

# The Roots of Reductionism: A Counter-Ontoepistemology for a Systems Approach

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Systems thinking is presented as the antithesis of "reductionism." This article—the first in a trilogy which intends to present an ontoepistemological foundation for interpretive systemology—is concerned with understanding the ontoepistemological roots of reductionism. The immediate purpose of such an understanding is to provide an interpretive contrasting context (a counter-ontoepistemology) against which an ontoepistemology for systems thinking can dialectically be drawn (the second and third papers in the trilogy published in this issue of *Systems Practice*). The inquiry into the ontoepistemological roots of reductionism leads to the principle of noncontradiction. Such a principle is shown to be the source of the merging together the most fundamental ontological and epistemological principles ruling Western thought. As such, they are shown to have brought about reductionism in modern science. Finally, the "form of essential recursiveness" is put forward as a logical antithetical form with regard to the principle of noncontradiction and which will serve as a logical instrument for developing an ontoepistemology for the systems approach.

**KEY WORDS:** interpretive systemology; systems philosophy; philosophy of science; soft systems thinking; critical systems thinking.

## 1. INTRODUCTION

The introductory paper to this special issue of *Systems Practice* (Fuenmayor and López-Garay, 1991) presented an overview of the theoretical problems and questions which defined the program of Interpretive Systemology. The main theoretical problem was that of designing an ontology and an epistemology for an "interpretive systems approach."

### 1.1. The Meaning of a Systems Approach

It seems natural to start such task with the question, "What is meant by a *systems approach*?" or, more precisely, What is that which distinguishes a *systems approach* from other approaches? Answer: A "systems approach" means to "approach" or "see" things (or phenomena) as systems—a simple answer indeed. Now, when in the literature on systems the phrase "systems approach" is found, it is quite obvious that it does not refer to an everyday approach to phenomena in all life

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activities. It is rather concerned with the narrower context of science and design (of human activity systems, of technological software and hardware, etc.). Thus, it could be said that a systems approach is concerned with *studying and designing* (not just "perceiving") phenomena as if they were "systems."

However, what is meant by a "system"? A system is "a group of interrelated, interdependent, or interacting elements forming a collective unity" (*Collins English Dictionary*, 1979, p. 1475), or, in fewer words, a system is "a complex whole" (*The Concise Oxford Dictionary*, 1976, p. 1174). Before such a definition, what is so special about seeing things as if they were systems? Is there anything that is not a system? Two possible types of nonsystems can be inferred from the previous definition:

- (1) *Indivisible entities* (e.g., subatomic particles) which are not constituted by a plurality of elements and
- (2) *Sets of elements which do not form a "collective unity."*

The first type really cannot be considered phenomena (what is presented to us). Rather, they are atomic concepts without a direct phenomenal correlate (a subatomic particle or an atomic sensation cannot be experienced as this table, a symphony, or a university can be experienced). Thus, this first type of non-systems can be discarded because a systems approach is concerned with studying *phenomena* as if they were systems.

The second type of nonsystems refers to collections that do not constitute a unity, i.e., sets defined by "extension" (not by "comprehension"). For example, the set constituted by a pencil, a cow, and my feeling of joy does not constitute a unity. To put it more precisely, this set of elements *does not constitute a unity that transcends the mere meeting of their parts*. On the contrary, a table, a computer, a living creature, or a hospital presents a unity which transcends the mere collection of its parts. To "transcend" means here to go beyond the mere collection of elements. This "going beyond" implies that a "collective unity" or "whole" has something in it that is present neither in the separated elements nor in their mere being together. It has thus a *holistic sense*. This *apparently* is equivalent to saying that there is a sort of "*emergent property*" arising from the interrelation of the elements<sup>2</sup>. So it can be said that a set defined by extension—a nonsystem—is an immanent set, whereas a system is a transcendental set or, rather, a *transcendental whole* (which in the following is also called "*holon*").

The above statement gives a first answer to the original question. *The quest of the systems approach is to study phenomena as if they were transcendental wholes (holons) and not mere aggregates of parts*. Thus, a systems approach focuses on the holistic sense of phenomena.

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<sup>2</sup> It is argued elsewhere in this issue of *Systems Practice* (Fuenmayor, 1991a, b) that the very idea of "emergent property" arises from an ontological dualist and "Eleatic" prejudice which traps the systems approach in a "lobster pot." [For the meaning of "lobster pot," see Fuenmayor and López-Garay (1991).]

## 1.2. The Antithetical Essence of a Systems Approach

A systems approach is put forward as a revolutionary approach (Bertalanffy, 1968; Churchman, 1979; Ackoff, 1974; Checkland, 1981). Hence, its quest—that of studying phenomena as if they were *holons*—is distinctive and revolutionary.<sup>3</sup> Therefore, a systems approach is opposing some other approach that does not treat phenomena as if they were transcendental wholes. This means that a systems approach is essentially an oppositional or *antithetical* approach whose meaning is rooted in the opposition or dialectics held with that which it is opposing. In other words, the *being* of an *antithetical* approach is not merely a "being," but a "*being-against*." Now it can be seen that, in order to answer the initial question concerning the meaning of a systems approach, we must gain understanding about *that* against which a systems approach is *being*. Only in these terms, the *being-against* that is essential to our *antithetical approach* can be understood. Furthermore, as discussed later, *that* against which an antithetical approach is being gains its meaning only through being the thesis against which the antithesis is reacting. The logical form in which the relation between antithesis and thesis inheres is called a "*form of essential recursiveness*." We take care of such a logical form in Sections 8.2 and 8.3; however, the present question is, "What is that approach against which the systems approach is being?"

## 1.3. The Ontoepistemological Claim of a Systems Approach and the Need to Define Its Counter-ontoepistemology

According to the previous discussion with regard to the concept of "system," a systems approach claims that phenomena should be regarded as transcendental wholes and not as mere collections of elements. Now this claim purports a judgment both about the being of phenomena and about the possibility of their knowledge. In other words, it purports an ontological and an epistemological judgment. When seen in these terms, it can be observed that a systems approach is not another scientific approach which simply deals with a special "region" of beings; rather, it is a meta-scientific approach whose very claim concerns Being in general. It is thus an "approach" or "perspective" whose standpoint is of an ontological and epistemological nature. Although at the beginning it was stated that a systems approach is scientifically and design-like intended, its ontological claim concerns phenomena in general; i.e., phenomena as they are presented in everyday life, before any scientific or design attempt takes place.

The original ontological judgment of a systems approach can be stated thus: "*Things (phenomena) are wholes which transcend the mere collection of their parts.*" Call this proposition "SOP" ("systems ontological proposition"). Since a systems approach is scientifically and technologically driven, SOP is logically followed by the epistemological claim stated as "*Things (phenomena) should be*

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<sup>3</sup> That is to say, if everyone would study and act over phenomena as if they were transcendental wholes, this quest would be totally meaningless.

*studied as transcendental wholes and not as mere aggregates of parts.*" Call this new proposition "SEP" ("systems epistemological proposition"). Both propositions, put together, are announcing what is called the "ontoepistemological" claim of a systems approach. Now we can return to the question concerning the thetical approach *against* which a systems approach is being its antithesis.

If a systems approach is originally nothing but an oppositional or antithetical ontoepistemological claim, the thesis of which it is an antithesis must be an ontoepistemological stand which somehow opposes SOP and SEP. This stand is called a "counter-ontoepistemology for a systems approach." One possible way to move toward such counter-ontoepistemology is to ask, through SEP, what is the approach, method, or science that studies phenomena as if they were not *holons* but, rather, as if they were mere aggregate of parts? This was one of the leading questions with which the research program of interpretive systemology was started. In fact, it was one of the main questions being addressed in two different projects carried out by two members of the research group in interpretive systemology (see Fuenmayor, 1985; López-Garay, 1986). The results were not very different. In the following a summary of such findings, following the line of inquiry of Fuenmayor (1985), is presented. Before starting such a summary a comment on the form of the inquiry is due. The question, "What is that which is opposing the systems approach?" must, in the first instance, be addressed to the systems approach itself. Once a first answer is obtained, such an answer will be questioned again in search of the counter-ontoepistemological core of interest here. Once a second answer is obtained, it might be necessary to question again, and so on, until a satisfactory picture of what is searched for can be obtained. The process will not necessarily be that of pushing aside layers of "veils" so that, behind all the veils, the "thing" being searched for is found. It might rather be like peeling off the layers of an onion in search of the core of the onion. Will there be such a core or will we discover that the onion is nothing but a coreless structure of layers?

## **2. FIRST LAYER: THE REDUCTIONIST CHARACTER OF MODERN SCIENCE**

A systems approach is concerned with gaining understanding about the holistic sense or holistic meaning of phenomena. Thinking further on what might be the holistic sense or meaning of something, we discover that the transcendence to which it refers is not solely transcending from the mere collection of its parts, but it is transcending from the "thing in itself."

Things have meaning with regards to a context. Without a context, there would not be meaning. The "context of meaning" is, however, usually intuited as being "outside" the thing in itself. It is usually placed within the person or persons for which there is a meaning. But, how can that be if the holistic sense is what provides its unity to the thing in itself? How can holistic sense be simultaneously inside and outside the thing in itself? Does it not mean that this intuition of holistic sense is violating the principle of noncontradiction; namely, that something cannot

at one and the same time be and not be? How can a scientific approach violate the principle of principles in logic?

So conceived, the notion of holistic sense, although still very problematic at this stage, confronts two frequently mentioned methodological characteristics of Modern Science which seem opposed to the quest for holistic sense: *a priori* reduction and a *priori* analysis.<sup>4</sup> To start a study by *reducing* the phenomenon to an isolated "in-itself" (a *priori* reduction) and to separate it into parts (properties or pieces) in order to study them apart (a *priori* analysis) seem to oppose the quest for holistic sense.<sup>5</sup> Since an *a priori* analysis is a sort of second reduction performed on the object in-itself, the generic name of "reductionism" is given to the combination of a *priori* reduction and analysis.

It would seem that *reductionism* is somehow serving an ontoepistemological conception which does not regard phenomena as transcendental wholes. What conceptions of Being and of knowledge are then supporting reductionism? The origins of this methodological hallmark of most of modern sciences had to be researched in order to discover its ontoepistemological foundations. In the following, a brief description of the path followed by that research is given. It eventually brought forth a first version of an ontoepistemology for an interpretive systems approach (Fuenmayor, 1985, 1991a, b).

### **3. SECOND LAYER: CARTESIAN ONTOLOGICAL "MIND-MATTER" DUALISM**

Descartes, at the beginning of Modernity, offered one of the first discourses on the method of the just-born Modern Science. The Cartesian method clearly showed both features: aprioristic reduction and aprioristic analysis (Descartes, 1637, pp. 20-21). Thus, Descartes' philosophical work would tell us something about his conception of Being on which his method was based. Indeed, we were faced with Descartes' mind-matter ontological dualism. Mind and matter are, according to Descartes, separated substances. This means that they have an independent existence. Furthermore, the difference between the two is infinite (see Descartes, 1642; Heidegger, 1962; Fuenmayor, 1985).

Now, if the primary intuition that holistic sense is somehow in between the thing in itself and the context of meaning (which is rather associated with the mind or minds for which the thing has a sense) holds and, on the other hand, Descartes' idea of an infinite gap between mind and matter is accepted, then holistic sense falls in the infinite abyss of that gap. Holistic sense cannot be explained within an ontological dualism of the Cartesian kind.

Nevertheless, the problem of the counter-ontoepistemology for a systems

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<sup>4</sup> This was noted by various systemists. Their systems ideas were presented as antithetical to the thesis, represented by a method, which starts by reducing and analyzing its object of study. See, for example, Bertalanffy (1968), Ackoff (1974), and Checkland (1981).

<sup>5</sup> Furthermore, a science, which organizes itself around a ferocious specialization, does not seem to provide the more suitable organization for studying holistic senses.

approach is still not clear. What is underpinning Cartesian dualism? What conception of Being was driving such an ontological dualism?

When turning to Descartes' philosophical work, contained in his *Meditations* (Descartes, 1642) and in his *Principles of Philosophy* (Descartes, 1644), we discover that a methodological principle forced him into his dualism. Such a methodological principle was, in turn, based on an epistemological principle pivoted on a conception of truth.

As explained in more length elsewhere (Fuenmayor, 1990, pp. 532-534), the implicit Cartesian dualistic assumption and the idea of the Galilean and Newtonian *more geometrico* ("Mathematical Project of Modern Science") merge together to reinforce the Cartesian ontological dualism. The epistemological thrust was conditioning the ontological account.<sup>6</sup> What is the origin of this mathematical or geometrical conception of truth, and again, what is the origin of Cartesian implicit dualism? This very question led to the study of ancient Greek thought. There we found another type of dualism, very related to mind-matter dualism, namely *genera-individuals* dualism.

#### **4. THIRD LAYER: ARISTOTELIAN "APPEARANCES-BEINGS" DUALISM**

When ancient Greek philosophers began to reflect upon the nature of things, they faced a difficult problem invisible to everyday thought: on the one hand, they observed that things (entities, individuals, appearances, *esse*, *existentia*) were changeable. A tree could be burnt to ashes. Such a tree was transformed into something radically different. On the other hand, there was something fixed in things (*essentia*, *quidditas*). The tree is a tree and cannot be ash. Tree and ash are different beings. For a tree to be transformed into ash, it has to stop being a tree and thereafter become ash. In being a tree there is something fixed to which a particular entity (e.g., the tree in my garden) belongs. After this particular tree has been burnt, that *generic being* to which it belonged continues being. *To be* a tree is precisely to belong to that *generic being* which is fixed. Thus, it seems that the *essence* of being a tree lies in the generic quality of "*treeness*" —not in the fugacity of individual trees. Furthermore, to *know* about trees means to know about the generic being of a tree, not about that unthinkable fleeting character of the changing individual. But how can generic beings (*genera*) be if there are not individuals? Besides, how can change be explained if it is not compared with that which does not change? The problem was clearly posed by Aristotle:

If, on the one hand, there is nothing apart from individual things, and the individuals are infinite in number, how then is it possible to get knowledge of the infinite individuals? For all things that we come to know, we come to know in so

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<sup>6</sup> We strongly recommend reading the above argument concerning Descartes' ontological dualism by Fuenmayor (1990, pp. 532-534), because it is important for keeping the thread of the argument of the present article. Unfortunately it cannot be included here due to space limitations.

far as they have some unity and identity, and in so far as some attribute belongs to them universally.

But if this is necessary, and there must be something apart from the individuals, it will be necessary that the genera exist apart from the individuals. (Aristotle, 1928, B, 4, p. 999a)

Here one could ask, Why is it so important to consider *genera* apart from individuals? The answer was already clear in the above quotation: one can only *get knowledge* of generic beings.<sup>7</sup> Aristotle states it even more clearly in the following:

If there is nothing apart from individuals, there will be no object of thought, but all things will be objects of sense, and there will not be knowledge of anything, unless we say that sensation is knowledge. (Aristotle, 1928, B, 4, p. 999b)

Here again, as in Cartesian thinking, the quest for true knowledge, the epistemological thrust, was conditioning ontology. Here again, we discover that the logical order of an ontology founding an epistemology is being reversed. This seems to suggest that in everyday life, when one is not involved in a reflexive process of knowing about our access to phenomena, one is faced with phenomena in a way in which that which is fixed ("being") is not distinguished from that which is not fixed ("appearance"). Maybe, in that basic level of everydayness (which founds and determines any sort of reflection or scientific activity), one is faced with unitary, nondual phenomena. If this were the case, the duality *genera*-individual would only be a sort of illusion stemming from a particular use of the intellect. Stopping this digression here (it is resumed further on), the inquiry must come back to the interpretation of the ontoepistemological origin of reductionism.

There is also another reason for considering *genera* apart from individuals, namely, the need for something fixed in order to conceive change. Change, movement, and/or the flow of time can be conceived only against the background of something fixed, static, eternal. In Aristotle's words,

Further, nothing will be eternal or unmovable; for all perceptible things perish and are in movement. But if there is nothing eternal, neither can there be a process of coming to be; for there must be something that comes to be. (Aristotle, 1928, B, 4, p. 999b)

The problem persists. Phenomena seems to present two sides, that which changes and change itself—treeness and ashness, on the one hand, and a "not-any-more-being a tree changing into a not-yet-being ash," on the other hand. Fixed, generic "beings" (trees and ashes) can be known, but pure change (a "not-any-more-being a tree changing into a not-yet-being ash") cannot. Nevertheless, since, according to Aristotle, "there is nothing [phenomenally manifested] apart from

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<sup>7</sup> According to Sartre, "To the extent that men had believed in noumenal realities, they have presented appearance as a pure negative. It was 'that which is not being;' it had no other being than that of illusion and error" (Sartre, 1958, pp. xxi-xxii).

individual things," generic, fixed beings cannot exist without the changing individuals. The paradox remains. Later we will see how Aristotle attempted to get rid of such a paradox by placing time out of beings; however, before that we must understand better the source of the paradox.

The need for separating beings (*genera*, essences) from entities (individuals), from which the paradox stems in the first place, seems to be strongly conditioned by a conception of knowledge which somehow is interwoven with a conception of Being. What are those very basic conceptions that seem to be at the origin of the stream of Western thought, and how are they interwoven? Necessarily, one must go back even further in the history of this kind of thought; indeed, back to its very spring. There we find Parmenides, giving the ontological rules that would dominate Western thought; and there we also find Heraclitus attempting to subvert those very rules.

## **5. FOURTH LAYER: THE ELEATIC CONCEPTION OF BEING AND TRUTH AS THE ORIGIN OF DUALISMS**

In the following a brief *interpretation* of one of Parmenides' Fragments is drawn.<sup>8</sup>

According to the Spanish philosopher Ortega y Gasset, Parmenides' ontological position is called "Eleatic Ontology."<sup>9</sup> Let, thus, Ortega y Gasset lead our inquiry:

Starting from Parmenides, when the orthodox thinker searches for the being of something, he believes he is searching for a fixed, static consistency. He is searching for something that already is, something that already constitutes the entity. The prototype of this fixed, stable and present mode of being (= "be what already is") is the being of concepts and of mathematical objects. It is an invariable being, an always-the-same being. Since he found that things in the world were changeable, were "movement," he started by negating its "movable" reality. (Ortega y Gasset, 1941, p. 39; my translation)

According to Ortega this Eleatic ontological principle dominates, in varying degrees, ancient Greek thought:

Greek thought finds its epitome in Parmenides. Without doubt this man was of the pure Greek essence, for, in fact, Eleatism has always reigned in Hellenist minds. Anything which was not Eleatism —simple or composite— was only opposition. This Greek destiny continues gravitating over us and, in spite of some illustrious rebellions, we are still prisoners kept in the magic circle drawn by "Eleatic Ontology." (Ortega y Gasset, 1941, pp. 38-39; my translation)

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<sup>8</sup> In passing, it is worth noting that there are other interpretations of presocratic thinking which differ from the one considered here (see Heidegger, 1975).

<sup>9</sup> Parmenides, Xenophanes, and Xenophanes belonged to a school founded in Elea, a Greek colony on the Tyrrhenian coast of Lucania.



There was in the time of Parmenides, however, another line of thought different, in principle, from Eleatism. It was represented by Heraclitus of Ephesus (died after 480 B.C.). His most well-known doctrine was that all things were in an essential state of flux. Beings were not static and fixed, they were change in their very essence. Being was regarded as a process whose essential dynamism lies in the dialectic tension between "being" and "not-being" (Marcovich, 1967).

However, since "not-being" is "unspeakable" (it cannot be expressed in terms of *genera*), the Heraclitean conception had to be rejected. The point was clearly brought forward by Parmenides in his poem "On Nature":

I am going to tell you now, but pay attention to my words, the only ones that are offered to thought from among the many ways that invest the quest.  
That which affirms that Being is and Non-Being is not. This is the way of persuasion —since it accompanies Truth. And that which says that Non-Being exists and that its existence is necessary. This, I do not hesitate to say, results in an avenue that offers nothing to knowledge. Because one will ever come to know the Non-Being —an impossible thing— nor can it be expressed in words. (Parmenides *et. al.*, 1975, pp. 49-50; my translation)

### **5.1. The Interest of Persuasion at the Bottom of Eleatism**

If we pay careful heed we can find, within the lines of this poem, the clue to the quest for the origin of both dualisms (mind-matter and appearances-beings) that have dominated Occidental thought. We can also find, between the lines of the poem, the origin of the merging together of ontology and epistemology in most of Western thought. As shown later, this merging together is neatly represented by the principle of principles in Western thought: the principle of noncontradiction.

The only possible path offered to thought, says Parmenides, is "that which affirms that Being is and Non-Being is not. This is the way of persuasion —since it accompanies Truth." Those who, like Heraclitus and much later Hegel, Heidegger, Sartre, and others, have been concerned with dialectically explaining Being from Non-Being,<sup>10</sup> go by a path of thought which "offers nothing to knowledge." At least, it offers nothing to that sort of knowledge which can be communicated to others (human beings) so that they can be *persuaded* by it. A notion of truth (*aletheia*) and knowledge, or rather a normative notion of knowledge which pretends to be true, decides in advance that Non-Being, and with it the ground from which any being is possible, have to be disregarded. What notion of true knowledge is that which Parmenides relates to "persuasion"?

### **5.2. The Traditional Concept of Truth in Reductionist Science**

The Greek word for truth is *aletheia* (ἀληθεία). According to T. Gaisford's *Etymologicum Magnum* (quoted by D. Farrel Krell; Heidegger, 1975), *aletheia* means "unconcealment." That which is unconcealed is that which appears as actual,

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<sup>10</sup> Or, more precisely, in Heidegger's words, "Nothingness is the not of being and thus is Being experienced from the point of view of being." (Heidegger, 1969, p. 3)

and thus, it is not concealed. That which appears as actual are actual beings, that which is the case. But when the Greek term declares them as "unconcealed," it is somehow implying that what appears as unconcealed becomes from the concealed (see Fuenmayor, 1990, pp. 527-530). That is to say, what appears as an actual being is somehow becoming from Non-Being. Nevertheless, we can say something about something, not about nothing; that is, through language, determinations are performed in that which already is actual. Nothing can be said about what is concealed (Non-Being). Parmenides, and the tradition of thought (Eleatism) inaugurated by him, was driven by the *interest* of persuasion. Indeed Eleatism was interested in getting the sort of knowledge which could be communicated to others so that they could be persuaded of its truth. Hence, even when the sort of thinking in which Parmenides was involved clearly indicated to him that, although an authentic understanding of presence required of the dialectics of Being and non-Being, such an authentic understanding had to be put aside for it could not be in the way of persuasion. What sort of knowledge can we get of that which is actual (and thus unconcealed) so that it can be communicated to others in a way that they can be persuaded? This query seems to be a clearer formulation of the epistemological preconditions which were closing the path of the original ontological question, namely, how that which appears is unconcealed from the concealed? In our example of the tree, the Eleatic epistemological question turns to be, What can we know about that particular tree which could be burnt to ashes, so that we can persuade others of that knowledge? We can speak about its properties, about its parts. We can formulate *declarative propositions* regarding that tree which can be tested by others in the tree. However, we cannot say anything about a {not-any-more-being a tree changing into a not-yet-being ash} which could be tested by others in something which *keeps on being actual*. This is how Eleatism *reduces* phenomena to things in-themselves.<sup>11</sup> As already commented, holistic transcendence is lost in the reduction.

The interest of persuasion conducted the original notion of *aletheia* into the Aristotelian *homoiosis* (accordance) of a statement (*logos*) with a matter (*pragma*), which gives rise to the traditional concept of truth in Western thought. From Aristotle it passes to Aquinas so that truth is defined as *adaequatio intellectus et rei*, the correspondence or agreement of public knowledge with general objects of that knowledge. *Adaequatio intellectus et rei* becomes thus the prevailing idea of truth in Western thought. Indeed, on the side of idealism, Kant speaks of "the agreement of knowledge with its object"; on the side of contemporary logical positivism, truth is sometimes defined as "empirical verifiability" (see Popper, 1959). Further on [Section 6 in this article and Fuenmayor (1991d)] it is shown more clearly that truth so conceived is nothing but the reduction of the fleeting richness of phenomena to fixed "beings." How this notion of truth blocks the quest for holistic transcendence is also discussed by Fuenmayor (1991a, b).

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<sup>11</sup> The point is treated again by Fuenmayor (1991b). There, it is shown, that this reduction implies to reduce the phenomenon to something that can be "the same with itself" and "the same for me and for the other."

### 5.3. The Externality of Time in Eleatic Ontology

We have seen how an epistemological thrust, pivoted on a particular conception of truth and driven by an interest of persuasion, was conditioning a conception where beings are considered fixed and static. According to Ortega y Gasset, Aristotle drops the radical position denying change and adopts a "*juste milieu* solution."

He [Aristotle] looks for what is stable within change in the moving thing. This is what he called the "nature" of things. Thus, nature is that of a being which appears to hide itself in the real thing; i.e., concepts and mathematical objects. *Physis*, θῆσις (physical), was the invariable principle of variations. In this manner, it was possible to preserve the fundamental eleaticism of being and yet, to think as realities those things that for absolute eleaticism lacked authentic reality. (Ortega y Gasset, 1941, p. 39; my translation)

According to this "*juste milieu* solution," that which is changing, that which is becoming, must "be" something "within" a process of change. (Notice that change is taken as external to beings.) To *be* is to be fixed, static, and permanent. Hence, change has to be accidental to what is primarily fixed. Observe that the externality of change with regard to being is predetermined by the aprioristic assumption of a fixed being.<sup>12</sup>

Thus, the paradox is apparently solved by assuming an essential fixity in beings and supposing that entities could change through time. Time becomes the connecting thread of entities through beings.<sup>13</sup> As connecting thread, it becomes an "external coordinate axis" where entities are located. In consequence, entities are conceived as "states of beings" located at a point which divides the line of time into *past* and *future*. Beings, on their part, are the temporary transcendence of entities (i.e., that which entities are through time). Notice that the notion of time is at the base of the difference between beings and entities.

The inclusion of such a conception of time allowed Eleatic Ontology to keep the idea of fixity of beings together with the changing character of entities. Time enables the description of something which is changing. This is no more than description of Nature in terms of its nomological essence. Of course, this is very different from the description of something whose very being is change (which may have been Heraclitus' idea).

The Eleatic conceptual trilogy {being-entity-time} can be taken as the very ontoepistemological foundation of the counter-ontoepistemology for a systems approach. As already discussed, it is not a pure ontological foundation given that its roots are inseparable from the epistemological intention of expressing knowledge universally claimed as true. But how can such a claim be justified?

It is important to notice that the interest of persuasion, which somehow

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<sup>12</sup> Besides, it is interesting to notice that what is fixed can only be thought as such, if it is contrasted with change, and vice versa.

<sup>13</sup> Aristotle conceives time as the essence of movement (see Aristotle, 1928, Δ, p. 1020a).

deluded the original presocratic notion of Being and truth, is not limited to an everyday situation in which one particular human being is persuading another particular human being. On the contrary, it is an interest with a pretension of universality among rational beings, disregarding the nuances of persuasion in particular, face-to-face, human encounters. This means that true knowledge must find a way of being manifested or expressed so that it can persuade any rational being. The expression of knowledge becomes, in this way, a central problem for the Modern notion of truth. What should be the general shape of the expression of true knowledge so that this interest of universal persuasion can succeed? In other words, what are the rules for argumentation in this Modern conception of truth? Those rules of argumentation are framed within the "Mathematical Project of Modern Science."

## 6. COMING BACK IN BETWEEN THE SECOND AND THE THIRD LAYER: THE MATHEMATICAL PROJECT OF MODERN SCIENCE

Empiricism (which seems to give priority to "appearances") and Rationalism (which seems to give priority to "beings") are often seen as two incompatible epistemological approaches which contend for supremacy in modern science. In opposition to this view, Immanuel Kant argued, in his *Critique of Pure Reason* (1787), that both empiricism and rationalism belong together in a single "project" of modern science. Indeed, empiricism could not wrest away the *axiomatic* character of the rationalist beginning of natural sciences. The very core of the "*project*" of Modern Natural Science —neatly represented by Newton's *Mechanics*— was brilliantly explained by Kant as follows.

In the earliest times to which the history of human reason extends, *mathematics*, among that wonderful people, the Greeks, had already entered upon the sure path of science. (Kant, 1787, p. Bx)

A new light flashed upon the mind of the first man (be he Thales or some other) who demonstrated the properties of the isosceles triangle. The true method, so he found, was not to inspect what he discerned either in the figure, or in the bare concepts of it, and from this, as it were, to read off its properties; but to bring out what was necessarily implied in the concepts that he had himself formed *a priori*, and had put into the figure in the construction by which he presented it to himself. If he is to know anything with *a priori* certainty he must not ascribe to the figure anything save what necessarily follows from what he has himself set into it in accordance with his concept. (Kant, 1787, pp. Bxi-xii)

Notice that "*a priori* concepts" are fix Eleatic beings. Kant proceeds:

Natural science was very much longer in entering upon the highway of science . . . When Galileo caused balls, the weights of which he had himself previously determined, to roll down an inclined plane; when Torricelli made the air carry a weight which he had calculated beforehand to be equal to that of a definite volume of water; or in more recent times, when Stahl changed metals into oxides, and

oxides back into metal, by withdrawing something and then restoring it, a light broke upon all students of nature. *They learned that reason has insight only into that which it produces after plan of its own, and that it must not allow itself to be kept, as it were, in nature's leading-strings, but must itself show the way with principles of judgment based upon fixed laws, constraining nature to give answer to questions of reason's own determining.* (Kant, 1787, pp. Bxii-xiii; my italics)

In the above paragraph the German word for "plan" (in "They learned that reason has insight only into that which it produces after a *plan* of its own"), *Entwurf*, may be translated more properly as "project." "Project," in the sense of "to cause to appear onto something," together with that other sense of "plan," "scheme," or "design," gives full meaning to Kant's idea: "Reason only gains insight into what it produces according to its own projects." This means that *Reason projects its project* (what it is searching for, regularity) *onto things and reflects back a part of "Nature"* (regular phenomena). The designing of that which is to be projected is the plan, or project. This project so conceived defines the epistemology of natural science.

Science, as conceived by Kant, must start from axiomatic principles (definitions whose validity is intuitively accepted without proof, argumentation, or demonstration and which serve the purpose of being principles from which new propositions are deduced) just as mathematics does. Thereafter, by means of *deductive* reasoning, a theoretical model (project, scheme) is developed. Euclidian geometry is the classical example of such a model. In the case of formal sciences (mathematics and logic), this model is completed in itself. Natural Empirical Science must test the "hypotheses" resulting from the deductive process by means of induction performed on experimental data. Newtonian Mechanics can be taken as the paradigm in this case. In Kant's words,

Mathematics and physics, the two sciences in which reason yields theoretical knowledge, have to determine their objects *a priori*, the former doing so quite purely, the latter having to reckon, at least partially, with sources of knowledge other than reason. (Kant, 1787, p. Bx)

What are those sources of knowledge? How are deduction and induction orchestrated?

### **6.1. The Transformation of Things into Mathematical Definitions**

Heidegger (1967) reopened the topic about the axiomatic character of modern science with incisive insight. Heidegger's argument may be summarized as follows.

First, a philological examination of the word "mathematical" is performed:

In its formation the word "mathematical" stems from the Greek expression *ta mathemata*, which means what can be learned and thus, at the same time, what can be taught; *manthanein* means to learn, *mathesis* the teaching, and this in a twofold

sense. (Heidegger, 1967, pp. 249-250)

The *mathemata* are the things insofar as we take cognizance of them as what we already know them to be in advance, the body as the bodily, the plant-like of the plant, the animal-like of the animal, the thingness of the thing, and so on. . . . (Heidegger, 1967, p. 251)

Observe that in this sense the *mathemata* are "beings" (*genera*, essence) as conceived by Eleatic ontology. The learning of *ta mathemata* "is therefore an extremely peculiar taking, a taking where he who takes only takes what he basically already has" (Heidegger, 1967, p. 251).

The *mathemata*, the mathematical, is that "about" things which we really already know. Therefore we do not first get it out of things, but, in a certain way, we bring it already with us. From this we can now understand why, for instance, number is something mathematical. We see three chairs and say that there are three. What "three" is the three chairs do not tell us, nor three apples, three cats, nor any other three things. Rather, we can count three things only if we already know "three." In thus grasping the number three as such, we only expressly recognize something which, in some way, we already have. This recognition is genuine learning. The number is something in the proper sense learnable, a *mathema*, i.e., something mathematical. (Heidegger, 1967, pp. 252-253)

Notice that in this wider sense mathematics is not "numerical in character" but "the numerical is something mathematical." It is in this wider sense of the concept that we can speak about the "mathematization" of Modern Natural Science or about the "Mathematical Project of Modern Science."

*The "Mathematical Project of Modern Science" consists of the reduction of phenomena to Eleatic beings which can be axiomatically defined and mathematically operated within deductive and inductive chains.* But how are deduction and induction orchestrated within the Mathematical Project of Natural Science?

According to Kant, Empirical Natural Sciences cannot approach nature "in the character of a pupil who listens to everything that the teacher chooses to say, but of an appointed judge who compels the witnesses to answer questions which he has himself formulated" (Kant, 1787, p. Bxiii). How are such questions formulated within the inquiring process? Heidegger treats the topic by examining Newton's major work: *Philosophiae Naturalis Principia Mathematica* (1686-1687):

This work was not only a culmination of preceding efforts, but at the same time the foundation for the succeeding natural science. It has both promoted and limited the development of natural science. When we talk about classical physics today, we mean the form of knowledge, questioning and evidence as Newton established it. When Kant speaks of "Science," he means Newton's physics. (Heidegger, 1967, p. 255)

Heidegger concentrates his examination on the "First Law of Motion," which is the first principle (axiom) of the "Principles or Laws of Motion" ("*Axiomata, sive leges motus*"). This is the so called principle of inertia (*lex inertiae*): "Every body continues in its state of rest, or uniform motion in a straight line, unless it is compelled to change that state by force impressed upon it."

The First Law of Motion acts as the axiom which allowed the *mathematization* (both in the wide and in the narrow sense) of the motion of bodies. It is a principle —containing a *convenient* conception of Being, things (bodies), movement, space, and time— stemmed from Eleatic ontology which pervaded modern science and, in general, modern thought. Let us see why.

"Body" is a high-level abstraction of particular things, and is viewed simply as a unit of the *res extensa* (Descartes, 1642). This pen in my hand is a *body* as much as those *three* chairs are a "*three*." This pen, then, *is not* a body; rather it belongs to the genus "body." The abstraction involved in this belonging singles out some properties common to all individuals forming the genus. Physics refers to "bodies," not to particular entities. "Bodies" are mathematical (Eleatic) beings whose properties —which have been axiomatically assigned— can be measured. In this way, *particular things are used as illustrations (as "witnesses") of something that they "represent" and have to obey.*

Now it can be seen more clearly how induction and deduction are orchestrated within the Mathematical Project of Modern Science. For that purpose a methodological outline of the Mathematical Project of Modern Science is presented below.

- (1) The supposed phenomena under study are *reduced* to certain axioms alluding to generic eleatic beings (e.g., "bodies") and their initial *determinations*. (Notice the meaning of *Reduction*.)
- (2) The axioms are rationally (deductively) connected in order to derive new relations and hypotheses.
- (3) The resulting hypotheses are tested against experimental reality. This testing is, as wittily indicated by Kant, like that of the "judge who compels the witnesses to answer questions which he has himself formulated." That is to say, Nature is constrained "to give answer to questions of reason's own determining" (Kant, 1787, p. Bxiii).
- (4) In Natural Science, hypotheses testing is performed by means of induction: experiments are set in order to show the "statistical significance" of relations obtained among certain "facts" (properties) indicated "*a priori*" in the hypotheses.
- (5) The proved hypotheses, then, turn into new "principles" which would enrich the Mathematical Project.

The conceptual material introduced under the title of "The Mathematical Project of Modern Science" sheds new light on the whole counter-ontoepistemology

for the systems approach. To be sure, the Mathematical Project is at the very base of Descartes' thought. Descartes' work, understood as the formal starting point of modern thought, laid the foundation for the Mathematical Project. Reason, according to Descartes, must be guided by a method which starts from simple principles (axioms). The Method, then, is the procedure and general guideline by means of which rational thought must be conducted so that what is to be questioned (either about nature or, directly, about "pure reason") emerges from the application of such a Method:

The method consists entirely in an orderly arrangement of the objects upon which we must turn our mental vision in order to discover some truth. And we shall be observing this method exactly if we reduce complex and obscure propositions step by step to simpler ones, and then, by retracing our steps, try to rise from intuition of all of the simplest ones to the knowledge of all the rest. (Descartes, 1701, p. 157)

Observe that the simplest "principles" to which Descartes referred in the analytical phase of his method seem to be *axiomatic principles* and not simply "parts" as it is commonly understood within the Systems Movement or within the first part of this counter-model. There is certainly a reduction, but in light of the latter arguments, it becomes clearer that it has its foundation in an *ontological reduction*: each particular phenomenon is *reduced* to a "thing-in-itself." A thing-in-itself is a generic Eleatic being. A being which is indicated and partially determined within a set of axioms.

Now it can be seen how the Mathematical Project of Modern Science pretends to accomplish the Eleatic thrust toward a universal framework for *argumentation* so that the underlying interest of *persuasion* can be satisfied. Indeed, the original idea of *ta mathemata* provides the basis for a universal language for anonymous persuasion. It is indeed a *"mathematical language" that claims to be "potentially" universal, due to its self definition and to the possibility of reducing arguments to precise logical relations.* The universal validity of those logical relations is founded on universally true "logical principles" underlying deduction and induction. Of those logical principles, there is one that provides the foundation for the others. This "principle of principles" is the principle of noncontradiction: "the same thing cannot at one and the same time be and not be." (Aristotle, 1952, p. 590)

## **7. RETURNING TO THE FOURTH LAYER: THE PRINCIPLE OF NONCONTRADICTION**

The axiomatic ("mathematical" in the broader sense) character of "Modern Reductionist Science" was depicted above. Such "axiomaticness" was illustrated within the paradigm of Modern Natural Sciences: Newton's *"Principia Mathematica."* Axiomatic principles, such as Newton's First Law, are *convenient* and, if possible, *intuitively evident* propositions, or sets of propositions (discourses), serving as a basis for the deductive development of the "Project" and which cannot



be contradicted by such development. *This last idea of "noncontradiction" is the fundamental criterion for truth within the Mathematical Project of Modern Science.*

As such, the principle of noncontradiction is both the main and fundamental axiom of any axiomatic development and the defining principle of "axiomaticness" itself. It is the starting principle (i.e., that from which any axiomatic building starts), the ending principle (it is the last and highest Court of Appeals for demonstration), and the fundamental criterion for truth. Thus, it is the core of the Mathematical Project.

Ah this is widely accepted —although not widely considered explicitly— in the milieu of Modern Reductionist Science. What remains hidden starts with the observation that *the principle of noncontradiction indicates and connects the main regions of an ontology.*

The principle of noncontradiction, as announced by Aristotle, states that **"The same thing cannot at one and the same time be and not be"** (Aristotle, 1952, p. 590; my emphasis).

Observe that the notions dealt with by this principle are those of *Being* (Being and Not-Being), *time* (synchronism and diachronism), *possibility* (what can be), *sameness and diversity* (alteration).

There are two meanings usually attached to this saying.

- (1) Either A is or A is not.
- (2) Either A is B or A is not B.

The first case refers to the whole being of A. As noted by Hegel in his *Logic* (1984, CXV), this is nothing but the negative formulation of the principle of identity ( $A = A$ ). The second case refers to a particular determination of "A." "A" cannot have and not have the same determination ("B") at the same time (A cannot be green and not green at the same time). The first interpretation, discussed in the following,<sup>14</sup> is of primary interest here.

As stated above, the principle of noncontradiction can also be stated in a positive way in the form of the principle of identity ( $A = A$ ). The latter says that A is identical to A or that A is the same with itself. The question here is the meaning of "identity" or "sameness." In its negative formulation (the principle of noncontradiction), the subject of the sentence —that of which it is saying something— is "the same thing" ("*the same thing* cannot at one and the same time be and not be"). What does "the same" in the phrase, "the same thing," mean? On the other hand, what is this "thing" which is declared as "the same"? Again, in the negative version of the principle of principles the question concerning the meaning of "identity" or "sameness" seems fundamental.

"The same" (τό αὐτό), or rather "sameness," according to Aristotle, "is a

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<sup>14</sup> The reader will be able to appreciate that the argument with regard to the first interpretation is applicable to the second.

unity of the being either of more than one thing or of one thing when it is treated as more than one." In the latter case, proceeds Aristotle, "when we say a thing is the same as itself, . . . we treat it as two" (Aristotle, 1928, Δ, 9, p. 1018a). Sameness is a belonging together of two or more things (individuals, appearances) in the unity of their being.

When I say "this is the same person," I mean that this person, who is present now and here, is "identified" with my image of a person that I saw before. To be "identified with" seems to mean to put together in some sort of gathering. But "to identify" also means to "give identity." To give identity means both to recognize *as such* and to give unity. Therefore, it seems as if the "image" of a person that I saw before allows for recognition, hence, for the appearance of this person *as such*. In this way, "this is the same person" is equivalent to saying "This is X" —e.g., "This is Peter." "Peter" is the name of that "image" which allows the "identification" of this person. Observe that this person is present now and here, whereas my "image" is nonpresent; rather, it is a sort of ground for the appearance of that which becomes present.

"This is the same thing" means that this which *is present* has been gathered, in a gathering that we call "sameness," together with something which *is not present*. The latter nonpresence is necessary, for if two things are simultaneously present, they cannot be "the same thing." In this case, even though they are "identical," they are different entities, hence, they are not "the same thing." This which *is present* has been gathered with what *is not present* and *cannot be present*.

Come back now to the example of the person of which it is said "this is the same (person)." Suppose I find again this person. I say again, "This is the same person." The series of appearances of this person is gathered together in that *sameness*. "The same" thus seems to be *that which persists in time through the series of appearances*. But what is *that* which persists in time?

The Eleatic answer is that *that* which persists in time is the unity of the being of that which has multiple appearances. This which is present (the changing individual, the fleeting appearance) cannot be, according to this interpretation, the source of sameness. Rather, sameness seems to lie in that which is not present, which provides the qualification of "the same" to the present thing. This is what Aristotle seems to mean when he says, "Sameness is the unity of the being of. . . ." Sameness is the unity of the being (that which is not present) which, in the gathering called "sameness," provides the ground for the identification of an accidental presence. But "unity of being," according to Aristotle, is the same as "being," for "being and unity are the same" or, with more emphasis, "unity is nothing apart from being" (Aristotle, 1928, Γ, 2, p. 1003b). Now, as stated before, this "being" which persists in time is nonpresent (whereas each one of the appearances is in each case present). It is both fixed (unchangeable, persistent through time) and nonpresent. This fixed and nonpresent "being," this "image" or "idea" (εἶδη), is that to which the principle of noncontradiction refers. It "cannot at one and the same time be and not be," whereas the changing individual, e.g., a not-

any-more-being a tree changing into a not-yet-being ash, can be and not-be at the same time.

With regard to the positive version of the principle of noncontradiction, i.e., the principle of identity, the same conclusion can be reached. "A" can only be the same with itself, if we are referring to a fixed essence of "A." The treeness of a tree can be the same with itself, but "a not-any-more-being a tree changing into a not-yet-being ash" cannot be the same with itself.<sup>15</sup>

The principle of noncontradiction (or the principle of identity) defines a conception of beings to which the principle is applicable. But it also can be said that an ontology is conditioning the possibility of the principle of noncontradiction. This is the same Eleatic ontology indicated by Parmenides in his saying, "That which affirms that being is and non-being is not, this is the way of persuasion since it accompanies truth" (quoted before). Furthermore, now it is clear that such a saying is nothing but the principle of noncontradiction. However, in Parmenides' saying, the principle is explicitly conditioned by an epistemological thrust. Such a thrust is pivoted on a particular conception of truth, grounded on the interest of persuasion.

Now it can be seen how the Mathematical Project of Modern Science, pivoted on the principle of noncontradiction, provides the framework for the epistemological thrust which in the origin was defining Eleatic ontology. On the other hand, Eleatic ontology provides the basis for the principle of noncontradiction, for the whole Mathematical Project of Modern Science, for Cartesian dualism, and for the reductionist character of Modern Science.

Now we have a more complete picture of the *counter-ontoepistemology* for a systems approach. But, how to define its antithesis: the ontoepistemology for a systems approach? What is the dialectical climax where both approaches touch and reject each other?

## **8. THE DIALECTICAL CLIMAX BETWEEN THE COUNTER-ONTOEPISTEMOLOGY AND THE ONTOEPISTEMOLOGY FOR A SYSTEMS APPROACH: THE FORM OF ESSENTIAL RECURSIVENESS**

It has been argued that the Eleatic ontology embedded in Reductionist Science cannot explain Holistic Transcendence. Thus, such ontology could not be the basis for a Systems Approach. *Would not a different conception of Being and Time—for example one suitable for a Systems Approach— weaken the principle of noncontradiction?* If this is the case, would not the Mathematical Project also be uprooted?

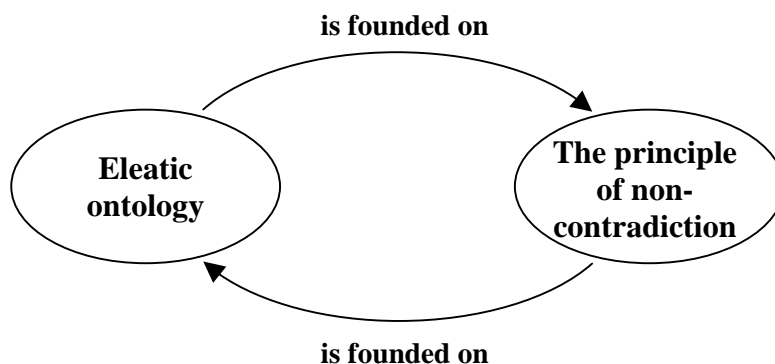
We are proposing to question both Eleatic ontology and the Principle of noncontradiction. But how can the "principle of principles" be questioned, if it is constantly being used? *How can we see such a principle from outside, so that another possibility may be uncovered, if we seem to be completely trapped within*

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<sup>15</sup> According to Hegel, the principle of identity, "far from expressing a real law of thinking, is only a law of abstract thinking" (Hegel, 1984, CXV, p. 12, my translation).

*it?* The principle of noncontradiction was said to be founded on Eleatic ontology. Therefore, one way to question that principle could be to design a nonEleatic ontology and construct over it a "new logic." However, the problem is much more complicated than this. *If it can validly be said that the principle of noncontradiction is founded on Eleatic ontology, it can be said, with the same validity, that Eleatic ontology is founded on the principle of noncontradiction.*<sup>16</sup>

In this way it becomes clear that the Principle of Noncontradiction and Eleatic ontology are recursively defined with regard to each other. See Fig. 1.



**Fig. 1.** Essential recursiveness between Eleatic ontology and the principle of noncontradiction.

This recursive situation complicates the possibility of questioning the principle of noncontradiction by designing a non-Eleatic ontology and, thereafter, constructing over it a "new logic." Nevertheless, it also shows a way to approach the question: both the "new logic" and the non-Eleatic ontology should be recursively constructed. However, the problem remains: How to start such a recursive process? The answer can be found in recursiveness itself. For this purpose, the principle of noncontradiction must be called again before this inquiry.

### **8.1. Revisiting "Sameness" in the Principle of Noncontradiction**

When the notion of "sameness," underpinning the principle of noncontradiction (or of identity), was discussed above, an Eleatic (rather Aristotelian) path was followed. A fundamental objection to this Aristotelian reply can now be posed.

Following the Eleatic path, it was stated that the source of "sameness" lies in the fixed, nonpresent being persisting through time. However, if there were not that

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<sup>16</sup> To see the certainty of this last assertion, remember the problem of explaining change for the ancient Greek philosophers: the wood which burns to ashes *is-not* a wood any more, it is ash. But how could such a piece of wood lose its very being and become a new being? For it cannot be wood *and* ash. It is either wood *or* ash, because "something cannot *be* and *not-be* at the same time." This problem, which was taken to be a fundamental conditioner of Eleatic Ontology was, in turn, clearly conditioned by the implicit assumption of the principle of noncontradiction.

present thing, of which we say it is "the same," we could not be speaking or thinking about "sameness." Hence, *sameness* cannot simply lie (or be founded) on the unity of the nonpresent and nonaccidental (fixed) being. Sameness must lie in the gathering together of both the present thing (the fleeting appearance) and the nonpresent being. That which is to become present does become present *as such* only on the grounds of that which is nonpresent. This nonpresence is then both a negation of presence (nonpresence) and a sort of copresence essential to presence. On the other hand, as argued before, that which is nonpresent is "realized" only through the presencing of that which becomes present as such. Therefore, "This is the same person" or "This is Peter" announces the transcendental synthesis of a very strange sort of duality. The transcendental synthesis, however, has temporal priority over its constitutive duality. That is, when we are faced in everyday life primarily with "the same person" there is just a unitary phenomenon—not a duality. When we thereafter reflect on the meaning of this "sameness," we find that the original unity seems to stem from the duality of *appearance* (A) and *being* (B). Nevertheless, if we think about it more carefully, we also find that "A" cannot be without "B" and "B" cannot be without "A." It is precisely this "essential recursion" held between *appearance* and *being*, what gives back its original unity to the phenomenon.<sup>17</sup>

However, this strange duality constitutes a sort of self-referential paradox. Such a paradox was precisely what Parmenides and all the Eleatic tradition wanted to avoid by prescribing the principle of noncontradiction. However, precisely by avoiding it, and by separating appearance and being in an irreconcilable duality, the principle of noncontradiction becomes contradictory in itself. In the following, this paradoxical logical form of self-reference, or as we call it, "essential recursiveness," is considered in greater detail.

## 8.2. The Form of Essential Recursiveness: A Pictorial Introduction

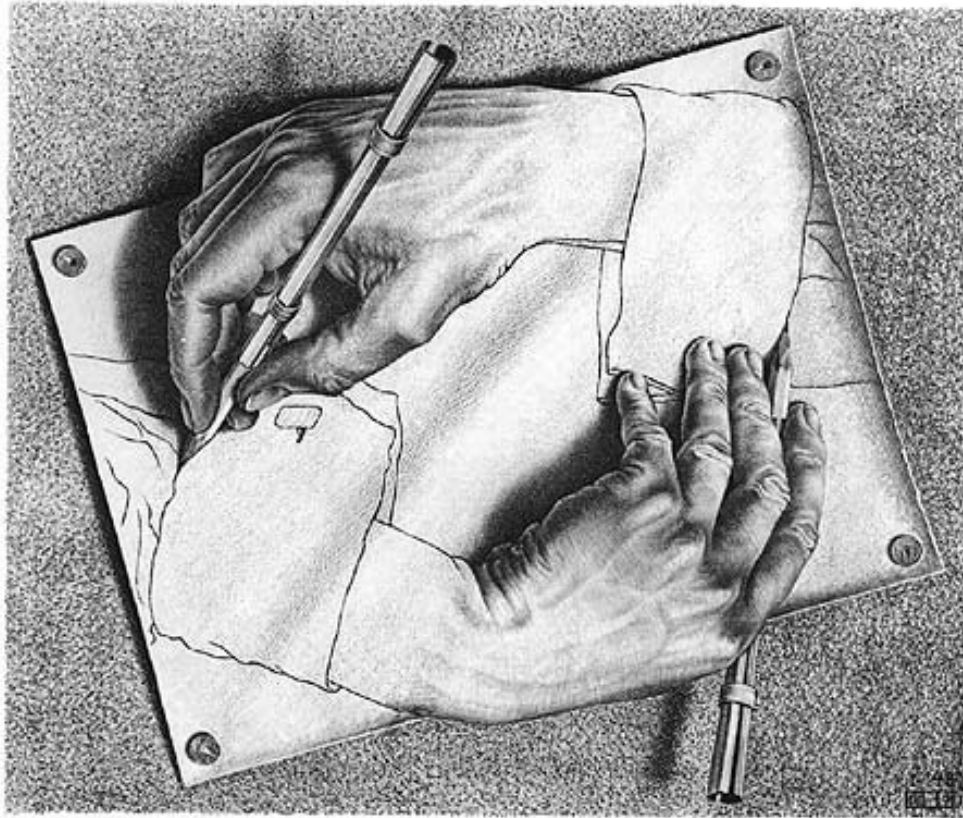
Let essential recursiveness be illustrated by the amazing "Drawing Hands" of Escher in Fig. 2. When we look cursorily at the drawing we see two hands. (This first look is a first holistic perception.) "One" is drawing "the other." "The other" is drawing the "one"!<sup>18</sup> (We have performed a diachronic analysis.) "Going back in time," we ask who drew one of them in order to draw the other. (This question triggers off the synthesis that brings about the paradox.) The astonishing answer is that "the other" drew "the one" in order to draw "the other." (Notice that the difference between "the one" and "the other" becomes blurred within the recursive loop.) These hands seem to be outwitting the concept of causation. A "first look" at the "Drawing Hands" revealed just two hands. At that moment we still had not realized what was occurring. Nevertheless, after observing them more carefully, we fall into a "paradoxical" closed loop. There are two questions that conduct this

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<sup>17</sup> The same sort of argument can be applied to the "mind-matter" dualism (see Fuenmayor, 1985).

<sup>18</sup> The verb "to draw" is used here simultaneously with regard to two of its English meanings: "make with a pencil" and "cause to manifest."

process of analysis-synthesis and which make manifest the recursive form: (1) What are the hands doing? and (2) How did one of the hands come to be?



**Fig. 2.** "Drawing Hands" by M.C. Escher.

Observe that we first saw two things. In that first look we did not identify, *a priori*, a perceptual unity as it occurs in most perceptions. In the first moment we see two hands, but at the same time, a quick insight says that they belong to something which still is not clear. Such intuition —perhaps triggered by what the hands are doing— puzzles us, so that an analytical exam is performed on each hand. An attempt is made to discover what they are doing. We seem thus to be searching for a "process" which might discover the unity to which the hands belong. However, this process is not searched for as a unitary process from the beginning: we start by observing two *things* and looking for two process for each one. In this way, the inquiry assumes *a priori* the presence of two processes (what each hand is doing) separated in time. That is, *we arbitrarily split a priori the synchronism of the whole process into an analytical diachronism*. The arbitrariness does not seem to be harmful because time is conceived, according to Eleatic ontology, as an external coordinate to beings. Hence, events can be placed on different points on this coordinate axis.

The procedure by which an aprioristic diachronic analysis on each hand's

doing is performed, and by which, thereafter, the product of such analysis is synthesized in order to find the required unitary process that gives meaning to the parts, is condemned to fall into a paradoxical trap. Is there no way out of this trap? Vickers' account of our inner trap (see Fuenmayor and López-Garay, 1991) provides a clue:

. . . We the trapped tend to take our own state of mind for granted—which is partly why we are trapped. With the shape of the trap in our minds, we shall be better able to see the relevance of our limitations. . . . (Vickers, 1970, p. 16)

As Vickers proposes, the way out of the trap is to gain awareness of "our own state of mind." We must have the "*shape* of the trap in our minds." This means, in the case of the paradoxical trap described above, to learn to observe its *shape* as a holistic and essentially dynamic process, as an essential recursive *form*. Such learning will enable us to recognize *a priori* the transcendental unity—the new logical form—to which the structure belongs. Let us then see the *form* of the trap so that the trap disappears.

If one considers time as essential to the whole "Drawing Hands" situation—not as an external coordinate where separated events may be put—one hand cannot be thought of without the other, and vice versa. *The hands are essentially and ontologically connected "sides" of one unitary situation: the "Drawing Hands"*.

Escher's "Drawing Hands" *represents* what was called the "Logic of Essential Recursiveness." Formally, it can be characterized as a *two-sided unitary situation in which each one of the sides is ontologically and essentially founded on the other. Such a foundation is rooted in the situation as a whole. The "sides" are not elements with independent existences. However it is always possible, through a "timeless" and "apparent" look, to see each side as an "element of a set."*

Now it is possible to understand how essential recursiveness threatens the principle of noncontradiction:

1. Take the simplest version of the principle of noncontradiction: "P *or* not-P." This means, "Either P *is or* not-P *is*" (both cannot be at the same time).
2. Let A and B be the sides of an "essential recursive phenomenon." A *is being* only in so far as B *is being*, which in turn *is being* only in so far as A *is being*, and so on and so forth. In this case and according to the usual meaning of "*being*" (eleatic meaning), one cannot simply assert that "A *is*" or that "A *is not*" (the same holds for B). *Hence, "A neither is nor is-not."* This, in turn, is equivalent to "A *is and is-not at the same time.*"

The threat against the principle of noncontradiction involved in Essential Recursiveness can be seen more formally by means of a short review of the history of the so-called (in logic) "self-referential paradoxes."

### 8.3. The Victorious Presence of Self-Referential Paradoxes in Formal Logic

Escher's "Drawing Hands" can be considered as a pictorial illustration of a self-referential paradox. However, the paradigmatic and oldest example of this kind of paradox is the liar paradox.

Epimenides, a Cretan, claims "All Cretans are always liars." Is this a lie? The simplest form of this paradox would be provided by the man who says "I am lying." If such a proposition is true, then it is false, and vice versa. Another form of the self-referential paradox which shows more clearly its essential recursiveness is the following.

Let  $P_1$  and  $P_2$  be two propositions.

$P_1$ : " $P_2$  is true."

$P_2$ : " $P_1$  is false."

Here  $P_1$  is true if and only if it is not true. The same can be said about  $P_2$ . The apparent violation of the principle of noncontradiction is plain. Whitehead and Russell (1910, p. 60) tried to show that these kind of paradoxes are the product of a logically careless construction. Their argument can be posed as follows.<sup>19</sup>

Classes (or sets) may be of two types.

- (a) *Normal classes* are those which are not members of themselves. For instance, the class of pencils is *not* a member of itself.
- (b) *Nonnormal classes* are those which are members of themselves. For instance, the class of nonpencils is a member of itself.

Let  $N$  be the class of *all* normal classes. The question is, "Is  $N$  a normal class?" If  $N$  is normal,  $N$  is not a member of itself (remember that  $N$  is the set of all normal classes); hence, it is a nonnormal class. Now, if  $N$  is not-normal,  $N$  is a member of itself; hence  $N$  is normal. In conclusion,  $N$  "is" normal if and only if  $N$  "is-not" normal.

Russell's paradox displays with great clarity a form of essential recursiveness leading to a drastic violation of the principle of noncontradiction. This affront to the principle of principles was readily confronted by Russell himself. His arguments, or rather his "prescription," are founded on the idea that *a totality may not have members which are defined in terms of such totality*. This is called the "Principle of the Vicious Circle."

The *Principle* of the Vicious Circle (notice that it is an axiom) leads to the "Theory of Logical Types" to be used to solve the contradictions involved in self-

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<sup>19</sup> Russell's account of this paradox is as follows: "Let  $W$  be the class of all those classes which are not members of themselves. Then, whatever class  $X$  may be, ' $X$  is a  $W$ ' is equivalent to ' $X$  is not an  $X$ .' Hence, giving to  $X$  the value  $W$ , ' $W$  is a  $W$ ' is equivalent to ' $W$  is not a  $W$ '" (Whitehead and Russell, 1910, p. 60). However, we follow Nagel and Newman (1970, pp. 40-41) for that which we consider to be a clearer expression of such paradox.



referential paradoxes. The establishment of the Principle of the Vicious Circle together with its formalization, the Theory of Logical Types, appeared to be the final and definitive stroke for exiling paradoxes from the land of Logic and Mathematics. Such an exile would be of great importance for keeping the positivistic scope of Modern Reductionist Science.

Nevertheless, this was only an apparent victory against self-referentiality or essential recursiveness. Russell's argument was soon enough overwhelmed by Gödel's work, particularly by his famous "Proof" (Gödel, 1981).

Gödel's argument is twofold: on the one hand, he shows that Russell himself does not follow the Vicious Circle Principle in "*Principia*." Such principle is contradicted by classical mathematics and, partially, by modern mathematics. This line of argumentation is wittily finished by Gödel with the following remark:

I prefer to consider this as a proof that the Principle of the Vicious Circle is false, rather than as a proof that Classical Mathematics is false. (Gödel, 1981, p. 308; my translation).

On the other hand, Gödel shows that it is possible to construct a self-referential paradox without violating the Vicious Circle Principle. Indeed, Gödel's main and demolishing argument against the apparent extradition of paradoxes performed by Russell is the famous Gödel's Proof ("*Über formal unentscheidbare Sätze der Principia Mathematica und verwandter Systeme*"). It is considered, together with Heisenberg's Principle of Uncertainty, as one of the main cracks in Modern Science's positivism (Ortega y Gasset, 1974, pp. 78-80). By means of a complex—but logically accepted within Russell's rules—hierarchical system of representations, Gödel arrives at a self-referential paradox, namely, a formula (proposition) which says of itself that it cannot be proved.

Thus, it can be seen that even in the very "solid" and "serious" field of Symbolic Logic, essential recursiveness is not simply a "joke" or a thoughtful hobby.

The work to be done on self-reference (or essential recursiveness) within the field of Symbolic Logic is to develop a formal logical structure (more properly called a "calculus") based on essential recursiveness. This difficult and extremely important work (for Science and Philosophy) has been initiated by George Spencer-Brown (Spencer-Brown, 1969) and continued within the field of Systems by Francisco J. Varela (1979).

Further exploration of this trend of thought within the realm of Symbolic Logic is not necessary here. We rather follow a phenomenological path, for which the logical form of "Essential Recursiveness" plays a fundamental formal role. Such a "logical form" is used as an essentially dynamic principle for the non-Eleatic ontology outlined by Fuenmayor (1991a). From now on reference is made to the "Logical Form of Essential Recursiveness" or, simply, the "Form of Essential Recursiveness."

#### **8.4. Toward a Phenomenological Ontoepistemology for the Systems Approach**

The following two papers in this issue (Fuenmayor, 1991a, b) outline an ontoepistemological position for the Systems Approach. Within this position the "Form of Essential Recursiveness" is claimed as the very basis of the ontological structure of presence. Thus, Cartesian mind-matter dualism and Aristotelian being-appearances dualism are seen as "apparent" and "timeless" looks of *that* which the new approach considers describable in terms of a Form of Essential Recursiveness.

#### **9. CONCLUDING REMARK**

The systems approach was introduced as an antithetical approach whose very essence lies in opposing reductionism (both in science and in design) due to its incapacity to deal with the holistic transcendental character of phenomena. It was argued that, in order to bring forth a "systems theory" to explain holism, it was necessary to uncover the ontoepistemological roots of reductionism. Only by uncovering the preconditions of current scientific and design activities, the new theory could be liberated from the trap of the former and, hence, be *critically* (Fuenmayor, 1990; Fuenmayor and López-Garay, 1991) founded on an ontoepistemology which could account for holistic transcendence.

The very roots of "reductionism," found in Eleatic thinking, dominate Western thinking (science and most of philosophy) through the principle of noncontradiction. It was shown how Eleatic thinking sacrificed ontological thinking, which could account on holistic transcendence, to the interest of persuasion. That is, it chose a sort of discourse which could be "persuasive" according to principles of logic, presided by the principle of noncontradiction. This principle, in turn, reduced Being to fixed beings which are not holistically transcendental. Both the mind-matter and the appearances-beings dualisms were presented as consequences and as reinforcers of the original reduction. The "Mathematical Project of Modern Science" was shown to contain the argumentation rules and the general laws under which the process of reductionist science would deal with Eleatic beings.

Finally, the "form of essential recursiveness" was presented as a sort of tunnel to escape from Eleatism and its subsequent dualisms. This is a logical form which arose from the observation that the principle of noncontradiction is self-contradictory. Such a logical self-referential form is brought forth as a non-fixed concept offering a logical instrument for explaining holistic transcendence. This is the subject of the two papers that follow.

#### **ACKNOWLEDGMENTS**

Thanks are due to Dr. Abdel Fuenmayor and to my colleagues in the Research Group in Interpretive Systemology, J. Dávila, H. López-Garay, and A. Ochoa, for their helpful comments on and criticisms of the manuscript. I also want to express my gratitude to Michelle Lee for her careful proofreading of the manuscript.

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