacred. This being said, we can summarize what has come before in the following points:

1. All thought, or series of thoughts, implies "logic", a man-

[4] Benjamin Lee Whorf, *Language, Thought, Reality*, Cambridge, Mass., MIT Press, 1956; see explanatory table on p. 132.
[5] Claude Lévi-Strauss, *La Pensée sauvage*, Paris, Plon, 1962, p. 17.

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ner of organizing and validating a principle of coherence ensuring the cohesion of elements in interaction.

2. In Western culture a preferential tendency was manifested quite early for encouraging the primacy of reason, a rational division leading to conceptual division and "disciplinary" division.

3. Upon reflection, that is when one asks oneself about suppositions and the established frame of reference, one is aware that the rational and the "disciplinary" are measures produced historically in given conditions of civilization and relative to these conditions.

4. From that point multi- or pluri-disciplinary systems, even if they appear subsequently, belong to the power that is attempting to remedy reductionist reason.

5. As for the "transdisciplinary", it is manifested not only as a sort of "progress" that would follow the multi-pluri-inter-disciplinary, but as the passage that leads to fragmentation, to the division of the real, to regaining integrality.[6]

At the level of myth, which can be incarnated in the sacred (and there is nothing, mathematics included, that is not part of it), the transdisciplinary seems to be the operation by which the dismembered body of a god is reconstituted and reanimated. Osiris, the first god to rule over men while bringing them civilization, was killed by his brother Set, and the parts of his dismembered body strewn over all of Egypt; Isis, his sister and spouse, found them and, with the help of Anubis, Tot and Nephtis, managed to reconstitute the body, which was then resuscitated by appropriate rituals to become the god of the dead and of eternal life. The Crucifixion tends to move in the same direction. For it is thanks to transubstantiation that passage from the Father to the Holy Spirit takes place in the body of Christ. I would not go so far as to suggest that breaking reality up into disciplines is a form of dismembering or crucifixion; but with no black humor intended, it can be asked if, unbeknownst even to their organizers and participants, the permanent round of conventions, seminars and round table discussions are not "Isis-like" operations meant to "re-member" (reassemble) the Logos, the Spirit,

[6] This is the problematic presented, for the realm of art, by the exhibition "Le corps en morceaux", shown in 1990 at the Musée d'Orsay in Paris.

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the Word or to invent Cognition anew, all under the standard of the interdisciplinary.

A MODEL OF TRANSDISCIPLINARITY

Leaving the realm of myth, it could even be asked if Norbert Wiener, a child prodigy it should be recalled, is not one of the recent improved incarnations of Isis.[7] Mathematician and philosopher, father of cybernetics, his work is more than an interdisciplinary success; it is a model of transdisciplinarity. In the course of regular meetings bringing together scientists with differing types of training and activities—mathematicians, biologists, physiologists, doctors, physicists—discussions were inspired by a state of mind that Wiener described in these words: "For many years Dr. Rosenblueth and I shared the conviction that the most fertile areas for development of the sciences were those that had been neglected as a 'no-man's land' between the different realms of established sciences".[8]

A conviction that is shared, for it is at the boundaries of established disciplines that can be found the areas most favorable for discoveries. Challenged in this manner are both the traditional division of sciences and the authority presiding over it. The subject and *raison d'être* of this conviction, almost a creed, can be stated as follows. "For years we dreamed of an institution of independent scientists working together in one of these unexplored regions of sciences, not as subordinates of some important administrative committee chairman but united by the desire, better, united by the spiritual necessity of understanding this region as a whole and giving to one another the strength of this understanding".[9]

It sounds almost like Wassily Kandisky in his moving essay "On

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[7] Norbert Wiener, *Ex-Prodigy: My Childhood and Youth*, and *I Am a Mathematician, The Later Life of a Prodigy*, both Cambridge, Mass., MIT Press.
[8] See in particular *Cybernetics, or Control and Communications in the Animal and the Machine*, 1958; *The Human Use of Human Beings. Cybernetics and Society*, Boston, Houghton Mifflin Co., 1950; *God and Golem, Inc.*, Cambridge, Mass., MIT Press, 1964. The remarks I quote are taken from the first work, pp. 8, 9, 11.
[9] *Ibid.*

the Spiritual in Art''. ''The artist's is the hand that, by using this or that touch, obtains the proper vibration from the soul. *Thus it is evident that harmony of colors should not be based on anything other than the principle of effective contact.* The human soul, touched in its most sensitive spot, responds. We shall call this basis *The Principle of Inner Necessity*''.[10] For Wiener spiritual necessity is linked to understanding and for Kandinsky to sensitivity; but for each it is born of a vision of the world that it extends.[11]

Thus the transdisciplinary not only cuts across disciplines or, as in Norbert Wiener's case, explores regions on the fringes of disciplines, but also working from a conviction, from faith or from any other strong motivation, it led to a new system, cybernetics, that rapidly was converted into a science, even a discipline, despite the fact that in its emerging period it was manifested by a generalized power of polarization. This is the reason for the multiplication of what could be called quasi-symbioses such as biocybernetics, neurocybernetics, psychocybernetics.

Quasi-symbioses function linguistically, either by means of compound nouns (first with hyphens then without) or through linkage of terms: cybernetics and society, cybernetics and sociology, cybernetics and psychology, cybernetics and culture, art and cybernetics (poetry, painting, architecture, sculpture).

Frequently designated by the term crossroads-science, cybernetics characteristically causes all the phenomena it embraces, of whatever origin they may be, whatever state they may enjoy, to converge into a common perspective opening onto a new horizon.

This is precisely what occurred in art with the ''invention'' of perspective that offers an evident analogy to the ''invention'' of logic and the invention of cybernetics. Perspective indeed was born of the combined efforts of artists, engineers, scholars, geometers, mathematicians, often combined in the same individual: Al-

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[10] Vassily Kandinsky, *On the Spiritual in Art. Über das Geistige in der Kunst* was written in 1910 at a time when the artist was painting his first abstract works. The essay seemed so daring and revolutionary that no publisher would print it. Finally it was published by Piper in Munich in 1912.

[11] In Wiener's case cybernetics was born of circumstances as well, namely the state of war in which the planet, particularly the United States, was engaged. Without the war being the priority objective, it is true that cybernetics owes much to the

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berti, Piero della Francesca, Vitruvius, Viola, Brunelleschi (Leonardo da Vinci remains the legendary paragon). These individuals belonged to the circles in full intellectual effervescence that were enlightening the nobility of that period: the Sforza in Milan, the Medici in Florence, Montefeltro in Urbino, Gonzaga in Mantua, Urban VIII and Leo X in Rome, Aldo Manucio and Francesco Colonna in Venice.

Perspective, then, was not an isolated discovery; it was the fruit of encounters and exchanges that attest to the emergence of a new vision of the world.[12] In the technical sense it meant developing a system for projecting three-dimensional objects onto a two-dimensional plane. Or, in Alberti's own words, "The picture is a plane intersecting the visual pyramid". By analogy to the "cybernetic effect" that made feedback a favorite notion, it is possible to say that the "perspective effect" establishes and validates the system of representation that makes of the object represented the "equivalent of the object perceived", or rather *the equivalent of the object conceived*. As Erwin Panofsky emphasizes in his work tellingly entitled *Perspective as Symbolic Form*, "Homogeneous space (that of perspective) is never a given space; it is a space created by a construction". And the meaning of this construction is to replace the religious conception of the Middle Ages with a "humanist" conception. Broadly put, we can say that the symbolism of God gives way to human symbolism. The keystones of the different constructions through which an era, a society or a civilization attempt to perceive reality, symbolic forms change over the course of time, as proven not only by Egyptian art, Chinese art, Indian art, Japanese art but also modern art for example. Symbolic systems are the means by which a conception of the real becomes the very object of a perception that in turn confirms it as conception. As another pioneer, Pierre Francastel, has stated in *La Figure et le Lieu*, "The true scope

search for improvements in anti-aircraft defense against enemy war planes: "To find some method of predicting the future position of the plane". This introduced the notion of feedback, retroactivity, but its scope can be understood better from the work's sub-title; *op. cit.*, 1948. See note 8.

[12] Erwin Panofsky, *La Perspective comme forme symbolique*, Paris, Éditions de Minuit, 1975. Quotations on page 147, 42.

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of the change in the system lay in the voluntary use of a small number of these means by demonstrating that art, here painting, is capable of manifesting at certain moments, with no intermediary, the intellectual foundations of an understanding and representation of the world in conformity with a set of hypotheses that bring into question the place of man in nature.[13] In his study *Peinture et Société*, subtitled "Birth and destruction of the plastic realm, from the Renaissance to Cubism", the author explains clearly how art developed out of encouragement from intellectual circles as well as in accordance with determined political, social and economic conditions that form, to use his expression, its figure and place.[14]

Renaissance perspective gradually infiltrated everywhere, and not only in the plastic arts but also in mathematics (geometric perspective) as well as in the performing arts, theater, ballet. From "transdisciplinary" construction, heralding a new world, it became in the course of the centuries an ensemble of formulae employed by education to impose a normative view of the established world. The ontological aim is adulterated into a "realist effect" that degenerates into "realist illusion".

The problem may appear academic; neverthless, it assumes new and pressing importance when, with the arrival of computers, a technique and an art are developed under the name of infography, whose productions are multiplying, Already courses and chairs of infography are taking shape in art schools, sometimes even leading to the creation of new institutions; festivals and exhibitions can be found in many places.[15] Certain studies are appearing, such as that of Couchot, *Images, de l'optique au numérique*, that do not hesitate to hail the emergence of a new form of art out of a technical innovation. "The synthetic image is no longer the impression of a mass of photons emitted by the object to be represented that are inscribed on a chemical or mag-

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[13] Pierre Francastel, *La Figure et le lieu. L'ordre visuel du Quattrocento*, NRF, Bibliothèque des sciences humaines, Paris, Gallimard, 1967.
[14] Pierre Francastel, *Peinture et Société. Naissance d'un espace plastique de la Renaissance au cubisme*, Lyons, Audin, 1952.
[15] Among others, *Sigraph* in the United States; *Arts Electronica* in Linz, Austria; *Imagina* in Monte Carlo; *Video Art Festival* in Locarno, Switzerland.

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netic medium; it is a matrix of numbers calculated by a computer from programmed instructions".[16]

AN ULTRA-DISCIPLINARY EPISTEMOLOGY

Without going into details it can be asked if today it is not from the cognitive sciences, barely several decades old, that we could expect a new transdisciplinary breakthrough.[17] These bring together many disciplines whose interactions produce new objects that open up in turn on new realms. Engaged in this are cybernetics, psychology, biology, mathematics, linguistic, philosophy, physics, anthropology, economics, sociology and others. Strengthened by their solidarity, the cognitive sciences attempt to describe, explain or even simulate the steps of our thinking and more generally of all our capacities: reasoning, perception, learning, communication, decision, appreciation. They are characterized by the dynamics of a largely interdisciplinary search seeking to ally the role of experimental sciences and that of the human sciences to the growing power of the engineering sciences. By doing this they paradoxically emphasize that this alliance is manifested for the first time not simply at the level of conceptual discourse but also, with the assistance of computers, at the level of man-brain-machine. Developing alongside the computer technology to which they have been linked since the beginning, cognitive sciences dispose of a variety of new technical means that make it possible for them to aspire to a global knowledge that formerly was claimed by science on the one hand and philosophy on the other. Thus can we expect that out of such a desire for convergence will arise a configuration more apt to respond to the complexity of our world in accelerated change.[18] To such an extent it would seem

[16] Edmond Couchot, *Images, de l'optique au numérique*. Paris-London-Lausanne, Éd. Hermès, 1988, p. 16. See also *Nouvelles images, nouveau réel. Cahiers internationaux de sociologie*, January-June, 1987, Paris, PUF.
[17] Daniel Andler, ed., "Une nouvelle science de l'esprit. Intelligence artificielle, science cognitive, nature du cerveau", *Le Débat*, Émergence du cognitif, No. 47, Nov. - Dec. 1987, Paris, Gallimard.
[18] Lucien Sfez, *Critique de la communication*, Paris, Éd. du Seuil, 1988. After the observation, trite in itself, that our world is dominated by technology, the author

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to go beyond the notions of the multi-pluri- or even interdisciplinary by opening up onto the active transdisciplinary. Indeed it is as if the general movement so minutely observed in the political upheavals rumbling through all countries could also be found in the no less radical movement touching all our knowledge, even though the phenomenon is less ostensible. Political structures and mental structures are in full transformation.

With regard to the cognitive sciences as such, two principal orientations can be discerned: cognitivism and connectionism. Faithful to analytical tradition, the former places emphasis on the inference from a system of adequate symbols to the system of agreed-upon mental representations. The latter draws on biology by postulating the possible comparison of a network of artificial neurons (''neuronlike network'') with the functioning of our brain. The accent is no longer placed on logic and the chains of inferences constituting classical programs; it lies instead on the capacities of the system to recognize forms by constructing an associative memory (similar to our own in this respect), created and fortified by the faculty of learning by means of a massive parallelism.[19]

And so we are brought to ask ourselves if cognitivism and connectionism, more so even than cognitive sciences as a whole, do not derive from two fundamental philosophical models, one under the sign of Descartes and the other under that of Leibniz, as Gilles Deleuze explains them in a work bearing the enigmatic

specifies the three models that in his eyes flow from the position that one takes with regard to the machine. Either one lives by using it (live *with* the machine), or one experiences it as an environment (live *in* the machine), or one exists through it (exist *by* the machine). This last model, which the author calls the ''Frankenstein model'' and for which he creates the term ''tautism'', receives the majority of his criticism, denouncing ''cognitive science'': ''*autistic* science, because deaf to events of the external world; *tautological*, because it reproduces its own structure infinitely: *totalizing*, because it is enclosed in its own circularity...; *totalitarian*, because it decides there is no other mode of knowledge than that consisting in reporting every thinking object to the computer''. Why be upset?

[19] The best approach to the problem as a whole seems to me to be found in *Daedalus, Journal of the American Academy of Arts and Sciences*, Winter, 1988, vol. 117, No. 1, Cambridge (Mass.), entirely devoted to artificial intelligence and in particular to the development of neo-connectionism. The authors, among some of the best experts, are remarkably unafraid to situate their contributions in the perspective of philosophical questioning.

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title *Le Pli*.[20] The first model consists in believing that "the real distinction between parties would lead to separability by *positing separable minima*, whether in the form of finite bodies or at infinity in the form of points...". And so resolution of the problems that can be broken down into ever smaller difficulties until they are dissolved and reassembled according to the rules given by Descartes in the *Discourse on Method* is based on a discrete conception of the real that leads to acceptance of a calculable real. To this is contrasted the model Leibnitz exposed using the metaphor of a fold. "The division of the continuous should not be thought of like sand broken down into grains but like a folded piece of paper or tunic so that there can be an infinity of folds, each one smaller and smaller, without the body ever dissolving into points or *minima*". Unlike Cartesian division, the Leibnitzian conception of the "infinite fold" stresses continuity, not indistinct but modulated like waves whose inner movement avoids being broken off or disintegrating into diffuse indeterminacy. By doing this it aligns itself with our familiar experience in general and our aesthetic experience in particular. Setting aside quantitative objectivation, it anticipates separation of the object (thrown before, thus separate) just as it anticipates division of the whole into discrete parts. A mosaic cannot be reduced to the sum of the basic cubes making it up. The folds are the very interface between the subject and the object that are intertwined in an indefinite refractory spiral of granular dimensions of Cartesian scope. It can even be asked if Mandelbrot's fractals are not an extension of this intuition creating the first art of computer folds.[21]

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[20] Gilles Deleuze, *Le Pli, Leibniz et le baroque*, Paris, Éd. de Minuit, 1988. Quotations, pp. 8-9. As Deleuze notes, associating Whitehead, Bergson and Leibniz in the same fundamental intuition, "Events are in flux ... but ... This does not mean there are no eternal objects ... that enter into the event. Rather at times these are Qualities, like a color or a sound, that qualify a component with prehensions; sometimes Forms, like a pyramid that delimits an expanse of space; or sometimes Things, like gold or marble that break matter down. Their eternity is not opposed to creativity. Inseparable from the process of actualization or realization in which they enter, they have permanence only within the limit of the flow that realizes them or prehensions that actualize them", p. 108.

[21] The traveling exhibition, *Frontiers of Chaos—Computer Graphics Face Complex Dynamics*, illustrates the fractal geometry invented by Benoît B. Mandelbrot

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Without going any further we realize the complementarity of these two operations, provided it is specified that they each function at different levels. Thus the cognitivist way lends itself more to the part of reality taken as an ensemble of problems to be solved by dividing them into sub-problems; this way is superbly apt for dealing with operations linked to action. On the other hand, the connectionist way lends itself more to the part of reality dealing with perception, recognition, learning and, no doubt, evaluation; this way is recently apt for what might be called an adaptive (creative?) disposition. In any case the two models are not opposed to one another if they are set in their proper place. And at this point we hear the echo of the native's cry: ''Every sacred thing must be in its place''.

But now, what is the ultra-disciplinary? Without being able to define it, perhaps we can begin to sense it. The ultra-disciplinary is radically distinguished from the disciplinary, based as it is on division and specialization. It is also distinguished from the pluri-multi-disciplinary as well as the interdisciplinary. It brings to light a dimension that can neither be delimited nor eliminated and yet one that exists and in which all other dimensions are in some manner included.

Schematically every operation of knowledge is in some way an operation of formalization in the largest sense of the term. This operation manifests itself in a number of areas, at quite different levels and degrees. Thus every language is made up of a set of concepts that make it possible to divide up the real and to act on it thanks to the means of communication placed at the disposal of users. We must immediately note that so-called natural languages, those we speak every day, are complex in nature, contrary to the idea we may have of them. This complexity is manifested each time we express ourselves. Even the simplest

(Cf. *Les Objets fractals, forme, hasard et dimension*, Paris, Éd. Flammarion, 1975). The exhibition has been the subject of a book by H. O. Peitgen and P.H. Richter, *The Beauty of Fractals—Images of Complex Dynamical Systems*, Berlin-Heidelberg-New York-Tokyo, Springer-Verlag, 1986. To give an idea of its contents, in presenting the exhibition that began in New York in September 1986, the author entitled his essay, ''The Beauty of Fractals: How to Imitate the Mountains and the Clouds and to Generate Wild and Wonderful Shapes''. Mandelbrot's theory is widely used in infography. Cf. also ''Un baroque fractal'' by Severo Sarduy and Klaus Ottman, *Art Press*, 144, Feb. 1990, Paris, pp. 28-33.

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declarations are filled with ambiguity. "How are you?" seems an innocent question, but it can express quite different meanings depending on whether we expect information and confirmation or whether we make of it a threat, a means of intimidation or a password, for example. All linguistic communication, insufficient by itself, is illuminated by its context. The situations in which we express ourselves are thus determinant for creation of meaning. And this provides J.J. Grize the opportunity to point out that, "Every word contains three properties that, as in formal languages, are also its defects. First they have been much used and therefore are accompanied by a whole range of aspects. Then most of them also have multiple meanings. Finally they are, if I may say so, malleable. ... No geometric discourse can transform a triangle into another shape. Beginning with the true it remains true. But a discourse of natural logic continuously modifies what it is dealing with".[22]

Is it possible to imagine a situation sufficiently "pure" that no ambiguity subsists in it? In the West, where creation and development of disciplines have increasingly taken as their model science, which upholds rationalism as principle and rationality as criterion, David Hilbert's famous challenge was to have believed in the possibility of an exhaustive formalization of mathematics, which nourished great hopes until receiving a death blow in 1931! In his famous essay appearing at that time, Kurt Gödel "showed that such a supposition was not tenable. It placed mathematicians before a stupefying and disheartening conclusion: the axiomatic method possesses certain internal limits that exclude the possibility of axiomatizing it entirely, even if only the arithmetic of wholes".[23] Or, in Gödel's own words in a note added

[22] Jean-Blaise Grize, *op. cit.*, pp. 47-48. I will not even discuss the famous paradoxes, including the one about liars. "All Cretans are liars. But I am Cretan. Therefore... which can be summarized as 'This statement is false' and that continues to attract the attention of commentators." See B. Godart-Wendling, "Le paradoxe du menteur: essai de résolution dans le cadre d'une approche dynamique", *Intellectica*, Langage et cognition, No. 6, Paris, ARC, 1988/2, pp. 123-168.

[23] *Le Théorème de Gödel*, Kurt Gödel, Ernest Nagel, James R. Newman, Jean-Yves Girard, Paris, Seuil, 1989 (translation of *Gödel's Proof*, New York University Press, 1958, based on Gödel's original text, *Über formal unentschiedbare Sätze der* Principia Mathematica *und verwandter Systeme I*, 1931). Quotations pp. 19, 143, 155.

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in 1963, "It can be demonstrated rigorously that in any consistent formal system containing a relatively developed finitary theory, there are undecidable arithmetical propositions and that, moreover, the consistency of such a system cannot be demonstrated within the system". And this leads us to the remark by Jean-Yves Girard, in the chapter delightfully entitled "The Field of the Sign or the Failure of Reductionism", "What the formalists have in mind is a mechanical and mechanist model of mathematics (and of the world), in which everything can be reduced to a play of symbols operated by a giant computer. The thinking that lies behind this is unpleasant; moreover the purely formal treatment of language, overlooking its content, is called bureaucracy in common parlance. Far from despairing that Gödel leads us away from the 'final solution', let us be glad for the space he has left for creativity". It is evident that such an explanation has important consequences going well beyond mathematics. In any case it brings out the fact that every discipline, no matter how formal it may aspire to be, must deal with a "gape" that is both its injury and perhaps its salvation. Something exists beyond all formalization.

On the other hand can we be satisfied with everyday language knowing that, although it makes ordinary communication possible, it can in no way lay claim to a "pure" rigor that would deliver it from all ambiguity? I will quote but the beginning and end of the phrase used by Mallarmé to explain this: "*Les langues imparfaites en cela que plusieurs, manque la suprême...* Seulement, *sachons* n'existerait pas le vers: *lui, philosophiquement rémunère le défaut des langues, complément supérieur*".[24] In short this means that natural language in its ordinary usage manifests an "imperfection" which only poetry can remedy. But even though poetry can remedy the insufficiencies of "tribal language", it is still unable to escape the "gape". Whereupon Mallarmé continues, "Create a relationship between exact images and a clear third and mergeable aspect appears for divination". The gape means the intrinsic limit of every language reduced to "tribal language"; at the same time it signifies the passage to "ultra-communication". The absence that poetry suggests renders

[24] Stéphane Mallarmé, *Oeuvres complètes*, Bibliothèque de la Pléiade, Paris, Gallimard, 1945. Quotations, pp. 363, 364, 368.

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presence more palpable than could the words used to describe it.

Relatively speaking, cannot the same observations be made with regard to religious systems? Every religion attempts to establish itself from an ordinary principle that can be compared analogously with a system of "logic". However, whatever power this may have, we see that each time the proposed "formalization" comes up against either an inexplicable hereafter outside our realm of understanding or a contradiction that the believer is required to accept through faith: *Credo quia absurdum*.

Christianity is based on the Trinity of Father, Son and Holy Spirit, truly a mystery whose fecundity has been confirmed over the centuries by the condemnation as heresies of all attempts to contain it. It is, said Saint John Damascene, a mystery in which "the hypostases are united not in order to be merged together but in order to be contained mutually within one another..., each one contains unity through its relation to the others no less than through its relation to itself". This has provided us with manifestations in Christian iconography that are as abundant as they are troubling, where God, Christ and the Holy Spirit are represented as a triple face or in the figure of a triple angel.

Nor will I dwell too long on the notion of *Ma* designating a "spatio-temporal" entity or "third" reality that plays a fundamental role in Japanese civilization. "The specific feature of the Japanese language is a non-structural approach in which words do not necessarily have a logical relationship among themselves but in which spoken words have a number of invisible meanings and *Ma* or silent measures out of which the hearer is presumed to extract and interpret the meaning stated by the person who spoke to him", as the author Akira Miyoshi explains citing examples drawn from poetry, music, the theater and architecture.[25] In contrast to European architecture, which places emphasis on "solid and durable materials such as stone and brick used to create a separation between the inside and outside of buildings, ... in traditional Japanese architecture there is an element called 'veranda' that runs along the outer edge to form a sort

[25] Akira Miyoshi, "The Silent Beat of Japanese Music", *Japanese Essences*, (Japan as I see it - 3), Shichi Yamamotu, Kenichi Fukui *et. al.*, eds., Tokyo 1985. Quotations, pp. 103-105.

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of roofless corridor. This veranda is thus outside the house. But at the same time it is separated from the inside only by a glass door and so is considered to be part of the inside of the house. In other words, it is a 'third category of space' serving to bring together the interior and the exterior''.

This point then leads to another equally important one, art, or at least the great majority of art. Briefly, we can state that the fine arts and more broadly what we today call the plastic arts are, at least in the West, based on the ''logic of representation''. Even though this has changed over time and includes infinite variations, it remains at the origin and heart of artistic activity. However, it is no less singular to observe that such a logic in turn collides with its own limits, namely, the representation is and always remains of another nature than that which is represented. This is because the order of artistic representation is in its own way a ''formalization'' that it was long thought possible to extend to the complete realization, supposed realism/naturalism. However, just as Gödel established the definitive failure of mathematical formalizaton by the means and resources of a formal system, Magritte in turn superbly denounces the failure of iconic formalization in his famous painting representing a pipe upon which is written in large letters the equally famous phrase, ''This is not a pipe''. In both cases the failure established a ''gape'' that opens up on the hereafter, on the ''mergeable third aspect'' that culminates in *the ontological imaginary*.

Let us summarize. The disciplinary is based on the postulate that reality is theoretically ''divisible'' and that each discipline represents a system (or sub-system) whose coherence is guaranteed by rules deriving from a system of logic, or from a ''particular ordering''. The system is characterized by its *intentionality* (the objective determined and pursued by the system) and its *functionality* (how the components of the structure act among themselves). And so it goes with every operation of formalization, no matter how meager or elaborate it may be. Various disciplines develop, fuse together, sometimes combine to enrich one another, multiplying all the multipluri-, inter-. Hence the plethora of neologisms: some vanish quickly while others lead a vacillating existence; still others persist and ultimately find a place in the dictionary.

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But the important point is that no discipline escapes the "gape" representing the very limits of the system of thought upon which they are based and which ensures their strength. On the other hand it is thanks to this existential "vulnerability" that they open up on the hereafter of the "disciplinary", onto the ultra-disciplinary, onto the vision of the world from which they are inspired, in the literal sense, from which they draw their life and breath.

CHINESE THOUGHT

Joseph Needham brought the preceding to light remarkably in *Chinese Sciences and the West*. "The *philosophia perennis* of China is *organic materialism*. Chinese thought never developed a mechanist view of the world, and it is the organic perspective, which holds that each phenomenon is linked to all others according to a hierarchical order, that has prevailed universally...". The author continues, "The harmonious cooperation of all beings comes not from orders of a superior authority (which would be *external* to these beings), but from the fact that these beings are all part of a *hierarchy of ensembles* forming a cosmic and organic model that obeys only the (*internal*) orders of their own natures".[26]

Thus all civilizations are born and developed from an "intuitive kernel" that represents their "vision", their orientation, their manner of acting, of feeling, of anticipating, of understanding,

[26] Joseph Needham, *La Science chinoise et l'Occident*, Paris, Seuil, 1973. Quotations pp. 14, 37, 40-41 (original edition Allen and Unwin Ltd., 1969). This leads to the following conclusion: "I often illustrate the evolution in China with a curve that rises slowly but surely towards a higher level, sometimes much higher, than the one reached in Europe between, for example, the second and fifteenth centuries. But after the beginning of the scientific Renaissance in the West, with the Galilean revolution (which one could almost say was the discovery of the fundamental technique of scientific technology itself), the curve of science and technology in Europe begins to rise abruptly, almost exponentially, reaching the level achieved by Asian societies, thereby overturning the conditions that had existed throughout the preceding two or three centuries". There is a complement, which today seems a summons to reflection. "This violent break in equilibrium today is beginning to correct itself". How can we not think of our growing concern for our endangered planet? How not to think of the extraordinary development of ecology, once looked upon as a rather quaint exercise?

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of organizing their behavior. This "intuitive kernel" radiates an energy that is incarnated in religions, rituals, beliefs, systems of thought and of communication. These dynamic figures make of each civilization a *cosmogony not only conceived but experienced*, and they furnish both presuppositions and the finalities of their actions in the course of history.

Thus the ultra-disciplinary, origin, motivity and finality belong both to the beginning and to the future. In this respect it is distinguished from intentionality that, no matter how varied it may be in its applications, remains in fact linked to disciplines ordered to a goal. The ultra-disciplinary is both pre-Faustian and post-Faustian. It inspires what precedes the "*Im Anfang war die Tat*", just as it inspires the meaning of action. What inspires breath at the same time provides form. It is not a matter of confusing it, as is so often the case, with a process of adaptation that derives from the disciplinary, from the organization of actions through an improvement of selective mechanism for the purpose of achieving a determined objective.

The difficulty with taking the ultra-disciplinary into consideration is precisely that it defies any ordinary "taking into consideration", which schematically means circumscribing its contents in a definition. The ultra-disciplinary implies the fact of "being disposed to", in other words of adopting or assuming an attitude, or, in accordance with its etymology, to a "manner of arranging the body" and thus by extension to a "manner of arranging the mind". It can be understood how it most often escapes observation since it is a given determined, scientific, religious or economic attitude that makes us see the "facts" in relation to the perspective it establishes. Thus the "intuitive kernel" is not only a concept; it is at the heart of the mental and physical dispositions required for the purpose of orienting, organizing and regulating our behavior, given the fact that beyond the "satisfaction of needs" it serves, it accomplishes the symbolic integration that gives meaning to the individual and to the group and that often takes the form of myth, or at least mythic illustration. And I will have recourse to this for my conclusion with the hope that it will enlighten the past as it can assist us in illuminating the future.

I would like to situate this impossible task at three major con-

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figurations that attempt, I stress, not to retrace some historical view or another, but to sketch the outlines of a metaphorical perspective. The first shows us the gods who, together with animals, establish a complex but determinant alliance. In the Hindu pantheon, Ganesha occupies a privileged position. His young man's body, well fleshed out, is topped by the head of an elephant, making of him a master of intelligence. Ambivalent, he is the god who both appeases and who raises up obstacles. In Egypt, the goddess Hathor wears the sun between her two cow horns. Wife of Horus, she incarnates fertility, love, the intoxication of pleasure. Without wanting to expatiate on the immense variety of these amalgams or symbioses, I note simply that two principles are found simultaneously at their origin and at work, one human and the other animal, which are combined into a doubly surpassed otherness. The zoomorphic configuration, if we can sum it up in a single word, in no way consists in simply giving animal forms to the human figure, which would not go beyond the level of representation. It is a matter of attaining, through the ''gape'' proper to each of the two principles, human and animal, the ''third mergeable aspect'', the ''third entity'' that inspires the dynamism of every civilization.

The second configuration, still at a level that is not historical but metaphorical, is located at what I would call anthropomorphic cosmogony, which tends to model the divine figure on that of men. This is pre-eminently the case with Greek civilization. Even if certain dark areas persist, which psychoanalysis will be required to explain, the general picture is that of an assembly of superhuman gods that seems installed once and for all. But here too a ''gape'' is evident, on the one hand that of the divine omnipotence ''controlled'' by Nemesis who watches over the balance destiny desires by maintaining beings and things in their places, and on the other by the ''gape'' of our human condition that condemns us to die. Unable to save ourselves from death, we humans attempt to seize supreme power for ourselves. Prometheus is but one step in this process. The heavenly fire is a metaphor for the Logos. This is what must be conquered, and the ''third mergeable aspect'' is manifested first of all in the prodigious efforts undertaken by men to make an intelligible Logos out of obscure destiny. Thus is born the ''third entity'' of reason, with the

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temptation to make of it sufficient reason on the horizon. Rationality eliminates the animality of zoomorphic gods. Anthropomorphism is transformed into anthropocentrism. This does not mean that all ambiguities disappear; they change in nature as well as in appearance. "Monsters" are transformed into "strange loops", paradoxes, contradictions, dilemmas, that Douglas Hofstadter brings together into an eternal braid with the help of Zeno and Lewis Carrol.[27] But these are games that become dangerous when they put the planet in danger with their applications and take on the disturbing shape of "fatal strategies" denounced by Jean Baudrillard.[28]

THE NEW GOLEM

The third configuration seems to me admirably announced by Norbert Wiener in his last work, *God and Golem Inc.*, originally published some thirty years ago. Its sub-title specifies both the subject and its scope: *A Comment on Certain Points where Cybernetics Impinges on Religion*.[29] After examining development of the machine that learns and the machine that reproduces itself ("not merely *pictorial* representations but *operative* images"), the author does not hesitate to affirm in conclusion, "The machine ... is the modern counterpart of the Golem of the Rabbi of Prague", that semi-artificial, semi-human creature that is found both in Jewish magic tradition (the Rabbi of Prague being the best known) as well as in oriental legends. Here we have entered the era that brings humanity to a New Covenant. From now on our destiny is sealed with the machine. Not the mechanical

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[27] Douglas Hofstadter, *Gödel, Escher, Bach: An Eternal Golden Braid*, New York, Vintage Books, 1980.

[28] Jean Baudrillard, *Les Stratégies fatales*, Paris, Grasset, 1983. "Once upon a time it was the Sphinx who asked men the question about man, which Oedipus thought he had solved and which we in turn thought we had solved. Today man asks the Sphinx, the inhuman, the question about the inhuman... The object (the Sphinx) is more subtle but does not respond. But by disobeying laws, by thwarting desire, it responds secretly to some enigma."

[29] Norbert Wiener, *God and Golem Inc., A Comment on Certain Points where Cybernetics Impinges on Religion*, Cambridge, Mass., MIT Press, 1965.

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machine of earlier times but a machine that learns, that reproduces itself, that shares our fate, the machine as colleague. Hyperbole? Not when we realize that the new frontier, that is space, cannot be reached without it. Deprived of technology, we are reduced to our earthly destiny. To raise our eyes toward heaven requires a machine, not only in order to realize our dream but also to share it. Another visionary precursor, Warren S. McCulloch, neurologist, mathematician and poet, also declared this in his own way in a book published about the same time (1965), entitled equally significantly, *Embodiments of Mind*.[30]

If the cognitive sciences have a future, if they indeed represent a multidisciplinary crossroads leading to a restructuring of the paths of knowledge, despite certain reservations,[31] it is necessary not only that the metaphysical dimension be taken into account but that it become, like the ultra-disciplinary, the driving force and finality of the future. There is no reason for surprise that so much research goes beyond "disciplinary boundaries"; that robots attempt to free themselves of their ancillary servitude in order to reach the fringes of artificial life;[32] that artificial intelligence, with the help of massive parallelism, photonic as well, increasingly approaches the mysteries of our brain; that the concomitance between mental states and neurophysiological states evolves toward increasingly refined forms; that, thanks to increasing numbers of rockets, satellites and probes, space is becoming the "natural" place for astronautical humanity. *From Animals to Animats*.[33] The neologism *animats* anticipates what can be achieved through the new ultra-disciplinary realm that radiates

[30] Warren S. McCulloch, *Embodiments of Mind*, Cambridge, Mass., MIT Press, 1965.
[31] See L. Sfez, *op. cit.*, note 18.
[32] Christopher G. Langton, *Artificial Life*, New York, Addison-Wesley Publishing Company, Inc., 1989. His postulate is as follows: *Extremely* complicated behavior can be produced in "machines" governed by extremely simple rules because, as the author observes, "Perhaps the most intriguing thing about life resides in the fact that it is more an *organization* of matter than a property of matter itself". His conclusion is: "Artificial Life forces us to re-examine our place in the universe and our role in nature."
[33] *Simulation of Adaptive Behavior: From Animals to Animats*, is the sub-title of a symposium organized in Paris in September 1990 by The Rowland Institute for Science, Cambridge, Mass. "The objective of the conference is to bring together

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the energy of man and the machine, no longer simply linked but now wedded together. Is it by chance that voices so distant and yet so near, pre-Socratic like Empedocles, reach us. "Hearken to this. Nothing that is mortal has birth nor end through death that carries all off. But the elements are merely assembled together; and once they are combined, they are dissociated. Birth is but a name given by men to a moment in this rhythm of things".[34]

When the metaphor achieves its point of perfection it becomes, if not reality, at least an annunciatory vision. The ultra-disciplinary opens up on the *ultra-human*.[35]

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researches in ethology, ecology, cybernetics, artificial intelligence, robotics and other areas concerned in order to develop our understanding of behavior and underlying mechanisms that make it possible for animals and, potentially, for robots to survive in uncertain environments."

[34] Éditions Gallimard, in the Bibliothèque de la Pléiade series, has just published *Les Présocratiques* that Jean-Paul Dumont, along with Daniel Delattre and Jean-Louis Poirier, rightly present as "the memory of our Western civilization", while noting that therein is revealed "what philosophy and science were at their beginnings, namely theology, mathematics, astronomy, geography, history and medicine" (p. IX).

[35] Cf. O.B. Hardison, *Disappearing through the Skylight. Culture and Technology in the Twentieth Century*, Viking, 1989, p. 347. And this conclusion, to which I subscribe: "We have passed in review the fundamental truths that are disappearing in the principal areas of our modern culture, in science, history, language, art. An examination of intelligent machines suggests that the idea of humanity is itself in the process of changing so rapidly that it could be said, legitimately and without exaggeration, that it is even on the path to extinction." But does disappearance in one place mean a reappearance somewhere else? In another manner? "Birth is but a name given by men..." (see above).

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