



COMMENTARY

Foundations of transdisciplinarity

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Abstract

If we go through a list of some of the main *problematicques*¹ that are defining the new Century, such as water, forced migrations, poverty, environmental crises, violence, terrorism, neo-imperialism, destruction of social fabric, we must conclude that none of them can be adequately tackled from the sphere of specific individual disciplines. They clearly represent transdisciplinary challenges. This should not represent a problem as long as the formation received by those who go through institutions of higher education, were coherent with the challenge. This is, unfortunately, not the case, since uni-disciplinary education is still widely predominant in all Universities. There are exceptions, but few, of interdisciplinary attempts, especially in areas such as planning and philosophy, which are integrative disciplines to begin with. The situation is not solved, as frequently attempted, creating supposed teams conformed of specialists in different areas, around a given problem. With such a mechanism one can only hope to achieve an accumulation of visions emerging from each of the participating disciplines. An integrating synthesis is not achieved through the accumulation of different brains. It must occur inside each of the brains and, thus, we need to orient higher education in a way that makes the achievement of such a purpose possible.

Two possibilities are proposed in this paper, in terms of a weak and a strong transdisciplinarity. The former can be applied following traditional methods and logic, and is essentially practical. The latter represents an epistemological challenge that introduces a kind of quantum logic, as a substitute for linear logic, and breaks with the assumption of a single reality. It is based on three pillars: Levels of Reality; the Axiom of the Included Middle; and Complexity. Three Laws of Transdisciplinarity are proposed.

Strong transdisciplinarity is still in the making, thus representing an unfinished scientific programme that offers fascinating possibilities for advanced reflection and research.

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Keywords: Weak and strong transdisciplinarity; Levels of reality; Axiom of the included middle; Quantum logic; Complexity

1. Opening remarks

The structure of the great majority of Universities in terms of Faculties and departments, reinforce the uni-disciplinary formation, especially at the undergraduate levels. Therefore, a first step towards a

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¹ The term *problematique* here is used in the sense proposed by the Club of Rome; that is, problems of global and long term impact.

necessary transformation should occur at the level of postgraduate programmes oriented, whenever possible, around thematic areas instead of specific disciplines. As an example, a postgraduate programme in “Water”, could call together engineers, lawyers, chemists, biologists, agronomists and achieve trans-disciplinarity in each of them, considering that the result would not be the study of water as seen from the perspective of the engineer, or of the agronomist, or of the biologist, but as seen in an integrated manner.

But before continuing our comments, some clarifications of terminology and concepts are in order.

2. Clarification of concepts

To better understand what is being advanced here, we shall analyze the continuum that goes from discipline to transdiscipline.

2.1. Disciplinarity

The early Universities such as Salerno, Bologna, Oxford and Cambridge, started with Faculties of Medicine, Philosophy, Theology and Law. It was around these four areas that the totality of knowledge was contained. In fact, academics were versatile and omniscient, legitimate forerunners of the Renaissance thinkers and creators (Schulz, no date).²

With the passing of time, Faculties became more and more specialized. Thus arose and multiplied disciplines and sub-disciplines. As long ago as around the 1950s, as mentioned by Schultz, the University of Illinois published a book that listed over 1,100 known scientific disciplines, without including the humanities.

The association between disciplines, departments and institutes is a relatively modern phenomenon that begins to consolidate itself at the end of the XIX Century. Such departmentalization has been signifi-

cant for the maintenance of disciplinary autonomies, for the competition of research funds, and for the consolidation of academic prestige. Professors and disciples develop and enhance disciplinary loyalties up to the point of frequently feeling that theirs is the most important of the entire University.

Disciplinarity is about mono-discipline, which represents specialization in isolation. One person may, in fact, study biology and handle it well without the need for knowledge about physics or psychology. In fact, if we write a list of sciences, from left to right:

Physics, Chemistry, Biology, Psychology, Sociology, Anthropology...

we perceive them logically connected in a horizontal, not vertical, manner.

2.2. Multidisciplinarity

A person may have studied, simultaneously or in sequence, more than one area of knowledge, without making any connections between them. One may, for example, become competent in Chemistry, Sociology and Linguistics, without generating any cooperation between the disciplines. Multidisciplinary teams of researchers or technicians are common and frequent nowadays. In them, the members carry out their analyses separately, as seen from the perspective of their individual disciplines, the final result being a series of reports pasted together, without any integrating synthesis. (See Graph 1).

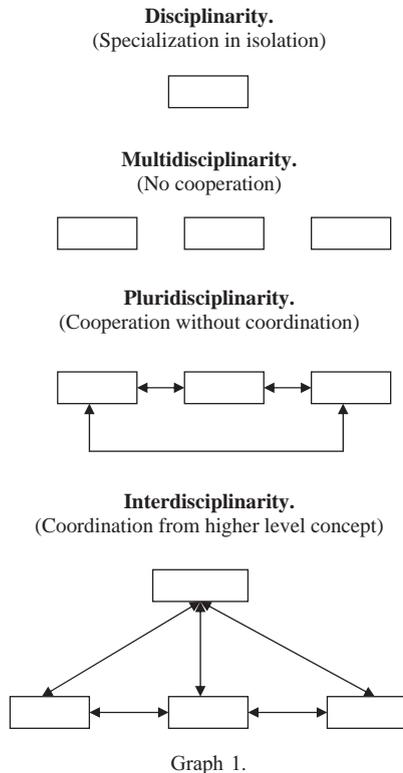
2.3. Pluridisciplinarity

Pluridisciplinarity implies cooperation between disciplines, without coordination. It normally happens between compatible areas of knowledge, on a common hierarchical level. Examples could be the combination of physics, chemistry and geology, or history, sociology and language. The study of each one of them reinforces the understanding of the others.

2.4. Interdisciplinarity

Interdisciplinarity is organized at two hierarchical levels. It thus connotes coordination of a lower level from a higher one. “... a sense of purpose is

² Arnold Schultz, Reader from his course on “Ecosystemology”, University of California, Berkeley. This Reader is not a formal publication. It is, instead, a collection of papers and quotes from different authors, both scientists and artists, including Schultz’s own commentaries and reflections, simply pasted together. Several of the basic descriptions in this section are taken from Chapter 9 of the Reader.



introduced when the common axiomatics of a group of related disciplines is defined at the next higher hierarchical level” (Schulz, no date). So, what is meant by “hierarchical level”? The disciplines that were listed above horizontally (in addition to others) can be considered as the base of a pyramid, identifiable as the *empirical level*. Immediately above is another group of disciplines that constitute the *pragmatic level*, (see diagram of Graph 3), including, among others, engineering, architecture, agriculture, medicine, etc. The third is the *normative level*, including disciplines such as planning, politics, design of social systems, environmental design, etc. Finally, the top of the pyramid corresponds to a *value level*, and is occupied by ethics, philosophy, and theology. Thus is defined a hierarchical image in which the purpose of each level is defined by the next higher one.

In Graph 2, examples of three types of interdisciplinarity are shown, one related to *values*, one *normative*, and two of a *purposive or pragmatic* type. For example, medicine becomes interdisciplinary when granting a defined purpose to the empirical field represented by biology, chemistry and psychol-

ogy. In the same manner, agriculture defines the purpose of chemistry, soils, sociology and biology. These are purposive or pragmatic interdisciplines (first and second hierarchical levels). An example of normative interdiscipline is planning, which defines the purpose of technical disciplines such as engineering, agriculture, forestry and architecture (second and third hierarchical levels). Finally, ethical and philosophical principles define the purpose of planning and of politics, giving origin to a value interdiscipline (third and fourth hierarchical levels).

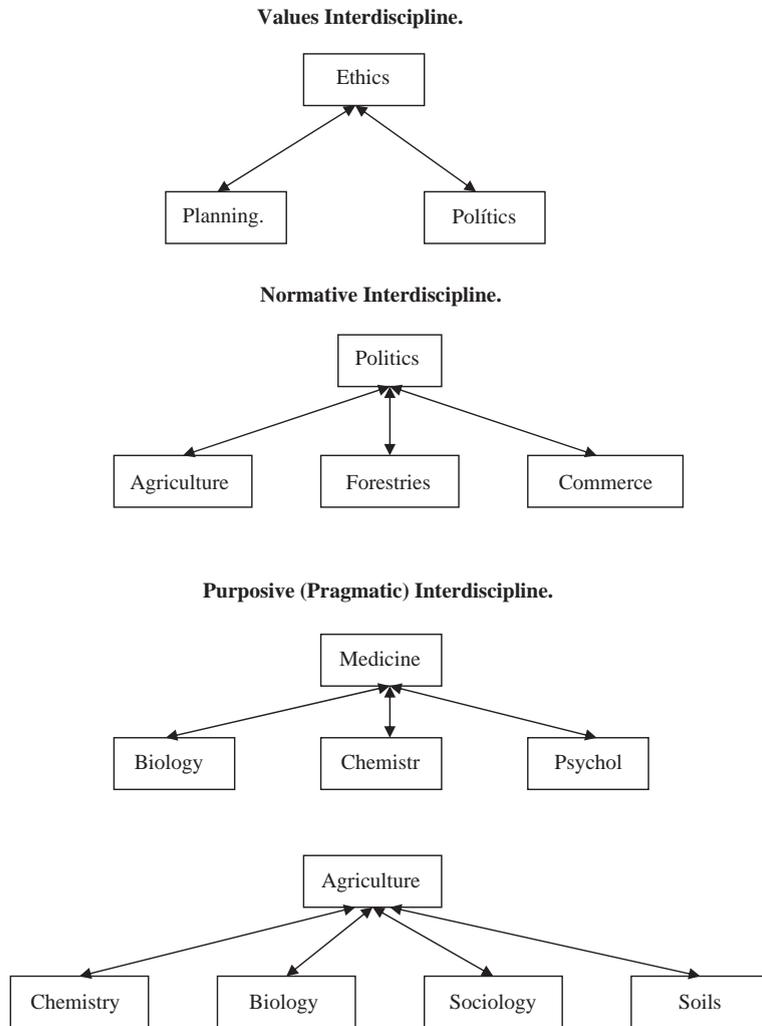
2.5. Transdisciplinarity

Transdisciplinarity is the result of a coordination between all hierarchical levels. Levels which we can now describe in a different way.

The disciplines at the base of the pyramid (see Graph 3) describe the world as it is. Here we can learn physical laws of nature and the principles that drive life and societies. This level asks and answers the question *¿what exists?* Through physics we can learn about quanta, through astronomy we can learn about the magnitude of the universe and the birth of stars. Through biology we can learn about the composition of organisms that defy entropy as open systems. On the other extreme of the pyramid’s base, sociology and economics attempt to describe and explain (not always successfully) the behaviour of rational human beings. The organizing language of this level is logics.

The next level is composed mainly of technological disciplines. This level asks and answers the question *¿what are we capable of doing?* (with what we have learned from the empirical level). Here we know how to build bridges, how to travel to Mars and how to navigate in the high seas. What this level does not tell us, is whether our capacities should be implemented. The danger often is that we do things simply and only because we know how to do them. The organizing language of this level is cybernetics, that emphasizes only the mechanical properties of nature and society.

The normative level asks and answers the question *¿what is it we want to do?* In democratic societies the answers are normally put to vote. A good example is the application of environmental impact assessments that originated as a consequence of the environmental



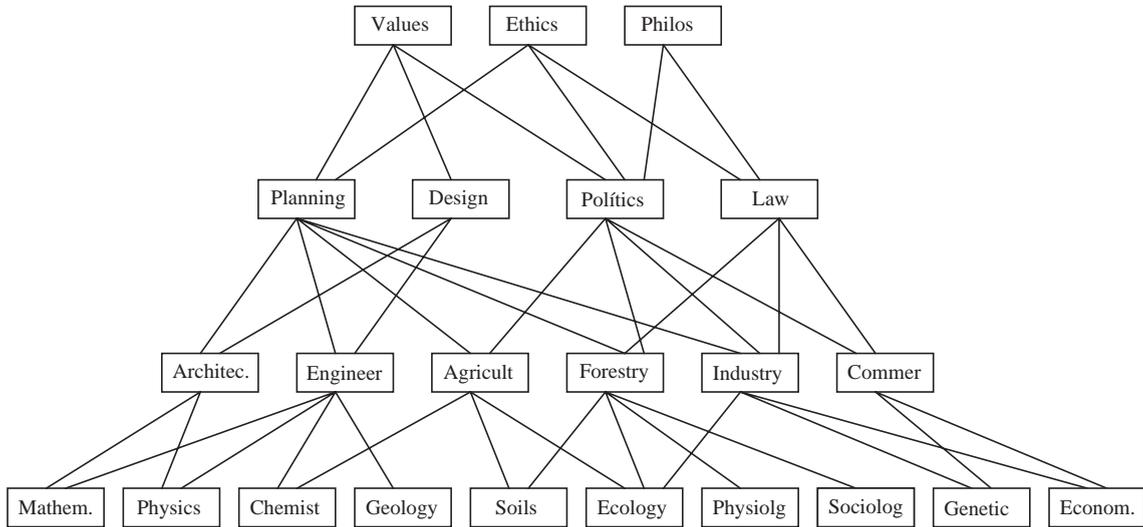
Graph 2.

movement. Similar positive results can be identified as a result of the feminist movement. These, and others, are clear examples of people having a capacity of directly influencing what they want to happen in their milieu. The organizing language of this level is planning.

The value level asks and answers *¿what should we do? Or rather ¿how should we do what we want to do?* This level goes beyond the present and the immediate. It aims at generations yet to come, at the planet as a whole, at an economy “as if people matter”. While making explicit a global concern for the human species and life in general, the organizing language—as suggested by Schultz—should be some kind of deep ecology.

It goes without saying that no transdisciplinary Universities exist. In the best of cases we find some interdisciplinary efforts taking place, but mainly as marginal experiences not integrated into the University structure. Departments, Institutes and Faculties continue being organized around isolated disciplines.

Furthermore, in as much as the influence of the conventional economic discourse increases the belief in the efficiency of the market; ethical, political and value judgments are plainly excluded or left along the road. Economics, as it is still being taught in the Universities, is presumed to be a *value-free science*. In fact, the argument runs that the “intromission” of



Graph 3. Transdiscipline. Reading the graph from bottom to top, the lower level refers to *what exists*. The second level to *what we are capable of doing*. The third to *what we want to do*. And finally, the top level refers to *what we must do*, or rather, *how to do what we want to do*. In other words, we travel from an *empirical* level, towards a *purposive or pragmatic* level, continuing to a *normative* level, and finishing at a *value* level. Any multiple vertical relations including all four levels, defines a transdisciplinary action.

values distorts the economic process.³ This being so, it should not be surprising that, for example, efforts to overcome poverty tend to fail systematically. Contrary to such naïve assumptions, it should instead be obvious that if ethical principles and values that should conform a society oriented towards the common good, are not made explicit, no policies coherent with the challenge can successfully be designed. As a matter of fact, the so called poverty eradication policies, so abundant all over the world, are, in general, not policies, but rather mere mechanisms to stimulate economic activity, under the assumption that that sole activation will point to the solution of the problem. If equity and the components of the common good, instead of remaining as electoral rhetoric, were actually specified in term of concrete purposes (like policies), the assumed role of the market as supreme orientator of economic activity, would be limited to that for which it is really useful and efficient, i.e. not for the overcoming of poverty.

To summarize, and looking back to the transdisciplinary pyramid, we will realize that most of our actions do not go beyond combinations between the

inferior levels. In terms of behaviour, our pyramid is beheaded and, in as much as we do not restore it, we will not be able to successfully confront the great *problematiques* of the new century.

¿How to go about it? It is certainly not easy. First of all, to radically change the structure of the University is almost impossible. Internal resistances can become insurmountable, since the feuds within which academic prestige is constructed, will vigorously defend themselves against any structural change. It is quite amazing if we realize that almost three hundred years ago, Leibnitz expressed his hostility towards Universities, because their organization in terms of faculties, impeded the expansion of knowledge across and beyond disciplines. The change is necessary and, in spite of all existing difficulties, it can only come from within the University, through the action and cooperation between *enlightened* academics. In fact, we may detect that such a process, here and there, is already under way.

3. Epistemology of transdisciplinarity

What has been presented so far, is based on a practical and simplified approach, addressed toward the applicability, for research purposes, of a method

³ At closer scrutiny, this is quite an amazing assumption, because, if it really were so, the economic process would be determined by natural laws, instead of being the result of human action.

that tends to be transdisciplinary. I shall identify it, as will later be explained, as *Weak Transdisciplinarity*. Although, perhaps practical, it is insufficient. The transdisciplinarity to be discussed in the rest of this text will be identified as *Strong Transdisciplinarity*, meaning by it, that it goes much deeper into the realms of reality.

Epistemologically, strong transdisciplinarity (which from now on I will refer to as simply transdisciplinarity, unless otherwise specified) is based on three fundamental pillars: a) levels of reality, b) the principle of the “included middle”, and, c) complexity (Nicolescu, 1998). In addition, it recognizes as simultaneous modes of reasoning, the rational and the relational. Transdiscipline represents, thus, a clear challenge to the binary and lineal logic of Aristotelian tradition.

In the course of human evolution, the transition from oral communication, where knowledge was imparted through histories and myths, to written communication—essentially the Western product of the development of the Phoenician/Greek alphabet—the primacy of rational thought over relational thought became the rule. The result has been that the fascination produced by reason has been so immense, that we have lost other faculties and sentiments that facilitated, so to say, our understanding of Nature from within.

4. Beyond reason

In this sense it is interesting to note that Goethe, whose scientific contributions have been unjustly overshadowed because of his colossal achievements in literature and the arts, felt upset with what he believed to be the limitations of Newtonian physics. For Goethe, “science is as much an inner path of spiritual development as it is a discipline aimed at accumulating knowledge of the physical world. It involves not only a rigorous training of our faculties of observation and thinking, but also of other human faculties which can attune us to the spiritual dimension that underlies and interpenetrates the physical: faculties such as feeling, imagination and intuition. Science, as Goethe conceived and practiced it, has as its highest goal the arousal of the feeling of wonder through *contemplative looking* (Anschauung), in which the scientist would come to see God in nature and nature in God” (Naydler, 2000).

None other than Werner Heisenberg, one of the fathers of quantum physics, suggested that there is actually no conflict between accepting Goethe’s way of contemplating nature, and the contributions and findings of modern physics. For him both ways are complementary instead of opposites (Heisenberg, 1952).

Heisenberg is in fact one of the first great scientists of the XXth Century to vindicate Goethe’s scientific contributions.

But our present situation is something else. In fact, in an editorial of the year 2000 in the Journal Nature Neuroscience, reference is made to the growing problem experts and scientists have in order to understand each other (Nature Neuroscience, 2000). It is pointed out that, “In Darwin’s time, it was possible to write a book that was both a primary scientific report and a popular bestseller. Today, however, that seems like a remote ideal. Not only is it difficult to communicate scientific ideas to the general public, but scientists seem to have increasing difficulty communicating with each other. Even within biology, researchers in different areas of specialization are often unable to understand each other’s papers”. We are witnessing what can be recognized as a “disciplinary big bang”.

The growing rupture in communication is, to a great extent, the product of the exacerbation of rational thought, which manifests itself through the predominance of reductionism and of a binary and linear logic that, among other shortcomings, separate the observer from the observed. From quantum physics we have learned that the presence of the observer can be reduced to a minimum, but can never be totally eliminated. We require access to new types of logic that allow for disciplinary cross-fertilization and for the recognition of the validity of the *contraria sunt complementa* proposed by Niels Bohr. A bipolar perception, a dynamic tension between opposites. A yin and yang, as suggested by Taoism, in which the yin is analogous to relational thought and the yang to rational thought. In other words, a logic capable of harmonizing reason with intuition and feeling, as Goethe would like it. In this last sense, one must honestly recognize that innovators in all fields, whether in the sciences or in the arts, often rely on intuition in order to reach a solution for the problems of their concern. The strange thing is, however, that when they share with, or exhibit their results to, colleagues, the tendency is to reduce their expressed findings to reductionist and rational

approximations. A strange sort of shyness seems to prevail in the sense that confessing the contribution of intuition may be perceived and ridiculed as an indecent exposure, not worthy of a true scientist. Einstein, who could afford to be above and beyond such shyness, declared that “the intuitive mind is a sacred gift, and the rational mind is a faithful servant. We have created a society in which we honor the servant and have forgotten the gift”.

“When Niels Bohr, the illustrious Danish physicist, was granted a title of nobility by the king of Denmark, as a tribute to his transcendental contributions to science and the culture of his country and of the world, he was asked to make suggestions for the design of his coat of arms. His request was to put on the center the Taoist symbol of the Yin and Yang, and below the sentence: *Contraria sunt Complementa*. Through that act he revealed the essence of the most transcendental truth his wisdom had allowed him to surmise.” (Mallmann et al., 1979).

5. Levels of reality

For a pragmatic understanding of the different modes of thought, it is necessary to examine the first pillar of transdisciplinarity; that is, “Levels of Reality”.

Adopting the suggestion of Nicolescu, let us designate as reality “that which *resists* our experiences, representations, descriptions, images or mathematical formalizations. Quantum physics caused us to discover that abstraction is not simply an intermediary between us and Nature, a tool for describing reality, but rather, one of the constituent parts of Nature. In quantum physics, mathematical formalization is inseparable from experience.” (Nicolescu, 2000).

“In so far as Nature participates in the being of the world one must ascribe an ontological dimension to the concept of Reality. Nature is an immense, inexhaustible source of the unknown which justifies the very existence of science. Reality is not only a social construction, the consensus of a collectivity, or an inter-subjective agreement. It also has a trans-subjective dimension, to the extent that one simple experimental fact can ruin the most beautiful scientific theory”, (Nicolescu, 2000).

By *Level of Reality* we will understand a set of systems that are invariant with respect to the action of

certain general laws. Once more, quantum physics reveals that quantum entities are subordinated to quantum laws that differ radically from the laws to which the macrophysical world abides. Again, as pointed out by Nicolescu, “two different levels of reality are *different* if, while passing from one to the other, there is a break in the laws and a break in fundamental concepts like, for example, causality (Nicolescu, 2000). So far, no rigorous mathematical formalization has been found, to interpret the transit from one to another reality (we might perhaps even say, from one world to another). There are mathematical indications, however, in the sense that the transit from the quantic world to the macro-physical world is not continuous. The discontinuity that is manifest in the quantum world is also manifest in the structure of the levels of reality. It follows—and this is fascinating—that at least two worlds coexist.

The coexistence of two worlds as revealed by science so far, coincides with many similar visions that emerge from some religions, traditions and beliefs when it comes to searching deeper into our interior universe. The belief in parallel worlds is something that I myself have allegorically referred to as, “There is a world in which you have to see in order to believe, and there is another world in which you have to believe in order to see”. Several philosophers of the XXth Century speculated around different levels of perception of reality and of multi-dimensional realities; among them Husserl. The German–Anglo philosopher Karl Popper and the Nobel laureate neurobiologist John Eccles, jointly speculated during the last years of their lives about the brain–mind enigma (Rodríguez, 2004). They finally proposed a philosophical theory about three worlds: World 1, contains all objects and physical states, including the brain. World 2, is that of the subjective experiences and states of consciousness. World 3, is the one produced by humans, including language. On his part, Werner Heisenberg introduced in his *Manuscripts of 1942*, the idea of what he called *Regions of Reality*. The first region is that of classical physics; the second is that of quantum physics, of biology and of psychic phenomena; and the third is that of religious, philosophical and artistic experiences. We know the laws that rule in Heisenberg’s first and second regions of reality. However we ignore what the laws are that rule in the third region. In any case, what appears to be increasingly evident is that we can no longer assume

that there is just one reality, fully describable and understandable in terms of pure reason.

From all that has been expressed so far, we should realize that although transdisciplinary research and approaches are necessary, transdisciplinarity in itself is still an unfinished project, around which there is still much to be discovered and investigated. It should be clear that transdisciplinarity is, at this stage, both a tool and a project.

If the existence of two levels of reality (as we have defined levels of reality) has been demonstrated, and intuition accounts for an additional level as is the case of the third one proposed by Heisenberg, we may ask ourselves how many levels can eventually be possible. ¿May it perhaps be that we as humans drift and live in multiple realities without having consciousness of it? If that were the case, ¿can consciousness be awakened? (Laszlo, 2003). It is in the search of answers to these questions that a fertile terrain arises for the dialogue between science and mysticism. And this is where transdisciplinarity could and should make its most transcendental contribution.

6. The logic of the included middle

Contraria sunt complementa was Niels Bohr's motto. That is to say "... day and night, particle and wave, sun and moon, male and female, reason and emotion, logic and intuition, matter and spirit, pragmatism and mysticism, discipline and transdiscipline not as dichotomies, but as complements that converge and merge without losing their identities. The West defined its culture by wandering on just one side of the road: humans bewildered by the sun and the day, imposed reason and logic; organized institutions to dominate matter, celebrated the success of pragmatism; and created, for greater efficiency, a whole taxonomy of concrete disciplines. The Eastern culture, on the other hand, is perceived by Westerners as interesting and mysterious, but seldom as competent and efficient (unless it has become Westernized). The road we follow in order to pursue the truth, through definitions, descriptions, demonstrations and proofs, are Cartesian designs that require wakefulness imbedded in action. The sort of interminable nocturnal meditation through which the Buddhist and Taoist orient attempts to achieve revelation, enlightenment and transcendence,

seems to us no more than a strange and peculiar exercise whose utility we do not quite understand." (Mallmann et al., 1979). It is quite fortunate that at this stage, both sides of the road seem to be slowly beginning to converge. There are no doubts in my mind that, as a consequence of such a convergence, fascinating and extraordinary revelations are waiting to be unveiled.

The evidence about the coexistence of the quantic and macro-physical worlds has provoked, so to say, a *rebellion* of what were traditionally considered to be mutually exclusive pairs (A and non-A), such as: particle/wave, continuity/discontinuity, local causality/global causality, etc. Such pairs are certainly contradictory if analyzed through a classical logic that recognizes the existence of just one level of reality.

Classical, linear logic of Aristotelian tradition, still in force today, is based on three fundamental axioms:

1. The axiom of identity: A is A.
2. The axiom of non contradiction: A is not non-A.
3. The axiom of the excluded middle: There exists no third term T, that is simultaneously A and non-A.

If we accept the validity of classical logic, we must conclude that pairs of contradictories, such as particle/wave, revealed by quantum physics are mutually exclusive, since one cannot assume the validity of something and its opposite at the same time (A and non-A). As a consequence of such a situation, already in the 1930th, the founders of quantum physics realized the necessity of formulating a kind of "quantum logic". Their efforts concentrated on the modification and reformulation of the second axiom; that is, introducing non-contradiction with several truth values in place of the pair (A and non-A). Such logical efforts still remain controversial.

A more interesting, and perhaps more fruitful, effort may be the reformulation of the third axiom in the sense of turning it into an *axiom of the included middle*. Basarab Nicolescu reminds us that, "History will credit Stéphane Lupasco with having shown that the logic of the included middle is a true logic, formalizable and formalized, multivalent (with three values: (A, non-A, and T) and non-contradictory." (Lupesco, 1987; Nicolescu, 1999).

Although difficult to accept or to understand the validity of an axiom that states that *there exists a third term T which is at the same time A and non-A*, the

difficulty can be overcome if we introduce the notion of *Levels of Reality*. Let us imagine a triangle in which one of the vertices corresponds to one level of reality, and the two other vertices to another level of reality. What in a unique level would appear as antagonistic and contradictory (wave A and particle non-A), ceases to be so, when the third element, the T-state, exercised from another level of reality, turns what appears to be antagonistic (wave or particle) into a unified entity (quanton), which is perceived as non-contradictory.

The T-term situated at a different level of reality from A and non-A, induces an influence upon its neighbouring level of reality (Nicolescu, 1999). There is, so to say, a kind of *permeability* between neighboring levels of reality. Along similar lines, Popper and Eccles (Rodríguez, 2004) who, as mentioned earlier, proposed a philosophy of three worlds, suggest that the brain, located in World 1, and mind, located in World 2, interact, which means that the frontier between both worlds is permeated in both directions by fluxes of information. Based on comments of Nicolescu, and on what has been argued so far, we can now state a fundamental principle of transdisciplinarity, that draws some distant recollection of Gödel's theorem, and which I propose to be identified as The First Law of Transdisciplinarity: "the laws of a given level of reality are not self-sufficient to describe the totality of phenomena occurring at that same level".⁴

The logic of the included middle is not a metaphor. It is, in fact, a logic of transdisciplinarity and complexity, since it allows, through an iterative process, to cross different areas of knowledge in a coherent manner, and generating a new simplicity (or *simplicity*, as proposed by Nicolescu). It does not exclude the logic of the excluded middle, it just limits its boundaries and range of influence. Both logics are complementary.

The logic of the included middle allows to describe the coherence between levels of reality, through an iterative process of the following type: 1) A pair of contradictory elements (A and non-A) situated in a given level of reality, is unified by a state T', situated in a contiguous level of reality; 2) In turn, the state T' is linked to a new pair of contradictories (A' and non-A') located in its own level; 3) The contradictory pair

(A' and non-A') is, in turn, unified by a state T'', situated in a new neighbouring level which shelters the triad (A', non-A' and T'). The iterative process continues indefinitely until all levels of reality have been exhausted, assuming that they are exhaustible.

The action of the logic of the included middle upon different levels of reality, induces an open structure of the unity of levels of reality. Such open structure has extraordinary epistemological consequences, since it implies the impossibility of constructing a complete theory closed upon itself. What we get instead, is a permanent potentiality for the *evolution of knowledge*. From these considerations we may now propose what I will identify as the Second Law of Transdisciplinarity: "Every theory at a given level of reality, is a transitory theory, since it inevitably leads to the discovery of new contradictions situated in new levels of reality". Such a process can continue indefinitely without ever accomplishing the construction of a completely unified theory. Knowledge is, thus, and may forever remain, an open structure.

The different levels of reality are accessible to human knowledge through the existence of different *levels of perception*, which stand in a one-to-one correspondence with the levels of reality. Such levels of perception can be activated as a consequence of states of consciousness induced by our physical structure and our sensorial organs. Levels of perception can also remain as potentials awaiting to be activated through practices as those taught by Buddhism and Taoism, the *Satori Experience*⁵ being a case in point, as well as through Shamanic rituals, or other means that induce altered states of consciousness.

We can now say that the unity of the levels of reality constitutes the *Object of Transdisciplinarity*, and the unity of the levels of perception constitutes the *Subject of Transdisciplinarity*. A flux of *consciousness* that runs coherently across the different levels of perception, must correspond to a flux of *information* that runs coherently across the different levels of reality. Both fluxes are in a relation of isomorphism.

⁴ I believe that this statement of (Nicolescu, 2000) deserves to be recognized as a law. The same holds for the Second Law of Transdisciplinarity proposed later on.

⁵ *Satori*, in Zen Buddhism, is the inner intuitive experience of enlightenment. It is said that *Satori* is inexplicable, indescribable and impossible to be understood through logic and reason. *Satori* is normally achieved after a concentrated period of preparation, and can happen spontaneously as a result of a sudden accidental stimuli, manifesting itself as a sudden awakening (break-through) toward a superior consciousness.

“Knowledge is neither interior nor exterior; it is at the same time interior and exterior. The study of the Universe and the study of human beings sustain each other” (Nicolescu, 1999).

7. Complexity

Beyond the verification of the existence of different levels of reality, the last century has witnessed the appearance of complexity, of chaos, and of non-linear processes in many areas of science. Systemic visions have brought about the demise of the assumptions that Nature can be described, analyzed and controlled in simple terms that correlate with a traditional linear logic. All these new concepts have revolutionized many ambits of the basic sciences. However no significant break-through is to be found when it comes to disciplines related to social action, economics and politics. Paradoxically, the concept of a uni-dimensional reality, oriented by a logic of linear simplicity, seems as strongly grounded as ever, precisely at a time when we are trying to adapt ourselves to a world undergoing increasingly accelerated change. It seems evident that such an incoherence is to a great extent responsible for many of the crises affecting us today. Fundamentalist movements of all sorts, and the simplistic punitive reactions we are witnessing, can only be understood as manifestations oriented by an absolutely simplistic logic.

Our relation with a complex world and a complex Nature, requires complex thought. Edgar Morin has been making proposals along these lines for over twenty years. Among other things he proposes a radical reformulation of our organization of knowledge, considering its increasing complexity. The idea is to develop a kind of recursive thinking.⁶ That is to say, a

⁶ Recursive definition (also called inductive definition and definition by recursion) is a definition in three clauses in which: 1) the expression defined is applied to certain particular items (the base clause); 2) a rule is given for reaching further items to which the expression applies (the recursive, or inductive, clause); and 3) it is stated that the expression applies to nothing else (the closure clause), e.g. “John’s parents are John’s *ancestors*; any parent of John’s ancestor is John’s ancestor, nothing else is John’s ancestor”. By the base clause, John’s mother and father are John’s ancestors. Then, by the recursive clause, John’s mother’s parents and John’s father’s parents are John’s ancestors; so are their parents, and so on. Finally, by the last (closure) clause, these people exhaust John’s ancestors.

thinking “capable of establishing feedback loops in terms of concepts such as whole/part, order/disorder, observer/observed, system/ecosystem, in such a way that they remain simultaneously complementary and antagonistic (Morin, 1992).

At first sight, Morin’s proposal appears to be an impossible task. However, once we understand and integrate, in our way of seeing the world, the different levels of reality and its associated logic of the included middle, both the vision and the way in which to proceed become clearer. The bottom principle is not to separate the opposing poles from the many di-polar relations that characterize the behaviour of Nature and of social life. Such a separation, normal in rational thinking and its correspondent linear logic, is actually artificial, since neither Nature nor the human society does function in terms of mono-polar relations. Our insistence in artificially and ingeniously simplifying our knowledge about Nature and human relations, is the force behind the increasing disfunctions we are provoking in the systemic interrelations of both eco-systems and the social fabric.

As already pointed out, the discourse advanced so far in this essay, is more accessible (although not to the unanimity) to those involved with the natural sciences, especially quantum physics and biology, than to those whose boundary of knowledge is within the social sciences. The most worrying case is that of economics (stubbornly engaged with linear reason), because being a discipline which, in practice, exercises enormous influences in decision makings that affect both Nature and society, its impacts can, and have, become destructive, devastating and, in many cases, irreversible. There are overwhelming evidences today, that the way in which economics is taught in the Universities, and practiced in real life, is incapable of solving the problems with which it is concerned, and which, after all, justify its existence as a discipline. Only in so far as transdiscipline can penetrate and transform the economic visions of the world, can we aspire to find solutions to situations such as poverty, unemployment and sustainability.

If I were asked to define our times, in few words, I would say that we have reached point in our evolution as human beings, in which *we know very much, but understand very little*. It goes without saying (evidences are clear) that linear logic and reductionism

have contributed to our reaching unsuspected levels of knowledge. The *knowing* has grown exponentially, but only now we begin to suspect that that may not be sufficient, not for quantitative reasons, but for qualitative reasons. Knowledge is only one of the roads, only one side of the coin. The other road, the other side of the coin, is that of *understanding*.

Describing and explaining generate knowledge, and knowledge, guided by reason, belongs to the realm of science. But knowing is not the same as understanding. Here goes one example. Suppose that you know everything that can be known, from philosophical, anthropological, biological, theological and psychological points of view, about a human phenomenon called Love. So, you *know* everything that can be known about Love; but you will only *understand* Love, once you fall in love. You can only *understand* that of which you become a part, when the *Subject* that searches and observes becomes inseparably integrated with the *Object* searched and observed.

While within the realm of *knowledge* it makes sense that I (Subject) pose a problem and look for its solution (Object), in the realm of *understanding* no problems exist, but just transformations that indissolubly integrate Subject and Object. We may, therefore, perhaps conclude that *knowing* and *understanding* belong to different levels of reality. Let us remember that two different levels of reality are *different* if, while passing from one to the other, there is a break in the laws and a break in fundamental concepts like, for example, causality. It is clear that formal knowledge, linked to reason, is constructed following rules of method and causality, while understanding, more linked to intuition, rules out both method and causality. Hence, being in different levels of reality, *understanding* may solve the contradictions that arise in *knowledge*. Other neighbouring levels of reality may probably be found in the cases of *being* and *having*, and, as insinuated, in the cases of *reason* and *intuition*. Here we may begin to catch a glimpse of possible ways to reorient the procedures of dealing with the social disciplines.

8. Summary and conclusion

Weak transdisciplinarity, as suggested in the first part of this paper, is a practical way of tackling

problems in a more systemic way. It helps, but it is far from sufficient. Strong transdisciplinarity, on the other hand, is both a tool and a project. An unfinished project which demands many efforts of systematization still to be undertaken.

The disciplinary investigations concern only one level of reality. Transdiscipline, instead, extends its action through several levels of reality, in the case of strong transdisciplinarity, and through several levels of organization (see again the pyramid of Graph 3) in the case of weak transdisciplinarity. Discipline and transdiscipline must be understood as complementary. The transit from one to the other, attaining glimpses from different levels of reality, generates reciprocal enrichment that may facilitate the understanding of complexity.

Transdisciplinarity, more than a new discipline or super-discipline is, actually, a different manner of seeing the world, more systemic and more holistic.

Although the epistemology of transdisciplinarity may be relatively clear, its applicability as a methodology in the social sciences still suffers from deficiencies. Specifically, we need to attain more clarity with respect to levels of reality in the social world. ¿Do *knowledge* and *understanding* really belong to different levels of reality? ¿What about *being* and *having* or *reason* and *intuition*? ¿Do the *anthropocentric* and *biocentric* visions and attitudes towards the world belong to different levels of reality? ¿Could we affirm, for instance, that *growth* and *environment*, frequently identified as opposites (A and non-A) in conventional economics, are opposites only at the anthropocentric level, and that such opposition is solved from the biocentric level of an Ecological Economics through which *growth* and *environment*, as complementary opposites, become a unified *development*?

All are open questions that, nevertheless, insinuate the path to follow in a programme of investigation the purpose of which would be to complete and consolidate transdisciplinarity as a project destined to improve our understanding of the social world and of Nature. It is clear that if such an effort is not undertaken, we will continue generating ever greater harms to Society and to Nature, because of our partial, fragmented and limited visions and assumptions. The challenge is to practice transdisciplinarity in a systematic manner, whether in its weak or strong version

(depending on possibilities), and make efforts to perfect it as a world vision, until the weak is absorbed and consolidated in the strong.

Since there is no University or center of superior studies transdisciplinarily oriented for the education of students, it is imperious to create instances that stimulate its application and development. The “Transdisciplinary Journal of Ecological Economics”, if only because it calls itself transdisciplinary, should become a forum to promote creative contributions for the completion of a fascinating yet unfinished programme.

9. Coda

Said Lao Tsu, 2,500 years ago.

“Thirty spokes share the wheel’s hub;
It is the center hole that makes it useful.
Shape clay into a vessel;
It is the space within that makes it useful.
Cut doors and windows for a room;
It is the holes that make it useful.
Therefore profit comes from what is there;
Usefulness from what is not there.

From what Lao Tsu had to say, we may infer what I would like to call, even if only allegorically, the Third Law of Transdisciplinarity: “Only because of what is not there, it is possible that there is what is there; and only because of what is there it is possible that there is not what is not there”.

Here we face the unity of all things! ¿How far removed is the science we teach in our Universities, from the understanding of this truth?

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