Can philosophy overcome its current ancillary condition? OR: Anticipation – the premise for a new Cartesian revolution

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Summary

This could as well be a lecture on philosophy's progressive lack of significance ever since the Cartesian revolution. As it uncritically embraced determinism and reductionism, philosophy became a mere interpretive endeavor. Even when it addresses its own condition, it does not escape the vicious cycle of explaining complexity away while dealing with complexity. In our days, the ancillarity of philosophy is extreme to the extent of making it a parasitic intellectual exercise. As *vitalism* was, for circumstantial reasons, purged from scientific discourse, philosophy was assimilated in the products of the deterministic and reductionist natural sciences.

As some of its failed practitioners see it, philosophy celebrated, without ever questioning, the premises it adopted, a viewpoint that negates its necessity, or at least its *raison d'être*.
In acknowledging anticipation, and pursuing its own program of investigation, philosophy might challenge the deterministic and reductionist descriptions of the physical world. This could lead to suggesting a view of complementarity, of dialectics (in the original sense of the term). In doing so, philosophy might be able to reinvent itself as the expression of *love of wisdom* at a fundamental level—of thinking and expression. Failure to live up to this opportunity, which has been brought about by science's new focus on the living, could result in a course leading to oblivion.

The trouble with philosophy

"The trouble with poetry is that it encourages the writing of more poetry," wrote Billy Collins, one of this nation's more recent poet laureates. If he had been the philosopher laureate—but why in the world would anyone even think about a philosopher laureate in an age of the insignificance of philosophy—he might well have stated that the trouble with philosophy is that it encourages the writing of more philosophy. Focused on poetry, he asks a philosophical question, "How will it all end?" and decided:

> When we have compared everything in the world to everything else in the world and there is nothing to do then but...break into the poems of others with a flashlight and a ski mask!

Here again, the description perfectly fits philosophy and its current status: monkeys, millions of them, performing in front of a computer (not a typewriter) high numbers of permutations until everything that can be written has been written; or lazier monkeys, breaking into the texts of others, paraphrasing, continuing the language game that Wittgenstein predicted (and even took part in with a pleasure few philosophers of our time have).

As I defined the subject of this lecture, I realized that

1. I will address people who might not accept the premise that philosophy is nothing but the maidservant (the *ancilla*, the female servant) of education (because outside education it plays no role whatsoever).
2. I will address colleagues who might consider the Cartesian revolution defining a moment in science rather than in philosophy.
3. The notion of anticipation is rather ill defined, therefore barely an acceptable candidate for redefining the status and methods of philosophy.

These preliminary aspects will be touched upon in the lecture, but the ultimate goal goes beyond the rhetorical question that we shall entertain together. I shall advance views (the Greeks of yester-ages would have called them *doxai* or *dogmata*; the Latin-speaking world would have defined them as *opiniones*) that pertain to the fundamental condition of philosophy—the love of wisdom expressed in natural language with the purpose of understanding the world we are part of—and its dynamics. Indeed, for me the various "philosophies"—of physics,

chemistry, society, religion, feminism, multiculturalism, structuralism and post-structuralism, etc., etc.—are not part of philosophy. Successful or not, they are at best a cultural discourse on various subjects, usually extracted from the broader context to which they belong. Their legitimacy is not unlike that of the subject of their interpretive intent. The various specializations of such "philosophies" correspond to the specializations triggered by the reductionist model advanced by Descartes, and practiced by unanimous consent since his time.

There is no such thing as *applied* philosophy. Philosophy is always *fundamental*. When philosophy was practiced as an all-encompassing discipline, it used to be focused on understanding the whole before fragmenting it into the infinite number of parts making it up. Geometry, music, grammar, rhetoric, and astronomy were ancillary to philosophy. So was history, the attempt to keep a record of change based on which philosophic hypotheses could be formulated and transmitted, as living knowledge, from one generation to another.

If we start only with the question (posted on the website of the Philosophy Club at Stanford University) "What are you going to do with your degree in philosophy?" we realize that no Aristotle, no Plato, and no other philosopher worth his fame could be possible today. "Maybe philosophy doesn't ruin your future, but it doesn't prepare you for your future either," we read on the same Website. But didn't we know this already? Is the ancillary condition of philosophy today the result of some plot of the sciences, or of the arts, or of society? By no means. Actually, philosophy was killed by philosophers too eager to become the servants of more lucrative endeavors.

I will not rehash here the history of philosophy. It pains me deeply that for many the study of philosophy is nothing but the study of its history. It scares me even more to hear about "philosophers" who are specialists on Aristotle, or on Hegel, or on you name one. Many such philosophers will wind up with a Ph.D. tagged to their names. Philosophy implies the awareness of its change over time, the culture of philosophy. But it ceases to be philosophy as it starts fragmenting, breaking into smaller and smaller particles, becoming "philosophic dust" instead of advancing knowledge pertinent to who we are and what we do in the world.

Having said that the history or philosophy is not a valid philosophic subject, I prefer to look at various ideas that shaped the world in which they were articulated. Concepts such as *existence, change, time, space, interaction,* and *causality* are of interest. The variation in defining them over time is no more than an expression of new practical experiences. One cannot expect from Democritus more than the realization of *hen diapheromenon heauto*—everything changes, just like the river in which we step, which is never the same. Once practical experience broadens, more questions can be asked. And yes, philosophy is more relevant in its *questions* than in its answers.

Philosophic answers are provisional

If you are a philosopher at heart, you know that philosophic answers—such as the atomistic model advanced in antiquity, or the current understanding of matter based on quantum mechanics—are only provisional. What is permanent is the *need to question*. One of these questions marks the obsession with the living. Aristotle wrote on the subject (*De Anima* [1]) and defined the soul as definitory of the living. Today, we might find some of the arguments ludicrous, or naive at best. But one thing cannot be ignored: the question of what distinguishes the living from the non-living. Over time, many other answers have accumulated in continuation of very old representations going back to primitive cultures and their rituals. And the term acquires a more religious dimension than it had in Aristotle's book.

As science—later, the sciences—evolves, its program called for emancipation from religion; discarding animism as the explanation of the world's dynamics became an obsession. The scientific approach, in contrast to that of philosophy, is not driven by questions, but rather by the need to provide a systematic description of reality in the form of knowledge (*episteme*). Dynamics as a subject of fundamental inquiry is replaced by specialized descriptions of change (from one state to another). The philosopher does not describe; the philosopher questions. The scientist describes and advances hypotheses as to the consequences of such descriptions. Philosophy does not exclude religion. Science starts where religion is no longer an adequate answer to questions pertaining to causes, the associated effect being the *change*. With *reductionism,* deity is replaced by determinism,

which becomes the underlying religion of science. Judith Shapiro, an anthropologist and president of Barnard College in New York City, took note of this: "The reductionist desire to find a deterministic cause for everything is akin to religion," (Letters, *Chronicle of Higher Education*, January 2005).

The "Descartes moment" in the history of philosophy, as much as in the history of science, corresponds to the elimination of Aristotle's *anima* as definitory of the living and as the source of its underlying dynamics. Many arguments in favor of this choice are embedded in Descartes' work. Others result from the broader context of the pragmatic framework in which machines—as extensions of the human being and his tools—are being built. Descartes was in search of a method for guiding the accumulation of knowledge in a time obsessed with change. Therefore, the reduction and determinism associated with his rules are to be understood as thinking mechanisms:

1) The first was never to accept anything for true which I did not clearly know to be such; that is to say, carefully to avoid precipitancy and prejudice, and to comprise nothing more in my judgment than what was presented to my mind so clearly and distinctly as to exclude all ground of doubt.
2) The second, to divide each of the difficulties under examination into as many parts as possible, and as might be necessary for its adequate solution.
3) The third, to conduct my thoughts in such order that, by commencing with objects the simplest and easiest to know, I might ascend by little and little, and, as it were, step by step, to the knowledge of the more complex; assigning in thought a certain order even to those objects which in their own nature do not stand in a relation of antecedence and sequence.
4) And the last, in every case to make enumerations so complete, and reviews so general, that I might be assured that nothing was omitted.
(*Discourse on the Method of Rightly Conducting One's Reason and of Seeking Truth in the Sciences* [2])

After Descartes, we talk about *Western rationality*. By that we mean the mechanical model of reducing complexity, and of inferring from the past to the present: The current state of a system depends on past states. Identification of the body of the living (animals, in particular) as machines seemed at that time innocuous, although La Mettrie (*L'Homme Machine*) is quite passionate about it. But in the perspective of time, Descartes' description became the mold for looking at things, explaining things, building new things, understanding dynamics. In short, the description of the physical world, a world of relative stability and permanency—i.e., of limited dynamics—at that time, was adopted as the only acceptable description. And philosophy began its decline into ancillarity, despite the impressive questions issued by the philosophers of the Renaissance (e.g., Machiavelli, Hobbes), by Locke and Hume, by Kant, Fichte, and Hegel (idealist philosophy, as it is known). Later came the pragmatists—and among these, Peirce must be distinguished from James, Dewey, and others of their ilk. With Moore and Russell, with realism and logical positivism, with linguistics-based analysis (Wittgenstein, Ryle, Austin), with Existentialism, with Phenomenology (Heidegger, Sartre), with Postmodernism, and finally with Feminism, we are no longer in the realm of philosophy, but on the many tangents that begin with the Cartesian model of reductionism. A superb intellectual effort, of extreme expression at times, but tautological to the Cartesian model— specialized philosophy is just as much the world as each of its infinite number of components, and their relations, can claim to be representative of the whole. The constructive and critical dimensions of philosophy, at a fundamental, abstract level, are either abandoned or vulgarized.

Posing questions regarding the essence of things and actions, philosophy implicitly asks questions regarding its own condition and its own dynamics. Does philosophy indeed have an *essence* (that which does not change)? Does philosophy have a dynamics? These are legitimate questions insofar as they help us focus our attention on some property that is monotonic to all philosophic endeavors. The fact that the notion of essence informs our perceptions of things cannot be ignored. The essence of all there is, of all that moves and changes, of truth, etc.—these are fundamental inquiries not to be substituted by the examination of a brain under some scope (a CT scanner or an fMRI device), or the measurement of all that scientists measure, moved by the hope that quantifying equals knowing. Change expressed in numbers is at best an expression of the changed numbers, not

of what they describe. What makes pseudo-philosophy dangerous is that it makes society unfit for accepting philosophy.

This is a weighty assertion, one that begs a second as a consequence. Pseudo-philosophy is a greater enemy of philosophy than the people who claim that philosophy is useless. Once the reductionist method is adopted, science produces tautological knowledge: the perspective adopted is reflected in the description. When some years ago Alan Sokal, a physicist of good academic standing, concocted a fake study—*Transgressing the Boundaries: Toward a Transformative Hermeneutics of Quantum Gravity*, which was eventually published in a peer-reviewed journal—he did not, in fact, test the system; rather, he played by the rules of the game at work in science today. Interestingly enough, some "philosophy," of the sort guided by the Cartesian reductionist model, could not stand up to the minimal test of philosophy. Given a relevant philosophic question—such as the relation between beings (in the most general sense)—Heidegger produced a hilarious precedent. He asserted that "Being can indeed be without beings," (in the 1943 edition of *Was ist die Metaphysik?*) and "Being never is without beings," (in 1949). Paul Ricoeur, like Paul de Man, produced many such statements; and so have Peter Singer, together with several of the philosophers who America imported and celebrated more for their "star" status than for their depth of inquiry.

Adding a "No" to the statements of pseudo-philosophy does not make it or its practitioners either more or less plausible. But on this note (not necessarily an attack against a mediocre philosopher whose fame transcends the impact of his work), a "No" in front of major works—start with Hegel and continue in our days to the so-called philosophers of the mind—makes no statement of difference. Why? Because, after all, since Niels Bohr—the first non-reductionist thinker after Descartes—we know that the old dialectic interrogation of the ancient Greeks (things are and are not at the same time) applies to all our descriptions. The particle-wave nature of light ascertained after quantum mechanics is but a profound scientific description that follows a fundamental philosophical question: What is light? The quantum states describe the same dynamics.

The instrumental value of pseudo-philosophy today is the justification of scientific descriptions. Where the mathematician advances conceptual models that are constructs projecting a very personal image of the thinker, the pseudo-philosopher uncovers, or assumes to uncover (either BS or authentic *Aha!*), levels of generality that cannot be there. String theory, to name a topical example, is for pseudo-philosophers the bandwagon on which *to be* means to have access to some funding (the opportunistic mechanism of how money is disbursed for research), or to some publication avenues. The philosophizing exercise in a rather abstract language is ancillary in nature, and subject to fast fading away. Experts in string theory will not even notice that they lost some uninvited companions on the journey between their current questions and those waiting to be posed.

To question existence (in its many forms) is to start at the level of abstraction at which the notion of existence—as the unity between permanence and change—makes sense. Philosophy is not the sum of assertions of *right* and *wrong* exchanged in the current social and political context. It is about questions relevant to the broad context in which profoundly competitive forces are at work. Philosophy questions science—be it the Darwinian model or the rather inarticulate alternatives (making it to a court of law, a supreme machine for testing the validity of conformity to law or to anything else regulated, including the inherent regulation of science), or the extremely exciting applications of an observation made by a physicist: "There is a lot of room down there." He (Richard Feynman) referred to the molecular level. But his observation does not accompany nanotechnologists from one conference to another as they celebrate some obscure new material (which will soon be forgotten because much more will be learned as we probe matter at the nano-level).

The conflict between philosophy and pseudo-philosophy is the expression of a deeper conflict: between the reductionist perspective—perfectly valid in its own domain—and its associated determinism, and the non-reductionist, non-deterministic perspective. The dictatorship of Cartesianism resulted in our skewed understanding of ourselves as machines (functionalist philosophy). Where science looks for *truth* as a measure of the validity of its descriptions, philosophy should look for *meaning*, as reflective of its inquiries. Rorty has it right: Truth is what your contemporaries let you get away with. Yes, this is how the machine model works, and it applies to politics, science, fashion, and education. If you see it on a computer screen, it must be true! Automated

mathematics as truth generator! Philosophy maintains that questions and the numerous changing answers they elicit go together. Contrary to what all Cartesian-based philosophy asserts, our minds do not *only* mirror the world, they *constitute* it, and they articulate critical views of it (*critical* in Kantian terms).

This brings to discussion the need to revisit the world. Indeed, for the physical world, of postulated homogenous components (molecules, atoms, electrons, or whatever scientific description advances), the mind can successfully generate a mirror image. And operating on this image, as a limited form of knowledge, we can create the science of materials and build homes, cars, and rockets. But the living world, to which we belong, and in which our physical condition is ascertained, is quite different. Descartes and his cohorts killed animism, and nobody should mourn it. But in doing so, he postulated that every form of dynamics is reducible to the dynamics of physics. Philosophy embraced this reduction, and in doing so committed itself to be the maidservant of the sciences and technologies that reductionism and determinism made possible.

However, since the times of Galileo, Descartes, Newton, Einstein, and more recently the elaboration of quantum mechanics, not only has physics changed, but also our view of rationality. Reductionism and a holistic view of the world, as well as determinism and non-determinism, do not have to necessarily exclude each other. A view of the world based on complementarity is by far more inclusive and better suited to the foundation of science—and more conducive to philosophic inquiry. The living began to examine itself; and despite the difficulties of the task, it dug deeper and deeper into levels of existence. It also applied methods of inquiry for which neither reductionism nor determinism is the appropriate unquestionable guiding principles. From among those who have discussed this situation at length, I will focus on two scholars: the late Robert Rosen, active in the mathematical foundations of biology; and Walter Elsasser, the quantum mechanics physicist who elaborated a rather intriguing theory of organisms based on a holistic model. They are not the alternative philosophers or the new philosophers, but their views are grounded in the tradition of philosophic inquiry.

Complexity-Based Foundations of Biology—A Necessary Premise

For the purpose of defining anticipation, I shall succinctly summarize the foundational work of the two scientists mentioned above and their respective activities. I am well aware that, given my purpose, I shall not exactly do justice to the work of either, since my reading and reporting are shaped by the subject of anticipation and the suggestion that philosophy can overcome its ancillary condition by realizing the specific nature of the dynamics of the living.

Robert Rosen discussed the limitations of Descartes' conception and advanced the notion that the hierarchical model of physics → machines → organisms should be replaced by one in which physics is the main category (*Überbegriff*, as German scientists would say) for two distinct entities, each with its own characteristics: machines and the living. My purpose is not to reconstitute Rosen's thinking—a difficult task given the scope of his work—but to define here the broad context in which it emerged. Elsasser, an eminent geophysicist, argued that the behavior of living organisms can *not* be reduced to physico-chemical causality. Neither Rosen nor Elsasser attempted to recover the vitalistic notion in reaction to which Descartes and all the scientists who followed him defined as their approach.

To repeat, *vitalism* is the metaphysical doctrine that living organisms possess a non-physical inner force or energy that gives them the property of life. Vitalists believe that the laws of physics and chemistry alone cannot explain life functions and processes. While vitalists differ in detail, they share some general beliefs: Life and reality, in so far as it is living, consist in movement and becoming, rather than in static being. Reality is organic, not mechanical. Biology and, often, history are more central than physics. Life is known empirically or by intuition, rather than by concepts and logical inference. Life is objective and transcends the knowing subject. Vitalism stresses the diversity of life and tends towards pluralism and, occasionally, relativism.

Neither Rosen nor Elsasser made any attempt whatsoever to deny the so-called laws of nature at the foundation of physics, or to claim that these need to be altered when considering the living. As a matter of fact, Rosen and Elsasser call for the acknowledgment of an extremely important qualifier: complexity. Descartes' reductionism did

away with complexity as it reduced the whole of an entity to its parts, and left their interrelations out of the picture. The rationality of this important procedure cannot be denied, regardless of where one stands concerning the fundamental questions of the living.

Rosen's Relational Model

In the history of modern biology, Robert Rosen—its most dedicated mathematician and a distinguished biologist in his own right (a student of Rashevsky, the initiator of relational biology)—contributed fundamental work on the subject of life (see *Life Itself* [3] and *Essays on Life Itself* [4]). His arguments, both rigorous and passionate, are not easy to summarize. Aware of the statements from distinguished scientists that physics had failed to produce any relevant knowledge concerning the biological, Rosen took it upon himself to ask why and, furthermore, within a seamless line of argumentation (for which he used the mathematical category theory) delivered provocative ideas for a different kind of a science of the living. His contribution would be of no import to anticipation if in the process of defining the living, Rosen had not concluded that what distinguishes the living from the world described in the language of physics is exactly its anticipatory characteristics.

In many of his writings, Rosen argued that life is not a specialization of a machine; moreover, that giving up the model of the machine does not automatically result in renouncing science or the science-based understanding of existence. The first argument is relatively easy to understand. The foundation of science based on Descartes and Newton (what Rosen identifies as the Newtonian Paradigm) became, over time and after successful application, a belief structure. This belief structure is, as I already mentioned, similar to a religious or political belief, although grounded in a different practical experience. Since physics deals with the fundamental laws of nature, biology could use them for specific applications. This makes the relation between physics and biology one between the general and the special. As captives to this kind of thinking, we could conclude either that the entity in question is probably not real, or that eventually physics will catch up whenever something biological—let's say consciousness—could not be explained by applying the laws of physics.

Rosen was not willing to discard physics or the mathematical descriptions on which it is based. This does not make him less an authentic philosopher. Rather, he joined those scientists who acknowledged the limitations of physics and tried to come up with an alternative science of the living. He quoted from a letter that Einstein sent to his friend, the famous nuclear physicist Leo Szilard: "One can best feel in dealing with living things how primitive physics still is. . . ." In many articles, Rosen also dedicated many of his observations to Erwin Schrödinger's book (*What is Life?* 1944), aware that the scientist, well known for his work in quantum mechanics, was after a new physics that could eventually shed light on distinguishing the living from the non-living part of the world. Schrödinger looked at ways to divide an organism into a part that is life (human life, frog life) and another part that is everything else. Life would be the common denominator, and the *everything else* part, for which physics could deliver better explanations, would vary. In Schrödinger's view, a different physics, repository of what makes an organism what it is, would explain what makes a molecule, which science can describe quite well, into a gene, which the science of his time could not convincingly describe. The notion of order, and thus, indirectly, complexity, played an important role in Schrödinger's theory. He advanced the model of *order derived from order*—an idea quite opposed to what thermodynamics—order from disorder—advanced, and which still dominates science to this day.

But even while entertaining the self-criticism of physicists and their attempts to re-evaluate physics, Rosen would not ignore that something fundamental prevented physics from coming up with an adequate description of the living. In order to make it compatible with a dynamic different from that of moving bodies (be these electrons, moving points on a plane, objects in 3D space, and moving terrestrial bodies), scientists were willing to concede that physics could not yet explain everything. This belief has not changed for quite some time. As advanced as physics and chemistry are in telling us how atoms and molecules make up everything that there is, they ignore the relations among the components of matter, just as they ignore the functions accomplished by the structures they describe. Ultimately, reducing things to their simplest expression renders them partially easier to understand. But there is a price to pay: complexity, which makes something a living system, is exactly what physicists discarded. Let me add that in our days, physics is trying to come around and pursue complexity—one of

its most recent embodiments—and the results cannot be dismissed. However, it is only at the level of authentic philosophy that complexity is fully acknowledged.

In the traditional view of science, in what is called its *belief structure*, measurement guarantees the objectivity of the undertaking. *Quantity* is implicitly regarded as the underpinning of all there is. To measure means to map what takes place in experiments to numbers. Rosen challenged this view, but not the expectation behind it: how to get to data without letting consciousness affect it. This is why, in Rosen's view, to measure also means to discriminate (distinguish) and classify. His theory of measurement is a prerequisite of the method that he advanced for producing a description of the living that is compatible with that of physics, but not reducible to it. The order of the world about which science informs us, expressed in scientific measurements—measuring anticipation, for instance—is captured in more than one way. According to his *Modelling Relation*, there is more than one mapping possibility between a natural system and a formal system. The natural system is what we want to describe and understand. In the formal system, we can manipulate our descriptions of events observed—as is done in mathematics and logic—or the hypotheses can be manipulated to see if they are formally acceptable or not. We can also measure (map to numbers what we observe) and fill the results of these measurements in the formal description in order to check the range of the observed phenomena. Last but not least, we interpret, that is, we try to assign an understanding to the relation between *what* we describe and *why* we describe. We also try to establish the meaning it might have for whatever we do with this understanding.

This methodology of modeling instead of measuring is an alternative to the Newtonian Paradigm. It has the advantage of integrating older and newer physics—from Galileo's system to quantum mechanics—and of integrating sensory perception and human action. The major effort is no longer to acquire data but to identify relations. We can also match relationships between objects and processes investigated—such as anticipation—and the formal system. The world of simple mechanisms described in the Newtonian Paradigm and the world of complexity expressed through interrelationships in Rosen's relational model are quite different and not reducible to one another. As I have stated, one entails an understanding of time as interval, and of space as distance. In my view, Rosen's model overcomes part of this limiting understanding of space and time. Within the complex world, emergence—the occurrence of new relational properties corresponding to a different level of complexity—is no longer excluded. The analytical models in the world of complexity cease to be equivalent to synthetic models. We cannot just assume that what analysis produces—disjoint sets of parts—can serve as a basis for reconstructing, i.e., synthesizing, the whole. Functional components do not map to the material constitutive parts, as the Newtonian Paradigm guaranteed. Rather, they are context dependent. This dependency runs against the expectation of homogeneity in the physical description. If, for reason of acquiring knowledge or manipulating the real world as we experiment with it, a reduction of the system to its parts is performed, the system as a whole irreversibly loses information. This is a fundamental assertion at the foundation of a science of the living that integrates information into the constitutive structure and its functionality.

Rosen's system deserves more than this rather succinct presentation. But our objective is to find out how life is defined and, in connection to life, how anticipation, as a characteristic of the living, is expressed through particular processes. Based on this understanding, philosophy can operate at a level of abstraction that is not possible in the reductionist model. Insistence on causality—going all the way back to Aristotle's model of the four "becauses"—prompts the switch from "How does it work"— to the encompassing "Why"—a question practically eliminated from science when it decided for the reductionist-deterministic path that Descartes outlined. Indeed, the *Why?* is philosophical; the *How?* and *What?* are merely interpretive—and definitely functional. In the last analysis, Rosen advanced a dynamic systems theory for life focused on the (M,R)-systems. It corresponds to a class of objects he called Metabolism-Repair systems, and which he described, as I already mentioned, using the means of mathematical category theory. Instead of the input-output devices corresponding to a machine representation of the living, Rosen works with the (M,R)-system as a relational model of the organism. Based on this model, he demonstrates why an organism is different from a machine, and how metabolism and self-repair capture the essence of the living. Self-replication of functional components, not of parts, is based on the fact that every function is entailed by another. No longer are we confronted by an infinite regress, as in physics. In fact, living processes and organization are treated as though they have the same ontological reality as the material parts. Replication is to be understood as functional, not material, or, at least, not only material. So instead of

answering what turns out to be an ill-posed question—"What is Life?"—Rosen invites scientists to distinguish life from non-life. What is philosophy? is at least the counterpart question—ill posed and ill defined. In reality, philosophy is a living legacy of our never-ending questioning of all there is, ourselves included.

As a by-product of this perspective, he comes to realize that "living cells arise from other living cells"—which is a program for anyone involved in the understanding of the living and its making, or creation, if you can take the term in its most neutral definition. In the same vein, evolution of life is defined anew, although the processes involved remain undefined. A system evolving into an organism must reach a point where the functions of metabolism, self-repair, and replication are achieved. At this level, anticipation becomes possible, and even necessary, as part of the dynamics of evolution and as an expression of self-entailment. Machines are a-temporal in their functioning; what counts are durations, always the same (otherwise, the machine fails). Their own "time" is artificial; synchronization mechanisms ensure the rhythm of functioning. The living unfolds in time, as the goals related to its self-constitution affect, in a process of entailment, its current condition. Rhythm is not constant, as in machines, but rather variable, as though there is interaction between the living and the time of their unfolding.

Elsasser—Architect of a Holistic Theory of Biology

A physicist of distinguished reputation, Walter Elsasser became very interested in the living from an epistemological perspective. As in Rosen's case, it would be an illusion at best to think that we could satisfactorily summarize his courageous attempt at reconciling physics with what he correctly perceived as a necessary theory of organisms. While never addressing anticipation, Elsasser gave many reasons to believe that, had he been exposed to it, he would have had all it takes to probe into its many manifestations and underlying biological mechanism. Rosen and Elsasser have the focus on complexity in common. But as opposed to Rosen, Elsasser is willing to pay his dues to the scientific matrix within which he found his own way: "The successful modern advance of reductionism rests on certain presuppositions which at this time are no longer questioned by any serious scientist," [5]. Moreover, and here I quote again, "There is no evidence whatever that the laws of quantum mechanics are ever wrong or stand in need of modification when applied to living organisms." All this sounds quite dogmatic and, for those versed in science theory, almost trivial given the fact that theories are ultimately coherent cognitive constructs, not continents waiting to be discovered. Physics, in its succeeding expressions, is no exception. For the reader not willing to delve into the depths of the argumentation, the position mentioned is not really inspiring. Opportunistically, and as Rosen did as well, he refutes vitalism: "the idea that the laws of nature [that is, physics] need to be modified in organisms as compared to inanimate nature." Serious scientists in all fields and of all orientations have discarded vitalism, just as alchemy was discarded centuries before. After all these preliminaries, Elsasser finally articulated a clear point of departure for his own scientific journey, which justifies continued interest in his work: "Close reasoning indicates the existence of an alternative to reductionism. This is so despite the fact that the laws of quantum mechanics are never violated."

From this point on, we have quite an exciting journey ahead of us. Indeed, biology is a "non-Cartesian science." The "master concept" in describing the holistic properties of the living is complexity (p. 3), more precisely, what he describes as unfathomable complexity. Yes, this was the goal of philosophy before it abdicated to reductionism. This concept of unfathomable complexity dominates the entire endeavor. An extended quotation is probably justified.

> Unfathomable complexity "implies that there is no series of actual experiments, and not even a set of suitably realistic thought—experiments such that it would be possible to demonstrate the way which all the properties of an organism...can be reduced to consequences of molecular structure and dynamics...."

Furthermore, he defines as *morphological* those properties that remain unaccounted for by physics and chemistry. Four principles and a "basic assumption" stand at the foundation of his biology. The assumption refers to the holistic view adopted: the living cannot be understood and described other than as a whole. "...the organism is a source (or sometimes a sink) of causal chains which cannot be traced beyond a terminal point. . . ." That is, they are ultimately expressed in the unfathomable complexity of the organism.

The first principle is known as *ordered heterogeneity*, and was inspired by R.D. Hotchkiss (in 1956), himself a distinguished biochemist and biologist. It states that, as opposed to the homogenous nature of physical and chemical entities (all electrons are the same), the living consists of structurally different cells. There is order at the cellular level and heterogeneity at the molecular level. Heterogeneity corresponds to individuality, a term that has no meaning in the domain of physics. The principle of *creative selection* is focused on the richness of living forms. For homogenous systems, the variation of structure (if there is such a variation) averages out. For heterogenous systems, i.e., the living, an immense multitude of possible states is open to realization, i.e., selection. The property of selection is attributed to matter alone—the mathematics of dynamic systems would here probably define some self-organizing action. The selection as such is based on the third principle: *holistic memory*. The new morphological pattern actually selected resembles earlier patterns, but is not the realization of stored information. Elsasser is quite convincing in arguing for a "memory without storage"—the "touchstone of the theoretical scheme proposed" (p. 43). The argument is based on the distinction between two processes: homogenous replication—the assembly of identical DNA molecules—and heterogenous reproduction—a self-generation of similar though distinct forms. Replication is a "dynamic process" (p. 75) resulting in what we perceive as regularities in the realm of the living. Replication and reproduction need to be conceived together. What makes this possible is the fourth principle, i.e., *operative symbolism*. The discrete, genetic message is represented by a symbol that stands for the integrated reproductive process. Elsasser himself realized that this operative symbolism is merely a tag for all processes through which the living experiences its own dynamics. He looked for a triggering element—a *releaser*, as he called it—that can start a restructuring process. From a piece of genetic code, the releaser will trigger the generation of the complete message necessary for the reconstruction of a new organism. We can imagine this releaser—the operative symbol—as able to start a "program" that will result in a new biological form, as an alternative to storing and transmitting the form itself. The biological information is stored as data (in the homogenous replication) and as a space of an immense number of alternate states from which one will eventually be realized (in the heterogeneous reproduction). This latter assumption implies that biological phenomena are "in part" autonomous.

Instead of searching for laws, Elsasser highlights regularities. Where reductionists would expect that "the gametes contain *all* the information required to build a new adult," a non-reductionist biology would rely on holistic memory and his *Rule* of repetition: "Holistic information transfer involves. . .the reproduction of states or processes that have existed previously in the individual or species as the case may be" (p. 119). Of special interest to him is the re-evaluation of the meaning of the Second Law of Thermodynamics (and the associated Shannon law of information loss). Elsasser argued that since paleontology produced data proving the stability of the species (over their many millions of years of existence), and since the Second Law of Thermodynamics points in the opposite direction, only a different integration of both these perspectives can allow us to understand the nature of the living. Therefore, two types of order were introduced, in a way such that they never contradict each other. This is what he called biological duality: "living things can be described by a different theory as compared to inanimate ones." As a consequence, if one attempted to verify holistic properties, a different kind of experiment from the one conventionally used in physics would be required.

It is at this juncture that Rosen's thinking and Elsasser's meet—I doubt that they had a chance to study in depth each other's work on the living and life. Rosen was "entirely dedicated to the idea that modeling is the essence of science" (*Essays*, p. 324); Elsasser realized that no experiment, in the sense of experiments in physics, could capture the holistic nature of the living. Moreover, both asked the fundamental question: What does it take to make an organism? Elsasser, like Rosen, concluded: "The synthesis of life *in vitro* encounters insuperable difficulties" (p. 155). It is quite possible that such a strong statement corresponds to the realization that anticipation, as the final characteristic of the living, might be very difficult to describe (the analytic step), but probably impossible to reproduce (the synthesis). It is therefore of particular interest to take a closer look at the various factors involved in what, from a holistic perspective, appears to us as anticipatory.

Anticipation: a new subject of philosophic inquiry?

What qualifies anticipation as a philosophic perspective is the confluence of many fundamental subjects:

1. Causality: Is it only reducible to the cause-and-effect sequence, or does it involve the future in its condition as a possibility?
2. Existence: Is the specific condition of the living, embodying matter but extending beyond it, philosophically definable as long as the definition would come from a living [person] observing itself?
3. Change: Do physical change and the dynamics of the living—in some cases self-inflicted—correlate in some manner? If yes, how does self-organization account for the teleological component of the dynamics of life?
4. Time: Does the linear sequence corresponding to the interval explain how faster-than-real-time information processes characteristic of the living actually make possible anticipation as a selection from the infinite space of the possible?

The current interest in time (see special edition of *Scientific American*, 16:1, March 2006) suggests that the fundamental area of inquiry defined as space-time is now being taken over by the sciences. If indeed the laws of physics are the same for all observers (cf. general covariance, a founding/basic principle of relativity), we face fundamental philosophic questions—from which philosophers (including the very visible John Earman and John Norton, who dare to step into the territory of physics-based speculations à la Stephen Hawking) ran away. It is not surprising then that a physicist in need of solid philosophic help wrote: "To tell you the truth, I think that most of my colleagues are terrified of talking to philosophers—like being caught coming out of a pornographic cinema," (Max Tegmart, University of Pennsylvania).

To state that the anticipation dimension of the living points to a domain of inquiry that will redefine our way of thinking is at this moment more provocative than substantive. Upton Sinclair (of *The Jungle* fame) remarked: "It is difficult to get a man to understand something when his salary depends on his not understanding it." Well, changing the frame of mind of those, including myself, shaped by reductionism and determinism means to realize how the process made us blind to our own anticipatory condition. But this realization, together with the regained sense of the whole, would be the domain of an authentic philosophy, one willing to regain its condition and ascertain the need for inquiry above and beyond disciplinary borders. If philosophy misses this new chance, brought about by knowledge so far excluded from cultural dialog, oblivion will be the destiny it deserves.

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Holding as we do that, while knowledge of any kind is a thing to be honoured and prized, one kind of it may, either by reason of its greater exactness or of a higher dignity and greater wonderfulness in its objects, be more honourable and precious than another, on both accounts we should naturally be led to place in the front rank the study of the soul. The knowledge of the soul admittedly contributes greatly to the advance of truth in general, and, above all, to our understanding of Nature, for the soul is in some sense the principle of animal life.

This is what led Democritus to say that soul is a sort of fire or hot substance; his 'forms' or atoms are infinite in number; those which are spherical he calls fire and soul.

The same tendency is shown by those who define soul as that which moves itself; all seem to hold the view that movement is what is closest to the nature of soul, and that while all else is moved by soul, it alone moves itself. This belief arises from their never seeing anything originating movement which is not first itself moved.

Similarly also Anaxagoras (and whoever agrees with him in saying that mind set the whole in movement) declares the moving cause of things to be soul. His position must, however, be distinguished from that of Democritus. Democritus roundly identifies soul and mind, for he identifies what appears with what is true-that is why he

commends Homer for the phrase 'Hector lay with thought distraught'; he does not employ mind as a special faculty dealing with truth, but identifies soul and mind.

In the same way Plato, in the *Timaeus*, fashions soul out of his elements; for like, he holds, is known by like, and things are formed out of the principles or elements, so that soul must be so too. Similarly also in his lectures 'On Philosophy' it was set forth that the Animal-itself is compounded of the Idea itself of the One together with the primary length, breadth, and depth, everything else, the objects of its perception, being similarly constituted. Again he puts his view in yet other terms: Mind is the monad, science or knowledge the dyad (because it goes undeviatingly from one point to another), opinion the number of the plane, sensation the number of the solid; the numbers are by him expressly identified with the Forms themselves or principles, and are formed out of the elements; now things are apprehended either by mind or science or opinion or sensation, and these same numbers are the Forms of things.

Some thinkers, accepting both premises, viz. that the soul is both originative of movement and cognitive, have compounded it of both and declared the soul to be a self-moving number.

Book III

That there is no sixth sense in addition to the five enumerated-sight, hearing, smell, taste, touch-may be established by the following considerations:

If we have actually sensation of everything of which touch can give us sensation (for all the qualities of the tangible qua tangible are perceived by us through touch); and if absence of a sense necessarily involves absence of a sense-organ; and if (1) all objects that we perceive by immediate contact with them are perceptible by touch, which sense we actually possess, and (2) all objects that we perceive through media, i.e. without immediate contact, are perceptible by or through the simple elements, e.g. air and water (and this is so arranged that (a) if more than one kind of sensible object is perceivable through a single medium, the possessor of a sense-organ homogeneous with that medium has the power of perceiving both kinds of objects; for example, if the sense-organ is made of air, and air is a medium both for sound and for colour; and that (b) if more than one medium can transmit the same kind of sensible objects, as e.g. water as well as air can transmit colour, both being transparent, then the possessor of either alone will be able to perceive the kind of objects transmissible through both); and if of the simple elements two only, air and water, go to form sense-organs (for the pupil is made of water, the organ of hearing is made of air, and the organ of smell of one or other of these two, while fire is found either in none or in all—warmth being an essential condition of all sensibility—and earth either in none or, if anywhere, specially mingled with the components of the organ of touch; wherefore it would remain that there can be no sense-organ formed of anything except water and air); and if these sense-organs are actually found in certain animals;-then all the possible senses are possessed by those animals that are not imperfect or mutilated (for even the mole is observed to have eyes beneath its skin); so that, if there is no fifth element and no property other than those which belong to the four elements of our world, no sense can be wanting to such animals.

Further, there cannot be a special sense-organ for the common sensibles either, i.e. the objects which we perceive incidentally through this or that special sense, e.g. movement, rest, figure, magnitude, number, unity; for all these we perceive by movement, e.g. magnitude by movement, and therefore also figure (for figure is a species of magnitude), what is at rest by the absence of movement: number is perceived by the negation of continuity, and by the special sensibles; for each sense perceives one class of sensible objects. So that it is clearly impossible that there should be a special sense for any one of the common sensibles, e.g. movement; for, if that were so, our perception of it would be exactly parallel to our present perception of what is sweet by vision. That is so because we have a sense for each of the two qualities, in virtue of which when they happen to meet in one sensible object we are aware of both contemporaneously. If it were not like this our perception of the common qualities would always be incidental, i.e. as is the perception of Cleon's son, where we perceive him not as Cleon's son but as white, and the white thing which we really perceive happens to be Cleon's son.

Aristotle proposed in Physics II, 3 that we employ four very different kinds of explanatory principle {Gk. αιτιον [*aition*]} to the question of why a thing is, the four causes:

The *material cause* is the basic stuff out of which the thing is made. The material cause of a house, for example, would include the wood, metal, glass, and other building materials used in its construction. All of these things belong in an explanation of the house because it could not exist unless they were present in its composition.

The *formal cause* {Gk. ειδοσ [*eidos*]} is the pattern or essence in conformity with which these materials are assembled. Thus, the formal cause of our exemplary house would be the sort of thing that is represented on a blueprint of its design. This, too, is part of the explanation of the house, since its materials would be only a pile of rubble (or a different house) if they were not put together in this way.

The *efficient cause* is the agent or force immediately responsible for bringing this matter and that form together in the production of the thing. Thus, the efficient cause of the house would include the carpenters, masons, plumbers, and other workers who used these materials to build the house in accordance with the blueprint for its construction. Clearly the house would not be what it is without their contribution.

Lastly, the *final cause* {Gk. τελοζ [*telos*]} is the end or purpose for which a thing exists, so the final cause of our house would be to provide shelter for human beings. This is part of the explanation of the house's existence because it would never have been built unless someone needed it as a place to live.

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[...] Et comme la multitude des lois fournit souvent des excuses aux vices, en sorte qu'un étal est bien mieux réglé lorsque, n'en ayant que fort peut, elles y sont fort étroitement observées; ainsi, au lieu de ce grand nombre de préceptes dont la logique est composée, je crus que j'aurois assez des quatre suivants, pourvu que je prisse une ferme et constante résolution de ne manquer pas une seule fois a les observer.

Le premier étoit de ne recevoir jamais aucune chose pour vraie que je ne la connusse évidemment être telle; c'est-à-dire, d'éviter soigneusement la précipitation et la prévention, et de ne comprendre rien de plus en mes jugements que ce qui se présenteroit si clairement et si distinctement à mon esprit, que je n'eusse aucune occasion de le mettre en doute.
Le second, de diviser chacune des difficultés que j'examinerois, en autant de parcelles qu'il se pourroit, et qu'il seroit requis pour les mieux résoudre.

[142] Le troisième, de conduire par ordre mes pensées, en commençant par les objets les plus simples et les plus aisés à connoître, pour monter peu à peu comme par degrés jusques à la connoissance des plus composés, et supposant même de l'ordre entre ceux qui ne se précèdent point naturellement les uns les autres.

Et le dernier, de faire partout des dénombrements si entiers et des revues si générales, que je fusse assuré de ne rien omettre.

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