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A FURNITURE DESIGN EXPERIENCE WITH A BIOMIMETIC APPROACH: LOT-US

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Abstract

Nature has perpetually remained a potent wellspring of inspiration for humans because over the years, through the process of natural selection, animals and plants have evolved unique traits to survive and adapt to their environment. These traits can be a source of inspiration for humans when they face problems that require solutions. Biomimetic approach based on the idea of designing inspired by nature or imitating biological systems, is used to understand the unique properties and functions of living organisms in nature and to apply these properties to human-made products. By referring to the possibilities of the biomimetic design approach, the study aims to emphasize how such a design process works in practice and to guide future designs. In this context, the authors have designed a multifunctional and hygienic furniture called LOT-US, which emulates the lotus flower, using a biomimetic approach. LOT-US meets the levels of biomimetic where form is imitated at the organism level and form, function and material behavior are imitated at the behavior level. At the end of the process, it is hoped that the outputs of the experience and the diagram created will be a guide for similar designs to be made in the future.

Keywords: biomimetic, furniture design, design approach, emulation, imitation of nature.

Introduction

"Nature" has been one of the main sources of inspiration for designers in many fields of design from past to present. The inspiration offered by nature provides designers with a unique perspective and creativity. Through millions of years of evolution, nature can be characterized as a rich data environment where functional solutions have been developed to overcome many complex problems. The structure and function of organisms in nature

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are unique examples of design principles such as creativity, efficiency and sustainability.

According to Sonneveld, to make a source a truly rich source of inspiration in the design process, it is necessary to look for ways to interact with it.[1] Gürcüm and Kartal argue that inspiration is not only about where you look, but how you see.[2] In this sense, visual interaction provides guidance for the designer to develop a source of inspiration.

According to Mougenot, et al., sources are dominant in inspiration and inspiration comes to designers through the five senses. Therefore, the design process is image oriented.[3] The details focused on in the act of observing nature can be transformed into images in the designer's mind and transformed into sources of inspiration that will help guide the design process.

The use of nature as a source of inspiration not only enhances the functionality and performance of design, but also provides aesthetic, efficient and sustainable approaches to design. Using the prominent features and functions of organisms in nature, developed over hundreds of millions of years of evolution, offers a different perspective in the development of human made products. For example, designers inspired by bat wings can utilize their aerodynamic properties to design more efficient and quieter airplane wings. Similarly, scientific studies on spider webs show that strong and durable materials can be developed based on these structures.

In their study, Kellert and Calabrese mention two different experiences, direct and indirect, while establishing the relationship between nature and design. According to them, the direct experience of nature refers to actual contact with environmental features in the built environment including natural light, air, plants, animals, water, landscapes, and others that will be described. The indirect experience of nature refers to contact with the representation or image of nature, the transformation of nature from its original condition, or exposure to particular patterns and processes characteristic of the natural world. These include pictures and artwork, natural materials such as wood furnishings and woolen fabrics, ornamentation inspired by shapes and forms occurring in nature, or environmental processes that have been important in human evolution such as aging and the passage of time, information richness, natural geometries, and others.[4] Kuday groups the methods of inspiration from nature as animal, plant and human-based inspiration and imitation.[5] Genç expanded this grouping and classified it as form, internal structure (structure), external structure (texture), colour and material.[6] Ives et al., on the other hand, examined the relationship with nature in terms of sustainability. According to them, Humanity's relationship to the natural world has been a topic of scholarship since ancient times, yet with growing recognition of environmental crises over the past decades, society's disconnection from nature has been proposed as a root cause of unsustainability.[7] The experiences and methods mentioned here suggest that nature can be integrated into the design process as an important source of inspiration and data in furniture design. Various elements of nature inspire the creativity

and aesthetic understanding of designers and enable the development of furniture designs.

When nature-based resources are examined, various issues that can guide the designer and the design process in furniture design come to the fore. These are:

Use of natural materials: Wood, stone, bamboo, wicker, leather, textile and other natural materials are widely used in furniture design. The shapes and textures of these materials in particular can be a source of inspiration for designers, as well as increasing the durability of furniture and giving it a natural look. Natural materials are omnipresent in the bodies of plants and animals around us. They always have been used by humankind because they represent a valuable and renewable resource of materials, many of them with outstanding mechanical quality (e.g., wood, reed, or bamboo).[8]

Organic forms: Organic forms in nature are sources of inspiration that designers can use in furniture design. These forms can make furniture look more organic, fluid and natural. For example, the organic structures of trees and the sharp edges of natural stones can help determine the shapes and structures of the materials used in furniture design. Also, Kellert and Calabrese (2015) state that, the experience of shapes and forms characteristic of the natural world can be especially appealing. These naturalistic forms can be extraordinarily diverse from the leaf-like patterns found on columns, the shapes of plants on building facades, to animal facsimiles woven into fabrics and coverings.[9] Natural forms, characterized by specific functional and shape solutions, offer the opportunity to take advantage of their uniqueness. Their exact exploration and subsequent transformation can be a unique inspiration for the design of new innovative products.[10]

Color palettes: Nature's color palettes can be a source of inspiration for colors to be used in furniture design. For example, the green tones of a forest, the blue tones of a beach or the earth tones of a desert, or the colors and patterns of natural stones can help furniture designers determine the color palette and textures. People for good and obvious reasons are attracted to bright flowering colors, rainbows, beautiful sunsets, glistening water, blue skies, and other colorful features of the natural world. Natural colors, such as earth tones, are thus often used to good effect by designers.[11]

Functionality: Imitating the characteristic features of various organisms in nature, such as their relationships with life, their physical structures, their ties with their ecosystems, and using them in the working principles of furniture can be considered as unique sources of inspiration offered by nature. Kellert gives examples include the bioclimatic controls of termite mounds, the structural strength of spider webs, and the heat-trapping ability of certain animal hairs.[12]

Sustainability: Nature is also a great source of inspiration for sustainable furniture design. Natural materials such as wood, bamboo, hemp, linen, wool are both durable and environmentally friendly. In addition, furniture made from recycled materials also promotes sustainability and reduces the amount of waste. The Oxford English Dictionary defines the ecological meaning of "sustainability" this way: "Of, relating to, or designating forms of human economic activity and culture that do not lead to

environmental degradation, especially avoiding the long-term depletion of natural resources".[13] To be truly sustainable, existing resources should not be wasted faster than their ecosystem can replenish them, and objects should not be designed using unsustainable materials. Instead, innovative ways to obtain sustainable resources and materials should be sought.[14]

However, according to Pawlyn, in order for designs to respond to changes, one should look at nature and the organisms in nature that have adapted to all kinds of changes and challenges since the first existence of life on earth and benefit from 3.8 billion years of research.[15]

The patterns of nature, from the leaves of plants to the fur of animals, the sharp lines of mountains, the graceful curves of flowers, natural forms such as the spirals of seashells, natural movements such as the motion of waves and wind or the sway of trees are nature-based resources used in various areas of design.

When the research and designs are examined, it can be said that the above-mentioned use of nature-based resources and the level of utilization mentioned by Pawlyn are applied through two prominent methods in the field of design. These methods are based on two different actions: analogy and imitation.

Approaches based on simulation, that is, the establishment of similarity in the formal sense, are defined as biomorphism in the literature, while approaches based on imitation that is, imitating living things in nature in the functional sense and transferring the characteristic features of living things to designs, are defined as biomimetic.

Biomorphic designs are defined as designs that imitate natural or biological forms and shapes and patterns and textures that connect human beings to nature.[16]

Accordingly, the application of biomorphic forms in design can be categorized based on two dimensions, namely, similarity (which can be considered as a continuum that varies from abstract representations to a full resemblance) and utility (which also is a continuum that ranges from functional to significant social or cultural associations.[17] Biomorphic trends have been reflected in the design of many iconic structures across the world, such as Lotus temple, India; 30 St Mary Axe, London; Sagrada Familia, Barcelona; Helix Bridge, Singapore, etc.[18] Biomorphism has produced majestic works of architectural form, such as Eero Saarinen's TWA terminal, and was used to great symbolic effect by Le Corbusier.[19]

The term 'biomimetic', or imitation of nature, has been defined as, 'copying or adaptation or derivation from biology.[20] In biomimetic, solutions are obtained by emulating strategies, mechanisms, and principles found in nature.[21] Biomimetic, ideally, should be the process of incorporating principles that promote sustainability much like nature does from 'cradle to grave', from raw material usage to recyclability.[22] Leonardo da Vinci's sketchbooks shows that he closely studied the forms of skulls and birds' wings: he was, in many ways, a pioneer of biomimicry. As another example, The Daimler Chrysler biomimetic concept car, inspired by the surprisingly streamlined and roomy boxfish, surgical glue developed from an understanding of sandcastle worm and even ice cream that embodies lessons

from arctic fish have all delivered a superior product by learning from adaptations in natural organisms.[23]

Although the concepts of biomorphology and biomimetics share the important common denominator of being based on nature, they guide different processes and end products in the field of design. Benyus (2008) explains the difference between these two approaches as follows: …Focus on function points to a key difference between buildings that mimic nature to "look as nature looks" for decorative or symbolic purposes and those that mimic nature to "do as nature does" in order to enhance functional performance.[24] Likewise, Pawylin states that biomorphism is a formal and aesthetic expression, while biomimetic is a functional discipline.[25]

Within the scope of the study, the authors aimed to design a furniture design experience that references natural data, in other words, inspired by nature. In the design process, which started with the idea of designing a furniture that will contribute to the hygiene control of spaces and users with its various features, addressing the concept of hygiene, which has increased the level of awareness in the society after the pandemic, nature has been determined as the main source of inspiration.

Although the delicate distinction between biomorphology and biomimetics was considered, the design's biomimetic inputs were given more dominance, and the biomimetic quality of the design was emphasized. The design process, which started by interacting with nature, was continued by identifying the source of the design idea, observing the qualities of the selected source and adapting it to the design. While biomorphology was utilized in the shaping phase of the design, it was decided to use the biomimetic method in the qualities attributed to the design and the variety of functions and hygienic possibilities that the design brings to the user.

The authors' expectation from the design process was to create a road map of the stages of the transformation of the idea into design while designing a new furniture inspired by nature, and to create a process diagram that can serve as a guide for designers who will start the process with similar goals in future experiences.

A FURNITURE DESIGN PROCESS WITH BIOMIMETIC DESIGN APPROACH

Biomimetic Design

The word biomimetic is a combination of the Greek words βίος (bios) meaning life and μίμησις (mīmēsis) meaning imitation.[26] There are various sources that the words biomimetic, bionic, biomimicry are synonymous.[27] The word biomimetic was coined by polymath Otto Schmitt in 1957, who, in his doctoral research, developed a physical device that mimicked the electrical action of a nerve.[28] The word made its first public appearance in Webster's Dictionary in 1974, accompanied by the following definition: The study of the formation, structure, or function of biologically produced substances and materials (as enzymes or silk) and biological mechanisms and processes (as protein synthesis or photosynthesis) especially for the purpose of synthesizing

similar products by artificial mechanisms which mimic natural ones.[29] Professor of Biomimetics Julian Vincent defines biomimetic as the abstraction of good design from nature.[30]

The goal of this scientific field is to identify the desirable qualities and attributes in the biological systems and apply them to the design of new products, to solve problems in engineering, materials science, medicine, and to expand its application to other areas of practical human use.[31] A biomimetic approach to design, while emulating natural systems, derives its solutions through the utilization of a design process that seeks to satisfy the core requisites of a design in a holistic manner.[32]

Live beings have produced different solutions to the challenging situations they have encountered in various stages of evolution over millions of years. The abilities of these creatures such as running, flying, swimming, digging, climbing, attacking, hiding, etc. are features that are inherent in their creation and have developed as solutions to survival problems. Similarly, the defense systems that develop in plants against threats from the environment are remarkable. These problem-solving methods have inspired the emergence of many design ideas.[33] Structures, robotic arms, air conditioning solutions, aerodynamic vehicles and similar subjects are just a few of the hundreds of design examples that have been shaped with a biomimetic approach that learns from living things, and their behaviors.

	PROCESS	ACTIVITY		
1	SCOPING	DEFINE *(CONTEXT)*	IDENTIFY *(FUNCTION)*	INTEGRATE *(LIFE'S PRINCIPLES)*
2	DISCOVERING	DISCOVER *(NATURAL MODELS)*	ABSTRACT *(BIOLOGICAL STRATEGIES)*	
3	CREATING	BRAINSTORM *(BIOINSPIRED IDEAS)*	EMULATE *(DESIGN PRINCIPLES)*	
4	EVALUATING	MEASURE *(USING LIFE'S PRINCIPLES)*		

Table 1. Biomimetic Thinking Systematics (Adapted from the graphic prepared by Benyus, Baumester and their team on web site of their Biomimicry Design Lens, 2005).[34]

The field of biomimetic is highly inter-disciplinary. It involves the understanding of biological functions, structures and principles of various objects found in nature by biologists, physicists, chemists and material scientists, and the design and fabrication of various materials and devices of commercial interest by engineers, material scientists, chemists and others.[35] The biomimetic design approach can be interpreted as a process of intense

interdisciplinary interaction. From this perspective, it can be concluded that different methods and processes can be used in different design disciplines. However, when the biomimetic thinking and design process is considered in terms of its basic principles, it can be encountered similarly in almost all design disciplines. Benyus and Baumester (2005), in their website on biomimicry, state that the systematic of biomimetic thinking takes place in four steps. According to them, the biomimetic design process starts with the scoping and continues with the discovering, creating and evaluating stages.[36] These stages in Table 1 represent the systematics of biomimetic thinking.

STEP	PROCESS
1	DISCOVER *(NATURAL MODELS)*
2	ABSTRACT *(BIOLOGICAL STRATEGIES)*
3	IDENTIFY *(FUNCTION)*
4	DEFINE *(CONTEXT)*
5	BRAINSTORM *(BIOINSPIRED IDEAS)*
6	INTEGRATE *(LIFE'S PRINCIPLES)*
7	EMULATE *(DESIGN PRINCIPLES)*
8	MEASURE *(USING LIFE'S PRINCIPLES)*

Table 2. Biomimetic Design Process Steps (Adapted from the graphic prepared by Benyus, Baumester and their team on web site of their Biomimicry Design Lens, 2005).[37]

Table 2 shows the steps of the biomimetic design process based on biomimetic thinking. It starts with the discovering phase and refers to the steps that progress towards the design outcome. These steps may differ according to the characteristics of the discipline in which the design is realized. The process has a structure that develops according to the information learned. For this reason, different steps can be added to the process, or the order of steps can be changed.

The biomimetic thinking system, created by Benyus and Baumester, and the design steps that emerge depending on this system generally define the outlines of the biomimetic design approach. Two methods are followed in design studies in which principles from nature will be transferred within this system.[38] The first method, called "from biology to design" (Fig. 1), is realized by evaluating the potential of examples that exist in nature or whose useful properties have been discovered to be transformed into design.

The biology to design technique refers to the stages of transforming the data obtained by examining living beings and ecosystems in nature into an idea or design that can be used. In the discover step, the principles found in nature are evaluated. In the abstract step, simplifications are made to turn the principles into useful designs. In the next step, information-ideas are exchanged with experts and designers about the principles taken from nature. With the data obtained, the level and scope of imitation is determined. The resulting idea is evaluated, and design work is continued on the relevant

subject, and then the design work is finalized by re-evaluating it. This method can be described as useful in terms of approaching the problem. Nature has developed proven strategies for everything from energy efficiency to material durability. The "biology to design" technique allows these strategies to be abstracted and simplified and adapted to man-made systems. One of the biggest advantages of this way of approaching problems is that it helps overcome the limitations of man-made designs. Solutions that are difficult or inefficient to achieve through traditional methods can become more innovative and sustainable when inspired by nature.

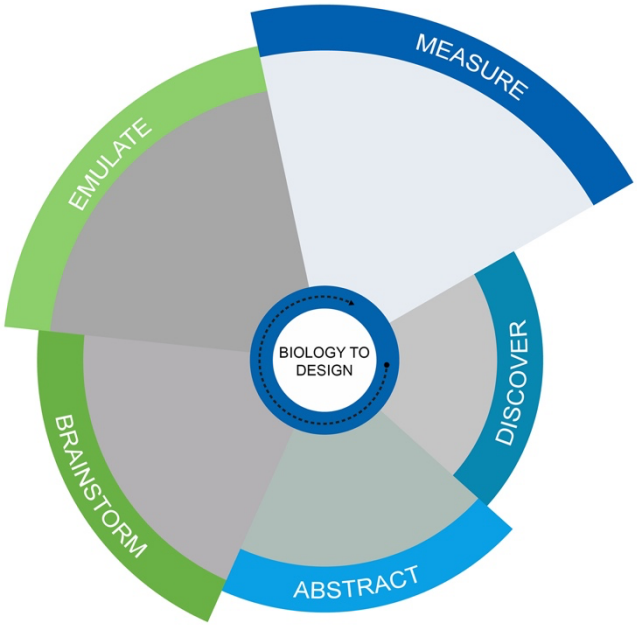

Fig. 1. Biology to Design Method Diagram (Adapted from the principles by Benyus, Baumester and their team on web site of their Biomimicry Design Lens, 2005).[39]

The second technique used in biomimetic design is called "asking biology" (Fig. 2). This technique refers to the process of systematically adapting solutions to the relevant problem from examples in nature to the design. It can be said that the designer has more say in this method in which studies are carried out in line with the solution of the problem posed.

As proposed by Benyus and Baumeister, the method of asking biology starts with the step called identify, where the problem and possible solutions are identified. In this section, the question of how the design will solve the problem is asked and possible answers are found in line with this question. In this way, the outline of the function that will emerge as a result of the design is determined. After determining the function, the definition is started where the working skeleton will be determined. In the definition step, issues such as sustainability, efficiency and innovation are added to the main framework of the design. In the step of relating with biology, how the principles that will be imitated and used in the design are realized in nature is examined. This is the stage where research and examination is carried out on how the situations that occur spontaneously in nature will be transferred to the design. After examining the relationship of the design with biology and

coming up with a useful idea, the next step is the discover stage. In this step, help is sought from biology-related sources and experts in the field. For the solution that the design will bring, how the entities identified in nature perform the functions sought is examined comprehensively. Information is transferred to the next stage by conducting comparative research from databases that constitute resources related to biology. In the abstract step, the features found in the identified natural entity or entities are simplified to be adapted to the relevant design. Unnecessary details are not included in the design. The examples used in the abstract stage go beyond the subject of biology and turn into design elements. The emulate and measure stages are the same as the biology-to-design method. The process is completed with the evaluation of the design. The processes and techniques related to biomimetic design may differ according to the disciplines and scopes of the designs.[40] The relevant steps and techniques are important as a general guide, but these steps can be developed according to the scope of the studies. Design studies based on these processes and methods are considered at three main levels (Fig. 3). These three main levels are name as "organism, behavior and ecosystem".[41] These levels are the organism level where the simple characteristics of the creature to be transferred from nature, such as its physical appearance, are investigated and imitated, the behavior level where the behaviors and unique qualities of the creature to be transferred are determined and imitated, and the ecosystem level where the living community is considered as a whole, such as the location of the creature in its natural habitat, its interaction and relationships with other beings. In the organism, behavior and ecosystem levels proposed by Benyus, there are five different sub-levels where nature can be imitated. These levels are listed as form, material, structure, process and function.[42]

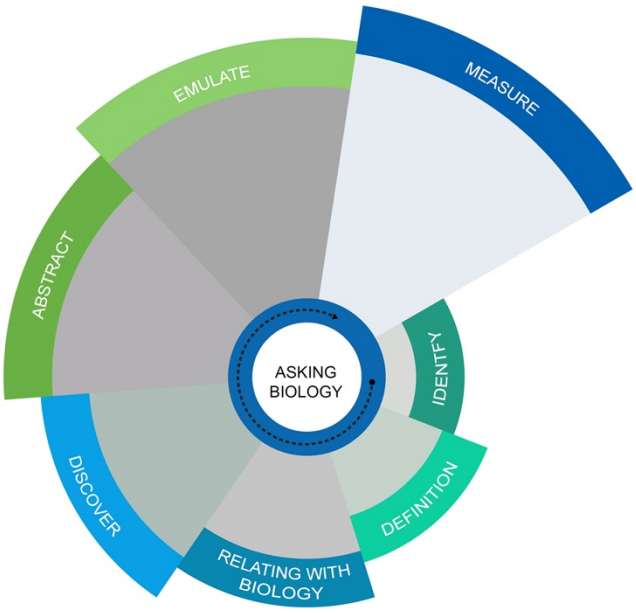

Fig. 2. Asking Biology Method Diagram (Adapted from the principles prepared by Benyus, Baumester and their team on web site of their Biomimicry Design Lens, 2005).[43]

Benyus' organism, behavior and ecosystem levels, have turned into a method where questions are asked of what the relevant design will look like, what it will be made of, how it will be made, how it will work and what it will do.

Similar to the concept of biomimetic, there are different design approaches based on the phenomenon of imitating nature according to the areas where it is used. Morphology, which is a branch of science that examines the structures, shapes, sizes, properties and their formation of living organisms in biology, appears as a technique used in the process of producing form in the field of design.

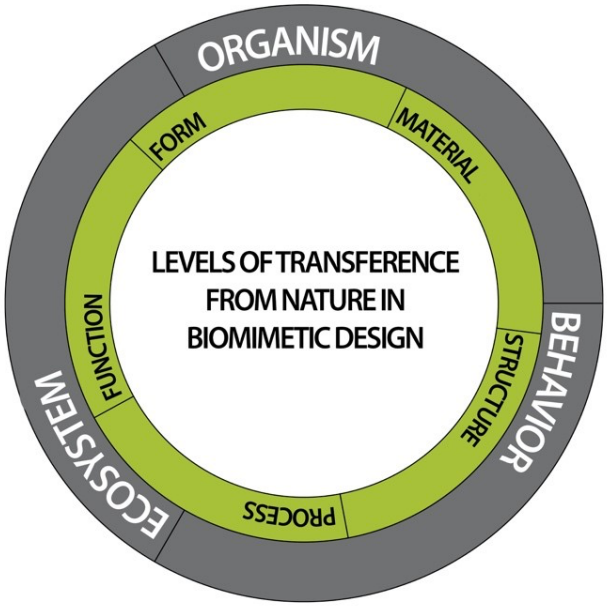

Fig. 3. Biomimetic Design Levels Adapted from the principles prepared by Benyus, Baumester and their team on web site of their Biomimicry Design Lens, 2005.[44]

Furniture Design Process with Biomimetic Approach

Within the scope of the study, the authors experienced the process of designing a furniture with a biomimetic approach. The design named LOT-US, which is the subject of the study, meets the levels of biomimetic levels of imitation of form at the organism level and imitation of form, function and material behavior at the behavior level.

First of all, nature-based resources to be used in order to design a multifunctional piece of furniture that is suitable for health hygienic were researched and the lotus flower was decided upon in terms of its various qualities. While the morphological characteristics of the lotus flower inspired the multifunctionality of the furniture, its self-cleaning ability, hydrophobic properties and ability to survive even in harsh conditions inspired the idea of creating a product that is beneficial to human. The process diagram

summarizing the experience of designing furniture with a biomimetic approach is presented in Figure 4.

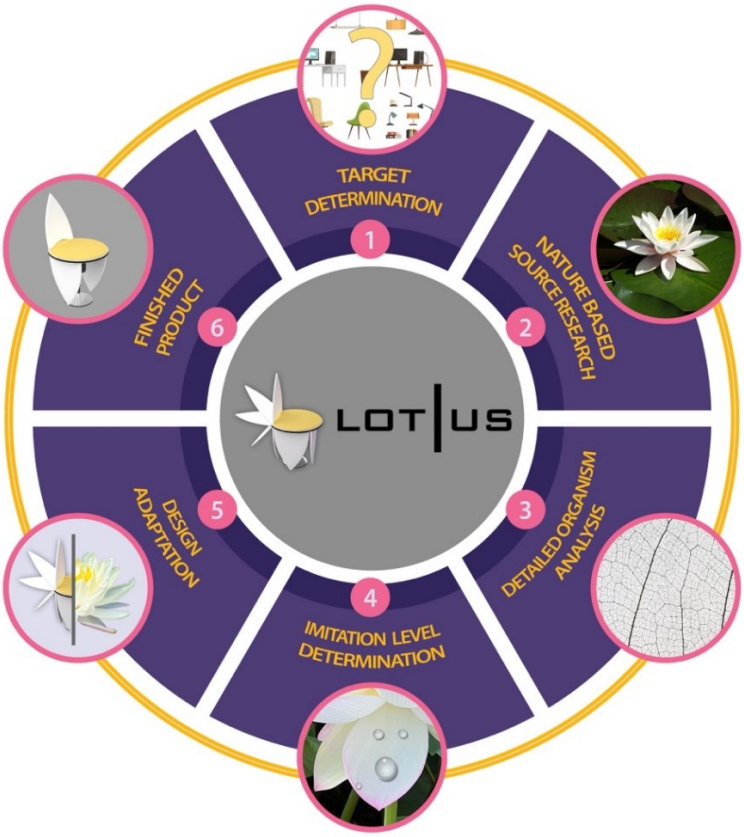

Fig. 4. LOT-US design process (Authors).

The starting point of the LOT-US design is the lotus flower from which it takes its name. The lotus flower (Nelumbo nucifera) is known as a symbol of cleanliness in many Asian countries due to its ability to clean its leaves by itself.[45] Lotus plant pushes the dust particles towards certain points on the leaves by moving its leaves, also, it can remove the dust from itself by flowing the raindrops on it.[46] This feature is called lotus effect,[47] and it has led to the design of a piece of furniture that imitates the lotus flower, whose parts can move. The first sketches made by the authors for the design utilized the formal language of lotus petals. The idea diagrams in Figure 5 include sketches of usage alternatives and material-detail decisions for the furniture.

LOT-US is a multifunctional piece of furniture offering alternatives to the user in design (Fig. 6). The furniture, depending on the user's preference, has a variety of flexible uses within the space such as a desk, desk chair, coffee table, stool and also as a lighting element.

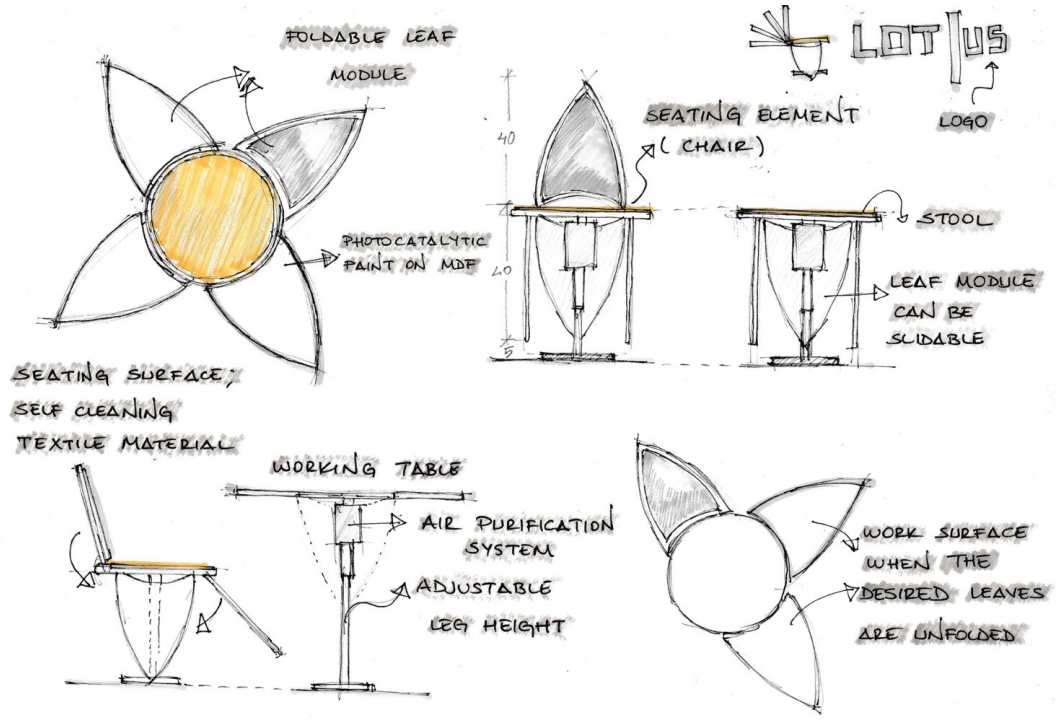

Fig. 5. First sketches of the design (Authors).

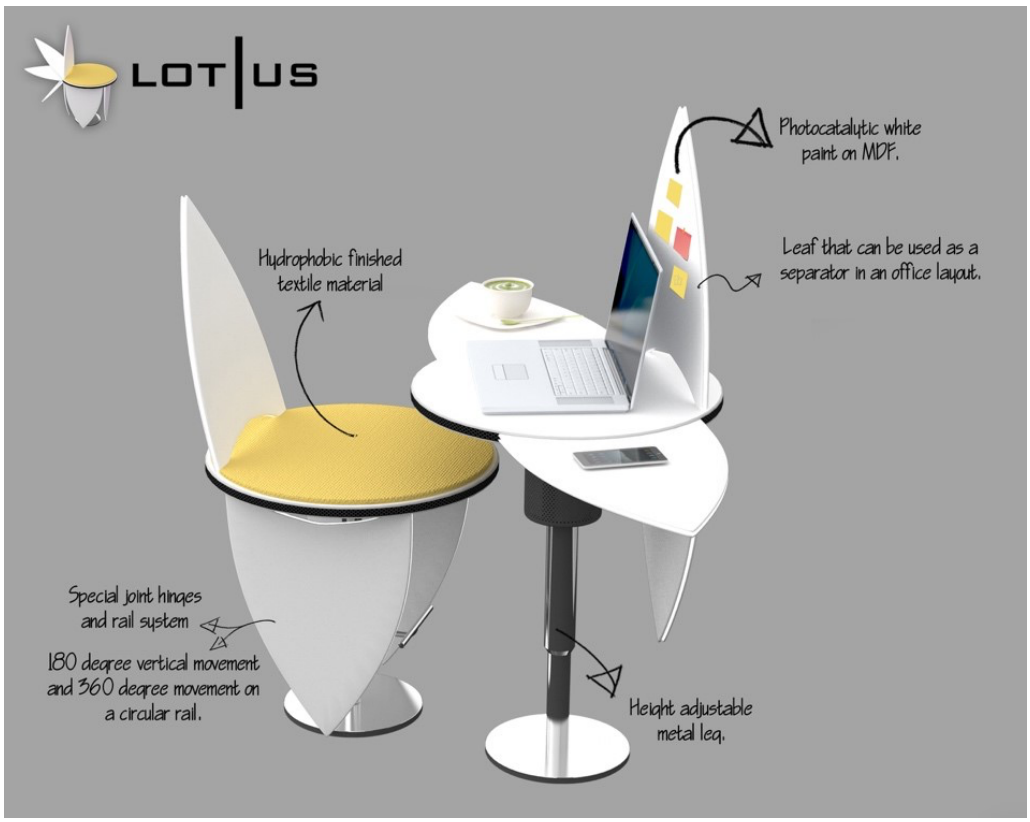

Fig. 6. Diagram expressing LOT-US features (Authors).

How to Use the Design

The upper area of the furniture consists of four leaves surrounding a circular seating surface. In the lower area, there is a height-adjustable metal leg and an air purifier system. The fact that each leaf can be opened and closed in different directions and at different levels and that, the height of the foot can be adjusted offers different ways of use (Fig. 7).

When the leaves are closed, the contours of the furniture are completed, while when opened, new work surfaces can be created. By adjusting the leg height and opening the leaf as much as the required space, it can either be a coffee table or a desk. In crowded working environments such as offices, a more private and isolated workspace can be created by lifting and fixing some of the leaves in an upward direction, which also serves as a divider for the user.

In cases where it is to be used as a seating element in work areas, a leaf can be fixed at the desired inclination and a backrest can be formed by opening it, thus functioning as an ergonomic chair. In addition, by opening the closed leaf in the opposite direction at a certain inclination, a surface where the foot can be extended is created and meets the need for rest.

Fig. 7. LOT-US usage alternatives.

In order to provide user comfort, a cushion covered with a hydrophobic finished textile material is used on the circular seating surface. In the hydrophobic finish, the fibers in the textile texture are coated with a water-repellent chemical, providing resistance to wetting and allowing water vapor to escape.[48] Cushions with antiperspirant properties allow the furniture to be used for a long time. In order to prevent slipping on the smooth surface during sitting, there is a non-slip coating on the bottom layer of the cushion. Thus, the cushion adheres to the surface underneath and remains stable despite user mobility.

LOT-US, which can function as a coffee table by lifting a stool or cushion when all the leaves are closed, can be included in the space design as

an aesthetic lighting element even when it is not used as furniture with the hidden LED strips on the edges of the leaves (Fig. 8).

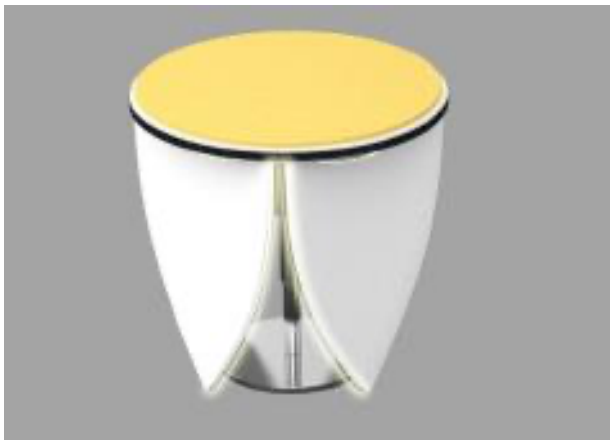

Fig. 8. LOT-US used as lighting element.

Air Purification System

Another important feature of the furniture design is that it has an air purification system. With the system integrated into the design, it is aimed to contribute to the construction of healthier spaces with LOT-US in the conditions of the pandemic and its aftermath, where hygiene is very important.

Fig. 9. Exploded perspective showing the components of the air purification system.

A cylindrical body is located at the point where the metal leg meets the circular top surface and houses the air cleaning system. The system consists of air filter, suction motor, hepa filter and perforated coating layers (Fig. 9). The energy requirement of the system is provided by connecting the roller plug device in the foot to any electrical outlet in the space. The working principle of the system is to clean the polluted air in the environment by drawing it into the cylindrical body and to return the cleaned air to the environment through the channels on the sides of the circular upper surface.

It is also envisaged that the manually operated system can be controlled remotely if a mobile application is developed by providing appropriate software support, and it can also help access data such as instant pollution rate and ambient air quality through the application.

On the other hand, photocatalytic white paint was applied to the MDF, the main material for the seating surface and the leaves. The photocatalytic quality, together with the Lotus effect, refers to another self-cleaning property.[49] In order to fulfill the cleaning function, UV rays in daylight are sufficient for the photocatalysis reaction to occur. With the help of the catalyst in the coating, organic dirt on the surface is dissolved. In this way, it is aimed to create a more hygienic environment by keeping the dirt away from the surface, especially in cases where multiple users will use the furniture.

Transportation

LOT-US can be disassembled and placed in a 40x50x60 cm box dimension (Fig. 10). The box includes 4 MDF sheets, seating surface and cushion, circular metal rail, height adjustable metal stand, air purifier system and filters, led transformer and Wi-Fi module. It can be securely packaged with Styrofoam foam support parts and slots suitable for the relevant component. Packages can be stored in accordance with international transportation standards and at least 8 pieces can be placed on a Euro pallet of 80x120. It has a high export potential, as it is suitable for transportation with many transportation vehicles.

Fig. 10. Visuals of box contents and palletized version.

Conclusion

The infinite qualities of nature have always been and continue to be a source of inspiration in the field of design. The colors, patterns, shapes and movements of nature are used in many fields from architecture to fashion design, graphic design to industrial design. Biomimetic design, an approach that places nature at the center of design, is an important method of using these resources effectively.

The biomimetic design approach helps people to use nature in a more sustainable way, while at the same time offering a number of rational solutions in terms of functionality and aesthetics. These solutions can be considered as important decisions guiding the design of furniture in terms of sustainability, aesthetics, functionality, durability, innovation and human health. Although LOT-US is an experimental and exploratory furniture that has not yet been produced, it claims to be a sustainable furniture that contributes to the protection of the environment with its function, material decisions and biomimetic approach.

While starting the design, firstly the process steps in the tables and graphs mentioned in the study of Benyus and her teammates were taken as reference. As a result of the design decisions and steps taken during the process, the main headings needed were determined and a process diagram containing a more simplified road map was presented (Fig. 11). This diagram can be adapted for any type of product to be designed with this approach.

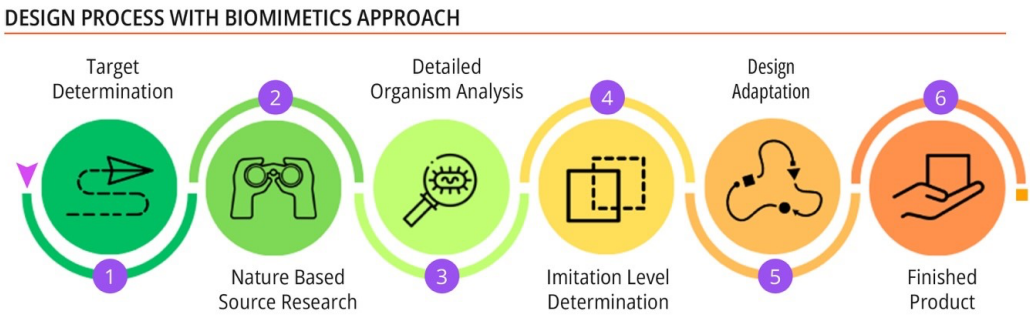

Fig. 11. Design process diagram with biomimetic approach.

According to the process in the diagram; when designing a product with a biomimetic approach, the goal of the product to be designed must first be determined. In the decision process, it is also important to determine the function and need of the product to be designed. Then, the living creature or organism to be imitated must be analyzed in detail. After examining all the physical and functional features of the creature, it should be decided which features will be used in the design. After determining the level of imitation, the design idea is concretized, and the final product is put forward. Considering that nature will be one of the most important sources of inspiration in future designs and will be a guide in creating aesthetic and functional products, it is possible to say that biomimetic discipline will continue to be an important approach in the design process.

In this study, the possibilities of the biomimetic design approach were referred to in order to underline that nature constitutes one of the most important sources of inspiration in the field of design and to experience that original designs can be created by correctly constructing many qualities that can be transferred from nature to design. At the end of the design process, it is hoped that the outputs of the experience and the diagram created will be a guide for similar designs to be made in the future.

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