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# The Contours of the Processes of Nature and Science Education

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**Abstract**

This essay analyzes the historical connections that have articulated the foundations of natural sciences and the technology in worldwide ambit during the 20th century. The need to construct new educational and philosophical conceptions committed with the sustainability and the future of the planet and the humanity is treated in this essay. The limitations of natural sciences as a solution to the complex problems of the humanity are issues that have been considered in this study. Finally the importance of education for the construction of the economic, and social development has been emphasized

**Keywords:** culture, sociology of education, history of sciences, natural sciences, society


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# Los Contornos de los Procesos en la Educación de Naturaleza y Ciencias

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**Resumen**

Este ensayo analiza las conexiones históricas que articulan los fundamentos de las ciencias naturales y la tecnología en el siglo XX. Él también reafirma la necesidad de construir nuevas concepciones educativas y filosóficas comprometidas con la sostenibilidad y el futuro del planeta y de la humanidad. Las limitaciones de las ciencias naturales en la solución de problemas complejos de la humanidad son temas también mostrados en este estudio. Por último, se reafirma la importancia de la educación para la construcción del desarrollo económico y social.

**Palabras clave:** historia de la ciencia, la cultura, la enseñanza de las ciencias, las ciencias naturales, la sociedad


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The full fusion of political, economic and scientific subjects has accelerated the emergence of a group of processes, influencing all sections, aspects and the essence of the contemporary life. It also molded new structures, conceptions and thought systems for this century.

The emergence of the New Age is based on the scientific, the technological and the marketing axes that constitute the main sustentation of the economic processes on all scales and the material base of globalization and a new world order. Anchored in a complex systems network, the global interests move at several space scales, dividing and fusing territories; recreating and pressuring the world market of labor; redefining the nature of the conceptions that it is public and/or private; subverting the places, the regions, the national states, the continents, the planet; and all connections that join and guide the social processes in course (Silva, 2000).

Freitas and Silva Freitas (2002, 2014) say that the identification of the theoretical and empiric elements of the physics and chemistry, which contribute to this new cycle, can be systematized in four great axes:

"The unfolding of the mathematical physical theory built by Planck to unmask the processes related to the phenomena of transport of luminous radiation, that unlike the existing theories until then, contain a mathematical constant, denominated Planck's constant that does not represent a property of the object but depict a property of nature. This conception led Einstein to postule the electromagnetic radiation formed by particles without mass and without electric charge, denominated photons. Unlike the foundations of mechanics, reference at that time, this conception establishes that the correct reading of the natural phenomena has to be done by scales, that is, the same phenomenon can be shown in different forms according to the scenarios and the intensities of the constituent elements of the process under analysis. In his studies about radiation, Planck re-introduces in creative and contusing form the category called 'discontinuity of the matter' while unfolding of mathematical structures designated 'symmetries', rescuing the Platonic's conception in solid and consistent theoretical bases. The sophisticated atomic model proposed by Rutherford and along with the results foreseen by Planck's theory and the existing Bohr's theory, that emphasized the discreet character of the electronic orbits and of other fundamental physical entities for the description of the microscopic properties of matter, let to more

advanced and sophisticated theorical and empirical studies at the atomic scale.

Heisenberg, Schrödinger, De Broglie, Compton, Born, Gibbs, Dirac, Pauli, Landau, Fermi, and others constructed the following steps, not necessarily in this order.[1]

The first, of the several contributions, established the limits of the classic theories in physics and chemistry, known at that time (Heisenberg, 1990). Through the physical relationships denominated 'uncertainty principles', it was possible to project the real and virtual scenarios, that can be built with the classical concepts, establishing when physical theories could be applied for the processes in atomic scale and when for the world accessible to our senses. Using the foundations of a non-commutative algebra and representing the physical entities for womb structures, Heisenberg substituted the classic concept of the orbit by of a 'quantum state', associating it with experimental measures (Heinsenberg, 2000). Unlike Heinsenberg, Schrödinger, using the self-function and self-value representations used by mathematicians and physicists during the 18th and 19th centuries, developed an analytical mathematical physics, proposition and explanatory theory for the denominated electron waves (Schrödinger, 1990). Special interest should be attributed to De Broglie's contribution which 'in the same form that to the existence of any particle is associated a wave; every wave state it is associated to the existence of a particle'. The other scientists assumed the difficult task of building the solid basis of the knowledge field that later on would become known as quantum mechanics and applied in valid problems at the atomic scale. The introduction of the concept of probability in the descriptive language of quantum mechanics, sophisticated the reading of the current effects of the natural phenomena as they now have probabilities of occurrence, and therefore of experimental verification, eliminating definitively the causal character and the deterministic nature, at least at the atomic scale. It is also intriguing to see the unfoldings of the researches developed by Compton, that confirmed the dual behavior of matter, that established that, matter, in appropriate conditions, can be presented in oscillatory or corpuscular form, depending on the scales involving the dynamics of the physical process in subject. Several physical properties of the material were unmasked. The foundations that guide the interaction of light, electromagnetic radiation with the matter,

the conduction of electricity and heat, elasticity, magnetism and other known aspects of the atomic/molecular structure of matter were explained, creating possibilities for technological innovation, in particular, in the electric-electronics industry that would become the main anchor of the globalization processes in course. The semiconductor industry has expanded in exponential scale. Advances in optic lithography have made possible the manufacture of transistorized circuits with greater performance and facilitated the miniaturization of electronic devices. The amplification of the power of microprocessors has greatly impacted technological sectors, especially those related to the acquisition, storage, processing, and transmission of information. The projection of a promising future for microelectronics has a great impact in the macro worldwide economy.

Another fundamental contribution is that due to Einstein's theory, in which the speed of light also represents a property of the nature. And still, that the apparent non-joining of the space and time concepts for all us admitted, is due to very specific and known conditions of space and temporary scales that we are subjected to in our daily lives. In atomic and/or cosmological conditions, the scale of merging can be quantified for these two concepts, that are articulated to each other by means of the speed of light, which constitutes a space-temporal structure. The above structure in presence of the matter provokes the curvature of space, demanding the use and the incorporation of a new geometric language, a different Euclidean metric in the physical reading of the fundamental laws of nature. Through the theory of relativity, Einstein also showed that energy can be transformed into matter and vice versa, indicating that the same is the 'fundamental unit of the universe' (Auger, 1990; Born, 1990).

Finally, we mention the greatest conquest of cosmology: the 'Big Bang Theory' or 'Great Explosion' proposed by Aleksandra Alexandrovich Friedmann and Georges Edonard Lemaitre, in the 1920s. It was developed and later it was confronted with the observations of the astronomer Edwin Hubble in the 1920s, confirming that the light emitted by galaxies is deviated towards the red color of the energy spectrum. This phenomenon, called 'Doppler Effect', already known by physicists at that time, mentions the change of the frequency of a wave emitted from a source in movement. In the same way, as the sound of a car horn is each time lower the measure that the same is moved away from an observer, the light is each time more

red when its emitting source moves away from the person who observes it (Hurwic, 2000). This theory foresees that the origin, the beginning of the universe, was through a great explosion, which happened about 15 billion years ago. Ever since the universe has been continuously expanding, in all directions, with its average temperature decreasing continually. In spite of the polemics raised by this theory, it has been strengthening with countless discoveries and astronomical observations. The possibility of the 'whole' to emerge from 'nothing', of the unmasking of dynamics of the creation of universe, close to the singularity, being projected real and virtual sceneries of the whole system starting from a part of the same, are emergent problems and of great significance in the current studies of cosmology (Silk, 1988).

The main theories of the physical sciences in the 20th century, quantum mechanics, quantum field theory, and general relativity, are not independent. Despite the restrictive structures of these theories, their great accuracy and their capacity of prediction, project a promising future for natural sciences.[2] Invented little more than the 100 years, they have an obligatory presence in all the contemporary thought systems.

Special highlight should be made for Gaston Bachelard (1884-1962), Karl Popper (1902-1994), and Thomas Kuhn[3] (1922-1996) who put in check the methodological foundations of this scientific knowledge through questioning, configuring, reconfiguring, and defining the scientific methodologies prevalent until 1960.

Bachelard is author of a vast and sophisticated philosophical work. Among the outstanding works are 'Novel Esprit Scientifict' (1996a) and 'La Formation de l'Esprit Scientific' (1996b) published in 1934 and 1938, respectively. In these works, Bacherlad analyses critically the scientific dogmas existent at that time. He combats the empiricism, the idealism and the positivism, refusing the classical dogma of science's continuous progress and reaffirming the existence of epistemological ruptures through the methods and concept changes. Among countless contributions, he collaborated with the transformation of the scientific thought in a social reality, and his work can be considered one of the precursors of contemporary epistemology.

Popper's main work, 'The Logic of the Scientific Discovery' was published in 1934. Through this book, he puts forward two basic subjects: the method of the empiric sciences, and how to distinguish and identify what

is scientific. Starting from these premises, Popper proposes a new form of ratiocinating scientifically, building scientific criterions to a theory.

Kuhn published his principal work, 'The Structure of the Scientific Revolutions' in 1962. In this book, he studies the individual characteristics of the scientific discoveries and progresses through the accumulation of knowledge, emphasizing the discontinuity, the ruptures and the epistemological crisis of the sciences. This work had a great impact in all organized knowledge fields, especially in the natural sciences, the human sciences and in the economic sciences.

The new epistemologies and methodologies contributed to the creation of new languages and scientific theories that formed the base material of various technological platforms. At this juncture, the economic networks triggered a new global division of labor matrix with major impacts on the worldwide market, at the end of the last century

## The March and Contradictions of Science

The notions of the transformation, evolution and development, and of the continuous variation of living beings (live organisms, societies, cultures) constitute a mark in the history of the sciences. These notions were the target of intense debates in Europe during the 20th century. Auguste Comte and Friedrich Hegel studied the society and the history of human spirit as a march going by states in a progressive form. While the linguistics showed, at that time, that the Indo-European languages were diversified starting from a same matrix; the idea of the people's evolution was also present in the history, the anthropological researches about the humanity and the conception of some philosophical systems, in particular, in Herbert Spencer's works (1820-1903).

The idea that societies should develop from the inferior to the superior races or from the primitive people to the civilized societies according to a continuous and irrevocable march has been submitted to intense criticism and understood as a colonialist and imperialistic conception of the central people (Dortier, 2001).

Starting from the 1980s, Ilya Progogine has been proposing a scientific thesis with significant impacts on the studies of the physico-chemical and biological processes. Based on the definition associated with the evolution, a

macroscopic growth of the information contained in a self-reproducer system without intelligent intervention, Progogine built a theory that answers subjects yet to deciphered in the natural sciences, such as what is the relationship between entropy and evolution? How can the laws of thermodynamics be applied to life? How the appearance of the order and of the complexity starting from the nature can be explained?

The intellectual concern of Prigogine is inserted in a more fertile speculation that can be translated in the following form: What is life? François Jacob (2002), a French physiologist of great scientific repute, reveals that life is a process, an apprenticeship of organization of the matter, and that it does not exist in a certain independent amount that we can characterize. He also attests that the biology has a long tradition in studies of nature, of which he highlights the following theory:

> *"(...) Towards half of the 20th century (...) the birth of molecular biology resulted in a new way of regarding the live entity: the idea is that the properties of the biological life should, necessarily, be explained by structures and the interactions of molecules which compose them (...) With such presupposition the way the study of live entities, their operation, their evolution has changed. The demand for molecular explanation won several branches of biology, cellular biology, virology, immunology, physiology, neurology, endocrinology, (...)." (Jacob, 2002).*

Thus, is observed a huge impact on all the fields of modern sciences and in a wide technological segment.

Of the above results, together with the research on the genetic code constitute the primordial problems that commonly have been denominated as physics, chemistry and modern biology.

The article "The Structure for Deoxyribose Nucleic Acid" published by James Dewey Watson (1928 - ?) and Francis Harry Compton Crick (1916 - 2004) in Volume 171, page 737, of Nature on 2nd April, 1953 introduced revolutionary advances in the understanding of the structure and cellular functioning. They identified the core of the cells as the 'residence' of the genetic material (DNA) of living organisms. They characterized this entity [the DNA] as the 'guardian' of the responsible information for all our biological features, creating connections between the past, the present and

the biological future, known as the 'alive entity', constructing universal possibilities of obtaining safe information and inferences of the whole, from a part of the same. It made possible the theoretical and empirical development of innumerable new arrays and patterns of organizations of 'biological life', with the emergency of genetic engineering. This article introduced also new relations and historical senses between politics-science-economy-religion.

In spite of biology to be a key knowledge field in the disentanglement of the subjects that articulate the nature-spirit category, Bitsaks (2001) emphasizes that:

> *"(...) the simplistic thought reduced the man to a chemical and biological machine. The behaviourism constitutes an ingenuous simplification, unable to understand the human being's true nature. The knowledge of the genome, on the other hand, provoked a new simplifying wave, moreover the genes determine directly the human nature. This way, the feelings, the political or ethical ideas, are certain recorded on our genome. In consequence, the history, the barbarism and the wars are a result of the direct properties registered inside of our brain. What is unfolded in an ingenuous conception that justifies the racism, the nazism, the wars, the social inequalities, in detriment of the social choices and determinations. (...) to explain the men's ideas, is necessary to research its origins inside of the society, not inside of the biology. And the march of the history is determined by the social forces and by the ideas of social origin. Evidently, the free will and the freedom are not registered inside the genome; the same is valid for the historical fatality."*

The psychoanalysis also placed new elements in the subject. Freud showed that the personality is not only a combination of genetic and sociocultural information. On the contrary, the conjunction of conflicting themes, certain resultants of genetic information (heredity), others of sociological information (culture), by the same potentially generating of conflicts constitute invisible internal events. In that form, the development is a chain whose links are associated by dialectic among internal events (results of internal conflicts) and external events. In this interactive dynamics the fixing traumatisms that play a fundamental role in the formation of the personality will appear.

Personality is formed and modified as a function of three factors: the genetic heredity, the cultural inheritance, and the events and the risks. It is interesting to examine as the antagonistic or heterogeneous association of the genetic heredity and the cultural inheritance, permanent source of internal events, allowing the event-risk to carry out a relevant issue inside the formation of the bio cultural system that constitutes a human individual (Morin, 1990).

The transgenic also revitalized the main foundation of the evolutionist biology,[4] which establishes that all the properties of a being organism cannot only be explained by its molecular structures. This impedes the reduction of the biology to the physical and chemical laws. Holistically, as if the whole is superior to its parts (Larrère & Larrère, 1997a). The laws that determine the preservation and evolution of life pretend to be of another nature. What does not constitute impediment so that the biology is placed as a field of key knowledge for the explanation of the relationships between the spirit and matter categories. The sociology and the anthropology are fortified with the emergence of news civilization contractions and the metamorphoses of humanity's old problems. The paradigm of 'Equality, Freedom and Fraternity' is again polemized with new social subjects (Freitas, 2002, p. 373).

In irreversible form, these three knowledge fields, physics, chemistry and biology, were separate among the old and the new, the past and the future. The consolidations of biochemistry, algebra, differential geometry and the topology in mathematics were basic for the emergence of this new worldwide scientific scenario.

## New Scientific Conceptions

Science and technology constitute the principal motor-agents of this new age; an age that changed the actors, the scenarios, the rules, the structures, the senses, the interpretations and the meanings, the conceptions and the systems of thoughts. It enlarged the reaches of the scientific and technological projects since the plane space to curved space and the classic scenarios where the absolute space-temporary structures prevail on the space-temporal metric. Highlight for the studies on the material content of the universe, and the researches on the chemical element of periodic table.

Emphasis on understanding of movement of an object around a centre of force to the waves of probability associated with the electronic configurations known for a certain atom or molecule, for the research involving the processes of change of heat in domiciliary ambit, and for the research that facilitates the 'freezing' and the 'heating' in atomic, planetary and cosmic scales. Its were also prioritized the research programs on the changes of phase of the substances in alimentary level, and the speculations and theoretical and empirical introspections concerning the microscopic behaviour of matter. Special attention was dedicated to the physical and chemical aspects that guide the process and the energy availability from atomic fusion, and to the study of process of burning of fossil fuel to the understanding of the mechanisms that maintain the stability and the possibility of the division of the atomic nucleus and the corresponding use of the immense liberated energy. The world has changed of the era of the lamppost for the processes generation, transport and distribution of electromagnetic energy; of the regional transports of vapours for the intercontinental cruises of transatlantic, of the displacements of locomotives to the space trips, of the logical processes of mathematics for the sophisticated theories and computational methods, of the cathode ray tubes for the transistorized circuits, and of the vinyl disks to the laser technology.

Scientists intensified the studies on the mosaic of the real and virtual materials, obtained with different atomic combinations and arrangements; sweet and bitter, hard and soft, multi-colored and multifaceted, conductors and insulators, semiconductors and superconductors, resistant and disposable, therapeutic and soothing, and opaque and transparent. Thus a new era was started for extensive agriculture, physics and the chemistry of new materials, personal computer-electronics, biology, health and the agronomic sciences, technologies, molecular, civil, electric-electronics, aeronautics, and naval engineering, and meteorology sciences.

New demands were imposed, the computational sciences were created. The food, genetics and forest engineering, the courses on ecology and environment, and many other professions related with the uses of the soil, of water, and of air also flourished. Complex communication nets were wrought with the code and the digital recording of the information, impacting the cultural industries and engendering new virtual conceptions.

The finance market was revitalized, it was multiplied, was broken up and

continually recomposed, acquiring various forms and multiple features. The market is non-territorial, overflown on the places, on the regions, on the countries, on the continents, on the planet, and it gets ready for the sidereal trips. It is like a fluid, introduced as a type of apparent reality, with several intermediary layers, that 'attracts' or 'repels' the consumers, in agreement with the conditions historically created by the market.

The economic processes amplify its production and performance scales, its self-fragment for best be expanded, composing new partnerships and reaching new consumers. The essential becomes the exception, and the superfluous is definitively incorporated in the new worldwide economics political structures. The production manners were sophisticated, excluding, pressuring, rejuvenating and rearticulating themselves with the trade and with the market.

All physical and chemical properties of the substances accessible to our senses originate from the microscopic behaviour of the matter, in general, from the recurrence phenomenon of physical interactions of the electronic clouds of the atoms and molecules, or from the dynamics of the atomic nuclei of the different chemical elements that compose the periodic table. The enormous knowledge accumulated by physicists and the chemists during the 20th century, based on this principle, corroborated for the current technological development, with impacts in all knowledge fields. The consolidation and universalization of the analytical method accelerated the emergency and the solution of new scientific problems, although in fragmented form, with the general theories of the natural sciences, facilitating the solution of the complexes technical problems of humanity.

The understanding of the basic principles of the atomization of nature's phenomenon, permeated by the social processes, was coupled fully with the production and expansion of the economic processes in the global ambit. In unfolding, the complete control of the development and application of the technologies of new materials, the information network, and the denudation of the genetic code by the transnational groups contributed to a reordering of the economic world. This new feature of the economic processes meets organized in the operational integration of financial centres dislocated of territories and in the creation of volatile and speculative wealth, creating the necessary technical conditions for the globalization process.

The principles founding the Renaissance civilization 'individual, nature

and humanism' were diluted in massification, mechanization and in dehumanization under the form of two amoral forces: money and reason (Silva, 1999). That corroborated for the disjunction between the science and the ethics. Niels Bohr (1962) believed that the principle of completing, of his authorship could come to be an important reference in the solution of the conflict between need and freedom, building fertile articulations between science and politics.

For traditional and methodological limitations, the construction of explanatory theories of the phenomenon of nature, at different levels, abstracts the its historical character. The restrictive and disjunctive methods used in the theoretical and empiric structure of the natural sciences, in principle, fragments the object under study in two independent worlds: that of the nature (amorphous) and that of the sapiens man (rational); both immerged in historical dynamics (Freitas & Freitas, 2013a).

In fact, the interdependences among those two worlds, is present in a continuous, interlaced, simultaneous form and has been hindering the construction of systemic and complex theories concerning the cultural processes. One cannot deny that it was through restrictive scientific methodology, of the nature of sciences, that the hegemonic countries reached a high pattern of technological development and social promotion. However, is unquestionable the progresses of the basic research, in all fields of scientific knowledge. Although the sophisticated theoretical and empirical studies in the contemporary age, including the atomization of the nature; the complete control of the development and application of the technologies of new material; the information network; the linguistic studies; the disentanglement of the genetic code; the anthropological theories and the sociology of the globalization of culture; the sophisticated geographic and historical studies; the high precision and acuteness technologies of the health sciences, of pharmacology, of the engineering; and the progress of the political sciences, still do not apprehend the totality of nature.[5]

This structural and methodological injunction acts as one motive force of the world economic processes, stimulating and enlarging the non-compromise of the economic and political agents with the social promotion and the world dignification, according to the demands of each people. The simplification, the intolerance and the vulgarization of the wide universal cultural issues, have contributed to the market and the marketing incrusted

the ecological notion in the applied sciences, as a strategy for reinforce the process of original accumulation.

It reaffirms the urgency of incorporation to the foundations of the nature concept, elements that raise the essentialness of the social and natural diversities owns of the different cultures (Freitas & Freitas, 2013a).

## The Contours of Nature

The contours of nature processes are historical. The specialists insist on attributing more importantance in the construction of an aggregative and systemic political mentality to the education. A critical and contemporary conception, and committed radically with the complexity and the challenges put to humanity during the 21th century.

Edgar Morin (2000) idealized a set of ontological and methodological references for humanity's improvement that should to be incorporated in the educational conceptions of the 21th century. The most important among them is the favoritism of the culture, which in a wide sense involves, the introduction of a systemic conception that prioritizes the whole and its articulations, always valuing the human condition in its physical, spiritual, psychosocial and historical complexity. Continuing Morin states that it is also important to show the inseparable connection between unit-diversity, own of the human dimension; the critical historicity of the educational processes, since the singular to the universal, and reaffirms the communion of humanity's destiny. Finally, Morin puts the need of the educational processes standing out its conquests and in its fragilities and its historical uncertainties, and the creation of mechanisms that facilitate to incrust a limitless capacity of understanding, in the minds and in the human spirits, doing of that mutual understanding among the humans, the base of the solidarity and of the peace. This conception establishes the importance of the ethics in the improvement of the democracy and in the globalization of a fraternal and solidarity citizenship. Through education, Morin proposes general and universal principles that articulate the substance-subject, nature-spirit, and need-freedom categories in the construction of a more generous, solidary and human civilization.

The fragmented interests of central governments, the absence of full democracy in majority of the countries, and the crisis of the modern state

conspire against Morin's fecund proposal of building a human project of cosmic insertion, based in the faiths, sciences, politics, and human limitations. Maurice Langon (2001) stated what in a world permeated by poverty, it is necessary to rediscover and reconstruct the unit by human solidarity that requests the change of a non-human system.

The understanding of man's complexity demands the non-mutilation of the human condition. It also demands that the symbolic representations of the processes of the nature are spiraled outside, going to the encountering and fusing with the foundations of the world culture. It demands finally, that the philosophical, political and social-artistic foundations of the universal culture permeate through these processes of the nature.

The new production, storage, transmission, reception and decoding processes of information have introduced radical modifications in the world culture, with major impacts on the economy. The production of wealth under the form of merchandise was substituted by the finance market that, in voracious and independent forms creates a new industry of financial products. It an industry that has changed the production of goods and services for speculation of the future production of commodities, the future behavior of the currencies and the financial shares of companies. In network form, this abstract and virtual currency is being removed away from the traditional economic processes, introducing radical alterations to the world tendencies (Santos, 2001).

The duality that has delimited the non-developed and developed economies was dissolved in a political substratum impregnated by the virtual processes; endowed processes of logic and of an operational degree. If on the one hand, it accelerates the fragmentation of the local cultures, on the other, it builds new possibilities for the socioeconomic insertion of these same cultures in the local, national and world markets. Ecology, biotechnology, nanotechnology, cybernetics, and narcissism are constituent elements of the new civilization framework. The eight plagues of modernity: the racism, poverty, war, the structural unemployment, ecological destruction, child labor, endemic and epidemic diseases especially AIDS, and the moral crisis, constitute a series of deadlocks put for mankind in this new century (Freitas & Freitas, 2013a). With the mediation of science, they are being incorporated and pondered under a new 'light culture', a 'fashion world' that has been impregnated in mankind's thought frame; an archetype

that has restated the economy as the main reference to modernity. The disenchantment of the universe by analytical knowledge has been followed by the construction of a world without unity, and objects have been moved in search of an order that is generated or regenerated according to hegemonic interests. The meanings and senses of the national politics of development are reconstructed according to the perspectives of the asymmetric growth of the international market.

A self-characteristic of development is carried out through mechanical and/or non-mechanical unbalance processes, which are manifested through dissociations of the old forms and associations of new contents. Dissociations which represent a reaction against the affirmative essence of politics are constituent elements of the traditional confrontations between the form and the content. Development is imposed as a need for cosmic renewal, and for this reason, the movement of dissociation has been located against the category of "form-unity".

Jimenez (1977) states that

> *"(...) It is due to the form that workmanship is becoming critical: it is this that attests to the mechanical character, of the human product. Mediation in the relationship of the parts among themselves and with the whole denies the immediate character of the workmanship and confirms its statute of product (...). The form is nothing more than a sedimented content (...). The live content of the empiric reality allows the structural dissociation to reappear in the formal composition, as refuses of the alienation and refuses of the appeasement of the contradictions by the image of a false reconciliation."*

It results in the emergence of a new spatial and temporal order interlaced to each other and driven by the 'elastic' nature of time. The possibility of the control of temporary dynamics imposes restrictions to the space dynamics. This dimension becomes 'transparent' and lose their identities creating new scenarios which evolve in time, according to the circumstances and problems presented. This contradiction strengthens the self space-time logic of human actions. The relationships, the purposes and the conflicts become articulated by the logic of the movement; logic shaped by this space-time metric without defined contours and contents, mediated by the analytic and synthetic propositions in Kant's sense.

In this context, the initial conditions and the contour problems acquire the same relevance as the object in focus. Initial conditions and contours act as generating elements. The elements that mold the germination of the matrix of theoretical and empiric configurations are improved during the process of development of the 'contents-form' in time, incorporating the political discourses and configuring new development aesthetics. During this process, these generator elements are incorporated and merged into these scenarios, losing, in an irreversible manner their identities.

The 'development × culture' confrontation constitutes a structural problem of modernity. The human condition can be reinvented, it can also be apprehended as the unfolding of progress. On other ways, the development, through the culture fortifies the citizenship denying the 'other'. It restates the democracy without commitment with the diversity and the plurality and constructs a non-integrated social and economic totality on symbolic universe imbricated in the human condition (Jimenez, 1977).

The presence of these contradictions does not deny the concrete possibility of development, rather, it is reaffirmed. It reafirms the nature as a commodity and a eternal source of profit (Aknin, 2002). Development is also anchored on self-sustaining external agents in a process of progressive unbalance, prioritizing the categories of quantity in detriment of quality. The incorporation from the borders for the centers aggravates this picture, imposing a single sense in the flow of the sustainability, creating new contours for the processes of nature, science and of technological education. A new aesthetics concept on the world with a "look" towards the future (Freitas & Freitas, 2015b).

## Final Considerations: Wisdom Societies

The wisdom societies will have a decisive role in the economic and political unification of the planet. They integrate a set of entrepreneurial networks, directed to the social and ecological stability of the planet. Their purpose is to construct a worldwide culture of solidarity; to reaffirm the principle of freedom as the foundation of the civilizing process. It crystallizes the paradigm of technologically innovative cultural networks, shifts historical societies to societal networks. They available scientific and traditional knowledge in worldwide networks, reform institutions and create programs,

thereby guaranteeing continuous education for all. They, also, define superior education for the future with an emphasis on new education technologies, the new forms of the financing of university education and allow a revolution in scientific processes and technological managerial networks.

Finally, they construct national and international actions toward to human security, guarantee universal access to knowledge with an emphasis on sharing and copyright protection and renew public spaces to reaffirm the paradigm of sustainable development (UNESCO, 2005).

All this requires new approaches and conceptual structures for science education, communication, and marketing. Enterprises seated in multiculturalism processes which emphasize the humanistic values and the notion of sustainability are essential. These enterprises require the integration of the research and innovation programs that move the sustainable development models.

Therefore, there is a need for a new natural contract. A set of commitments institutionalized by governments and incorporated into national and international public politics could ensure the necessary technical instruments for the socio-ecological stability of the planet. The central axis of this contract is the preservation of human species, an issue that is articulated by the science education, ecology and science via the processes of production and reproduction of life.

Science education has a singular role in the construction process of sustainable public policies. Education should be of high quality, and permeated for environmental sciences. There must be greater public funding for education and new international forums to formulate and meet the goals of education systems. Programmes and educational projects for the training of teachers in science, which are centred on sustainability, are currently being developed and operated in various national and international institutions. The debate is complex with many issues regarding concepts, foundations and new curriculum metrics. These include: content, skills, hierarchies, nature, culture, research, abstraction, cognition, inference, theory, experimentation, teacher, school, student, society, structure, interdisciplinarity, taxonomy, thematic integration, educational psychology, technological innovation, cybernetics, citizenship and market. Elements of structuralism, behaviourism and Piaget's contributions are evident in this

debate on educational projects. The new complexities of the 21th century can enhance human dignity and conserve nature (Freitas & Freitas, 2013b). It has also contributed to the creation of new educational matrices committed to the future of humanity and the fight against social inequality.

Towards this kind of future, the humanization of the science education is a worldwide perspective.

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# Notes

1. Werner Karl Heisenberg (1901-1976), German physicist, and, Erwin Schrödinger (1887-1961), Austrian physicist, published relevant papers on the structuring and theoretical consolidation of quantum mechanics, a knowledge field that studies the physical phenomena at the atomic level. Louis de Broglie (1892-1987), French physicist, and Arthur Holly Compton, (1892-1962), American physicist, produced decisive contributions for the consolidation of the thesis that proves the dual, ondulatory and corpuscular nature of electromagnetic radiation, with impacts in several technological fields. Max Born (1882-1970), German physicist, published a central paper on the construction of the language of physical mathematics that cemented and molded the development of quantum mechanics. Josiah Willard Gibbs (1839-1903), American physicist, created important analytical connections between the classic thermodynamics and statistical mechanics, contributing to the consolidation of this scientific area. Paul Adrien Maurice Dirac (1902-1984), English physicist, published important scientific works on the foundations of quantum mechanics, contributing to its consolidation and generalization. Wolfgang Pauli (1900-1958), Austrian physicist, constructed excellent scientific articles on the foundations of the mechanics and the theory of relativity with innumerable applications in the atomic dynamics of chemical elements that compose the periodic table. Lev Davidovic Landau (1908-1968), eminent Russian physicist, constructed works of great scientific reach on condensed matter, with vast applications in the fluid physics and theory of solid. Enrico Fermi (1901-1954), Italian physicist, had a decisive role in the development of nuclear physics and in the foundations of statistical mechanics. These scientists had an important role in the construction of a scientific language that represents the matter in holistic dimension and integrated to a diversity of the forms.

2. Now the development has advanced techniques associated with the research on physical phenomenon of short duration, with significant impacts on chemistry, biophysics, quantum electromagnetism, studies of the structure of the matter, physics of particles and in other fields of scientific and technological knowledge. In general, in the studies the intervals of times change from a part from one billion ($10^{-9}$ s: 1 picosecond) to the a part from one trillion of second ($10^{-12}$ s: 1 femtosecond). Pulses of light laser are used facilitate obtaining important information about the molecular chemical connections, the movements of the

electrons in microcircuits, the transmission of optic pulses in fibers of telecommunications, and the transport of electric pulses in the nervous system.
3. Important intellectual references in the history of the philosophy and the sciences.
4. Biology, in general, studies the behavior of the organisms, the relationships among them and the environment.
5. Marcel Mauss (Ensaios de Sociologia, 1999) observes that "(...) All scientific observation refers to phenomenon chosen and isolated methodically of the other ones, that is, abstracted. The social phenomenon, more than all the other ones, cannot be studied at once in all their details, in their whole relationship. They are too complex so that they are not proceeded by abstractions and for successive divisions of the difficulties." Catherine Larrère (1997b) states that this restrictive process is enlarged when it is considered that the ontological unit of the sciences is problematic: the real is decomposed in different domains, in which the objects are not governed by the same principles, nor apprehended by the same procedures. However, any intellectual impediment does not exist such that historicity is printed to the scientific process in all the knowledge fields. The construction of the knowledge is historical, it is not isolated from the researcher's context and it should not only search for the explanations at the elementary level. The evolution of the knowledge is not linear, it is a product of contradictions born within the construction process of the knowledge and that facilitates the formulation of new concepts, laws and theories.

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