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H. Inter – and Transdisciplinarity in Science and Technology

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Transdisciplinarity approaches to mobility

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Abstract. The intense sustainable development of the knowledge society through the complexity of human activities, technologies, as well as theoretical concepts branched in all directions, have sophisticated user needs for products and services, for mobility. Following the performance of production and logistic units, the mobility of goods and passengers, the speeds of change and reaction to consumer demands, the quality of life is increasing. In the competition between production, logistics and circulation of information, which is becoming a quantum reality, it is necessary to quickly know the indicators by which to measure, analyze and make predictions of the activities that take place. Their quality means the avoidance of distorted images in different reality levels. It creates transdisciplinary work tools, and organizational and managerial structures for different reality levels. These systems integrate people's minds and psyches with physical reality, resulting the quantum psychology through which the human factor controls mobility.

Keywords: transdisciplinarity, mobility, quantum reality.

1. Introduction

In the knowledge society, the diversity and complexity of systems increases, which leads to the intensification of information flows, both within the system and in the network of systems. The integration of quantum physics with other knowledge fields has resulted in new sciences through which research can be performed at higher reality levels. It moves from a linear cause-and-effect approach to a networked approach in which many influences interfere on the programmed activity.
The human being's thinking is a continuous vibration of thousands of tiny variations, strings that create quarks, that is, decisions and actions, patterns and universes. The theoretical basis is quantum physics, especially the Kaluza-Klein theory [12] involving field equations in space-time in 5-dim. This theory was

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improved later by R. Feynman. The strings vibrate in a certain way in 10-dimensional space and produce a certain quark. If it vibrates differently, it produces another quark. An infinity of universes can be created, that is, an infinity of 'coherences'. In the case of a certain being, many decisional modes of quantum thinking result. An individual is able to communicate with the interior through causal relationships and the art of structuring, but also with the exterior based on analogies, schemes of approaching the universe, synthesizing and expressing the results of knowledge in images and intuitions [3]. Imagination dominates through spatial memory, through intuitive and interactive approach, synthesizing the relationships between objects, using associations of ideas, managing information to understand objects in context. As a physical and spiritual entity, man has the ability to interact quantum with matter in an intense and deep emotional experience. This is also part of the Gaia Hypothesis [13], a theory according to which organic elements interact with the inorganic environment to transform the planet into a life-friendly environment. The perception of man located with his psyche between macro and micro-cosmos leads to the quantum idea of interaction between mind and matter.

2. Quantum realities in the physical world

The diversification and further development of networks (production, storage, transport, supply, distribution, consumption, etc.) which are thus becoming increasingly complex, to which are added other networks, such as social, makes it necessary to introduce new theories of flows on such complex networks. The goods are sold and delivered in discrete amounts packed in logistic loading units (parcels, containers, etc.), based on financial transactions which are also discontinuous. These could even be called quantum networks under certain conditions, especially because people are integrated into their functioning. For a global assessment of the processes, it will no longer be necessary to identify each logistic unit (loading unit, vehicle, etc.) in the networks, but only the probability distribution of their position and momentum. As a result, there will be a need to define new concepts for characterizing flows in networks, such as logistic energy, logistic momentum, spin, rotating vectors, etc. Similarly, for the study of the 'collision' of logistics units (for example, the intersection of logistic flows, followed by different subsequent evolutions of freight units), for the elaboration of redistribution models of flows at the intersection of transport corridors. The refinement of such indicators can shape the behavior of systems, their propensity to cooperate, their mutual attraction or rejection, and even the feasibility of networking the networks. It can tend to higher and higher levels of reality, having as its absolute landmark one of the two fundamental commandments of Christianity, 'just as I have loved you, you also must love one another' (John 13: 34), which is the divine support of 'networking'. The high level of affinity of interests of the participants as nodes of the network, gives the appearance of its monolith, although it is not a compact body, there are

large spaces between nodes and arcs, such as between the electron cloud and the atomic nucleus.

Many of the methods of modeling random, quantum and chaotic phenomena [9] inspire us to build unconventional methods of modeling traffic flows in areas of separate potential, applications in traffic engineering, scattering of vehicles and loading units in a logistic area, estimating the probability of vehicle position or of packages, etc. Evaluations of the infrastructure network are carried out, comparing, for example, the physical network with the map of the virtual logistic flows on which the traffic would move, if the network existed as a physical reality.

In the fig. 1. a large density of vehicles flow is observed that could be modeled by quantum concepts, including of psychological kind. The aerial image highlights the quantum aspect facilitated by the small relative dimensions of the logistic units and their indivisibility in the context of the processes they go through. In addition, vehicles are driven by people who give them a quantum probabilistic behavior based on superposition of flow oscillations.

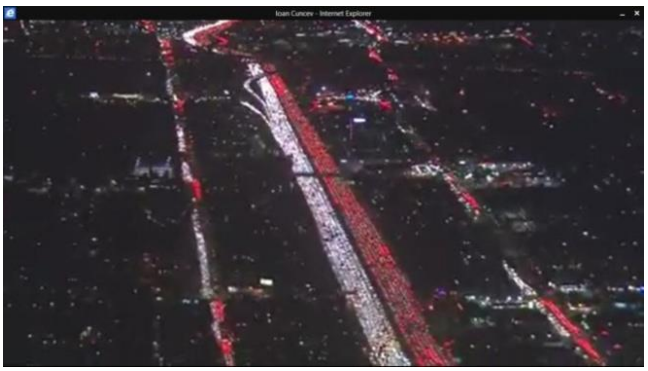

Fig. 1. Traffic on Highway 405, West Los Angeles (ABC7).

By quantum modeling we do not mean only a theory of mobility based on quantum physics, but also the application in mobility theory, of different mathematical methods of quantum physics.

Interpreting the experiment on the photoelectric effect [2], it is possible the analogy: vehicles that are shipped from producers in a certain node A to consumers in node B, leave under the influence of hν stimulation quanta (of information, logistic demands, orders, oscillation of freight and tariffs, fuel price, etc.). The stimulating factor has effect only if its frequency is $\nu > \nu_o$. The kinetic energy attached to the traffic is $E_{cin} = eU_s$. Traffic occurs regardless of the potential difference U between A and B. In order to generate traffic, there must be incentive, information flow (including advertisements) and market activity above a certain energy threshold U_S.

For a high density of logistic units, a field of logistic units results, each having a mass capable of energy, momentum, as well as a certain position.

Different average characteristics [14] of logistic units moving from A to B can be evaluated.

3. Flows engineering in quantum reality

Starting from the genesis of quanta, by analogy, it could be build the quantum thinking model in which, for example, in an economic environment, the logistic units are issued discontinuously at the exit of factories or terminals, as well as the respective financial transactions. The production activity (energy E or financial capital consumed for the manufacture and dispatch of products as logistic units) results generation of logistic or financial flows ħ.ω, proportional to the frequency ω output from the factory or terminal. The analogy of light emission/absorption with the sending/receiving of logistic units can be developed based on Balmer's formula and Bohr's postulates [1]: sending/receiving flows of units occurs discontinuously by jumping from a steady state with energy E_n (a certain level of production) at another stationary state with the energy E_m, being accompanied by the shipment of objects, if $E_n > E_m$, or by their reception (supply), if $E_n < E_m$. Constant energy of steady states give measure to different levels of reality. The energy of that flow is:

$$\hbar.\omega_{nm} = E_n - E_m$$

The wave-particle has a wave function ψ, whose propagation equation was given by Schrödinger [15]. The eigenvalues of the wave associated with a load unit are the values of its energy.

Quantum mechanics applied to the mobility market could also mean that a freight index, for example, is based on the tariff statistics of many transported logistic units. If the market index is a macro-scale object, then each logistic unit could be a micro- system, which is traded at certain price, as being its corpuscular property, and the tariff fluctuation is its wave characteristic. Then micro-scale object of wave-particle dualism, could be a quantum system.

In this context, let us consider the freight market of a shipping company having a quantum behavior. The wave function which describes the state of the market is a function Ψ(p,t) which depends on freight prices p of the transport services and time t. In the space of states and according to Dirac notation, the wave function is:

$$|\Psi\rangle = \sum c_k |\Psi\rangle$$

meaning that the function $|\Psi\rangle$ is a linear superposition of well-defined stationary wave functions, with complex coefficients $c_k = \langle \Phi_k | \Psi \rangle$,

k = 1, . . .∞. The probability density of freight prices is $|\Psi(p, t)|^2$. Then, the probability of price between a and b at time t, is:

$$P(t) = \int_a^b |\Psi(p,t)|^2 \, dp$$

Cargo units pass through a port (if the flow takes place between the sea and the hinterland) or through a logistic platform (if the supply chain is land-based). There is an uncertainty, according to Heisenberg's principle of indeterminacy (for example, along the

x-axis, Δp. Δx ≈ p. λ). Precise values of both the x position and the p momentum cannot be obtained simultaneously. In canonical variables:

$$\Delta p_k \, . \, \Delta q_k \approx 2\pi\hbar$$

So, the theory of mobility must be adapted to certain situations, in the sense of quantum-like thinking, in which the states of the system are described by wave functions.

For the probability of positioning a logistic unit in an elementary volume on time t shall be used:

$$\Delta P = \psi^{*}(x, y, z; t).\ \psi(x, y, z; t)\ .\Delta V$$

From the probability density $P = \Delta P / \Delta V$, it results:

$$P(x, y, z; t) = \left| \psi(x, y, z; t) \right|^{2}$$

For a system of logistic units whose configuration is given by the generalized coordinates $q_1, q_2, \ldots, q_k, \ldots, q_f$, the relation becomes:

$$P(q_1,..,q_f; t) = \left| \psi(q_1,\ldots,q_f; t) \right|^{2},$$

meaning probabilistic nature of quantum approach.

The quantum model of thinking can be better applied in a very dense network which, at the limit, becomes a kind of continuous environment of smaller and smaller logistic units (till parcels, and articles which are finally consumed), with an increasing speed in which the units are positioned by probability density. Similarly, for financial flows, benchmarking, internet traffic, knowledge spread, contagion effect. Starting with the analogy between logistics units and particles, in order to follow the flows coming from two sources of units or the emissions of opinions from two social sources, it is to admit that their evolution is made according to Schrödinger's equation. By solving it, one can know, at a later time, the probability density of finding each of the two types of logistics units at any other point in space. It follows that the transitions of a quantum system between two states that differ from each other only by permuting identical units, cannot be detected experimentally. The same is true, for example, of individuals whose oscillations of belonging to different social groups are difficult to detect. If the two units are transposed, for example one politician goes to the left and another goes to the right, a full container instead of another empty one (the latter goes later to the loaded state and the loaded one becomes empty), it turns out that they inter-change their positions. The state of system with two units is:

$$\psi(2,1) = \psi_a(2)\ \psi_b(1), \text{ etc.}$$

The previous results can also be obtained in a relativistic context, through which a wave package is associated with the particle [17]. Schrödinger treat things in a non-relativistic approach. The energy can only have certain discrete values depending on the integers n = 1, 2, 3, ... This leads to the quantification of energy because it has solutions only in cases where the energy E has eigenvalues. The theory was further developed by Heisenberg, using matrix calculus.

De Broglie suggested how to unify the principles of general relativity and wave mechanics [8]: 'Representing material (and also photons) as singularities in the space-time matrix surrounded by a wave field of which it would be part and whose definition would introduce Planck's constant, we should come to merge Einstein's conceptions of particles and those of my theory of the two solutions'. By merging the formulas of energy E according to the two theories, $mc^2 = h\nu$, we obtain the quantum and relativistic character of the events in the microcosm. The frequency is $\nu = c/\lambda$.

It results a single quantum-relativistic constant τ:

$$\tau = h/c = m\lambda$$

So, the mass m and the wavelength λ are variable:

$$\tau = (m + \Delta m).(\lambda - \Delta\lambda)$$

Between the quantum variables (mass) and the spatial-temporal ones there is a strict correlation given by the quantum-relativistic constant τ.

By analogy, the travel of objects in the network is a quantum process, they circulating in discrete quantities between nodes A and B: parcels, containers, trucks, vehicles, trains, ships, airplanes, financial units, information units. They wait in B for a certain period of time until sufficient logistic mass (energy) accumulates to make a new jump to another energy level (node, terminal). There is an equivalence between mass and energy. Einstein said that the mass of a body is a measure of its energy capacity. That is, the energy of a body varies with body mass. From the theory of special relativity, it results the equations:

$$m = m_0 / (1 - v^2/c^2)^{1/2}$$

$$t = 1 / (1 - v^2/c^2)^{1/2}$$

$$E = m_0.c^2 /(1 - v^2/c^2)^{1/2}$$

That is, when the velocity v of particles reach the barrier c, they disintegrate in quantum light (photons). For the analogy, in physical reality we consider that, similar to the maximum speed c, is the maximum speed limit of entropy variation in a certain environment (context), v is the becoming speed of objects, namely speed of system in entropic environment [4].

In the theory of special relativity, mass and energy have been merged in a principle of equivalence between mass and energy: if a body absorbs an energy E_o, its inert mass increases with E_o/c^2; the inert mass of a body is variable in proportion to the variation of its energy (Einstein). The mass of a body is energy at rest, it is a measure of the capacity of its energy. The variation of energy is done with the variation of the mass, without the energy being transformed into mass and vice versa. For example, other particles emerge from the collision of particles, without the mass being transformed into energy, but the new particles have mass and energy, with separate observance of the laws of conservation of mass and energy. The mass of the particles is converted into the mass of other particles and, similarly, the energy. So, Einstein's formula becomes:

$$\Delta E = c^2 . \Delta m; \Delta m = \Delta E / c^2$$

De Broglie says that an energy radiation E must have a mass equal to E/c^2. It means that a body that radiates, loses mass, and the body that absorbs radiation gains that mass supplement. The variations between the particle's own mass and the variable mass or moving mass are quantum in nature and are achieved by particle emission/absorption. The relationship between the proper mass and the variable mass is of a quantum and relativistic nature. These considerations can be useful in modeling the 'movement' of companies under the influence of investments and inbound and inside logistics to produce outbound logistics, firms with a certain financial, social and human capital (own mass), resulting the distribution of logistics unit flows in outbound logistics.

To represent the motion of a material point, wave mechanics takes into account the atomic structure of matter as well as the propagation of continuous waves. The relationship between the quantum character of the particle and its propagation wave was established, as well as the quantum and relativistic character of moving material particles. De Broglie extends the particle-wave duality to any 'physical being' [8], being valid for any micro-object. Depending on the projects, it needs to be determined in relation to what could be considered the logistics units as being micro-objects.

4. Levels of reality according to the principle of correspondence

The formulas obtained in a more refined theory must contain as a particular case the formulas obtained in a less refined theory, according to the principle of correspondence. In other words, the theories and models existing in a certain level of reality, are particularizations of those with a higher degree of generality, existing in a higher level reality. This idea can also be expressed through a transdisciplinary tool such as category theory: objects from lower level reality can generate an object in a level of reality immediately higher through a product in term of category theory [7].

5. Position of observer in relation to the system

The high speed with which processes and phenomena unfold is comparable to the speed of transport of information about them, which determines the subjectivism of some images about the system under observation. The knowledge of the value of entropy by an observer is influenced by the speed of sending/receiving the information, which makes it impossible to absolutely synchronize two events. That is, the state of a system cannot be known instantly, but depending on the speeds of information generation and transmission, and considering the reference systems in which the measurements are performed. In the entropic space of states the distance between systems or phenomena is measured by the amount of entropy that separates them on the trajectory of each system whose entropy tends irreversibly to the maximum possible limit [4]. Decreasing entropy by increasing the level of organization is achieved by consuming energy and other resources, with negative implications for the environment. For example, the development of an industrial park, the construction of canals, the chemical fertilization of agriculture, lead to the creation of organized structures with low entropy, but having negative implications by increasing the entropy of the environment (pollution, waste, etc.). It follows that the perception of time has a relativistic character and depends on the speed of variation of the entropy of the system, on the speed of its becoming, on the frame of reference in which the observer is located, and on the speed with which he is informed. The distance of the observer from a phenomenon is given by the volume of information that must be transmitted for its perception. The distance between

states (also phenomena) varies with the amount of information (or entropy) from one state to another.

If the observer is situated inside the system, he quickly notices the movement and transformation of the system. On the other hand, he also perceives the subjective aspects, having difficulties in the correct evaluation of its performances. Placed outside, in another frame of reference, the observer perceives the system as a whole, through the relations between its inputs and outputs, but has the disadvantage that the information will have a relativistic character. Indeed, the observer perceives the system after a time period, depending on the speed of compiling the information coming from the system in the mobile reference. The very process of knowledge is a discrete one, through which the observer perceives past sequences of the moving system. There is a time interval between the moments of information generation and perception in which the coding, transmission, reception, decoding and interpretation of the message are integrated. Man's ability to respond to perceived events depends on the relativistic assessment and prediction of the existing and future situation [5]. The relativity of information is given by the communication technique (metric aspect), the morphisms of the sender, the semantic meaning attributed to the reception, the valorization and the practical capitalization of the information by the receiver. By analogy with Einstein's theory of relativity, a limiting maximum speed of information could be defined that encompasses a light speed barrier, one organizational barrier and another technological:

C = f (speed of light in vacuum, level of system organization,
technological level of means for transmitting information)

The last two variables may depend on the chosen frame of reference. This is the case of the levels of reality in which the phenomena are not perceived directly, only through the rays of light, but especially, indirectly through the informational 'rays'.

6. Observers' subjectivity and interdependence

Quantum decisions are specific to beings, as are their actions. Reality is influenced by consciousness, which makes the observer influence experiments.

The relativity of knowing the truth about the activity of a system thus also depends on the observer, not only on its position in different references in relation to the observed system. The relative forms of truth can attract more or less adherents [10]. Any observer will perceive the system by observing the belonging of elements x_i to it. For example, state S = 'efficient port' is assessed differently by observers R and R' according to the indicators x_i, i = i...n, each establishing the membership $x_i \in S$. The system (S/R) can be represented by a point in the Riemann space endowed with the metric:

$$dL^2 = c^2 \cdot dh^2 - dH^2 - dJ^2 - dW^2,$$

which could satisfy the requirement that something common, invariant emerge from the qualitatively different aspects of the information [16].

The variables H, h, J, W could be [11]:
H (S/R) - internal entropy, namely the amount of knowledge that the R observer has about the internal structure of the S;
h (S/R) - external entropy, representing the quantity knowledge measured by R, which S has about the internal structure of its environment Σ;
J (S/R) - the objective that S must achieve;
W (S/R) - potential for transformation, defining the efficiency of information transfer within the system.
If H, h, J, W represent the state variables of the system, measured directly by the observer R, then H', h', J', W' are the values obtained by the external observer R' using R to observe the S system, resulting in a Lorentz observation process (S/R/R'):

$$H' = k\,(H+vh)$$
$$W' = W$$
$$J' = J$$
$$h' = k\,(h + vH/c^2)$$
$$v = \frac{dH}{dh}$$

7. Multi-dimensional universes

From quantum mechanics, a quantum-relativistic relationship results, $mc\lambda = h$, or $m\lambda = h/c = \tau$, where τ is a quantum specific to light with the velocity in vacuum c. That is, Heisenberg relations express a fundamental state in nature that represents neither indeterminism nor uncertainty [8].
The distance between two events in 4-dim space, is:
(x, y, z, ict): $ds^2 = dx_1^2 dx_2^2 dx_3^2 dx_4^2$
The world in 4-dim described by Minkowski and Einstein, consists of events specified by four coordinates (x, y, z, ict). Adding the 5th dimension, mass, results the reference coordinates (m, x, y, z, t) of the theory of relativity in 5-dim, which also includes the quantum character. According to the principle of correspondence, the i-dim universe is a particularization of the (i+1)-dim, also reflected in human consciousness and behaviors. Binary logic is no longer suitable in multidimensional universes, being necessary generalizations of Lupasco's theory. Sophisticated levels of reality can be reached if the number of dimensions continues to increase, imagining spaces of the type of infinite varieties that coexist simultaneously. The human imagination can generate thoughts that circulate in these realities in which the laws of physics are changed by generalization.

8. Conclusion

Human's activity continues to be achieved at dizzyingly increasing volumes and speeds.

Although technological innovations are emerging at the same rate, in order to increase the speed of informing decision-makers and to identify significant details of processes, new theories and models, even unconventional ones, are still needed.
Concepts such as Big Data, IoT, Block Chain, artificial intelligence, augmented reality and virtual reality, machine learning and deep learning, digitization and disruption, data strategy roadmap, smart mobility, etc. are useful.
A major technological revolution will be based on quantum way of thinking, using new working tools on the quantum computer of the future.

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