Implications of fractal geometry in scientific and technological developments in Latin America

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Summary - *When the geometry illustrate reality, it simplifies, considering that the processes are linear, assuming that the forms are smooth and regular. Use of the computer allows accelerated rework expanding the study of nonlinear dynamical systems that cause complex phenomena such as chaos and irregular shapes leading to fractal geometry. Nonlinear dynamics currently building a change of course in science, a new paradigm aimed at a third revolution. In Latin America you can analyze a wide variety of dynamic systems very sensitive to initial conditions that could well create chaos, these systems present in nature and the socio cultural evolution of those who inhabit it have been studied by remote mathematical models of the prehispanic geometry. Prehispanic geometry based study of fractals in chakana (incaica cross) as the axis of coordination by which mountains can be measured and establish patterns whose applications could adjust to the fractality of physical systems present in Latin America.*

Keywords - *Geometry, Fractal, Pre hispanic, Andean Civilization.*

I. INTRODUCTION

Currently in the world the increased the need for research in the mathematical models and statistical advanced tools. The use and proper interpretation of these techniques allow optimal consider, efficiency and achieving superior performance in different spheres, whose application encourages the development of productive systems (Chavez et al., 2013).

Structural modeling of the growth of animal and plant disaster prediction, studio relief for communication systems, comparative growth and distribution of native species at different scales species require own lengujes to study such systems are present in research to the three-dimensional modeling of plants through Systems-L (Fernandez, 2005).

Another way to model complex structures of nature such as plants is the theory of fractals. Fractal geometry allows describing aspects such as the branches of a bush, the rough surface of a rock, or the profile of a mountain. Fractals is set normally generated by repetitive mathematical processes and characterized by ways:

1. Look the same at every scale of observation,
2. Have infinite length,
3. Not be differentiable and
4. Have fractional or fractal dimension.

The geometric forms can separated into parts, each of which is a reduced version of all (González and Guerrero, 2001). The application of fractal geometry prehispanic involves optimization of fractal algorithms tailored to the rugged reality of the peoples that make up Latin America, adjusting better to intone that nature provides each of the elements that comprise it. (Guerrero 2004)

II. CONCEPT AND FEATURES

The brain can analyze the abstract (Cartesian mathematics) as concrete. Pre-Columbian designs fractal geometry with tangents, breasts and absolute values. The fractal voice has an inventor: the mathematician Benoit Mandelbrot, who wrote 4 decades the book The Fractal Geometry of Nature. The term comes from the Latin *fractus* meaning 'broken' and streams are the clefts of the mountains that rise above the Ring of Fire. The geographical relationship by nature.

Andean mathematics begins where Western mathematics ends, Western civilization was born in ancient Mesopotamia, between the Tigris and Euphrates rivers, in the present territory of Iraq, hued horizons and straight lines, on which surfaces were calculated. "The zero dimension is the point, displacement, or the first dimension line, which will form multiple dimensions."
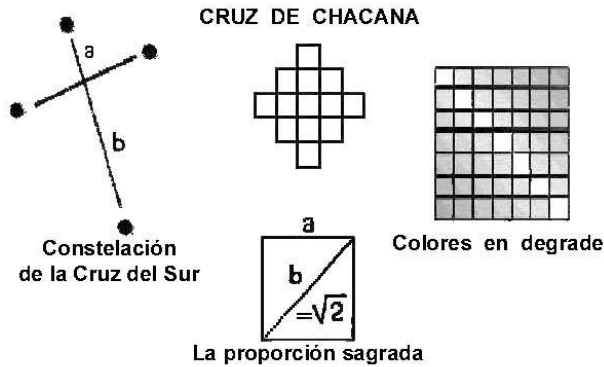

Fig. 1 Chacana cross an astronomical and geometric referential instrument of the pre-Hispanic civilizations

Aztec, Maya and Inca, however, its rugged landscape, broken, that prevailed volumes of the mountains, which measured and even replicated in the pyramids they built based. Pre-Columbian notation taking into account the qualities of things, in addition to the quantities in which they arose.

Regarding the quipus each of the strands of knotted ropes with various knots and various colors: guarismo, tissue, language and narrative at once, Marcos Guerrero wrote that through them "the Indians could make predictions about the behavior of qualitative objects in motion, which required the subject is diffused substantially in the concrete totality "(the Two Chief world Systems 2004).

Hispanic cultures observed the sky, had discovered the transcendental number named a Greek letter pi (π) expressing the ratio of the length of the circumference and its diameter and countless concepts used as the basis for build aqueducts and replicas of mountains so as not pyramids, as a temple.
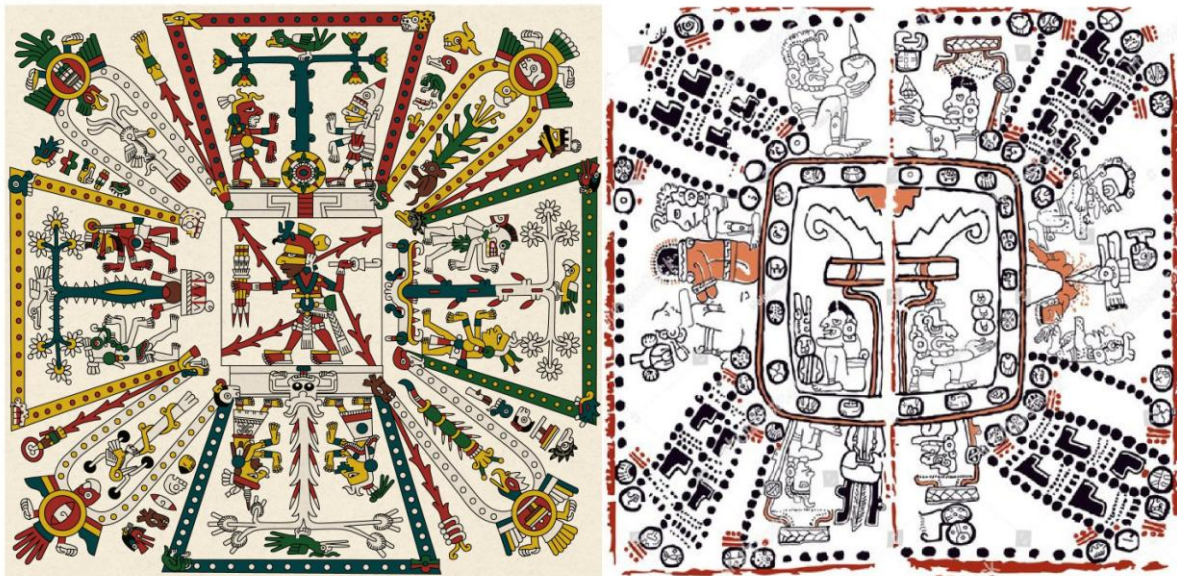

Fig. 2 Cosmogram of the post classic period from the Aztec and Maya codex recreating the same universe formed by four courses and a center associated with fire, regents deities that fight for the control of each one, determining the earthly event, in both the glyphic blocks are appreciated of the 20 days of a ritual calendar

The rugged terrain and the many ravines through which the aqueducts to carry water, vegetation is systematically distributed. Pre-Columbian pottery, like all creations of the time, have a fractal design, as evidenced by the mathematician Marcos Guerrero who mentioned that the Western world is governed by discards where everything is flat, without reference axes. Language, music, mathematics are treated from that reference.

The history of science developed under the premise that the basic configuration of scientific knowledge is a process occurred within the borders of Western civilization. While today tend to support that important and abundant intellectual developments of the ancient Egyptian and Babylonian cultures, or Hindu and Chinese, they are parents of that knowledge, not recognize, however, as scientists themselves products.
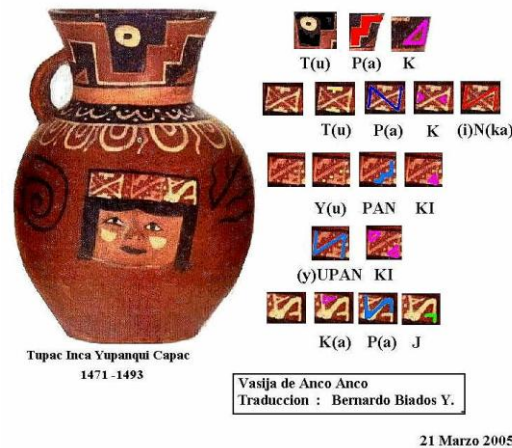

Fig.3 Application samples of the of prehispanic geometry in pottery and code names

The argument is quite convincing and reflects the fact that none of the history of Greek mathematics reached systematized as a geometry mode Euclid's Elements, whose appearance could be founded the stage for the smooth realization of thinking and knowing .

Fig 4. Drawing of ancient Peru a man extending the quipu

Prehispanic fractal geometry took both quantitative and qualitative part of the world and consisted of two branches: An Analytical Geometry Fractal totally unknown to date, which does not appear in the Annals of Mathematics, Geometry and arborescent. These, when combined in a complementary manner, they configured

Quipu, genuine reference coordinate system capable of representing a high resolution, both the quantity and quality of the specific processes, and useful for reliable predictions. The logical consequence of this geometry tube place the birth of a geometrized Cosmo vision. This mathematical system, which has unfortunately been much captive to a poor understanding time, was the ultimate expression of pre-Columbian American science. This could arise astronomy, medicine and various kinds of engineering that had an eminently practical interest.

Under this concept the researcher Marcos Guerrero discovered a reference coordinate system based on the square cross. This symbol was to the knowledge of this sacred Andean symbol. The theory of Genesis Andean Culture related in the Carlos Milla work. It be applying the concepts of mathematical space of representation and fractal new object could prove that the distribution of concentric crosses in them is observed topological formed a fractal body. Other than the Cartesian system generated by the culture of the Old World, as it was built in a space of strings; unlike the other, which is defined in a space-limit points.

Fig.5 Application samples of the of prehispanic fractal geometry in buildings

Once isolated mathematical object of symbolic object had to face a genuine and totally unknown Coordinate System Reference fractal character appropriate to represent discrete functions, quantum character. The invented by Descartes system is appropriate, however, to represent continuous and differentiable functions. The domain that owns this unprecedented analytic geometry is the inductive-constructive mathematics
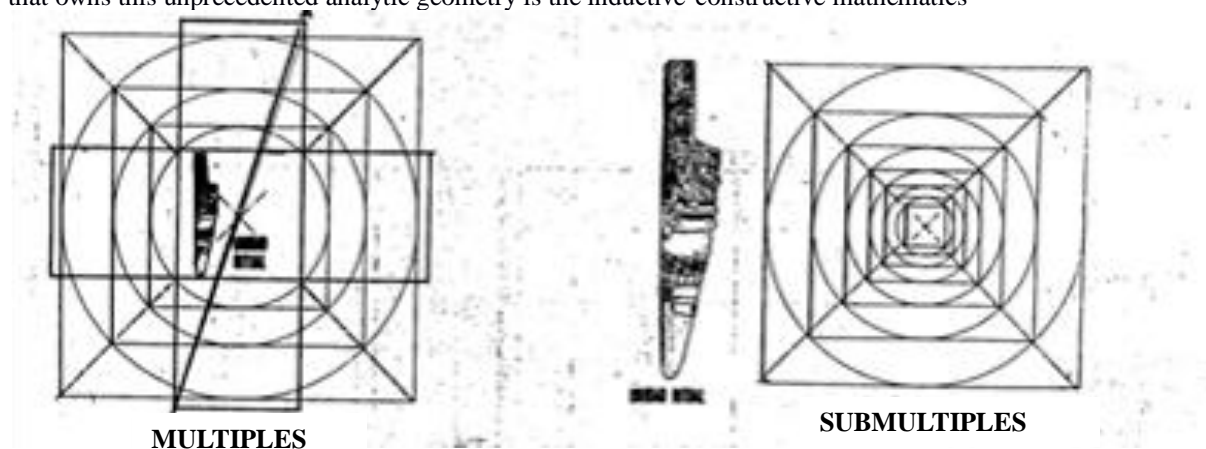

MULTIPLES　　　　　　　　　　　　　　　**SUBMULTIPLES**

Fig.6 Ritual system of proportional geometric measures of variable unit. Relationship between the major and minor side of the south cross. Relationship between the side of the square and its diagonal, square root of two (expressed graphically)

The fig. 6 presents the two coordinate systems. It is noted that the only common element having the two spaces of representation is the point 0, also be seen that when the outer sides of the cross tend to zero, this coordinate system is limited to the Cartesian. It is easily proved that the two bodies alike are topological, mathematical representation spaces, but with a different kind of topology. While in the first topology-limit points or differential, on the other topology ropes running performed.

"Coordinate System Cross Square" is used to represent functions whose independent variable n, is a number Z+ (see fig. 6). Its exterior-part macro is useful for graphing functions and increasing internal micro for decreasing functions, written as infinite fractional sequences. The function values expressed by the sides of the cross, by fractal dimension curve

$$D = 1.4649735 \ldots$$

The family of curves fractals successive concentric square represent numerical values is taking the role.

This is therefore an appropriate system to represent and study the properties of discrete functions and useful. Therefore, to describe the state changes experienced by specific processes, unlike the space dot-limit which is only appropriate to describe position changes of the particles, to represent the mechanical part of reality; ie is only capable of representing the quantitative aspect of the world. Therefore, it gives us a fragmented view of it.

It is of great interest to note that the distribution of square fractal curves concentric three-dimensional view is a stepped pyramid whose height is a free and continuous dimension. This makes it appropriate to define therein a coordinate system space-time, with the discrete and continuous time space that would describe the duration of the state changes, for example. It can also represent the complex numbers of the form

$$s = f(n) + g(t)i$$

Where $f(n)$ discrete $g(t)i$ continuous.

The system allows coordinate discrete and continuous functions, a quality that does not have the Cartesian system; since, formed around him by points-limit, it is transcendent and therefore it is generally exclusive, as it becomes paradoxical, ambivalent when accounting for other (Gödel effect). Tobe established in way that he is not only loses the universal character that had maintained so far, it becomes culturally relative.

With this discovery has raised Analytical Geometry Fractal developed by the pre-Columbian Andean man, allows study the properties of the discrete functions and divergent series; they are impossible to be studied in space punctate Western themes. This major step in the progress of universal science places this branch of geometry on the stage of cutting-edge mathematics.

III. CONCLUSIONS

At the end of this article, we can conclude that, although the notion of fractal is a young theory in Latin America, it has already produced a commotion about its applications in the different fields of science and technology, in the natural and social environment that it study, by their way of defining them, the following are noted:

• Fractals as a geometric procedure developed since pre-Hispanic times.

• Fractals as an analogy that allows expressing representations from non-European societies or a form of understanding in these societies (Wagner, 1991).

• Fractals as a characteristic of Latin American society considering complex systems (Mosko, 2005).

• The fractality of the physical environment requires an urgent study on fractal models and their incipient application in science and technology

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