BIO-DIGITAL ANALOGY AS A BASIS FOR FUTURE INTERIOR ARCHITECTURE

القياس البيولوجي الرقمي كأساس للعمارة الداخلية المستقبلية

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ABSTRACT

Architecture is defined by the intersection of different domains of knowledge. Biology can be linked to a wide range of technological and creative disciplines due to its comprehensive nature as a science. The research goal is to inquire into analogies between architecture and nature, specifically interior architecture, and biology. Because of the close relationship between form and function, the inherent balance of forces, and the corresponding geometric solutions found in living beings, biology is a recurrent source of architectural inspiration. The study's specific purpose is to determine how new technologies might reframe and support the process of creating analogies.

The benefits of a multidisciplinary approach to the conceptual process are well known among architects and interior designers. The research problem is the cognitive deficiency in determining the levels of biological similarity in contemporary interior architecture. Thus, in the research we are trying to spread awareness about relation between Biology and interior architecture to enhance the way of thinking of the student as a tool for creative design, and to be able to keep pace with future thinking in architecture and internal treatments.

KEYWORDS

Morphogenetic Interior Spaces; Science Fiction Prototyping; Bio analogy; Skin Analysis.

الملخص

أن العمارة يتم تعريفها من خلال تقاطع مجالات المعرفة المختلفة. في التصميم المعماري يمكن ربط علم الأحياء، على وجه الخصوص، بمجموعة واسعة من التخصصات التكنولوجية والإبداعية نظرًا لطبيعته الشاملة كعلم. الهدف من الدراسة هو الاستفسار عن أوجه التشابه بين العمارة والطبيعة، وتحديداً العمارة الداخلية وعلم الأحياء. بسبب العلاقة الوثيقة بين الشكل والوظيفة، والتوازن المتأصل للقوى، والحلول الهندسية المقابلة الموجودة في الكائنات الحية، فإن علم الأحياء هو مصدر متكرر للإلهام المعماري. الغرض المحدد من الدراسة هو تحديد كيف يمكن للتقنيات الجديدة إعادة صياغة ودعم عملية إنشاء المقارنات. فوائد النهج متعدد التخصصات للعملية المفاهيمية معروفة جيدًا بين المهندسين المعماريين ومصممي الديكور الداخلي. مشكلة البحث هي القصور المعرفي في تحديد مستويات التشابه البيولوجي في العمارة الداخلية المعاصرة. وبالتالي، نحاول في البحث نشر الوعي حول العلاقة بين علم الأحياء والعمارة الداخلية لتعزيز طريقة تفكير الطالب كأداة للتصميم الإبداعي وحتى يتمكن من مواكبه الفكر المستقبلي في العمارة والمعالجات الداخلية.

الكلمات المفتاحية

مساحات داخلية مورفوجينية؛ نماذج الخيال العلمي؛ القياس الحيوي؛ تحليل الغلاف.

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1. INTRODUCTION

Nature has inspired many throughout history in the models and designs adopted by humans, for example Leonardo da Vinci's attempt to build a flying machine by studying birds in flight. Due to the urgent necessity to develop environmental sustainability, nature orientation has recently taken on a revolutionary aspect. The new stage is witnessing a growing trend toward biological analogy in architecture to solve many emerging design challenges, as this trend provided the possibility of linking them with living organisms using technological developments that take their inspiration from nature, with the goal of achieving balance, preserving and harmony with its new trend which reflects beauty, versatility, and functionality. Also, the realization of the relationship between architecture, interior architecture and nature has increased awareness of the need to conserve resources, which embrace natural principles and solutions. So, it studies natural organisms that live in harmony with their surroundings.

2. METHODOLOGY

The research is an Article Review used the method of historical and genetic analysis , the comparative method , which are used when considering the evolution of non-stylistic ideas about morphogenesis in interior architecture and their philosophical and psychological conditioning, the modeling method in building conceptual research models with the aim of studying how can the nature concept inspire interior designers and how it can enhance the mindset of the interior designers and help them to create interior functional creative spaces by analyzing Bio Analogy in interior architecture.

3. STATEMENT OF THE PROBLEM

Nowadays new methodology appeared in architecture design using the biological and digital processes architecture. The problem is the cognitive deficiency in determining the levels of biological similarity in contemporary interior architecture and not being include the biological digital technology in the Interior Architecture curriculum.

4. NEW GENERATION IN ARCHITECTURE THINKING

“Less Aesthetics, More Ethics” the theme of the Biennale of Venice 2000 of Architecture tries to convey the deep unease of fast-changing societies, where an architect's data and reference points have completely changed. The initial plan was to use the Biennial of 2000 as a workshop for analyzing and attempting to give a comprehensible shape to the new planetary dimension of urban behavior and transformations. The demand for "something else" arose from the considerations, research, and intuitions about the evolution of cities. "Something else" from architecture, whose problematic existence we struggle to prolong every day, and "something else" from successful architecture schemes: it was about regaining the consciousness that the quality of architects and works was no longer adequate. The exhibition, which is located at "Le Corderie," draws attention to the "big" 280 X 5-meter screen, whose images pose questions about megacities, areas contaminated by contradictions, conflicts, pollution, refugees' dire situation, new social aggregation centers such as stations, airports, and shopping malls, as well as a series of interviews with fifty architects. (*https://fuksas.com/biennale-of-venice-2000-less-aesthetics-more-ethics*, n.d.)

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4.1. The Emergence of a Generation of Pioneers of Experimentation in Interior Architecture

The far-reaching impact of digital technology has brought a dramatic shift to architecture as we enter the information era. Bio-Digital interior architecture, which has been on the rise since the turn of the century, indicates the infiltration of digital technology into the core design process from its instrumentalist application. It is based on current bio-digital architecture theories and strategies. By aiming to blend scientific and philosophical thinking with methodology analysis to develop a rational and open bio-digital interior architectural strategy system. As everyone discusses sustainable architecture for a better quality of life in today's and tomorrow's world, Salvador Dali, a surrealist artist, was cited during a conversation with Le Corbusier as saying that "the future of architecture will be soft and furry" because he was so fascinated by Antoni Gaudi's works and his concept of plasticity and thought that anything could be made due to technological advancement. In the following, we will explain this philosophy through the vision of some innovative pioneers' architects:

4.1.1 Marcos Novac and Cyberspace

Marcos Novak is a pioneer of the architecture of virtuality (virtual+ reality) refers to himself as a "trans-architect" or "liquid Architect", because of his work with computer-generated architectural projects that exist only in the virtual realm and do not exist in the physical world. His three-dimensional, immersive works respond to the observer and can be transformed through user participation. engaging algorithmic concept, fast prototyping, and automatic prefabrication. Novak obviously wants to confuse the limit dividing the true field from the practical field (actuality to virtuality). Digital media are accountable for creating a new district where constancy and reality are hardened by this indefinable actuality: an actuality where variations of visual qualities, internal contents, and social expressions are influencing the creation of unusual spaces. nevertheless, this is not an absolute supposal. The issue of new practical spaces does not always mean the end of physical space. Furthermore, cyberspace relates to virtual reality (VR), data visualization, graphic user interfaces (GUIs), networks, multimedia and hyper-graphics.

4.1.2 Peter Cook and Performtive Architecture

Peter Cook is primarily known as a member of the Archi gram group. They fostered a hypothetical architectural praxis, the outputs of which have never been produced, as a kind of resistance. Peter Cook's work has always been focused on probing questions that unearthed awe-inspiring and surprising architectural possibilities. His works were based on a systematic exploration of utopianism as a form of architectural imagination and critical inquiry, and they evolved in tandem with his dialectical architectural debate with modernity, preventing any undialectical architectural interpretations.(Gizem Deniz Guneri, 2020) So, we simply can conclude from Marcos Novak and Peter Cook that with the advancement of technology and the development of the ages, the architect has a different perspective of all the space ad form. He is always complaining about the present and seeks to change it unexpectedly.

5. INTRODUCTION TO GENETICS AND BIODIGITAL ARCHITECTURE

Morphogenesis in architectural design: Morphogenesis is a term that is used in a variety of fields such as biology, geology, crystallography, engineering, urban studies, art, and architecture.

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This wide range of applications reflects a diversity of interpretations ranging from formal to poetic. The first reported examples of the term's use were in the field of biology in the second half of the nineteenth century. In architecture, morphogenesis (also known as "digital morphogenesis" or "computational morphogenesis") refers to a set of techniques that use digital media as generative tools for the creation of form and its alteration rather than as representational tools for visualization(Roudavski, 2009). “Morphogenesis came from the Greek “morphê”; shape and “genesis”; creation, literally, “beginning of the shape” is the biological process that causes an organism to develop its shape (Chaitanya Korra, 2018)

5.1 Metaphysics and Computation in Architecture

Theories of issue and Complexity:
Mountains, clouds, trees, stars, and rushing river waters have all piqued people's interest since the ancient period. Research into the universe, planet motion, ocean waves, and the structure and dynamics of the universe have all piqued scientists' attention. Chaos theory and complex systems science emerged from studies into the universe's seemingly complicated and chaotic character. Chaos theory and disaster management science and complex systems theories are strongly related to the behavior of dynamic systems. Following Edward Lorentz's famous physical hypothesis of the "butterfly effect," chaos theory and related calculations were gradually introduced, with Benoit Mandel port being the first to publish chaos theory calculations in 1975.
Lorenz the American mathematician, meteorologist, and a pioneer of chaos theory had discovered the Butterfly effect by chance. He decided to rerun one of his weather simulations using a simple computer model for a longer period one day in 1961, but rather than redoing the entire simulation, he started the second run in the middle, entering in data from the previous run for the initial conditions (Figure 1). Because the computer program was identical, the weather patterns in the second run should have been identical to the first. Instead, the two weather trajectories quickly diverged on completely different paths, all because Lorenz made a minor rounding error of less than 0.1 percent with his inputs — he entered the initial condition 0.506 from the printout instead of the full precision 0.506127 value which completely changed the result. Lorenz soon recognized what he was up against.(Kenneth Chang April 17, 2008)

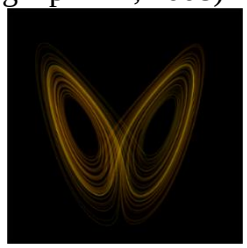

Figure 1: A plot of Lorenz’s strange attractor for values ρ=28, σ = 10, β = 8/3. (Source: James Tanner, 2016)

Nature was sought as a source of conviction in the fundamental principles of beauty and taste by architect and critics. Their notion that art and architecture are just reflections of natural beauty, and so are less significant than natural beauty. The way we perceive nature shows us the extraordinary ability of structure and analysis that the brain possesses.
Chaos theory aids in the comprehension of natural patterns and has been used to the modelling of biological systems, which are among the most unpredictable (chaos). Cloud patterns, blood flow through vessels, tree branches, astronomy, and other phenomena all display these patterns. According to chaos theory, "regular patterns can be regarded as developing from chaotic and

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unpredictable processes under particular conditions." Chaos theory emphasizes the order contained in the uniform behavior of similar systems rather than the chaos and unpredictability inherent in a system. As a result, many experts argue that the name "chaos" is inadequate in expressing the theory since it gives the reader the sense of randomness, even though basic processes in nature can turn systems into complexity without any randomness.

5.2 Algorithmic in Architecture and Interior Spaces

An algorithm is a method for solving a problem using logical processes in a finite number of steps. It is also possible that it is a rationalized form of human reasoning. An algorithm, according to Kostas Terzidis, is not simply a computer implementation, a set of lines or code in a program, or a language, but also a theoretical construct having profound philosophical, social, design, and artistic ramifications. As a result, algorithmic architecture should be considered a new stage in architectural design, in which the architect must be cognizant of the underlying logic of the tools he employs.

This appears to be the only way for architects to reclaim control over the design process. The algorithmic design methodology can handle a huge number of competing constraints at the same time, and it can be used to explore a big number of potential weighted design solutions in time frames that are just not viable with more traditional methods.

Though algorithms are being used in a variety of design and fabrication industries, architectural design may be where they are most useful, as they allow designers to work in intuitive and non-deterministic ways.

As a result, new and innovative designs can be created that attain structural and environmental performance that was previously thought to require post-design optimization.(Dr. Pankaja Bagul et al., n.d.)Algorithmic or computational design use a set of instructions to accomplish specific tasks, such as creating a computer model of a structure. Variations of the same code are generated by the parameters in the instructions. The algorithmic design is particularly well adapted to unconventional architectural forms that can be built from repetitive parts.

5.3 Bio Anology Impact in Interior Architecture

The knowledge of the relationship between architecture and nature has increased awareness of the need to conserve resources, to embrace natural principles and solutions, and to study natural organisms that live in harmony with their surroundings.(Couceiro, 2006) Architecture has long been influenced by biology, as evidenced by the ancient Greeks and Romans who incorporated leaf motifs into their friezes, the entire Art Nouveau movement, or Frank Lloyd Wright's obsession with erasing (or softening) the boundaries between his structures and their surroundings. To solve many of the emerging design challenges, this approach provided the possibility of linking them with living organisms by using technological developments that take their importance from nature, to achieve balance, preserve nature and harmony with it.

Philip Steadman Emeritus Professor of Urban and Built Form, seeks to make a comparison between the design of biology and the design of buildings. He intends to demonstrate that as issues changed during the evolution of one in biology, problems also changed during the evolution of one in architecture. Obviously, technology supplied the operational means to advance architecture to new heights as it evolved. The issues were simply solved by biology.

We can think about how contemporary biological thinking relates to design. Since the early 19th century, biologists have served as a source of inspiration for architects and designers. They have

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looked for ways to design that are like the natural processes of growth and evolution rather than just copying the shapes of plants and animals. Le Corbusier and Frank Lloyd Wright are only two of numerous modern architects whose writings frequently feature biological concepts. The big new word in architecture and planning, according to Le Corbusier, is biology.
The use of computer approaches in design throughout the 1980s and 1990s, which enabled the development of a new type of "biomorphic" architecture through "genetic algorithms" and other programming techniques, has sparked a current interest in biological analogy in architecture (Philip Steadman, 2008)

5.4. Analogical Reasoning in Architecture and Interior Spaces

Analogical thinking is the utilization of earlier 'source' information that can aid in the solving of a current 'target' problem. Cognitive processes, especially those involving creative problem solving, are thought to be centered on reasoning by analogy. It is a process in which information is transmitted and two areas are linked to private participation or relationships, and a third dimension, the function can be added to extend the similar idea to the design area.

5.4.1 Biogenic

It is the basis of design inspired by nature. We perform biological analogy on the idea that there are potential solutions to solve the design problem in natural models. There are many levels of similarity to include appearance, materials, production process, structure, or functions in living organism. Biological analogy relates to many overlapping terms such as, Biomimetics, Biomimicry, Bionic.
Biomimetic: It is a term developed by Schmit Otto in the fifties of the last century, and it means the study of the evolution of structural systems that simulate the structural and functional composition, materials, and processes of engineering analysis of organics, their behavior, and the application of its principles in solving the designed problem.
Nature as a model: by studying the natural form, processes, systems, and strategies, and then simulating them or inspired them to develop designs and processes to solve human problems in a sustainable way. As for nature as a yardstick, it is using nature to judge and control the quality of sustainable inventions. And nature as an observer by evaluating nature as a resource we learn from and preserve it rather than waste its resources. Zari classified three levels of simulating living organisms:

1- Organic level relates to a specific organism that is simulated or part of it.
2- Behavioral level means simulating the behavior of an organism.
3- The ecosystem’s level refers to the general principles that allow an organism to perform its life activities.

Bionic: It is a term developed by Jack Steele in reference to the applied scientific orientation that is concerned with biological functions in natural systems and transforming them into solutions to engineering problems. This trend is linked to the development of operational rewards, like living systems by employing technology.(Wijdan Deyaa Abdul Jalil, 2016)

6. BIOSIMILARITY TO NATURE AND ARCHITECTURAL TRENDS: THE RELATIONSHIP BETWEEN HUMAN AND NATURE

6.1 Coordination with Nature

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Following the Ultra-Organic style. The desire of man turned to the construction of architecture that gives him luxury and coordination with nature, and the emergence of natural patterns in important buildings such as Gothic cathedrals.

6.2 Controlling Over Nature

It is the post-industrial revolution period, where man has exceeded the need for safety and luxury to achieve the need for comfort and the maximum benefit from nature by raising architecture above nature or controlling it. We can mention two directions:

6.2.1 Infra Organic Style

By controlling nature and neglecting the principles found in nature with the effect of the industrial revolution and fascinating with the aesthetic of the machine. And the appearance of Le Corbusier's saying, "House is a living place."

6.2.2 Modern Organic Style

It is represented in the organic orientation in modernity through its most prominent pioneers Sullivan and Frank Lloyd Wright and represented by the call to use natural principles in architecture to be in unity with its surroundings and avoid unnecessary forms, and that form, and function be one in architecture, and the use of simple forms.

6.3 Return to Nature

It is the contemporary period and includes the employment of bio-analogies on multiple levels to achieve the connection with nature and restore lost values in the post-industrial revolution period and move towards sustainability by using bio-analogs with natural at multiple levels and by employing contemporary technology. Which took many directions with different names that revolve around the relationship with nature in its focus, which will be addressed in the following paragraph.

7. CONTEMPORARY TRENDS IN RETURNING TO NATURE

The New Organic Architecture applied in interior space

It is a trend that reintroduces organic ideas in modernity, but in combination with new means of producing natural forms and reviving the idea of merging with nature in line with the philosophical changes and technological developments witnessed by the digital revolution. It tends to use complex curves that are twisted and skewed and emphasize fluidity.
And the shift towards adopting ideas related to cosmological sciences, chaos theory and fractal geometry, and changing the idea that architecture is vague and has undeclared codes until it refers to the relationship with nature.

7.1 Biophilic Architecture

"I go to Nature to be soothed and healed, and to have my senses put together." – John Burroughs
The term "biophilia," which derives from the Greek words "bios," "life," and "philia," "love," refers to a love of life and the ethos of preserving and advancing human life in all of its manifestations (physical, psychological, social, artistic, moral, etc.). Architects have the chance to include this theory into their design process with the goal of creating a setting for a respectful and fulfilling relationship between human society and the natural environment.(Ankur Gautam, 2017)

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Architecture Biophilic is a new concept in architecture that works closely with ecological, human health, and sustainability principles. It is an integral aspect of the construction of an architectural structure and should be used in harmony with other building materials.(Amjad Almusaed et al., 2006)

7.2 Evolutionary Architecture

It is architecture that represents the trend towards integrating the sciences of computational mathematics, electronics, artificial intelligence, and genetics, and transfers various theories and techniques from scientific fields to architecture. It is concerned with the in-depth study of natural processes in living organisms, structures, materials, ecological relationships between living organisms and their applications in the built environment, and future ideas for the possibility of building a building in a self-generated manner, by analogy with living organisms that grow through information stored in their genetic code, so that architecture is capable of growth and even die as in nature. It is about ideas and future scenarios linked to access to advanced technology in materials and construction that are not available at the present time.

7.3 Bio-Interior spaces

Biological interior spaces represent the trend towards comparing built structures with patterns found in nature, and hybridizing architecture with biological forms, structures, and functions, with the aim of creating a building that performs its functions more effectively in harmony with the environment, in its appearance and the materials used in the mechanisms of operation and communication, which requires the employment of materials science and contemporary technology in achieving that. It also relates to architectural expression, shape, materials, and technology that benefit the living environment and human health. It aims at achieving an energy economy, energy acquisition, design, and construction consistent with sustainable design, successful solutions require a deep understanding of nature's formal, functional, and structural principles. By understanding the living environment and biodiversity and employing environmentally friendly technology as well as providing new sources and vocabulary in architectural expression, which may be a key objective of the project.
We conclude from this the importance of biological analogy in architecture since its inception. Its role, however, was to use subjective materials such as folk and traditional architecture or simulate images of living shapes as in traditional architecture or combine architecture with its surroundings and strip its apparent forms as in the organic architecture advocated by Frank Lloyd Wright, which is inconsistent with the reality of complexity in nature, because of technological deficiencies at that time. It is a superficial analogy that addresses the aspect of shape without function or natural formal characteristics compared to PSA is available for contemporary architecture due to technological advances. The latter is an effective means of bioaccumulation in contemporary architecture, but it has taken on two grants:

7.3.1 Surface Analogy:

Through the adoption of external formalities inspired by nature.

7.3.2 Deep Analogy:

Through the adoption of formal, functional, and structural systems in nature by employing computer technology in shape generation, the adoption of computer logarithms as a component of

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elements based on each other, such as the mathematical equation that changes by changing any element, the use of sacred materials and digital manufacturing.(Wijdan Deyaa Abdul Jalil, 2016)

8. BIOLOGICAL ANALOGY LEVELS IN CONTEMPORARY ARCHITECTURE

8.1 Bio-Conceptual Analogy

Biological analogy is perceptual by following a certain principle found in nature, and its opposite in the design, and aims to know the living structure and its component parts, the ways in which they relate to each other, the type of communication with the outside world, and the systems that control the relationship of the parts with the structure.

This is related to the study of the internal biological systems and not only to the study of the external appearance, but such also as studying the life of ants and bees, methods of building their homes, the flexibility of tree structures, which enable them to face various forces such as winds and earthquakes, and the way birds build their nests on trees. The perceptual representation of nature is linked to a set of theories, which influenced the perception of natural formations and biological analogues in architectural design.

8.1.1 Self-Generating Theory

It is based on the idea of a living organism owning the codes of self-generation for what the shape will be in its relationship with the environment, which will result in the processes of growth and organization of materials, and this idea was transferred to architecture using shape-generating programs.

8.1.2 Genetic Architecture Theory

It is related to the idea of generating architectural forms using logarithms and changing the data of the numbers of mathematical equations, to produce processes that simulate growth in the living organism. It aims to create an industrial life based on evolution and simulation processes. One of its pioneers is the architect Greg Lee, who proposed six models of natural behavior in the built environment. House Embryological using computer simulation.

For example, the Bio digital Skyscraper, Barcelona, the entire structure incorporates the study of sea sponges and how their natural genetic rules for growing and living are applied through digital DNA design, and it can also be created digitally.

The building has attained maximum sustainability efficiency and is self-sustaining in every way thanks to the merger of natural and artificial software. (Figure 2)

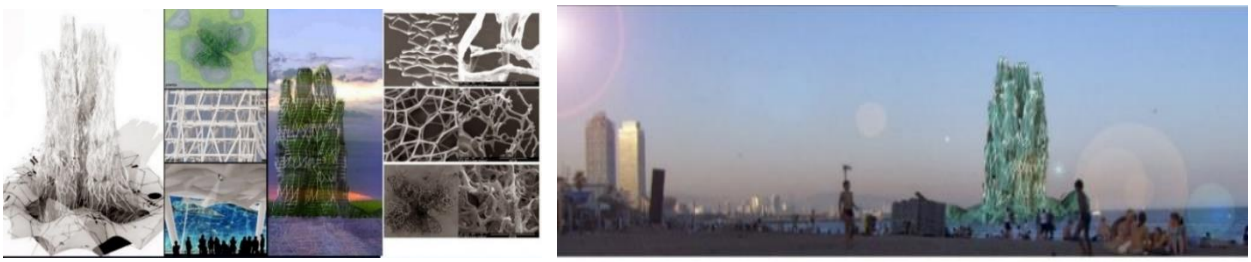

Figure 2. Alberto T. Estévez - Aref Maksoud, Biodigital Skyscraper, Barcelona seafront, 2008- 2009 (Source: domingo,2014)

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8.1.3 Chaos Theory

It is related to the interpretation of natural systems that show random behavior, emphasizes the concepts of multiplicity of possibilities and regularity through randomness, and explains natural phenomena as a continuous and dynamic instability that makes them appear random (Figure 3).(PaweÃl Rubinowicz, 2000)

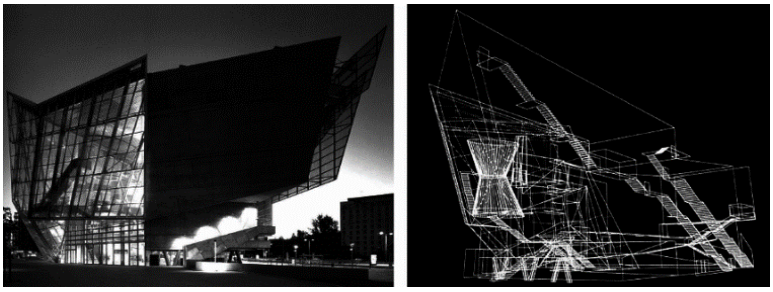

Figure 3. Irregular and "non-geometric" structure of the UFA Cinema Centre in Dresden, Germany, designed by Coop Himmelblau and finally realized in 1998 (Source: Paweł Rubinowicz, 2000)

8.1.4 Fractal Geometry Theory

It is a theory in mathematics developed by Mandelbrot and concerned with the study of natural forms that are characterized by being self-similar and repeating details of different scales, and that there are strict and hidden rules of form that can explain natural forms that may appear granular, twisted, branched, strange, twisted, turbulent, zigzag and wrinkled, and that they can be represented geometrically using Logarithmic mathematics and computer use to generate fractal structures in natural models. It provides the possibility of employing them to create creative architectural forms full of movement and fluidity.

8.2 Bio-Visual Analogy

Visual analogy provides a powerful tool in the architects to solve design problems and requires deduction by visual complacency to transfer images from a familiar state in nature to provide a solution to a specific design problem, and it is a widely popular method, partly due to the large number of sources available in nature, which stimulates the designer to transfer images Surface and structural to architecture like the forms found in nature. It is used in design to solve the design problem based on similarity with nature, similarity should not be limited to superficial similarity, but rather structural similarity because the first causes false similarity, and thus leads to wrong design solutions.

It is also following the characteristics of the shape in the living organism, including Dynamic, Flexibility, Pivotal, Complexity, Diversity, Separation and Unit.

We can summary that the visual analogy of natural images provides a wide range of diverse design options that reflect the formal qualities of natural objects, and which are a source of architectural creativity, which is within two main directions:

1- Superficial visual Bio Analogy, which relates to the characteristics of the apparent familiar state.

2- The Deep Analogy, biological, visual, and related to the repetition of the systems and the deep characteristics of the familiar state.

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8.3 Bio-Functional Analogy

It is by simulating the natural functions of the living organism, some of which are movement, adaptation, Development and Multiple functions. Drive interactions between biologists and architects are essential because they can direct design in the direction of ecologically friendly solutions. These collaborations will also result in further contributions to creative inspiration, which is an equally wonderful conclusion. A rich and fruitful source of invention, biology can be. Building design can benefit from a better understanding of biological morphogenesis because : The goal of architectural design is to solve problems that nature has frequently already solved; architectural design increasingly tries to combine ideas and methods, such growth or adaptation, that are like those found in nature. Moreover, because both biology and architecture try to simulate growth and adaptation, they speak a same language (or morphogenesis) In the opposite direction, research in biology can benefit from architecture and engineering because: Organisms' constituent parts grow and specialize in response to environmental factors like static and dynamic loads and sunlight availability. In addition to being uncommon or unavailable in biology, computational techniques for evaluating and modelling complicated physical performances (such as load distribution, thermal performance, or radiance values) have been developed in architecture and engineering. An increasingly crucial technique for examining such influences in biology and architecture is computational modelling.

9. CASES STUDY DEMONSTRATING THE APPLICATION OF BIO-DIGITAL ANALOGY IN AND INTERIOR SPACES:

9.1 Computational Models of Plant Morphogenesis

Cells, tissues, and organs are only a few examples of the numerous types and sizes of structural units found in plants. These entities' interactions combine to form various regulatory mechanisms. There are numerous conceptual definitions of how plants are organized, and a thorough, formal description of this organization is a must before any computational modelling of interactions between different plant elements.

9.1.1 Focus and limitations:

A more modern method for studying morphogenesis in biology is computational modelling. Due to this and despite the natural diversity, there are just a few working models that are readily available. Currently, the models focus on basic species, which are frequently the ones that many biologists utilize as models. In botany, plants such as Arabidopsis thaliana and Coleochaete orbicularis are commonly used to study generic processes because they are simple and already well researched. Conceptually, a parallel between normally motionless architectural buildings and similarly static plants appeared less troublesome than with mammals.

9.1.2 Dynamic Structure:

The structural dynamics of cell development, growth, and proliferation as well as chemical movement between cells both contribute to the high dynamic nature of plant organizations. The changeable characteristics of cell congregations in the context of architecture might be explained by a functional analogy to the dynamic transit of chemicals through cells, and the influence of this effect could be supplemented with other influences on cell attributes. The actual physics behavior of viscous plant cell walls can only be useful in design when applied to related materials. However,

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the basic concept of an extended cell can further enhance the computational model's ability to dynamically adapt. (Figure 4)

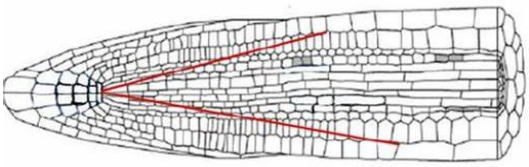

Figure 4. *Root meristematic zone of Arabidopsis thaliana.The red lines show the region considered in measuring the length of the meristem, and red contours represent the meristematic cells counted using DIC microscopy.(Source: Lien González Pérez,2012)*

9.1.3 Processual Continuity:

As is true of all natural processes, biological morphogenesis is continuous. As was previously mentioned, increased continuity, akin to the trait of living things, might be advantageous to creative processes in architecture. Even more intriguing is to think about how this continuity may be expanded beyond the bounds of a single design, allowing designers to experiment with different architectural genotypes and expand adaptable capacities into livable spaces.(Stanislav Roudavski, 2009) There is an example of proliferation type of morphogenesis in architecture design field. Using the same reasoning, Tom Wiscombe created "San Francisco Bus Terminal". They employ a diagram demonstrating cell growth during the design process. For this project, algal technology is also used to produce biofuels and oxygen through the growth of algae. (Figure 5)

Figure 5. Proliferation-San Francisco Bus Terminal. (Source: Joongsik yang, 2009)

The highly curved surfaces used in the architecture of the digital avant-garde are mathematically defined by NURBS, an acronym for Non-Uniform Rational B-splines, according to Kolarevic. Controlling nurbs involves adjusting control points, weights, and knots. (Figure 6) The Toni Osterlund-designed Bothnian Bay Cultural Center is an illustration of how control point matrices can be translated to modify NURBS-based surfaces. He examined several pieces of data that serve as the basis for the evolutionary process using this technology.

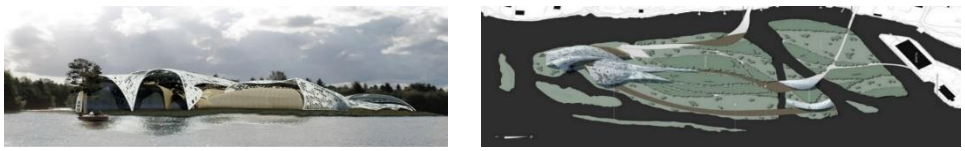

Figure 6. Perspective and Plan of the Bothnian bay cultural center clarifying methods for morphogenesis and ecology in architecture. (Source: Toni Österlund, 2010)

9.2 Procedural Production of the Parasite's Structure

The Parasite research project that was developed for the International Biennale of Contemporary Arts. The event took place in Prague in 2005.

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9.2.1 Focus and limitations

The Parasite project, Prague Biennale pavilion which integrates computer-supported design techniques currently under active discussion in architecture and incorporates a cellular structure resembling those found in biology, can aid in illuminating the comparison between biological and architectural interpretations of morphogenesis. The Parasite project is one instance in a broad subject and serves as an example of limited generality. Due to its tiny size, the construction did not have to deal with numerous challenges that big architectural projects must. (Figure 7)

9.2.2 Interrupted automation

This type of hybrid multi-stage process can be advantageous in many circumstances because it enables designers to overcome the drawbacks of computational processes that excel at clearly defined operations but struggle with ambiguity and are unable to render decisions in circumstances involving cultural, social, aesthetic, and other inherently human concerns. (Figure 8)(Roudavski, 2017)

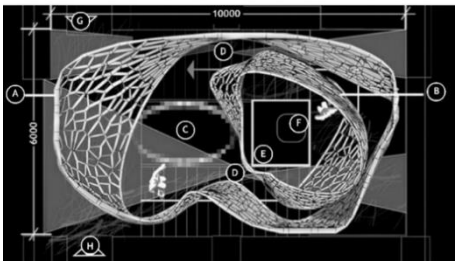

Figure 7. The Parasite. Plan view as designed formed the shells using dynamic curves. [A] Outer shell. [B] Inner shell. [C] Approximation of the area observed by the computer-vision system. [D] Video projections. [E] Disused lift. [F] Computers and the sound system. [G] Doors to the Main Hall. [H] Street entrance. (Digital rendering by Giorgos Artopoulos and Stanislav Roudavski. (Source: Stanislav Roudavski,*2009)*

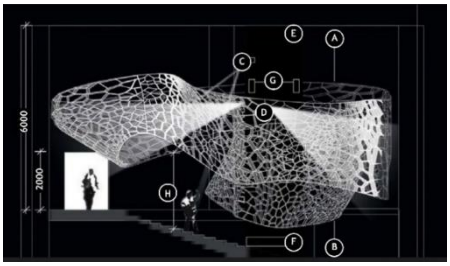

Figure 8. The Infection. as intended, a side view. [A] Outer shell. [B]Inner shell. [C] Approximate area that the computer vision system has detected. [D]Video projections are. [E] A abandoned lift. [f]The sound system and computers. [G] Speakers, in G. [H] We took precautions to keep the pedestrian walkway clear. (Giorgos Artopoulos and Stanislav Roudavski's digital rendering. (Source: Stanislav Roudavski,2009)

10. BIOMANUFACTURING BIO DIGITAL AND GENETIC INTERIOR SPACES

The challenge is to understand how "natural" DNA, with its transcription in four letters, is a biological information chain and how "artificial" software, with its transcription in zeros and ones, is a digital information chain, and how these two can be linked: DNA as a "biological software" and software as a "digital DNA." This is undoubtedly difficult and solely dependent on research funding. Understanding the advantages of this genetic and bio-cybernetic architecture, made with materials that emerge, that "grow," on their own thanks to self-organization systems, biological or digital, where DNA and software are the new materials of a new architecture and where genetic and cybernetic systems are the new systems of a new arc, allows the structure, form, and skin to "emergence" with biological processes or with digital processes.

Projects that can only be completed using digital tools and fabrication; projects that allow a more empathetic approach to users; projects that solve problems with the richness provided by the values of organic forms, continuity, unity, cohesion, and complexness, but also harmony in all of its parts

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in relation to the whole (this is the definition of beauty and of intelligence in architecture too); projects that take into account the new bicultural norms.(Alberto T. Estévez, 2017)

11. APPLICATION OF BIO DIGITAL PROCESSES IN ARCHITECTURE AND INTERIOR SPACES

Italian architect Tommaso Casucci has proposed the project for the new architecture school library, which will be situated on the edge of Florence's historic Centre. It is a part of a proposal to renovate a sizable area that was formerly used as a convent and then a penitentiary. A new extension offers study areas, conference spaces, an auditorium, and exhibition spaces for a continuously changing experience while converting pre-existing facilities into an archive. The study examines the features that emerge through surface modification in a dense field with the goal of achieving program, structure, and function equilibrium through morphodynamical processes. The emergent aspects of the same coherent system that are only tied to his environment are form, structure, function, and adornment. (Figure 9). Globally, the system investigates how is surface modulation, based on extensive field data from site study, can produce extremely distinct spaces and performative structures. The study employs a generative technique to examine many solutions based on the same procedure, from which the one that best balances structural performance, program, and connections was chosen. (Figure 10) A performative interface of bioclimatic management is defined at a finer scale by the surface's porosity, which is built on triply periodic minimum surface structures. Irradiation values on the surface are employed to modulate light perception in the library's internal areas (Figure 11,12).(Meghan Young, 2011)

Figure 9. The form is demonstrating the original brick building covered in an organic, porous shell that obliterates the distinction between inside and outside. (Source: Tommaso Casucci,2012)

Figure 10. The section demonstrate a performative interface of bioclimatic management (Source: Tommaso Casucci,2012)

Figure 11. The plan demonstrate structure, and function equilibrium through morphodynamical processes. (Source: Tommaso Casucci,2012)

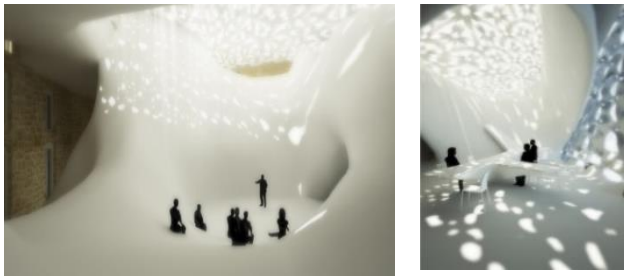

Figure 12. Irradiation values on the surface are employed to modulate light perception in the library's internal areas. (Source: Tommaso Casucci,2012)

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12. CONCLUSIONS

The Conclusions of the Research is mainly based on the use of new biological and digital processes interior design, as well as genetics in architecture. Obtaining knowledge of digital architecture based on genetic principles from the most advanced experimental architecture, to develop concepts such as bio digital architecture, emergence, genetic and generative concepts in the biological and digital worlds, bio mimesis, bio learning, morphogenesis, etc., students must pay special attention to new cybernetic-digital and new ecologic-environmental architectural design. Additionally, students must practice using genetically engineered software, evolutionary methods, emerging systems, algorithms, parametric functions, scripting, etc.

There are now more alternatives for manufacture (data-driven production, CNC machines, and 3D printers), which has led to the development of novel non-standard architectural formulations based on genetic principles (variation, mutation, and hybridization): A new architecture and way of thinking on the inside are needed to open new possibilities. Teaching of architecture and how to reshape interior spaces and computation, with concepts such as Artificial Intelligence (AI), Evolutionary Computation (EC), Logistic Regression (LR), Machine Learning (ML), Muti-Agent Systems (MAS), Shape Grammars (SG), etc. Education must match technology.

The designer's imagination is not the only place where design comes to life. The creative process is founded on analogies between the designer's thoughts and the information that surrounds. It is sometimes a question of capacity to develop and visualize structures beyond a certain level of complexity, rather than just a matter of time and effort, to imagine elaborate patterns.

It may be helpful for designers to envision a class of three-dimensional geometries that are difficult to generate conceptually without a computer. Designers can organize complex conceptual structures by visualizing the results very instantaneously. This suggests that creativity can be artificially boosted.

13. RECOMMENDATIONS

The most advanced level in the interior architecture industry is the most recent digital technology combined with biological understanding. As a result, there is an untapped labor market with limitless opportunities. It is beyond doubt that historically significant and definitive utopian movements have always been those in which many sets of ideas have publicly collided.

Interior Architecture reshaping spaces must respond to the digital revolution to meet the future trend and disciplinary in architecture and the future design thinking. Therefore, the research highly recommends:

- Aptitude to design projects that meet both aesthetic and technological needs, including advanced digital technology, environmental, biological, and genetic technology.
- To work with advanced software applied to architecture, for example, with computing programs as 3DStudio+VRay, Rhino, Rhino Cam, Grasshopper, Rhino script, Maya, Top Mod, XFrog, Top Solid, etc., parametric programs, CAD/CAM, scripting and other digitally novelties that come every year.
- Discovering new genetic application possibilities in architecture and interior architecture, as well as new biological and digital tools.
- Capacity to think on the research concepts and methodologies used in genetic and biological research as they relate to architecture, particularly when using digital tools.
- In the context of bio digital and genetic architecture research, the ability to innovate in the formulation and execution of concepts.

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• ability to efficiently manage research initiatives in bio digital and genetic interior architecture.
• Knowledge of the inner complexity of an interdisciplinary topic, such as informatics, biology, genetics, or architecture, and the ability to put knowledge together.

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