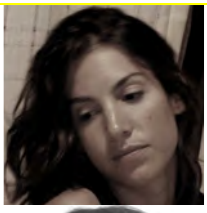
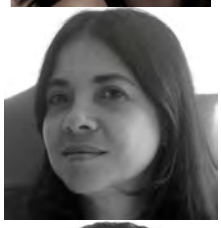
Silvia Titotto

Paper: **Bionic textiles**





Abstract:
This paper presents preliminary discussions of an ongoing research that aims to produce experimental installation artworks, based on fractal structures analogous to biological systems, using comparative relationships that come from the evolutive chain originated in the spider web culminating in the intelligent synthetic meshes. In this way, the concept of morphogenesis is discussed that, analoguely to the biology, there would be generative evolutions and agroupments in the chain: thread, web, cocoon, synthetic fabric and intelligent textile – textiles which involve the application of technology to the integration of the mesh to the human body [1].
To the understanding of this generative agroupment in this work, adjacent concepts to the fractal geometry will be used – the study of several irregular objects, as well as those mathematical obtained by successive iterations and the natural ones, which can be wrinkly, leaky or fragmented, but in the same level, in all the scales [2].
Although fractals are more known as objects resulting from matemathical algorithms in successive iterations in computer science, in this research the natural structures of irregular fractal geometry, those found in many organic and mineral systems will be more focused so that analogies with textile production can be made, from biologic threads until those that only use concepts of natural structures for production of high technology fibres.
By experimentations in the major of installation art along this PhD research, it is intended that the conceived space user can be able to enter the webs, cocoons or bubbles which remind environment completely different from the exhibition space of the kind “white cube”, focusing sensoriality. This kind of site-specific works will intend to modify the architectonic characteristics traditionally found and make it become an immersion experience.

Topic: Art/Architecture

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References:
[1] Sarah Clarke, “Techno Textiles”, London, ThamesandHudson, 2007.
[2] Philip Ball, “The self-made tapestry”, Oxford University Press, New York, 1999.

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Keywords:
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Bionic textiles

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Abstract

This paper introduces some ideas that are been developed in a doctorate research context which aims to produce experimental installation artworks, based on fractal structures analogous to biological systems, using comparative relationships that come from the evolutive chain originated in the spider web culminating in the nonwovens and intelligent synthetic meshes. In this way, the concept of morphogenesis is discussed that, analogously to the biology, there would be generative evolutions and aggroupments in the chain: thread, web, cocoon, synthetic fabric and intelligent textile – textiles which involve the application of technology to the integration of the mesh to the human body.

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By experimentations in the major of installation art along this doctorate research, it is intended that the conceived space user can be able to enter the webs, cocoons or bubbles which remind environment completely different from the exhibition space of the kind “white cube”, focusing sensoriality. This kind of site-specific works will intend to modify the architectonic characteristics traditionally found and make it become an immersion experience.

Keywords: biomimetics; techno textiles; fractal growth patterns; site-specific installation art.

1. Introduction

This is an investigation about biotechnology where the artistic process is one of the means, together with theory, to achieve the objective of the study - to investigate the evolution and morphogenesis as generative group in the chain: wireless, web, cocoon, and synthetic weaves and smart nonwovens, which is the initial hypothesis of this research and whose cut are fractal growth patterns in plants and some systems of the human body.

The design and architecture appear as illustration of possible applications of this investigation, while installation art here is used as the research process. That is, in terms of position methodological foundation, biotechnology applied to techno textiles is the "how" of research, i.e., the means to achieve immersion discussed in fractal art tridimensional with sensory matters.

The idea of this investigation came from some aspects of a master's research [TITOTTO, 2008] on experimental production of 'site specific' artworks. The references were large scale built environments that keep relations with their origins in the natural world, such as numerous kinds of spider silk orb webs and also cocoons of Mulberry silkworm. These productions were a starting point for further studies on structures found in nature and its relations with bionic creations mankind wishes to develop [OTTO, 1985], and also encouraged more ambitious experimental aesthetic practices.

For this, we studied the physical and geometrical principles of natural structural systems, with emphasis on caterpillar cocoons to study paraboloids surfaces; cobwebs to study the behavior of cables, eggshells and soap bubbles for understanding of geodesic domes, establishing the relationship between possible design solutions, methods of implementation and fidelity to the materials used in a state of tightness.

Traditionally the term morphogenesis is applied to the concept of process biological structures modeling (cells, tissues, organs, systems, organisms). But for a better understanding of what this work considers how morphogenesis seeks to organize and discuss the relationship between the morphological structures found in nature, bionically produced for the textile industry for developments - of great interest to the design - and those designed by artists, regardless of pre-established function.

Although many fractals can be found in nature, as exemplified in special figures throughout this text, outside the object of study, they posed for a clear introduction to the subject, and that the crop will be bound to fractal models of movement in plants and some units of the human body closely.

1. TITOTTO, Silvia. "The Poetics of Tension", 2008. Solo Exhibition at Museum of Contemporary Art — MAC-USP anexo, Sao Paulo - Brazil. Photo: Eliza Ramos.

2. TITOTTO, Silvia. "Caviar Project", 2010. Off Biennale, Sao Paulo - Brazil. Photo: Jeferson Chicarelli.

2. State-of-the-art

Japanese artists have prominence in this field of study. Machiko Agano studied weaving at the University of Art of Kyoto in the postgraduate level in 1979. Her works are inspired by nature and she works with very fine steel filaments, nylon and Japanese paper-art to produce large scale installation art.

Another international artist that can be cited is the Argentine Tomas Saraceno who develops his projects in Germany on the border between aesthetic practices and inflatable architecture, with which the man may experience unusual sensations. Pursuing the idea of a "realizable utopia", his work produces visions of transport infrastructure, cities and other kinds of floating construction. The objects we have been developing are the first step towards the realization of these images. His installations, sculptures and photographs go beyond the restrictions of the human habitat and suggest a new way of perceiving the nature [Rivitti, 2006].

The work of Arne Quinze has much to do with what is aimed to be conducted experimentally during the doctorate, because the focus of the immersive environments production is between the difficulty of building structures with complex geometry and wide possibilities for user interaction at the sensory level.

3. TITOTTO, Silvia. "Wings of desire", 2008. Slaviero&Guedes Gallery, Sao Paulo - Brazil. Photo: EloirTS.

3. Theorethical research

A decade after Mandelbrot published his physiological speculations; some theoretical biologists began to see that the fractal organization controlled structures throughout the body [Mandelbrot, 1987]. Therefore, other points of interest are the analogous relations between the human body and other natural forms, such as plant leaves and human blood vessels. This will be treated experimentally with aesthetic practices in research and sensory interaction with the user's exhibition space.

The arterial system form another type of continuum, branching off from the aorta, originating from the heart, And becoming so narrow that red blood cells are forced to slide in single file in your last link, the capillaries. The nature of these ramifications is fractal. As a matter of physiological necessity, the blood vessels they need to perform certain magic dimensional.

Just as the Koch curve, known for modeling the snow flake, compresses a line of infinite extent in a small area, the circulatory system adapts a huge surface area in a limited volume. The fractal structure imagined that nature operates with such efficiency that, in most tissues, no cell is at a distance of more than three or four cells of a blood vessel [Gleick, 1990].

Something similar occurs in human lungs, which account for an area larger than a tennis court [Gleick, 1990]. The description "exponential" classic of the ramifications of the bronchi was wrong: a fractal description is best framed in the data [Gleick, 1990]. The urinary collecting system has proven to be fractal, as well as the bile duct in the liver and the network of special fibers of the heart, which transmit pulses of current to the heart muscles.

The importance of fractal structure is such as to scientists argue that a key to understanding the rhythm is the fractal organization of this network, arranged to be identical to itself at increasingly smaller scales [Gleick, 1990]. How does nature produce this architecture could be so complicated? Mandelbrot's thesis is that complications exist only in the context of traditional Euclidean geometry [Gleick, 1990].

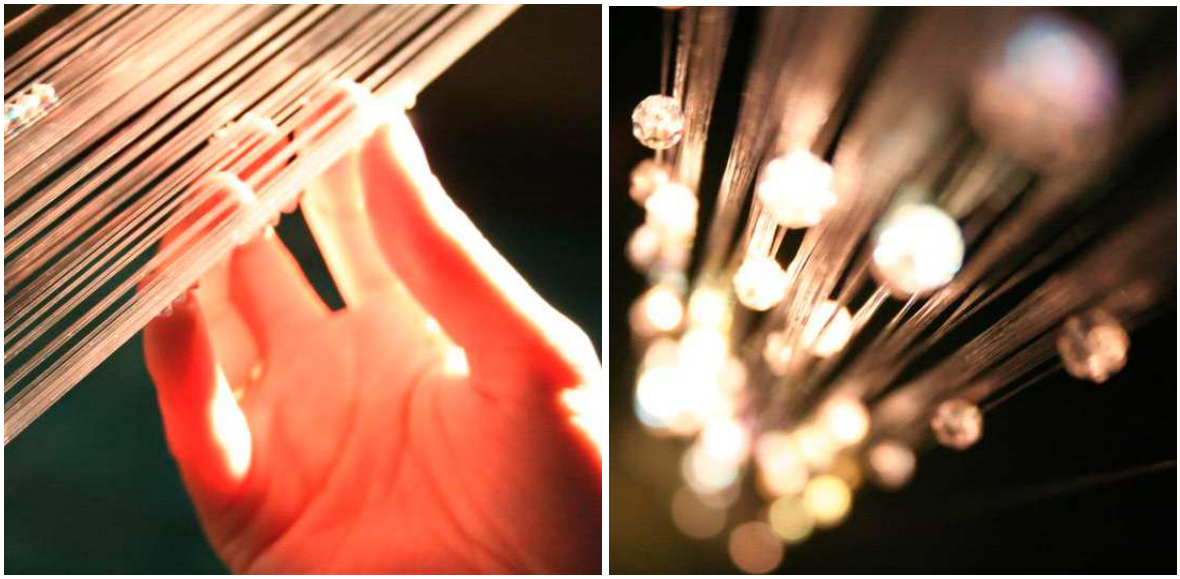
Like fractals, branching structures can be described with transparent simplicity, with only some information. Perhaps simple changes that give rise to the form imagined by Koch, Peano and Sierpinski have their analogues in the coded instructions of the genes of an organism. DNA certainly cannot specify the vast number of bronchi, bronchioles and alveoli, or specific spatial structure of the resulting tree, but you can specify a process of repeated bifurcation and development.

4. Methodology review

In this work the threads are covered under the scientific and poetic points of view, taking as its starting point the spider web, through natural silk, synthetic production and seeking to achieve the latest developments in sensory research. Among these morphological passages Historical concepts of connection between science and design are studied, such as the attempts of Chinese for over 3000 years using rudimentary techniques to weave spider silk clothing and those of Americans and Europeans in the last century using biotechnology, intending to create synthetic yarn structure similar to the spider one.

This leads to a 4-pillar methodology strategies:

- Knowing in depth the concept and definition of terms that come from the fractal theory in the context of application to biological systems such as: classical and fractal self-similarity, boundaries and self-similarity, length, L-systems, images encoded by simple transformations, chaos game, recursive structures, order and chaos, strange attractors, Julia and Mandelbrot sets, strange attractors, algorithms for fractal image compression and multifractal measures.
- Analyzing morphogenetic relations of the threads of spider webs and human tissues that, in addition to the basic function of covering and protecting function as an extension of the human body, providing new sensations or improving performance of some proposed activity.
- Establishing relationships between architecture and bionics, the observation of scale and space.
- Examining binomial relationships between cobwebs and Kevlar, silk and synthetic weaves, cocoons and bubbles, tissue and skin besides the human circulatory system and Knots theory.



4. TITOTTO, Silvia. “Construction”, 2007. MuBE- Brazilian Museum of Sculpture, Sao Paulo - Brazil. Photo: Fabio Risnic.

5. Preliminary discussions

This research seeks to materialize in installation artworks several concepts related to natural forms, sensing, industrial technology and architecture, using biological structures known as xylem and phloem of plants, for example, which closely resemble the industrial fabrics, being indeed inspiration for some advances in the textile industry. The biggest challenge of this research is to examine the possibilities for building immersive real space (not just virtual ones) from the fundamentals of biotechnology interconnected natural structures, like the spider and the cocoon, not only aesthetically, but considering the various levels of sensing that they allow. So far, few models of the simplest character in real space were performed by researchers around the world, and those were more related to experimental design than practical research on the border of technological innovation and installation art.

The merit of this work specially relies on the possibility of transdisciplinary scientific advance beyond the ideas and discussions of the passage of mathematical models for computing fractal level penetrable prototypes and exploitable spatially on a human scale. Some experiments have been performed in the laboratory of Botany in 2009 by Silvia Titotto for comparison between fractal structures in cells of plants and movement of the human body, the basis for carrying out the sensory experiences to be achieved in 2011, with support from the Politecnico di Torino. The patterns are similar in some degree to the structures of nets, in this way it is intended to prove so morphogenetic relations between spiderwebs and textiles.

Since the implementation of experimental installation art would be the means of validating such structures in a free way, i.e. without a specific use, but as "potential" or generative spatial structure - to be applied in design or architecture - with a high degree of sensory immersion, the questioning must come from both the perspective of technology, and hence the necessity for complementation studies in the "technological innovation for the built environment" in the department DISET, in the Politecnico of Turin, intercalating with the more artistic approach, specially discussing poetics and artistic procedures had been done in the home department - University of São Paulo under the supervision of Professor Clice Mazzilli.

On one hand, it reflects on the interaction of the body with the space, immersing the user in sensory structures such as "cocoons," "webs", "sensing skins" (somewhat phenomenological), study of artists who have similar poetics. On the other hand, the very biotechnology and morphogenesis are studied as poetics.

The challenge of building this argument rests on the difficulty of combining these two in the same poetic project: biotechnology and environment are the means and also the poetics at the same time.

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