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IMPLEMENTATION OF NOPAL FIBER FOR THE DESIGN OF LUMINAIRES

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ABSTRACT

This project shows the process of conceptualization and construction of luminaires with environmentally friendly materials reducing their time of degradation. This was developing with a polymer-based composite material reinforced with vegetable fibers such as "nopal" fibers, so commonly called. The plant of scientific name "Opuntia spp", inside the botany, belongs to the cacti family, having as main characteristic the storage of water, with which they survive to periods of intense heat. New ways of developing objects that cover the diverse needs of users, that have the use of materials that are friendly to the environment and that are degradable in a shorter time, have arisen today. Thus, results obtained from luminaires for interior spaces are shown.

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INTRODUCTION

Since illumination became a necessity for man, infinite objects have been made to project light from the most simple and well-known torches to the most sophisticated luminaries that can be found in hundreds of markets. The population grows day by day and with the damage that occurs in the environment also increases rapidly by being part of the consumption of products with materials that harm the natural environment. Due to that, in the last years have been developed objects with characteristics of industrialization friendly with the environment. The first environmental expectations surrounding the industrial design were centered on the concept of green design (also known as design for the environment) along with the emergence of green products, which suggested that these objects were surrounded by a set of indications that the new technologies had to be observed from the process to the end of the product, extending to the design activities at each stage of the product life cycle and that would later open the way to what is now known as eco-design.

MATERIALS AND METHODS

At present, the use of biocomposites or natural materials is an alternative and a good proposal was found in the use of nopal fiber, which can be found in different parts of Mexico, in States such as San Luis Potosí, Zacatecas, Oaxaca , Jalisco, Puebla, Michoacán, Hidalgo, Aguascalientes, Mexico City, among others. There is a great variety of this type of plants so this research focused on the species Opuntia Spp, (Figure 1), for the development of luminaires, which required a series of steps for its construction, where it was carrie out conceptual

design, using as primordial material the vegetal fiber of nopal. The history of illumination goes back to prehistory where the discovery of fire and the need of man to illuminate the spaces where he lived, looking for forms or objects for that illumination to persist. The way of life of man changed, and the way of obtaining enlightenment did, leaving behind the use of torches, candlesticks, candlesticks, and etcetera. The use and implementation of the materials changed, and in the middle of the XX century was when they began to use diverse materials, like: woods, metals, ceramics, plastics and combinations of these. Being in our days still highly consumable materials, in addition that the technology makes that it is possible to be consumed a smaller amount of energy, offering an excellent quality of illumination.

Figure 1. Scientific name, 'Opuntia spp.' Common name, 'Nopal' By: Authors

"In the 1950, new materials such as plastic became popular and since then the use of low voltage technology has allowed greater flexibility ..." (Gil 2009, 4). However, the use of polymers was so incredible, that today we are inundated with plastic waste that affects diverse ecosystems worldwide. In current research, it is found in state-of-the-art lumber articles that are also focused on building models with green materials, so this research focused, directly on creating a composite material, where the vegetable matter was obtained in a state Inert, so that the life cycle of the plant was not altered. Composite materials and biocomposite materials appear to be the answer or solution to the problem of polymer materials today. (Besednjak 2005, 15). "A composite material has been defined as; the whole material was combined from a (non-chemical) two-component bond rather than the specific characteristic properties."

Where the composite materials can be classified into three different groups:

- Metal matrix composites
- Ceramic matrix composites
- Polymer matrix composites

The properties of the composites may also vary depending on the load of fibers with which they are joined, as well as the position in which longitudinal, short, transverse and random loads are placed longitudinally. "If we analyze a test constituted by unidirectional reinforcements and subjected to traction, we can observe that the resistance of the matrix acquires higher values in the composite than in isolation" (Besednjak 2005, 13). The reinforcement of polymers with vegetable fibers is undergoing significant advances in both their properties and processing as well as their acceptance by the consumer. If we join the effort to use recycled plastics we achieve a greater capacity for recycling and exploitation, even at the cost of losing some of its mechanical properties, as mentioned in the article entitled "Use of natural fiber waste as reinforcing elements of polymeric materials "(Amigó and Sahuquillo 2007, 10). As for the second component of the composite material developed, a thermosetting polymer was used, which is intended to cover the vegetable reinforcements, in order to be able to modify its mechanical properties of said material. According to Besednjak, (2005, 16), it establishes that the polymers are classified in: thermosetting and thermoplastics. Being the thermosetting that can't flow by effect of the temperature to be molded. They tend to be very stiff resins. Resins since its discovery in 1936 have been gaining ground until today it is 75% of the total resins used in the market for thermosetting matrix composites.

There are established parameters that are necessary to take into account, regardless of the shape of the luminaire, such as temperature ranges, parts that make up a lamp or ergonomic factors, which are considered to be recognized as a luminaire. The different insulation used in luminaires are distinguished by the degree to which they are exposed to heat. The temperature ranges are lower than 275 ° C and depend on the type of lamp power contained in the luminaire, as well as the properties to trigger heat, (Colombo 2010, 18). According to the standard UNE-EN 60598-1 defines luminaire to the lighting apparatus that distributes, filters or transforms the light emitted by one or more lamps and that includes all the necessary devices for the support, the fixation, and the protection of The lamps and, if necessary, the auxiliary circuits in combination with the means for connecting to the mains.

In contrast to Luminotecnia (2002, 69), defines the luminaire as an object formed by a set of elements intended to provide adequate light radiation of electrical origin. This research according to Hernández 'et al' (2006, 151) is experimental, since it takes into account informative data containing characteristics of the materials used, as well as numerical data of the necessary quantities required in the production of the object, pointing out the practical condition towards the construction of the object of study with the selected materials.

As a support system for the development of this project, the methodology of British engineer Bruce Archer, who proposes an orderly procedure for designers, is based on a selection of materials to shape and thus satisfy both the functional needs and the needs. Aesthetic within its methodology, there are three main phases, being these Analytical, Creative and Executive. The first stage or analytical, we worked on the analysis and the search of the state of knowledge, to define the problem and to establish concrete solutions, about the materials that are intended to use, the costs, the mode of production, and so on. With the compilation and analysis, we had a broad overview of the problem and its solutions. The second stage or creative marked the scope to which it was intend to arrive, carrying out a formulation of ideas and possible solutions to our problem, conceptualizing the idea through a process of sketching. The third stage or executive, is the final part where the materialization of the idea is realized, carrying out the construction of the prototype experimenting with the chosen materials, obtaining the final prototype (Figure 2).

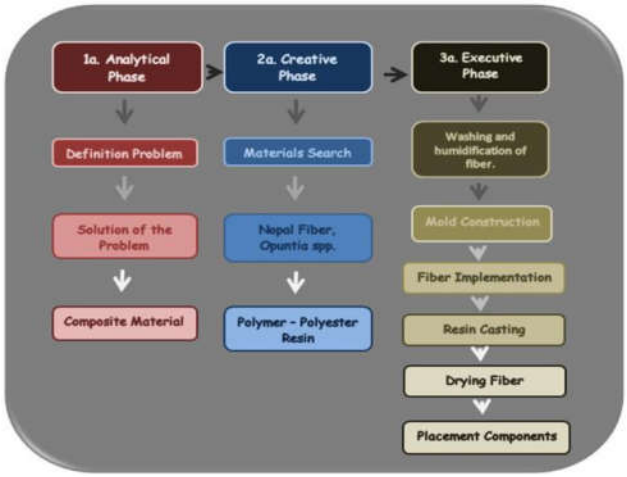

Figure 2. Methodological process of luminaire construction By: Authors

Phase1

Reading, observation, about what is lived in daily life, information about the new materials that are intended and being used in the industry, allowed to visualize this project, which focuses on the raw material of compounds applied to a product and the luminaire for interior spaces. In the search for composite materials, we chose the use of vegetable fibers. The raw material used in this project is the succulent plant Opuntia spp. This species is an abundant plant that can be used after its active life, because when it ends its life cycle tends to dry, reducing in large quantities the water contained in its body, leaving only the main structure of the nopal. Being the stem of the plant dried, together with a polymer as it was used for the conceptual design of luminaires, forming the composite. The dry structure of Opuntia spp. (Figure 3.), is similar to a mesh, taking advantage of this for luminaire design. The component part for the vegetable fiber was the polymeric material, called matrix, which consists of a polyester resin, which was responsible for encapsulating the nopal fiber giving the result of the luminaire.

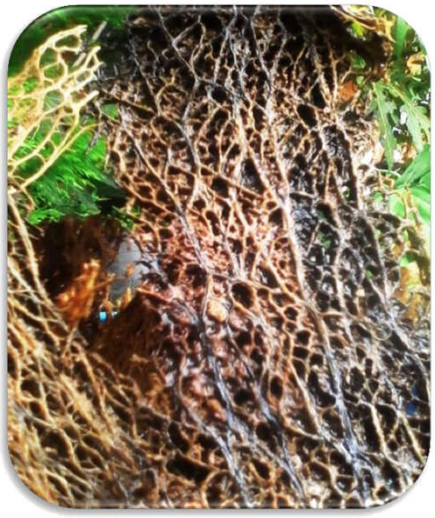

Figure 3. Nopal dry structure By: Authors

Phase 2

The variants were analyzed in the design part, by means of graphical representations of the possible models to be constructed by means of the fiber and the resin. Dimensioning the measures of the object, and determining its height, width, mode of use.

Also the search for the nopal fiber was carried out, obtaining it from the cactaceous that were found in inert state, generally is totally dry, however, there is matter that despite being inactive, contains great amount of moisture, for which in the executive phase or third phase were made more processes to be able to make use of it. Having several proposals of the model, it was made that was considered in form, with more dynamism, in, to denote light lines, and smooth.

Phase 3

In this third phase, concentrated in the experimentation and construction of the luminaire, it denotes in the previous phase the obtaining of the two main components of the object, being the nopal fiber and the polymeric resin, as well as the components that conform it, , Internal structure for the focus, wiring, eraser). In order to work with the fiber, it underwent different processes as follows:

Washing: Fiber obtained directly from the natural environment may contain sludge, so it is necessary to wash it to fully discover its mesh structure (Figure 4). Because the fiber is completely dehydrated, its malleability becomes difficult, and there is a risk that it will fracture its structure by following curves or closed angles that the shape requires. The fiber can achieve greater flexibility through a wetting process, by means of water raised in its temperature to approximately 30 ° C - 40 ° C, thus blurring the structure of the fiber and facilitating its operation.

Figure 4. Fiber washes By: Authors

Depending on the shape of the luminaire, it is possible to use preforms of another material for the use of molds, (Figure 5), where the fiber was couple by resin casting. The product of the resin was carrying through a catalyst, resulting translucent to allow the natural colors of the vegetable fiber to be observed. The drying of the already composed material is solved in two ways, naturally by means of the ambient temperature or by subjecting it to a heat-providing chamber which allows the material to dry rapidly. Subsequently, a sanding process was carried out to remove impurities or leftovers from the resin. Finally, obtained the material composed of resin and nopal fiber, proceed to place the components of the luminaire, such as upper wiring internal base, focus and support of the focus.

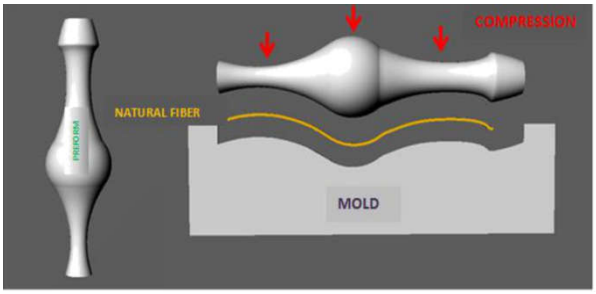

Figure 5. Preform, molds, and process By: Authors

RESULTS AND DISCUSSION

The nature of the design is established through a network of models that are the result of the different interactions that are formulated from the ideas, the forms, the trends, the colors, the resources, which suggests the information Of nature, is relative to the themes of function, form and material that are basic terms in the design scheme aimed at improving and and solving the technical and constructive problems that are part of the design seen from its very nature.

Figure 6. Luminaires on. Lobby By: Authors

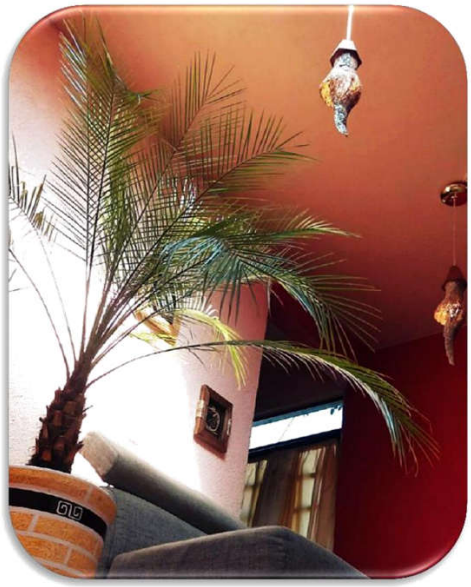

Figure 7. Lobby perspective with luminaries By: Authors

In this sense, the results of the construction of the luminaire, (Figure 6), based on the Opuntia spp plant fibers, fused with polymer resin, form a composite material innovating in direct forms and materials, retaking concepts of natural life, Meeting the objectives in a circumstantial way and for the environment, as well as the environment and the design when they congregate, reveal how important it is to know the mixture between both concepts, on the one hand it implies to recognize the society in harmony with the environment, and for the Another shape from the design of the light object, a relationship between the design object and the user. The importance of the design concept of the luminaire corresponds to a product of low environmental impact from its process, therefore does not interfere, in the life cycle of the plant species of the cactus.

A compound with biodegradable characteristics, also achieves this especially by the constitution of the vegetable fiber that accelerates its decomposition time, even in the mixture of the synthetic materials that make up the biocomposite. The literature indicates from Riascos (2014, 3) that natural fibers have not reached the level of mechanical performance of synthetic fibers, however, the fact that it is an environmentally sustainable material at a low cost, makes it attractive for the context of production, is that nature is seen as a rich source in giving solution to design projects that the same user requests to give a touch in the scenarios where it unfolds. While designing is a complex activity that involves not only observation, but also identifying habits, customs, tastes and propose the appropriate elements for the spaces where it is required to give life and light. Making decisions in the search for natural and synthetic materials, assumes the responsibility of the designer from the operational logic of care of the environment, so design is a synthesis activity and if eloquence incapacitates us to use the senses, it is certainly reflected in a make and propose concepts that are not very fruitful or innovative. It is then, in order to support this project based on the significance of luminaries, suggesting the use of vegetable fibers of succulent plants, such as cactus fiber, studies are considered such as Rossi (2009) in his article on biomimesis, which rescue the use of this type of vegetable after the active life of the plant to be brought to the plane of architecture and design in general.

From the sustainable approach, it can be emphasized that the use of natural fibers is environmentally friendly and has been used since ancient times, and that today is something that is present in both consumers and producers to be profitable goods within the market and the society. The world is focused on sustainability as a consequence of a substantial reduction in resources, energy challenges and stricter environmental restrictions. This has made synthetic materials as it says (Riascos 2014, 5) are beginning to be reconsidered by manufacturers and developers. That is why it was believed in the importance of using natural fibers (Figure 7), emphasizing that their use is done without damaging the environment, providing production advantages because its processing focuses on a low cost, in addition to the user is encouraged to enter Markets of low impact sustainable types. Thus, (Amigó 2007, 10) states that: "We are working intensely in the manufacture of polymeric compounds reinforced with natural fibers, which have a low cost and a low density which gives them a high specific resistance are biodegradable and no abrasive effects.. "

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