

# CREATIVITY AND BIOINSPIRATION AS A BASIS FOR INNOVATION IN SURFACE DESIGN

*CRIATIVIDADE E BIOINSPIRAÇÃO COMO BASE PARA INOVAÇÃO EM DESIGN DE SUPERFÍCIE*

*CREATIVIDAD Y BIOINSPIRACIÓN COMO BASE PARA LA INNOVACIÓN EN DISEÑO DE SUPERFÍCIES*

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## ABSTRACT

Currently, the use of varied methods for Teaching Design and for projecting has gained breadth, and as a result, there are more and more methods and variations in methods for teaching design and for designing products and services on the market. The union of methods is also widely used as a basis for ideating design concepts, thus adding more access to innovation and emotion to objects. The objective of this review is to survey and at the same time make a connection about Creativity, Innovation, Bioinspiration and Surface Design. This review work is the first phase of a broad post-doctoral research on Bioinspiration and the creative phase of Product development.

## KEYWORDS

Review; Design; Methods.

## RESUMO

Atualmente, o uso de métodos variados para o ensino de Design e para projetos tem se ampliado, e, como resultado, há cada vez mais métodos e variações de métodos para o ensino de design e para a concepção de produtos e serviços no mercado. A união de métodos também é amplamente utilizada como base para a criação de conceitos de design, adicionando assim mais acesso à inovação e emoção aos objetos. O objetivo desta revisão é fazer um levantamento e ao mesmo tempo estabelecer uma conexão sobre Criatividade, Inovação, Bioinspiração e Design de Superfície. Este trabalho de revisão é a primeira fase de uma ampla pesquisa de pós-doutorado sobre Bioinspiração e a fase criativa do desenvolvimento de produtos.

## PALAVRAS-CHAVE

Revisão; Design; Métodos.

## RESUMEN

Actualmente, el uso de métodos variados para la enseñanza del Diseño y para la proyección ha ganado amplitud, y como resultado, hay cada vez más métodos y variaciones de métodos para la enseñanza del diseño y para el diseño de productos y servicios en el mercado. La unión de métodos también se utiliza ampliamente como base para idear conceptos de diseño, añadiendo así más acceso a la innovación y emoción a los objetos. El objetivo de esta revisión es hacer un levantamiento y al mismo tiempo establecer una conexión sobre Creatividad, Innovación, Bioinspiración y Diseño de Superficies. Este trabajo de revisión es la primera fase de una amplia investigación postdoctoral sobre Bioinspiración y la fase creativa del desarrollo de productos.



***PALABRAS CLAVE***

*Revisión; Diseño; Métodos.*

## 1. INTRODUCTION

Design as a function is essentially design and planning. Compliance with the development and project stages needs to be well defined methodologically and this is passed on both in teaching and in the job market. Understanding the problem, establishing a method and developing the product effectively depends on the commitment and quality in executing these steps. When teaching design, the methods and development stages are essential for learning and successful project execution in the market by the designer. The result of design as a product or service has served humanity in surprising ways that until recently were unimaginable. The use of design as an innovation tool is undoubtedly the key point for maintaining human activities, conserving the planet, communication, use of new materials, teaching, science and technology. Design goes hand in hand with development and innovation. Although innovation is the result of product development along with its success in the market, its attributes are tools for maintaining companies in the economy of a city, state, country or even the world. It is through the innovative company, product or service that companies remain competitive and collaborative in the eyes of consumers. Therefore, innovation is dependent on the adopted model of creativity, approach and systemic vision of its developers towards a possible successful product or service (Kotler, 2011). In design teaching, this preliminary project phase has its importance focused on the study of methods. This understanding offers the student a creative framework at the time of development. Data collection is the interface between understanding the problem and developing the product itself. Data collection must follow a series of procedures that range from interviews with users, user habits, product function, product ergonomics, blueprint analysis, image panels, semantics, product dimensions, in short, structured information for the purpose of know the product to be developed, the opportunity and the user. (Baxter, 1998). The creativity phase is specifically one of the key points for innovation and the center of the objective of this research. The ideation phase is the essential phase of the design activity. It is at this stage that some design capabilities are put to the test. Design, spatial vision, creativity, materials and processes, systems, sustainability, ergonomics are important areas of knowledge for the designer's repertoire in ideation - precisely because the brain will make as many connections as possible in order to solve the problem and expose the possible

solution through sketches and later advanced drawings or even temporary modeling. "Creativity is the heart of design, at all stages of the project" (BAXTER, 1998, p.85). Therefore, the methods attributed to the creativity phase and the theoretical, practical and empirical framework of the designer and project student will dictate the level of possibility of product innovation. With the aim of increasing this possibility of innovation, post-doctoral research is being developed that aims to propose an inspiration tool through a simplified manual that moves between photography of natural elements and the search for concepts based on the perception of shapes of natural elements. And the first theoretical part of this research, which will be presented in this article, is the connection of bibliographic references between the research objects, which are Creativity, Innovation, Bioinspiration and Surface Design.

This research is justified primarily by the essence of design, which is creativity and innovation. And secondly by the constant search for new methods and combination of methods to achieve a product within the possibility of innovation. New methods and new creative situations are added daily to the creative process of new products. (KAYAT & MAGALHÃES, 2018 p2).

"Developing creative capacity is important for designers, as it can influence the success of a new product, brand or service, differentiating them through novelty and quality, increasing their competitiveness and generating innovation" (KAYAT & MAGALHÃES, 2018 p.2).

Still in the text, the author refers to creativity - not as a gift, but as a capacity that must be stimulated and highlights the importance of techniques for practice and development. Understanding the mechanism of the mind in the creation process is important to seek creativity. Genter e Markman (1997) apud Kayat & Magalhães (2018) developed research to understand these mechanisms and discovered that creativity is the result of observation, association, comparison, correspondence, similarity, similarity, memory, mapping and combination of ideas that were not previously related, thus generating original solutions. Alex Osborn (1948 p.103) in his book *Applied Imagination* he states that the mind goes through the understanding of the problem, a moment of expansion of the mind which is where the creative being must search in memory and in everyday life - ideas in as many numbers as possible, without judgment and then a moment of connection that it's time to choose the best ideas, that is,

judge the best ones and then define them.

## 2. DEVELOPMENT

The state of the art defined in the research was drawn up sequentially in a structured way at the level of development of the intellectual and scientific repertoire with the purpose of bringing together the interdisciplinarity that design has the function of uniting. However, the broad discussion that takes place on the areas pointed out results in the objectivity of the terms and information raised, focusing the state of the art of this research more on the correlation and links directly or indirectly linked to the main purpose of the research, which is the creative and objective phase of the design of Bioinspired Surface. In this way, a bibliographic connection was created of information that will be relevant for understanding, not just simply the terms raised, but rather the empirical link between the approaches, methods, technique, area and technology. Thus, figure 1 presents the broad organic mental map of how the State of the Art presents the most relevant points. However, in this article, only the bibliographic connection on Creativity, Innovation, Bioinspiration and Surface Design will be presented.

rite of Innovation. First you create and then you innovate, however, innovation must already be an objective at the moment of creativity. Therefore, knowing and truly mastering what innovation is is fundamental for a new look at creativity. Therefore, this topic was divided in this way, informing first about Innovation and then about creativity.

## 4. INNOVATION

It is important to emphasize that innovation is different from invention and this is often confusing. Not everything that is an invention is innovative, but everything that is innovative is invented. For something to be innovative, it must primarily be new and accepted by users. It is not enough to be creative, beautiful and attractive - the acceptance of the product, service (public or private) or graphic must be widely accepted by the target audience. There are a variety of methodological strategies for a product to seek innovation. The result is never certain, but the use of the innovation strategy must use tricks so that this search is more assertive, and that the loss gap gives way to a successful product (KOTLER, 2011 p.18).

An innovative product is the result of a series of initiatives implemented and developed by the corporation through the collaboration of various sectors. Every innovation starts from an individual, be it the boss, the leader, the owner of the company, an employee, or even a user. Innovation grows stronger as more individuals and processes take part in the development stages and the fulfillment of creative and development activities strategically forms the methodological stages and a series of questions are answered, developed and resolved. Hence the importance of intellectual training and the repertoire of each individual, whether through books, courses, lectures and conferences. Intellectual repertoire is the framework for creativity and innovation. The more contact individuals have with new artifacts and technology, the more chances the group will have of achieving a favorable result. Seeking innovation is currently a tool for maintaining the company in the market. Innovating is necessary and essential for the company to develop and maintain itself in the brutal competition of offering products and services that make a difference in people's lives. An innovative product is the result of the extensive efforts of people. We will not use the topic to classify innovation in detail, however it is worth highlighting that in most innovations we have open and closed innovation, where the company in Open

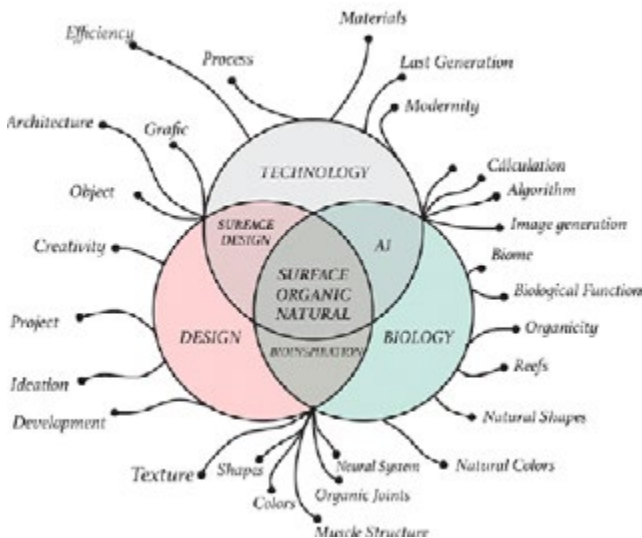


Figure 1: General Mind Map of the Literature Review.

Source: Author.

## 3. CREATIVITY AND INNOVATION [DESIGN]

In the absolute majority of references that discuss Creativity and Innovation, creativity always comes first and then talks about innovation. This sequence possibly follows the

Innovation brings new processes, products, machines, methods and repertoire. These activities aim to innovate in the product, process, organization or marketing (KOTLER, 2011 p.253, p254).

And in the midst of this highly planned development work comes creativity, which must also be structured and planned. Creativity is one of the most important tools for achieving an innovative product. The next topic will address this concept, initially presenting the beginnings of the creative activity of human beings.

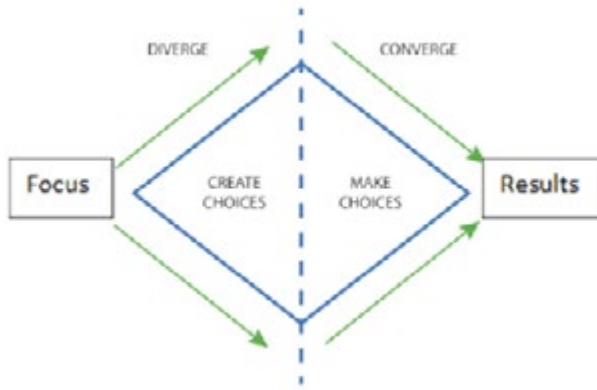
## 5. CREATIVITY

In the book "Where humanity went" Neves (2015, p.188, p.189; p.255, p256) concludes that humanity began creative thinking around 50,000 years BP (Before the Present) where hominids They began to realize that they could simply create. Scientists called this moment "**The Creative Explosion of the Upper Paleolithic**". At this time, Paleolithic man also begins spiritual questions and observes that creativity arises with the imaginative power of supernatural thinking. Therefore, man begins an unprecedented journey towards the creativity of environments, artifacts, agriculture, discoveries and new ways of living, relating, eating, imagining and obviously spiritual relationships emerge. After approximately one and a half million years of existence, man embarked on a life full of new perspectives, including the discovery of fire 10,000 years later (40,000 BP) which further opened the range of creative possibilities. Man observed that nature was a great source of inspiration and also of resources and gradually began to evolve both in the use of materials and in the evolution of processes and of seeing and also representing reality. The cave paintings appear in the boiling of this moment and are the greatest example of the yearning for creative representation. Natural materials such as blood and calcium oxalate were used for rock art painting, as stated by Gillespie (1997) in his research "On human blood, rock art and calcium oxalate: further studies on organic carbon content and radiocarbon age of materials relating to Australian rock art". Rock art is humanity's first form of expression. Creativity gave rise to new representations, the finding and treatment of new raw materials and material extraction processes. 10,000 BP saw the appearance of the first metals, such as copper, and a great leap in the acceleration of processes that in turn were exponential until the Industrial Revolution (WERTIME, 1964).

In short, the movements that precede design itself and that creativity was already being used in abundance, but without methods, only as an empirical idea, emerge in the midst of global movements initiated by artisans, architects, artists and even engineers. In the "Arts and Crafts" and "Art Nouveau" movements initiated by architects and craftsmen in the early nineteenth century, the main goal was mass production without losing the quality of the artifact, as a result of the high demand for the search for the form and function of the products (BAUER, 1955 p.51). In the midst of the ebullience of the need to produce in series, with the same creativity as the exclusive pieces of artisans, the Bauhaus appeared in Germany in 1919 and the emergence of design as a professional activity began. The methods for the creation and development of products emerge producing a great flow for new solutions and creating a multitude of products and even new needs. At this same time, there are a variety of continuous and intersecting flows to human and technological development such as the industrial revolution and the first and second world wars. The emergence of the aerospace industry and the massive development of automobiles run parallel to these flows (DAVIS, 2012. p.2 ). On the other hand, various methodologies from different areas are initiated and creative methods begin to be developed. One of the first models developed about the creative moment was developed by Graham Wallas, a social psychologist in 1926 (GOMES, 2011, p.110). The researcher elaborates some steps for creative development. And so the stages of Identification (defining the Problem), Preparation, Incubation, Warm-up, Illumination, Elaboration and Verification were proposed emphasizing the rationality of creative human thought.

Later in his book Applied imagination Alex Osborn (1953) describes the creative moment as being basically the choice of the problem, displacement (expansion of ideas without judgment) and connection of ideas (choice of the best alternatives) and that later methods of creativity would follow this logic. Figure 2 shows the flowchart based on the author's assumptions. It should be noted that the Brainstorming and Brainwriting also proposed by Alex Osborn follows this conceptual basis. Design Thinking, although much more complex, follows the same sequence proposed by Alex Osborn.

Still about creativity – Bioinspiration is one of the most fantastic methods of creativity and development based on observation and strategies that nature uses to solve its problems.



**Figure 2:** Flowchart based on the book *Applied Imagination* (OSBORN, 1953)  
**Source:** Author.

## 6. BIOINSPIRATION

Goethe (2018) in his book "Doctrine of Colors" exposes that the use of colors with Bioinspiration promotes greater assertiveness in the harmony between flows and proposals of different color combinations. Based on the creative process and the use of techniques that facilitate this process, Biomimicry brings a framework of approach, observation, the need for training of the biological environment, technique, aggregated knowledge and the personal power that each individual has when joining the steps that the method proposes with the creative capacity and expansion of consciousness. The strategic observation of how nature solves its problems and the solutions proposed by existing bodies is what makes the Biomimicry method one of the most fantastic methods of development and research among other methods in the field of design, architecture, services and engineering. A current example is presented in the research "Biomimicry and artifacts for aquatic environments: strategies of lightness and resistance inspired by the cellular structure of agave" where Araújo (2015) concludes that the natural strategies of lightness used by agave constitute a series of organic forms distributed in tune with the cell walls with microscopic spaces distributed in a balanced way along the agave tassel. In an analysis of other works developed, it is observed that biomimicry is an important tool to contribute to the inspiration of creativity in Design. The author concludes that:

"It is not about developing the lightest and most resistant material, but rather carrying out studies and seeking answers on how these materials and structures behave, an account of how they behave within this concept of lightness and

resistance, with the behavior of the samples being studied, and how these can be applied to specific functions according to the potential of each material (Araújo, 2015)."

In a research with a greater relationship between Surface Design and Bioinspiration, Guerra (2018) in the article entitled: "Surface design and bionics: nature as inspiration in the creation of prints for clutches" states that the proposed combinations of harmonious and organic form by nature brings originality and exclusivity to the design project which results in the attractiveness of users' observation. Users' search for something that is exclusive and original can be a relevant factor for the innovation of the developed product. The author states that bioinspiration is clearly linked to the first art and design movements such as Art Nouveau. One of the great names of Art Nouveau is Lalique, who focused on natural elements of fauna and flora to perform his creativity at its highest level. Figure 3 clearly presents this characteristic that Lalique applied to his creations.



**Figure 3:** Cockerel Diadem, Vase Ceylan e Dragon Fly.

**Source:** <https://www.du-grand-art.fr/arts-decoratifs/19eme-siecle/art-nouveau/artistes/rene-lalique/>

It is observed that the aesthetics of objects brings a possible attraction that corresponds to the natural beauty of shapes, organic curves and textures, not created from absolute zero by Lalique, but rather inspired by copies and junctions of the natural elements most relevant to him at the moment. of creative eureka. Norman (2004) states in his book *Emotional Design* that in relation to product observation, design reaches three levels, the Visceral: this is when our brain identifies and judges a beautiful object and feels attraction regardless of its functionality; o Behavioral: which is the perception of the product about its usability and o Reflective: it is about the context of the product, cost, function, aesthetics, sustainable, etc. Reaching the three levels is the pinnacle of design and the method approach ends up seeking this level to the maximum. A product reference, surface design and the object of this research, Bioinspiration, is the Acaú Armchair

by designer Sérgio Mattos. Figure 4 shows the elkhorn coral (*Acropora cervicornis*) found on the south coast of Paraíba in the town of Acaú and on the north coast of Pernambuco in the town of Carne de Vaca. It served as the inspiration for one of the most iconic armchairs in modern Brazilian design. Initially, the morphology of the elements can be observed, where they have points that resemble moose antlers with their tortuous points, sometimes pointed and sometimes rounded, and often in the shape of plates. The organicity of the coral gives the perception a unique characteristic that may be difficult to reproduce functionally in a product. However, the activity of design seeks a solution through its projective methods.



**Figure 4:** Coral Chifre de Alce .

**Source:** <https://www.mundoecologia.com.br/animais/coral-reino-filo-classe-ordem-familia-e-genero/>

Designer Sergio Mattos' page describes Poltorna's project and states that;

"Inspiration is lifted from the sea. A dive into the talent and keen eye of the Mato Grosso designer based in Paraíba, Sérgio Matos, who brings to light the products from the "Corais de Acaú" collection. The hallmark of its exotic design - imbued with the identity of the surroundings - appropriates the shapes of the Horn of Alce coral and brings together the artisanal and sustainable concept in collaboration with seafood restaurants and artisans from Acaú, a beach in the Paraíba municipality of Pitimbu. The armchair with a concave line and steel base evokes the poetry of a reef at the junction of the thousand pieces that support the structure. The perfect assembly simulates the limestone aesthetic reproduced in the wire that bends to the reference of nature and gains the coverage of cotton thread and the intensity of red varnish. The texture exudes fidelity to the inspiration that rests beneath the tides." (MATTOS, 2023)

Figure 5 demonstrates the full result of the creativity inspired by the acaú corals on the south coast of Paraíba. Addressing all the complexity proposed by the coral, Bioinspiration, resulting in a level of complexity and alternation of forms when applied to the final product and aiming for its replicability.



**Figure 5:** Acaú armchair.

**Source:** <https://pt.sergiojmatos.com.br/product-page/aca%C3%BA-armchair>

Therefore, it is concluded that natural forms have been addressed by developers for some time, where fauna and flora are quite common as creative inspiration and that nature exudes capacity as a mentor for the development of products, services and graphics. The organicity and variety of proposals presented by nature is infinite and carries with it the entire framework of billions of years, resulting through Bioinspiration new and exclusive products that offer greater access to innovation. Regarding Bioinspiration and the framework of creativity, the marine biome primarily holds in its complex diverse existence an infinity of creative possibilities. Therefore, the following topic provides this survey with important information to be observed and followed when searching for the Marine Biome as part of the creative development of research or products.

## 6.1 Marine Biome

Almost one hundred percent of the water on the planet is seawater, and for this reason planet Earth could be called a water planet. It is from the sea that a large amount of the oxygen that we breathe comes from. The Marine Biome needed to be characterized and there was already important research in this regard until the

World Congress of National Parks that took place in Bali, Indonesia. The Marine biome is named by the academic and research community as Marine-aquatic Biome or Aquatic Biome and is responsible for 71% of the planet's surface coverage. 97% of the water that covers the Planet is oceanic. The marine Biome is made up of a complex and diverse ecosystem chain that ranges from shallow coastal waters such as beaches, the margins of islands and continents to deep waters such as ocean trenches. Marine Biomes are a great climate regulator, temperature equalizer, production of oxygen and other important gases for the preservation of species and are therefore extremely important for the vitality of planet Earth. (Hayden, 1984).

Depending on the references, marine biomes may vary in their classifications, but are generally classified into 3 categories: Deep Marine, Coastal Marine and Pelagic. Hayden (1984) in his article Classification of coastal and marine environments classified the Marine Biome as Oceanic Kingdom, Coastal Kingdom, Seas and Archipelagos.

**Deep Marine Biome** – also known as the Abyssal zone, the depths of the oceans, the ocean floor and the marine trenches are included in this classification. The temperatures present here are very low and the pressure of the water volume is very high, resulting in an extreme living situation. However, there is a multitude of abyssal fish, worms and microorganisms highly adapted to this environment. (Hayden, 1984).

**Coastal Marine Biome** – Specifically, Coral reefs and Mangroves are part of this classification, along with Estuaries, Coastal Lagoons, Grasslands and Seagrasses and Rocky Coasts. It is one of the most diverse classifications and contains several types of ecosystems that differ in their biological characteristics and functions. This biome is characterized by its positioning close to the land areas of continents, islands and archipelagos..

- **Coral Reefs** – Coral reefs, which are one of the objects of research and inspiration for this work, are classified in the coastal Marine Biome and involve a series of variables for their existence and maintenance. One of the most important variables for the survival of corals in the sea is temperature. This variable includes sensitivity on the part of corals that survive in a narrow temperature range that, for the most part, thrives between 23 and 30 C. One of the largest coral communities in the world is present in the coral triangle that encompasses tropical

countries: East Timor, Solomon Islands, Philippines, Papua New Guinea, Malaysia, Indonesia. This area contains 605 zooxanthellates, including 15 regional endemics. Thus resulting in 76% of the world's total complement of species, giving this province the highest conservation priority in the world (Veron, 2011).

As this topic is part of the research object, a specific topic about corals will be covered in this work in a broader and more specific way.



**Figure 6:** The upper coral line are photos of Corals on Koh tal in Thailand and the lower line are Corals present on Gili in Lombok in Indonesia.

**Source:** Author in photographic field research.

- **Mangroves** – The mangroves that are also part of the coastal marine biome and that, due to their important function for the biological system of the coastal ecosystem, were taken into account in the photographic research of this research so that, like corals, they serve as a tool for creative inspirations in bioinspired Surface Design. Mangroves are coastal ecosystems found between seas, hills, rivers and the mainland, islands, estuaries. The trees found in these areas are highly adapted to the salinity of sea waters and also serve as breeding grounds for various species of fish around the world. The longest continuous mangrove coastline is in the Amazon. Approximately 85% of Brazilian mangroves occur along 1,800 km of the northern coast of the states of Amapá, Pará and Maranhão, which together contains 10,713 km<sup>2</sup> of these ecosystems (COHEN, 2012. p.50-58). Indonesia contains the largest mangrove cover in the world. To give you an idea, the total area of mangroves in the world is estimated at 137,760 km<sup>2</sup> and is distributed in 118 countries. Indonesia, which has the largest mangrove cover in the world and has been losing about 52,000 hectares per year over the years. Indonesia contains one of the world's largest reserves of blue carbon, precisely because of its large cover of mangroves, grasses and corals. Mangroves are great



photosynthesizing carbon filters and with that the importance of their preservation for other species of fauna and flora are also preserved (ARIFANTI, 2020).

- **Estuaries** – Estuaries are transition areas between the Sea and the River. They are very rich in nutrients and are home to a diversity of marine life. The reproduction of many species occurs in these areas precisely because of the protection of marine currents (Arthurton Et al., 2005).
- **Coastal lagoons** - These are permanent or endless aquatic environments that are present near the seas and are separated by dunes or terrestrial arms and are home to fish, reptiles, birds and a flora adapted to salinity. (Arthurton Et al., 2005).
- **Rocky Coasts** – Rocky beaches are characterized by the presence of a variety of rocks and substrate. The size and types of rocks may vary depending on the location and region where they are located. These places also serve for the development of coral life and reproduction of marine species. (Arthurton Et al., 2005).
- **Seagrass Prairies** – These are large concentrations of algae and marine plants that serve as a food framework for fish, turtles, small and medium-sized marine animals (Arthurton Et al., 2005).

**Pelagic Marine Biome** - The pelagic marine biome is the open ocean waters and is considered the largest marine biome. This biome is classified according to the presence of sunlight. It is therefore divided into three: a) Euphotic - Where photosynthesis takes place, i.e. sunlight penetrates at a higher percentage. B) Dysphotic - Sunlight penetrates with less brightness and heat and c) aphotic - which are the depths of the oceans where sunlight does not reach due to the density of the marine waters. (Floeter, 2009).

We can conclude that the marine biome is highly diverse in classifications, subclassifications, and functionally important for marine and terrestrial life. In the object of the research, which are corals, a variety of shapes and colors can be observed that can easily be used as inspiration in products and especially in bioinspired surface design. The textures, shapes, organicity, elemental positions, creases, reliefs produced in a natural way by the corals are of an assertive aesthetic precision and of great relevance for inspirations in the field of design, whether

in graphic and textile use with the purpose of sharing the importance of Bioinspiration, or in the field of product design. This variety of forms produced by corals opens up the field of creativity and, consequently, the sensitivity of innovation of bioinspired products. The natural surface design produced by corals is of great value for acquiring the creative framework in the development of bioinspired surfaces.

## 6.2 Surface design

Man's interest in graphic manifestations and the interest in making records coincide exactly with the aforementioned moment of the creative explosion of the Upper Paleolithic, whose drawings presented graphics referring to survival, hunting, moments of spirituality, explosions of creativity, thus establishing forms a connection to the events experienced (RÜTHSCHILLING, 2008 apud GUERRA et Al, 2018).

"Given man's different artistic manifestations throughout his existence, he has had to keep up with the evolution of his surroundings. In this sense, the professional emerges who will design, as well as reflecting the communication that exists between man, nature and objects; a professional who will be able to stamp creativity on surfaces, combined with contemporary needs. Associated with the professional is also the fabric" (GUERRA et Al, 2018).

Therefore, the main objective of surface design is to develop reliefs, textures and prints that can be placed on floors, fabrics, household utensils, coverings and carpets. For Freitas (2009, p8) surface design develops active communication produced through sensory elements and codes. Surface design appeals more to the emotional than the functional, but surface design interacts with the various classifications of design, as well as at different levels of design, with regard to the function and aesthetics of the product. For this brief literature review, we will describe Surface Design in three main topics, Coatings, Carpets and Fabrics and Other Objects.

## 7. COATING

Surface Design is widely applied to the engineering, architecture and interior design sectors. As mentioned,

emotional appeal is directly linked to surface projects that indicate some identity with the place, with history, based on some natural element and that meet some of the design levels proposed by Emotional Design. Norman (2008) states that design contains three levels, the Visceral, Behavioral and Reflective Levels. Where the visceral level is the first impression we have of the product, it is basically linked to the emotional and disconnected from the functional, that is, it doesn't matter if the product works, what matters is the emotion I have when observing it. Works of art or architectural works in Dubai, for example, have this characteristic. Curves and aesthetics used have few elements applied to the functional and the proposals are more linked to the emotional impact they will cause on people. In figure 7 you can see the surface design applied to the coating of the Largest Frame in the World (Dubai Frame) located in Dubai in the United Arab Emirates, where it uses gold materials, a surface design developed specifically for this purpose and The fact that its dimensions result in the largest frame in the world makes people impressed by the architectural ensemble of the project and eliminates the real function of a work in this format, where empty spaces could be occupied in a functional way.



However, it is observed that the function of the building itself is simply to generate a frame that in the background can see the sky or, depending on its position, can see the city of Dubai with the Burj Khalifa in the background. The golden materials bring an aspect of grandeur, grandeur and power to the monument. And the surface design is inspired by the Expo Dubai 2020 Logo as shown in figure 8.



**Figure 8:** Expo 2020 dubai UAE logo

**Source:** <https://news.sap.com/mena/2019/10/expo-2020-dubai-runs-sap-to-help-personalize-visitor-experiences/>

The Dubai frame was designed by Mexican architect Fernando Donis in a competition offered by the Dubai government and whose theme was to present the “new face” of Dubai. The Competition had the participation of 926 participants (LYNCH, 2018).

At Ngurah Raide International Airport in Bali, Indonesia, one of the most diverse countries in terms of nature, surface design is present in a multitude of covering panels where nature, elements of culture and religious diversity are exposed. The exterior design projects combine modern and traditional Balinese architecture, characterized by wide domes interspersed with Stuka-type exterior roof designs, while the interior design develops a luxurious line with diversity in the use of colors and materials. (The private Word 2017) Figure 9 demonstrates the variety of colors, shapes and combinations proposed by the panels present at Bali airport.



**Figure 9:** Decorative covering panels at Bali airport/Indonesia.

**Source:** Author in field photographic research.

## 7.1 Carpets and Fabrics

One of the most important applications of surface design are carpets and fabrics and it was the proximity to these objects that Renata Rubin brought the term surface design to Brazil in the 80s. Renata Rubin is a surface designer and pioneer in Brazil and currently works developing projects for the most diverse areas of design with surface projects. In the presentation of her book drawing the surface there are a series of questions and statements about surface design, design and art. Where does one end and the other begin? There is a conservative line in design that resists the applications of Surface Design, more as art than design. However, the author incisively states that art is art and design is design and questions the clarity of this statement. *"A designer has to be able to understand the needs of other people and to use his imagination and creativity to format many of the objects and much of the environment that surrounds him..."* (excerpt from a leaflet distributed by the Danish school Danmarks Designskole and replicated by Renata Rubin in her Book). Perhaps it is in the development and production of the rug where there is a frank conversation between art, craftsmanship and design. In any case, the creative process, whether empirically (art) or development methods (design), must be stimulated so that the result is as attractive as possible and within harmonious patterns between colors, shapes, textures and, obviously, functionality. Creativity methods, as well as their stimulus tools, have in common the search for a repertoire with the aim of increasing the imaginative framework of solutions, shapes and color combinations. Table 1 weighs heavily in this search for repertoire proposed by RUBIN (2004). We chose to place an ipsi litteris print of the book precisely because of the importance that the search for new repertoires has in relation to the **creative process** and as Soares & Arruda (2018) state in their book about the importance of observing how nature operates in the creation of its species and through observation and translation of the execution of natural systems, it can be applied to some product, construction or artificial systems.

c) Dicas para formar um bom repertório de imagens/idéias:

1. olhar atentamente para tudo ao seu redor;
2. fotografar;
3. anotar idéias;
4. ir ao cinema, teatro, mostras de arte, shows e, se puder, viajar!

**Table 1:** The search for repertoire proposed by Renata Rubin in her book designing the surface (RUBIN, 2004)

Translating the original image we have:

- C. Tips for creating a good repertoire of images/ideas
1. Look closely at everything around you
  2. Photograph
  3. Write down ideas
  4. Go to the cinema, theater, art exhibitions, shows and if you can travel!

In the search for visual references for surface design, an on-site visit was carried out at the Great Mosque of Abudhabi / United Arab Emirates, where the Largest Carpet in the World is located, with exactly 5,400 square meters of fabric hand-embroidered by 1,200 weavers from the Province of Khorasan to carry out the design by Iranian artist Ali Khaliqi. The Persian rug was produced and weighs approximately 35 tons upon completion, where 30% is cotton and 70% wool. Regarding colors, it is predominantly green, however, it is made up of a total of 25 colors (AMBA, 2022). In figure 10, an organicity of shapes and colors is observed based on floral elements such as petals, flowers, leaves, thin stems, which provides the surface design with assertiveness within the scope of visceral design. In the place that is open for visitors, there is a collective emotional outcry where visitors, mostly non-Muslims, stay for minutes to observe the details and grandeur of the piece. Certainly the use of natural elements brings the visceral level to the extreme, precisely because of the requirement to reproduce these elements. The harmony of color combinations created by nature possibly provides such a result.



**Figure 10:** Largest Carpet in the World present in the Great Mosque of Abudhabi.  
**Source:** Photograph produced by the author in photographic field research.

Still inside the mosque, surface design is present in other figurative elements. Thus demonstrating the importance that surface design has for the harmony, aesthetics and perception of the environment as a whole. For Rubin (2004) "surface design can be represented in the most diverse ways, as long as we accept that any surface can receive a project". Figure 11 shows other surface visual elements that make up the internal environment of the mosque.



**Figure 11:** Surface design in the composition of other elements of the Abudhabi mosque.

## 8. CONCLUSIONS

The theoretical review of a research is extremely important for the initial understanding of both readers and also important for rounding off concepts about the part and object of the research. This review is the result of the first part of post-doctoral research that has as its reference and connection creativity, innovation, Bioinspiration and surface design. It was observed in the theoretical field the absence of reference that connects Bioinspiration with surface design, although the photographic research that took place in the United Arab Emirates and at

Bali airport in Indonesia as part of the topic of surface design, presents an excessive use of natural elements for composing environments through surfaces. Thus, the importance of expanding this connection with the aim of bio-inspiring the creativity of surface design and other fields of Design. Photographic research into the Marine biome, specifically corals, elucidates a multitude of compositions and color alternatives that, in the creative phase, can generate bio-inspired surface designs never before created. The formal compositions, the colors, the textures, the combinations, the organicity that corals play in their existence is an inexhaustible source of inspiration. Both the connections between theoretical concepts and the observation of natural and artificial elements (made by man) bring fuel to the creative framework and thus increase the possibility of innovation in a given project.

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## HOW TO CITE THIS ARTICLE

SILVA, Marivaldo Wagner Sousa; ARRUDA, Amilton José Vieira de; SILVA, Thiago Ferreira da. *MIX Sustentável*, v. 10, n. 2, p. 127-140, 2024. ISSN 2447-3073. Disponível em: <<http://www.nexos.ufsc.br/index.php/mixsustentavel>>. Acesso em: [\\_/\\_/\\_doi: <https://doi.org/10.29183/2447-3073.MIX2023.v10.n2.127-140>](https://doi.org/10.29183/2447-3073.MIX2023.v10.n2.127-140).

**SUBMITTED ON:** 30/01/2024

**ACCEPTED ON:** 27/02/2024

**PUBLISHED ON:** 12/06/2024

**RESPONSIBLE EDITORS:** Lisiane Ilha Librelotto e Paulo Cesar Machado Ferroli

## Record of authorship contribution:

CRedit Taxonomy (<http://credit.niso.org/>)

MWSS: project, methodology, literature review, data collection (photography), selection and filtering of images, discussion of results and review, article generation and publication, writing - original draft, writing - review and editing.

AJVA: project, methodology, literature review, discussion of results and review, supervision, article generation and publication, writing - review and editing.

TFS: literature review, discussion of results and review, article generation and publication, writing - review and editing.

**Conflict declaration:** nothing has been declared.