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Journal of Architecture and Design

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The works must be unpublished and refer to issues of international architecture, technological innovation in architecture, industrial design, business design techniques, multimedia design, advertising design, web system design, residential architecture and other topics related to Engineering Sciences and Technology.

Presentation of the Content

In Issue 12, is presented an article *Vernacular architecture as heritage, by* VÁZQUEZ-TORRES, María del Rayo, CASTILLO-REYES, Alberto Rosendo, MORALES-ORTEGA, José Alejandro and MONTERO-URRUSQUIETA, Rubén Ángel, with adscription at Benemérita Universidad Autónoma de Puebla, in the next article *Efficient use of electric energy in homes through multi-agent systems, case study Monterrey N.L., Mexico*, by RAMOS-NOLAZCO, Jesús Alejandro, SILVA-AVILA, Alicia Elena, CASTORENA-PEÑA, Jesús Abraham and BRENA-PINERO, Ramón Felipe, with adscription at Universidad Autónoma de Coahuila and Tecnológico de Monterrey, in the next section *Conceptual development for the design proposal of the botanical garden of the academic unit of agrohydraulic in San Juan Acateno, municipality of Teziutlán, Puebla*, by NAVARRETE-GARCÍA, Mónica, VÁZQUEZ-TORRES, María de Rayo, CASTILLO-REYES, Alberto Rosendo and NAVARRETE-GARCÍA, Martín, in the next section *Architectural design with bioclimatic elements for thermal comfort in homes in Hidalgo*, by TORRES-AGUILAR, Carlos, SERRANO-ARELLANO, Juan, MACIAS-MELO, Edgar and AGUILAR-CASTRO, Karla, with adscription at Universidad Juárez Autónoma de Tabasco and Instituto Tecnológico Superior de Huichapan.

Content

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Vernacular architecture as heritage

La arquitectura vernácula como patrimonio

VÁZQUEZ-TORRES, María del Rayo, CASTILLO-REYES, Alberto Rosendo, MORALES-ORTEGA, José Alejandro and MONTERO-URRUSQUIETA, Rubén Ángel

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Abstract

The objective of this research is to recognize vernacular architecture as heritage architecture, a product of the community. The method applied to this research is qualitative in nature, the objective of which is the description of the characteristics of the object of study covering a part of the reality. Qualitative research is inductive, the study is on a small scale and through proximity to empirical reality. The research shows examples that were made through interaction with the inhabitants and as a result of direct observation. The stages of the research were: fieldwork linking access to the site with productive data collection; data analysis in a continuous review that consisted of reducing information, disposition, transformation and obtaining results and verifying them to reach conclusions. The preparation of the report generated a number of approaches, and one of them produced the subject of this work. The contribution of this work is that it aims to place a community rooted in its customs as Is Tochimilco, with an architectural richness that is transformed and even disappearing, because vernacular architecture is considered to be a worthless architecture.

Background, Concept, Focus

Resumen

El objetivo de esta investigación es reconocer a la arquitectura vernácula como arquitectura patrimonial, producto de la comunidad. El método aplicado a esta investigación es de carácter cualitativo, cuyo objetivo es la descripción de las características del objeto de estudio que cubra una parte de la realidad. La investigación cualitativa es inductiva, el estudio es en pequeña escala y a través de la proximidad a la realidad empírica. La investigación expone ejemplos que se hicieron a través de la interacción con los habitantes y como resultado de la observación directa. Las etapas de la investigación fueron: el trabajo de campo relacionando el acceso al lugar con la recolección productiva de datos; el análisis de datos en una continua revisión que consistió en reducir la información, disposición, transformación y la obtención de resultados y verificación de estos para llegar a conclusiones. La elaboración del informe generó diversos enfoques, y uno de ellos produjo el tema de este trabajo. La contribución de este trabajo es que pretende colocar a una comunidad arraigada a sus costumbres como es Tochimilco, con una riqueza arquitectónica que se va transformando y hasta desapareciendo, porque se considera a la arquitectura vernácula como una arquitectura sin valor.

Antecedentes, El concepto, Enfoque

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Introduction

The current interest in vernacular architecture begins in the sixties of the 20th century and the concepts of natural heritage and cultural heritage are incorporated with an ethnographic approach that favors the recognition of vernacular architecture as heritage. As for the name of vernacular architecture, it is due to Amos Rapoport, who studied vernacular architecture from the point of view of environmental design and gave it a cultural-environmental approach or what is called ethnographic. Amos Rapoport published in 1969 his book "House, Form and Culture" that provoked a renewed interest in this type of architecture and that in Mexico would provoke the interest of architects to recognize this type of architecture as part of the identity of Mexican architecture.

This architecture has been given different names such as autochthonous, popular or architecture without architects. However, this last name is the one that has generated conflicts to analyze it from the point of view of cultured architecture, since vernacular architecture in many cases lacks a documented temporal identification and a specific author, but in this case the author is the same inhabitant of the house, but his personality was lost in time.

The sections included in this work are: the concepts that intervene in the composition and definition of the term heritage and how vernacular architecture is included as heritage. The work is divided into three subtopics which are: background, concept and approach.

The background section shows the conditions that led to the conservation of objects considered heritage; In the concept subtopic it is shown how the current concept of heritage has been formed and in the focus on vernacular architecture subtopic.

Background

One of the most important moments in history is the Industrial Revolution, which can be defined as a process that began in the second half of the 18th century, which consisted of economic, social and technological transformation.

With the development of the industry, spaces were required for the industry and to distribute the goods that allowed the emergence of modern architecture ... "In that process the qualities of the new architecture were raised and traditional architecture was devalued, denying them any value functional, social and even aesthetic, radically putting “the new” before “the old” (Rehabimed, 2007, p. 11).

Consequently, vernacular housing is relegated, as it develops outside of European trends; opposed to universality, the dominant classical values and the concept of modernity; this situation prevails in current societies where this architecture is despised.

The most important work in defense of the traditional architecture of the seventeenth century belongs to William Gilpin, English empiricist, who published in 1748, anonymously "A Dialogue on Gardens." From the work of William Gilpin comes the definition of picturesque architecture or vernacular architecture since it was not aligned within the classical or continental historicisms, highlighting characteristics such as the contrast of irregular shapes, textures of the materials of the region that allow integration into the landscape (Maderuelo, 2012).

At the same time, the concept of heritage emerged in the 18th century, when a new philosophy of history was developed, produced by the conflicts between empiricist philosophers and Cartesian conceptions. The Enlightenment favored the renewal of historical science, with contempt for sometimes considered dark and a uniform conception of human nature. The concept of heritage is the product of the appearance of History as an autonomous discipline in the first half of the 19th century. (Hernando, 1995).

Vernacular architecture has been defined as architecture transmitted from one generation to another and is part of the tradition of the communities. This architecture identifies four criteria to characterize it, which are: cultural or socioeconomic, geographical, morphological and architectural or constructive, but its heritage value is discarded. The subject of vernacular architecture does not exist in current architecture teaching, but tourism can lead to its maintenance and even its recovery. (Paz, 2012).

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Vernacular architecture has been called the architecture of the earth; For Estéves and Cuitiño (2020), the earth is an easily accessible material because it is found on the earth's surface and its characteristics are determined by the mineralogical composition of each region, for which there are different procedures to produce products with variable characteristics. It is common that the term “mud” is used to name the clay soil whose components are clay, gravel, sand and silt.

The concept

Human beings as a product of socialization generated strong emotional ties with the region they inhabit, strengthening their social relationships where each individual needs others to survive. Vara, A. S. (2020), defines this process as the need to care and be cared for, that is, the concept of caring must be understood as the need to protect each other to exist and survive. It is an interdependence that leads to showing affection by safeguarding what is important; care is understood as the set of different activities that contribute to preserving the well-being of people and societies.

The term patrimony comes from a word of Latin origin linked to the idea of property, whose origin is the word "From the Latin patrimonium, property that a person has inherited from his ancestors" or as: "own property acquired by any title".

“For its part, the current vernacular would refer to those assets that are manifested as living heritage, where the vernacular anthropological values of a community that builds, maintains or uses the former are verified. They are works that continue to develop their function –primary or adapted– and that are elaborated, designed or maintained according to the pre-industrial construction tradition or its contemporary evolution” (Pérez Gil, 2018, 5).

Currently, cultural heritage is a collective property of society and for UNESCO, cultural heritage is a social construction of a people and includes the works of its artists, architects, musicians, writers and scholars, they also include anonymous creations, arising from the community that express their creativity that contemplate values that give meaning to their life. Currently, heritage is defined as goods and customs that are transmitted because a value is recognized and they are a collective property. In other words, the concept of heritage as collective inheritance has evolved according to the new conditions of society, recognizing certain (García, 2011).

UNESCO (United Nations Educational, Scientific and Cultural Organization) is an organization created by the World Heritage Committee, which analyzes and evaluates the nominations that countries consider as cultural assets and that they request to be considered as heritage. of humanity; where the representatives of international intergovernmental or non-governmental institutions with recognition in the subject participate… ”The Architectural Heritage is part of the Immovable Material Heritage and is made up of both monumental and unique buildings, as well as those modest and simple that characterize, give identity to the neighborhoods and to the city ”(Peñaranda, 2011, p. 15).

In an attempt to unify the criteria for recognizing vernacular architecture, an attempt was made to define it in the Charter of Built Vernacular Heritage (Carta, 2002). In this document the definition of vernacular architecture is expressed in the general considerations to the construction that arises from the community itself; a recognizable local or regional character linked to the territory; consistency of style, shape and appearance. All of this is the product of traditional knowledge that is transmitted informally; product of a need for protection that requires a solution to functional, social and environmental requirements (UCR, 2016).

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The constructed Vernacular Heritage is the product of the relationship between the way of life and tradition; that is, it is the result of the ways in which communities have produced their own habitat. This has occurred within a continuous process, which includes necessary changes and continuous adaptation in response to social and environmental requirements. However, this natural process or this gradual hybridization is threatened throughout the world by the forces of cultural and architectural homogenization. These forces can be controlled and it is the fundamental problem that must be solved by the different communities, as well as by governments, planners and by multidisciplinary groups of specialists. (ICOMOS, 1999).

In recent decades, vernacular architecture has a vulnerable position due to the homogenization of culture and socio-economic globalization, as they face serious problems of obsolescence, internal balance and integration, for which ICOMOS in 1999 created the general considerations to recognize it and its conservation principles. The general considerations include the following:

Vernacular constructions can be recognized by the way of building by the community; its local or regional character linked to the territory; consistency of style, shape and appearance; Traditional wisdom in direct response to functional, social and environmental requirements. Result of the application of traditional construction systems, trades and techniques that allow the community to appreciate and protect the vernacular heritage, the continuity of use and its maintenance.

Governments and authorities must recognize the right of all communities to maintain and protect their traditional way of life. All this through the conservation of the Vernacular Heritage by multidisciplinary groups of experts, recognizing the established cultural identity of a community; as well as cultural values and their traditional character. The built Vernacular Heritage is an integral part of the cultural landscape and must be considered in conservation and development programs. (ICOMOS, 1999).

However, there are currently conflicts between what is mixed heritage or biocultural heritage and the link between cultural heritage and natural heritage. Both heritages are currently facing a conflict with the declarations of protection, since the actions of each are divergent. This occurs because there is no awareness of a clear link between the use of natural resources for the expression of cultural heritage, especially in areas declared as natural reserves and that close to these are spaces or communities that for centuries have been dedicated to the extraction of the raw material required for vernacular architecture, criminalizing the traditional practice and causing the loss of knowledge and knowledge of the use and appropriation of the natural environment. (UCR, 2016).

Vernacular architecture within the economic and progress spheres is not considered heritage since it is considered synonymous with poverty, therefore its protection is not of interest; a situation that has favored their disappearance… ”Its habitability has not been enough to express the importance of the Mayan house, which is considered by public policies as a synonym of poverty, an undervaluation that has affected its inhabitants, who in its new generations express: “I live here because I am poor, if I had money I would not live here” (UCR, 2016, p. 114).

It is often thought that vernacular houses are buildings whose materials are unsafe, unhealthy and that are also synonymous with poverty, but the values that these structures possess as a cultural heritage and as a logical response to specific needs are ignored (Peñaranda Orías, 2011).

There is another vision about vernacular architecture that starts from the ICOMOS report, where it was proposed that the heritage declarations be broad to include “monuments” as well as their natural and cultural environment. It was recognized that within countries and communities awareness campaigns should be promoted so that the same communities that generated this heritage, value their construction tradition.

ISSN 2531-2162

Supporting this idea, the International Seminar for the Conservation and Restoration of Earth Architecture (SICRAT) was generated, which for more than ten years has carried out case analyzes and workshops with community participation in various traditional towns in northern Mexico and southern states. United (Guerrero B., 2002).

SICRAT is a binational organization whose objective is to make contemporary builders aware of the irreparable damage that rigid and waterproof materials such as cement, steel and plastic substances cause to mud constructions and present alternatives for their intervention. estate. In addition, they promote the recovery of traditional knowledge, the use of traditional construction materials and systems, and teach the inhabitants of the communities to rescue their constructive culture. This causes the users of vernacular dwellings to value and be promoters of their preservation (Guerrero Baca, 2008).

Currently, the preservation tendencies of vernacular architecture do not try to conserve "representative samples" or choreographies that represent the conditions of the past. This is due to the fact that vernacular housing must have a different treatment from that of a historical monument; since housing is a "living" place where spaces are used and adapted to new living conditions. The current idea is to apply methods that make it possible to recover the relationship between architecture and its environment, in order to adapt it to the needs of the users and the specific conditions of each site. But this search is not entirely new. Despite the historical disconnection between what is considered "cultured architecture" and vernacular, at different times in the past architects have recognized a series of qualities in traditional works that served as a source of learning. (Martín Galindo, 2006, p. 104).

An important part of the built heritage is being lost, as well as the wisdom that sustains it; the properties that replace these traditional works affect the quality of life and comfort of its inhabitants, as well as the balance between architecture and its location (Peñaranda, 2011).

For LLull Peñalba (2005), cultural heritage is that manifestation that arises in a society that has been received as a historical heritage and is part of its identity as a people; where objects become testimonies of the progress of civilization and have the function of modeling its society. The value of the object considers its age and aesthetics as cultural assets with a historical and artistic character, but they coexist with the creations and contributions of the present moment and the so-called intangible legacy. However, the concept of Cultural Heritage is influenced by the perception of the historical destiny of each community, determined by its feelings of national identity, its development potential, the meaning of its social relations, and the way it relates to the environment.

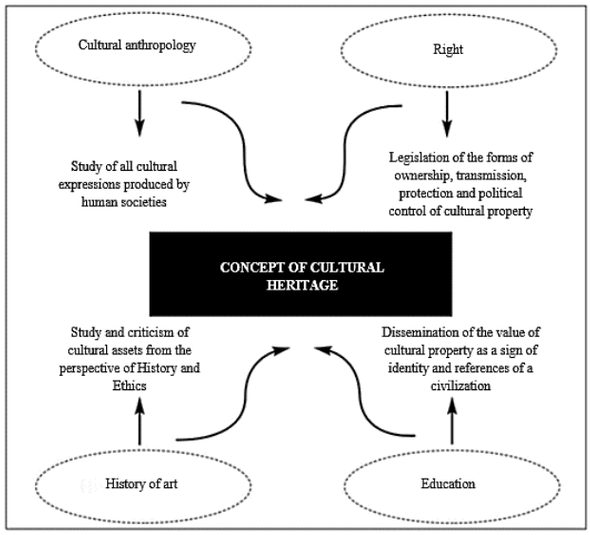

Figure 1 The concept of Cultural Heritage analyzed from an interdisciplinary perspective
Source: Llull Peñalba, (2005, 181)

Approach

The vernacular house of central Mexico, preservation of its pre-Hispanic heritage, organization around a patio, in which all activities are carried out abroad. The architectural spatial configuration has a different character depending on the climate and the characteristics of the communities that gives them identity through their colors, materials and architectural elements. In the case of materials, when the raw material emerges from the place, they produce homogeneous sets with minimal variations.

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The character is determined by the physical conditions of the environment such as rain, temperature, humidity, among other aspects. On the other hand, vernacular dwellings are related to local traditions, religious celebrations, food, dances, legends according to international guidelines, they confer heritage value. It is an empirical architecture since its execution is in accordance with its adaptability to the physical environment (Ávila, s.f.).

According to Martín Galindo (2008), it can be seen that tradition allows common cultural manifestations, different values, and allows different expressions to coincide; however, these traditions are imposed by the dominant groups and the dependent groups produce peculiar adaptations called popular. Vernacular architecture keeps its pre-Hispanic characteristics as a result of tradition but has had moments of hybridization where it is transformed or adapted to current needs. That is why the popular term has been put aside to refer to it as "traditional architecture" or "vernacular" ... "the way in which materials, generally extracted from the natural environment, and construction techniques, acquired either by endogenous evolutionary processes or by loans cultural, have served to respond to the physical and social needs of a group, generating architectural models (constructive techniques, spatial designs, and aesthetic results), with original achievements due to the historical-cultural experience and ecological adaptations of each territory "(Martín Galindo, 2006, p. 23).

Vernacular architecture can be understood as a product of tradition, where not only the object or physical part is important; but also the emotional and symbolic part that allows a configuration and distribution in a room. It is common for most of the activities to be done outdoors, in the patio or in the garden as places of conviviality. In groups of houses, the services are common and everyone shares the responsibility for their maintenance. Inside, the furniture is distributed around the room, the kitchen is usually located outside or in a room close to the house, although in rainy seasons it is common to place a bracero near the door for ventilation. The altar and the photographs of the relatives is very important and is placed near the door or in the place that the family considers important.

A population with vernacular architecture is Tochimilco, a town located east of the city of Atlixco, in the state of Puebla, Mexico. It is a population in a risk zone because it is located on the slopes of the active volcano Popocatepetl. The Tochimilco population is that it has the Temple and ex-Franciscan convent of the Assumption of Our Lady of 1560, it was founded by Fray Diego de Olarte and it is considered a cultural heritage of humanity since 1994. Tochimilco is mestizo and Nahuatl.

Figure 2 The atrium of the Church of the Assumption of Our Lady is surrounded by a wall finished in battlements or fortress
Source: Vázquez, 2017

The church of the Asunción de Nuestra Señora has a stone cross in the center and its facade is sober and has an open chapel, tower and belfry or wall structure that extends vertically, standing out from the rest of the building, and usually ends in a pinnacle.

Figure 3 The front of the church of the Assumption of Our Lord
Source: Vázquez, 2017

ISSN 2531-2162

The temple of the Church of the Assumption of Our Lady is of a nave with a flat head and Gothic rib vaults.

Figure 4 Inside the church where you can see the ribs of the ceiling where the choir is located
Source: Vázquez, 2017

The cloister of the Assumption of Our Lady has columns and lowered arches, a central fountain and remains of wall decorations in red.

After the earthquake of 2017 the church and the former convent of the Assumption of Our Lady.

Figure 5 The courtyard of the convent has columns and lowered arches on the ground floor and upper floor. The arches of the upper floor were damaged during the 2017 earthquake and the shoring of the arches is shown in the image
Source: Vázquez, 2017

The open chapel of the Church of the Assumption of Our Lady is above the gate, it has a single arch and there is a pulpit at the base of the tower.

Figure 6 The cover of the church of the Assumption of Our Lady; to the right and next to the tower you can see the open chapel
Source: Vázquez, 2017

Unfortunately, in 1994, Tochimilco was not seen as a heritage complex and vernacular housing was not considered, a situation that caused vernacular architecture to not be protected.

In Tochimilco it is common to see properties where there are several houses belonging to the same family, as is the case in Froylán street, very close to the zócalo.

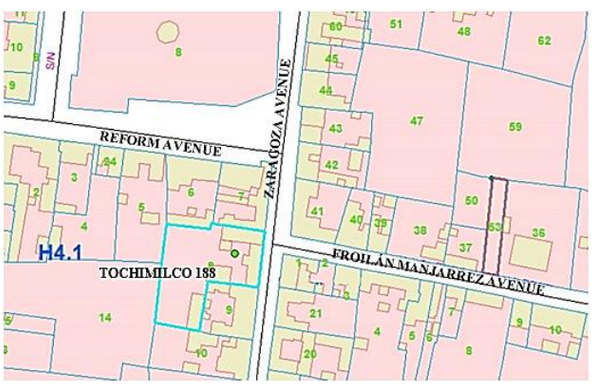

Figure 7 Location of the house on Froylán street
Source: Vázquez, 2017

It is the access to the children's homes, with thick adobe walls from the main house.

ISSN 2531-2162

Figure 8 Access to the property, where the roof of beams and brick is observed
Source: Vázquez, 2017

The houses like this that belong to the 18th century have adobe walls covered with wooden beams and red brick, they are constructions that have remained despite the lack of maintenance. However, it is common to see the kitchen or community sanitary services attached to the house.

Figure 9 This image shows the adobe construction, divided into parts and each section is inhabited by a family and a room that is used for the toilet is attached to it
Source: Vázquez, 2017

This house was built with blocks, a reinforced concrete structure, and a sheet roof. It is a 2-level construction without interior walls, except for the bathroom. You can see the custom of leaving the pots hanging on the wall of the main entrance; custom that was seen in several houses in the town.

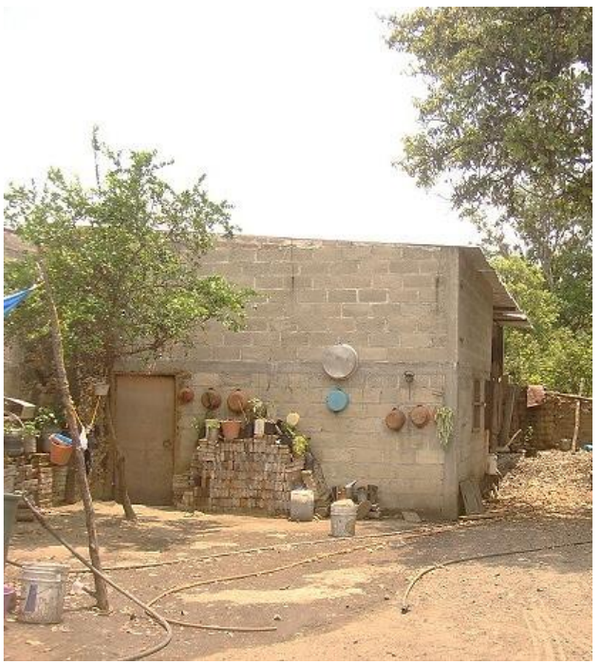

Figure 10 Construction made with a block and two levels and a mezzanine of reinforced concrete slab and a sheet roof
Source: Vázquez, 2017

Within the same land there is a two-level adobe construction; where each level is a house and a "new" construction of block, brick, reinforced concrete and covered with sheet; which is used as a warehouse.

Figure 11 The back construction is of two levels made with adobe and in front is a new house that preserves the traditional characteristics of the vernacular house that they are. Rectangular shape and sloping roof
Source: Vázquez, 2017

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As can be seen in the images, the former convent and the church of the Assumption of Our Lady is perfectly cataloged by the INHA (National Institute of Anthropology and History) and by UNESCO (United Nations Educational, Scientific and Scientific Organization). culture). However, vernacular architecture was not protected and much of that wealth has disappeared because it has not been explained or awareness plans have been established for the community to value their buildings.

Coinciding with Pérez Gil (2018), vernacular architecture has been analyzed from the description and classification of types and construction techniques that are directed towards the modes of pure sciences. However, the analysis must also be directed towards humanism and culture as material goods impregnated with cultural values that allow us to know their presence such as constructive, material, technical, type and aesthetic knowledge that allows to base their conservation. Although, vernacular architecture presents difficulties in its study from a historical perspective, because documentary testimony may not exist because it is decontextualized or in the absence of specific constructors of the building without the human factor, it is not possible to speak of culture.

Vernacular architecture in Mexico from its institutions is the most unprotected architecture, although it is recognized as heritage. Therefore, it is necessary to observe vernacular architecture as a cultural asset; that is, as an expression of a certain human community, which is objectified and conserves the essence of the community comprised in its history, customs and traditions. Although its spatial configuration, its forms and its history are important, these elements are criteria of the so-called cultured architecture, both opposite. The values of vernacular architecture lie in its authenticity and it is provided by the same society that produces it. Vernacular architecture is not understood because it is considered emblematic of poverty for using traditional materials or configuring its space in a rudimentary but functional way.

Conclusions

Consequently, the disappearance and rejection of vernacular housing had their origin in the industrial revolution and its industrialization processes, but this process worsened in the early twentieth century with the modern movement as the hegemonic current. The modern movement provoked the search for new models of living that surpassed the traditional models of making the city.

However, the term heritage also had to evolve in clear opposition to the modern movement and the ethnographic recognition of vernacular architecture that for a long time could not be analyzed. This situation arose from the point of view from the cultured architecture or the architects and not from the anonymous builders.

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Efficient use of electric energy in homes through multi-agent systems, case study Monterrey N.L., Mexico

Uso eficiente de la energía eléctrica en los hogares mediante sistemas multi-agente, caso de estudio Monterrey N.L., México

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Abstract

This article presents an experimental research whose objective is to verify through experimentation if the systems for air conditioning and lighting homes based on the use of Multi-Agent Systems (MAS) are more efficient than traditional systems in terms of perceived environmental comfort. by people and the electricity cost generated. The proposed methodology involved the development of a housing simulator, the definition of the "environmental comfort" variable, the description of the evaluated lighting and air conditioning systems, and the definition of the proposed experiments based on independent variables that could impact on the performance of the aforementioned systems. Based on the data obtained when conducting the experiments and taking the homes in the Monterrey Metropolitan Area as a case study, it could be observed that the use of MAS is a very good alternative to reduce the consumption of electrical energy in homes taking care of not sacrificing people's comfort, thus helping to reduce the ecological impact generated by electricity generation.

Domestic electricity consumption, Multi-Agent System (MAS), Contract Network Protocol, Efficiency, Social Welfare, Simulation

Resumen

El presente artículo presenta una investigación de tipo experimental cuyo objetivo es comprobar mediante la experimentación si los sistemas para climatizar e iluminar las viviendas basados en el uso de Sistemas Multi-Agente (MAS) son más eficientes que los sistemas tradicionales en términos del confort ambiental percibido por las personas y el gasto eléctrico generado. La metodología propuesta implicó el desarrollo de un simulador de viviendas, la definición de la variable de "confort ambiental", la descripción de los sistemas de iluminación y climatización evaluados, y la definición de los experimentos propuestos con base en variables independientes que puedan impactar en el desempeño de los sistemas mencionados. Con base en los datos obtenidos al realizar los experimentos y tomando como caso de estudio las viviendas en la Zona Metropolitana de Monterrey, se pudo observar que el uso de MAS es una muy buena alternativa para reducir el consumo de energía eléctrica en los hogares cuidando de no sacrificar el confort de las personas, contribuyendo así a reducir el impacto ecológico generado por la generación de electricidad.

Consumo eléctrico doméstico, Sistema Multi-Agente (MAS), Protocolo de Red de Contratos, Eficiencia, Bienestar Social, Simulación

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Introduction

The last official annual report with data from 2017, placed the domestic sector as the second with the highest consumption in the country with 27.4% of the 200,114 Gwh generated, only below the medium-sized company (Ministerio de Energía, Mexico, 2010). Despite the slight drop that the domestic sector could present in 2033, its consumption would continue to represent 23%, almost on a par with large industry with 25.5% (Centro Nacional de Control de Energía, 2019).

According to Morales, Luyando and Flores (2012), the higher the economic income of the people, the greater the electricity consumption, which exposes a difficulty for people to regulate their consumption in a rational way.

Demand-side management (DSM) in smart grids allows grid customers to autonomously make reasoned decisions about their energy consumption (Fioretto, 2017). To implement demand management at the housing level, various authors such as Brena (2015), Wang (2019) and Denysiuk (2020) agree that the use of Multi-Agent Systems (MAS) is an efficient solution to improve consumption of electrical energy in homes.

In the research carried out by Suástegui (2014), the importance of people being able to constantly monitor the electricity consumption in their homes with the help of technology is pointed out, which helps to reduce unnecessary expenses, making people more aware from the point of view of economic view, even when it seems that this solution implies the sacrifice of comfort related specifically to the temperature of your houses. It is common that the inhabitants of a house do not always agree on the amount of comfort they are willing to sacrifice to reduce economic spending, as proof of this, the same research showed that 39% of the households analyzed had an oversizing in their equipment air conditioning.

Taking the work of the previous authors as a reference, the objective of this research is to check if a Multi-Agent System (MAS) is capable of controlling lighting and temperature in homes in a more efficient way than control methods traditional; understanding by efficiency, the relationship between economic comfort and environmental comfort perceived by the inhabitants of the house during a billing period of the electric service.

To verify the effectiveness of the proposed solution, the document presents an experimental methodology based on the simulation of a house with people who carry out activities in the different rooms and with objects that, when activated, cause the variation of the light and the temperature of the rooms such as: spotlights, fans, air conditioners, doors, windows and blinds. In each experiment, the characteristics of the groups of people living in the house (each with different preferences) and the control method of the objects in the house used will be modified, one of them being a Multi-Agent System. At the end of the experiments: the electricity consumption generated by the control method and the comfort achieved by the inhabitants will be compared based on the lighting and the temperature of the rooms in which they were.

The methods against which the MAS is compared will be named as "Manual" to that mechanism in which people have to operate the objects of the house themselves; while the “Automatic” mechanism will be one in which people use electrical appliances that turn on autonomously with basic reactive control such as air conditioners and spotlights activated by presence sensors. In the automatic control, the doors and windows remain closed with some variations, as normally happens in homes due to people's carelessness.

ISSN 2531-2162

After the present introduction, Section 2 of the article addresses the current panorama of the operation and characteristics of Multi-Agent Systems (MAS); Section 3 describes the methods and materials necessary to implement and analyze the operation of the MAS, as well as the comparison against traditional methods to adjust the light and temperature conditions of the home; Section 4 presents the results and analysis of the information obtained from the experiments; and finally, in Section 5 it will be determined if the MAS can be considered as a good option to make the expenditure of electricity in households more efficient.

State of the art

Multi-Agent Systems

The "agent" is called the computational entity (software program or robot) that according to Stuart Russell and Peter Norvig (2009) must function autonomously, perceive its environment, persist for a long period of time, adapt to changes, create and achieve goals. The agent is said to be rational when he acts in order to obtain the best result, or the best expected result in the event of uncertainty. Mas (2005) mentions that an agent is a system capable of acting independently in favor of a user or owner and at present they are used to represent real users in virtual environments.

In accordance with the above, it is established that a Multi-Agent System (MAS) is made up of 2 or more independent agents, each one performing a specific task and communicating to exchange information and / or build the final solution to a problem. In these systems, the behavior patterns of the agents can be based on cooperation or competition, for both cases, the agents have roles and require acting under interaction protocols that are patterns for the exchange of messages.

Coelho, Cohen, Guimaraes, Coelho & Liu (2017) argue that the MAS paradigm has been advocated as a useful and promising tool for a wide range of applications, for example: Wang et al developed a multi-agent system to collectively minimize the cost of electric power and the delay in the use of appliances. In such a system, agents collectively optimize their own interests; meanwhile, the overall optimal solution is achieved.

Among other uses are those that help control smart energy grids, for example: Celik (2017) uses an MAS to model entities (homes and aggregators of electricity demand) in the neighborhood as agents. The aggregator agent is the supervising agent who determines the aggregate profile and dynamic price by communicating with local agents. Household agents are selfish, independent decision-makers who only focus on maximizing their own well-being while achieving near-optimal performance in the Nash equilibrium of a formulated non-cooperative coordination game.

Decisions of Agents based on Profit

Wooldridge (2009) determines the utility as a numerical value that represents how good is the state in which an agent is, the higher the utility, the better the state. Optimality in rational agents consists in maximizing the expected utility by executing the appropriate actions.

In the case of agents that seek to maximize people's comfort, the utility of an agent would be greater if it manages to make a person have the desired lighting or temperature, and the utility will be less if the temperature or lighting values are far from the desired.

Pareto Efficiency and Optimality

In “Economic Development” (Todaro, 2014), the concept of “efficiency” (in terms of consumption) is defined as the allocation of expenses that maximize consumer satisfaction or utility. One economic system is said to be more efficient than another (in relative terms) if it provides more goods and services for society using the same economic resources.

In a distribution of resources within a competitive economy, Vilfredo Pareto establishes that an allocation of resources is efficient if:

- There is no other allocation of resources capable of increasing the production of one good without reducing the production of another.

- Total production cannot be reallocated to generate a higher level of welfare, without reducing the welfare of some agent.

ISSN 2531-2162

This condition is known as Pareto Optimality (Ayala, 2004). Transferring this condition to the study of the allocation of resources in homes, it can be said that in a room where there are two or more people, an efficient situation will be reached when none of the people can improve their situation without another person having to worsen yours.

Social welfare

Social Welfare is the sum of the payments or profits of all the agents in a given solution. Social welfare "measures" or "determines" the degree of global welfare of the agents. Welfare maximizing solutions are a subset of Pareto efficient solutions.

Abram Bergson introduced, in 1938, the social welfare function. What has been called a Bergson-Samuelson function is a function that takes the form W = W (U1, U2, ..., UH) such that the welfare of society denoted as W is simply a function of the profits of its constituent members.

One of the social welfare functions considered in economics especially in the classification of income distribution is known as "Bernoulli-Nash", its value increases when the differences between the profits of the agents or people decrease; its result is the product of each of the group members' profits (Nguyen et. al., 2013). As mentioned above, this requires that the plan being evaluated represents a Pareto Optimal point, that is, that there is no other plan that improves the utility of all interested agents. The benefit that this function represents over others is that it reaches a social optimum point.

Coordination of agents through the contract network protocol

In SMAs, the communication protocols represent the patterns that shape the possible communications of their agents. One of the protocols standardized by the Foundation for Intelligent Physical Agents (FIPA) for agent-based systems is the Contract Network Protocol or CNP for its acronym in English (Singh, 2010), which is a variation of the original pattern proposed by Smith (1980).

In this protocol, an agent assumes the role of administrator who wants a task to be executed by one or more agents, who in turn send proposals to the administrator to carry out the task. Both the administrator and the possible contractors establish conditions. The administrator makes the decision on which contractor or contractors will perform the task, seeking to optimize a function that characterizes the task based on cost, time, or other unit of measure. The administrator makes the decision about which contractors will carry out the task, seeking to optimize a function that characterizes the task based on cost, time or other unit of measure.

Methodology

As mentioned in the introduction, the objective of this research is to check if a Multi-Agent System is capable of autonomously and more efficiently controlling doors, windows, blinds and electrical appliances in a home to illuminate and air-condition houses, compared to traditional methods.

To achieve the objective, it is proposed to carry out an experimental investigation in which the behavior of the different control mechanisms can be observed, generating different levels of comfort in people based on the preferences of each one, as well as different amounts of consumption of electrical energy. The relationship between the comfort obtained and the economic expenditure generated will indicate whether the MAS as a proposed method is more efficient.

Due to the complexity required to carry out these experiments in real life, it was decided to carry out the experiments in a simulator that allows modeling the environment of different houses and that, in addition, allows modeling the behavior of different control methods to illuminate and air-condition them.

To limit the scope of the experiments, it has been decided to take the Monterrey Metropolitan Area as a case study, since this area is the one that generates the greatest demand in the Northeast region of Mexico, and that region is one of the three with higher annual electricity consumption (National Center for Energy Control, 2019).

ISSN 2531-2162

The details of the methodology are described below in the following sections:

Development and implementation of the housing simulator to have an appropriate environment that allows testing.

- Description of the variables of interest in this research.
- Definition of the methods to illuminate and control the dwellings to be compared.
- Description of the experiments to be carried out.
- Execution and collection of results.

Development and implementation of the housing simulator

A simulator implemented on NetLogo has been used, which is an integrated development environment for agent-based modeling. In this simulator, the researcher can configure any dwelling they want using agent blocks that can represent different objects in a dwelling. Table 1 shows the different types of agents that are part of the simulation.

Type	State	Actions	Consumption
Structural (Ceiling or Wall)	Does not change state	Transfer heat to the interior or exterior depending on their physical characteristics and the environment that surrounds them	Null
Door	Open	Transfer heat by conduction	Null
	Closed	Transfer heat by convection	Null
Window System - Blind. (Material combination, glass and PVC are assumed)	Closed window Shutter closed	Transfer heat by conduction	Null
	Closed window Open Shutter	Transfer heat by conduction	Null
	Open window Shutter closed	Transfer heat by conduction	Null
	Open window Open Shutter	Transfer heat by convection (through air)	Null
Fan	Switched on	Modify Wind Speed, Consume Current	0.1 kWh
	Off	None	Null
Air conditioner	Switched on	Remove Heat, Modify Wind Speed, Consume Current	1.8 kWh
	Resting	Modify Wind Speed, Consume Current	0.1 kWh
	Off	None	Null
Spotlight	Switched on	Bring Light, Bring Heat, Consume Power	0.1 kWh
	Off	None	Null

Table 1 Objects available in the simulator to configure the houses
Source: Own elaboration

The simulator also allows you to configure agents to represent the people of the house, on these agents and to simulate different scenarios, you can configure the properties that appear in Table 2.

Property	Description of your values
Desired temperature and light levels, expressed in degrees Celsius (° C)	- Minimum: Minimum amount of temperature that the person could tolerate. - Desired: Appropriate temperature with which the person would be totally satisfied. - Maximum: Minimum amount of temperature that the person could tolerate.
Desired light levels, expressed in lumens (lm)	- Minimum: Minimum amount of light required to carry out your activities. - Desired: Appropriate amount of light to carry out your activities. - Maximum: Maximum amount of light that the person can tolerate.
Desired spending	Equivalent to the budget you have for the payment of electricity service during a two-month period.
Roles	- Adult 1 (Over 30 years old with activities related to work outside the home) - Adult 2 (Over 30 years old with activities related to the home) - Student 1 (Between 4 to 12 years old with school activities and little activity outside the home). - Student 2 (Between 13 to 25 years old with school activities and with more activity outside the home)
Schedule	Distribution of activities according to the role chosen for the agent. According to the activity, the simulator places the agent in one of the rooms or outside the house.

Table 2 Configuration of properties of the agents that simulate people
Source: Own elaboration

ISSN 2531-2162

The simulator executes a cyclical process of calculating variables based on the states of the appliances and structural elements drawn in the program, as well as the state and location of the inhabitants of the home; each iteration of the process equals 1 minute in time. The process stops after 2 months (30 days), or 86,400 cycles.

The developed tool contains two main sections:

- First section, Observation of the environment (Figure 1): Shows the distribution of the rooms of the study case, of the electrical appliances, doors and windows that can be configurable to represent different scenarios. The section also shows the location and activities of the inhabitants of the home at a certain time of day, as well as the outdoor weather conditions of temperature, wind and amount of light.

- Second section, Graphical behavior of variables (Figure 2): This section is made up of 3 main graphs in which it is possible to visualize:

  - The behavior of the temperature during each minute of the experiment in each room of the house. It can be set to observe the amount of light.

  - The second graph shows in yellow the total kWh consumed at each moment, and in green the billing cost reached up to the same minute based on the Rate used in the simulation.

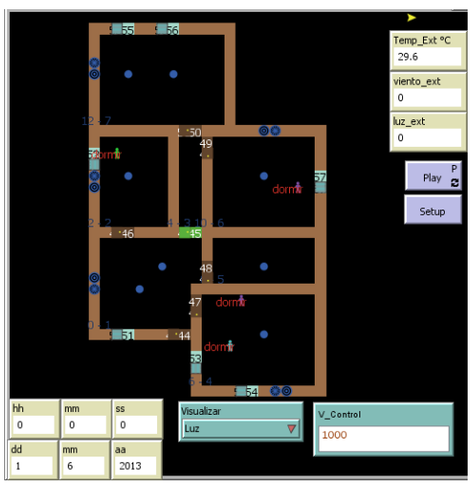

Figure 1 First section, observation of the environment
Source: Own elaboration

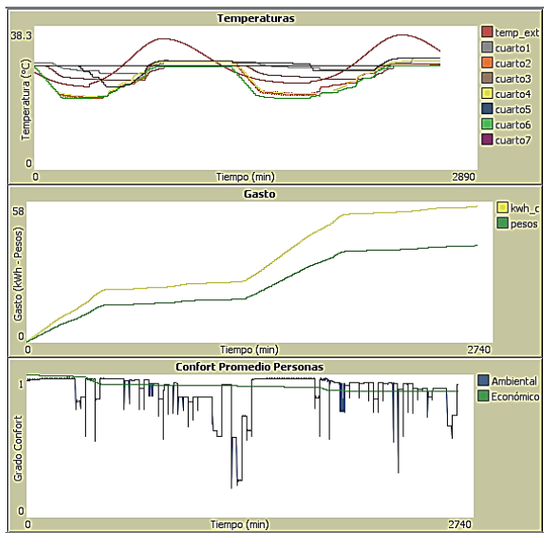

Figure 2 Graphical behavior of variables
Source: Own elaboration

To validate the calculations made by the simulator on the physical variables involved, measurements were made inside a house located in the City of Monterrey Nuevo León for a period of 48 hours. With all the structural objects intervening in the calculation, a maximum difference of 1.5 ° C and a mean deviation of 0.32 ° C are obtained, the latter less than that obtained by Gerlich and Zalesak (2010) in a similar simulator developed with MATLAB and COMSOL.

Description of the variables of interest in the comparison of the methods

Independent variables

The efficiency of both the proposed MAS and the other methods can be affected by different independent variables such as:

- The number of inhabitants in the home.

- The temperature levels desired by the different inhabitants of a home.

- The amount of money that the inhabitants would like to invest in electricity (Mexican pesos).

Therefore, these variables will be modified in the experiments to observe and compare the performance of the methods in the different situations proposed.

ISSN 2531-2162

Dependent variables

On the other hand, since the way to measure the efficiency of the methods is through the comfort achieved by the people and the expense that was required, it is necessary to define the way in which said environmental comfort will be measured.

We will base this term on some objective characteristics of a given space, parameters that can be analyzed independently of the user. The parameters of interest in this case are the temperature and the lighting (Table 3) perceived by the user in degrees Celsius (° C) and Lux (Lx) respectively. The formulas to calculate the environmental comfort are the following:

$$Confort_{iT} = \begin{cases} 0, \ Si \quad T_s \leq T_{min} \\ \frac{T_s - T_{min}}{T_d - T_{min}}, \ Si \quad T_{min} < T_s < T_d \\ \frac{T_{max} - T_s}{T_{max} - T_d}, \ Si \quad T_d \leq T_s < T_{max} \\ 0, \ Si \quad T_s \geq T_{max} \end{cases} \quad (1)$$

Where $Confort_{iT}$ refers to the level of comfort that person "i" feels with respect to the temperature of the room. Where T_s refers to the temperature perceived by the person "i", T_d is the temperature desired by the person and finally T_{min} and $T_{max}$are the minimum and maximum temperatures tolerated by the person.

$$Confort_{iL} = \begin{cases} 0, \ Si \quad L_s \leq L_{min} \\ \frac{L_s - L_{min}}{L_d - L_{min}}, \ Si \quad L_{min} < L_s < L_d \\ \frac{L_{max} - L_s}{L_{max} - L_d}, \ Si \quad L_d \leq L_s < L_{max} \\ 0, \ Si \quad L_s \geq L_{max} \end{cases} \quad (2)$$

As in the previous equation, $Confort_{iL}$ refers to the level of comfort that person "i" feels according to the lighting in the room. The variables L_s, L_d, L_{min} and L_{max} refer to the lighting levels: sense (perceived), desired, minimum and maximum.

We observe that as it is characteristic of the Membership functions, the value of $Confort_{iT}$ and $Confort_{iL}$ must be in a range of [0,1].

Finally, the level of Comfort due to Environmental conditions (C_{Ai}) reached by person "i" is defined in the following equation.

$$CA_i = (\alpha_i * Confort_{iT}) + (\beta_i * Confort_{iL}) \quad (3)$$

Where α_i and β_i are the coefficients that represent the level of preference of the person "i" towards the variables temperature and lighting respectively, both with range [0,1]. The sum of these two coefficients must be equal to 1. By assigning values higher than the temperature preference coefficient over the lighting one, it will be indicating that it is more important for a person to have a suitable temperature than an appropriate lighting level.

Definition of comparable methods for lighting and control of dwellings

Since the intention is to compare the MAS against other methods for the control of classic lighting and temperature of the houses, the most relevant characteristics about the operation of each method are described below. At this point, it is worth noting that the MAS described is a proposal made by the authors of this article, so that in the future, these experiments can be replicated with other SMAs.

Manual method

By means of this method, a scenario will be simulated in which the inhabitants of the house control the ignition of electrical appliances themselves.

Morales et. to the. (2012) and Suástegui (2014) conclude that the economic income of families is a determining factor for the consumption of electrical energy, in addition, Suástegui points out that air conditioning represents the highest cost of electricity in homes.

In order to verify the above, as well as to be able to represent the sector of the population that cannot afford high consumption due to a low economic income, it has been decided to characterize this method in such a way that a minimum electricity consumption is obtained through the following rules of action:

- People are limited to the use of fans, windows, blinds and spotlights to illuminate and air condition the rooms.

- The spotlights may be used when the amount of light required to carry out an activity cannot be obtained through the opening of the blinds.

ISSN 2531-2162

- Air conditioners may not be used at any time.

- The use of fans is allowed when the temperature level is higher than that supported by one of the inhabitants in a room and cannot be adjusted by opening windows.

- Strictly, the rules of action will not be modified regardless of the comfort that is observed in the people of the different groups, the electricity cost generated, or the cost of the service until the moment of observation.

In this method, despite being characterized to obtain a minimum expenditure, there will not be a credit limit to observe the expenditure of the different groups of inhabitants by following the rules mentioned above.

Automatic method

The particular objective of this method is to provide people with the highest level of comfort possible through the use of technology in light bulbs and air conditioning devices, to adapt the light and temperature conditions without human action.

The rules of action in this method are the following:

- People are limited to the use of air conditioners and spotlights to illuminate and air-condition rooms.

- The air conditioners will be on while someone is in the home.

- The spotlights will automatically turn on when the presence of a person in the room is detected and the amount of light is less than that required to carry out the activity of the person.
- Doors, windows, and shutters will be kept closed for most of the time of the experiment. Randomly, the status will be changed to "open" for short periods of time, in order to represent typical neglect situations in homes.

- Strictly, the rules of action will not be modified regardless of the comfort that is observed in the people of the different groups, the electricity cost generated, or the cost of the service until the moment of observation.

The previous rules of action will allow emulating the situations exposed by Morales et. to the. (2012) and Suástegui (2014) about the irrational use of electrical energy in homes, with an excessive use of air conditioners in homes, all with the aim of reaching the highest levels of comfort.

As in the Manual method, there will be no credit limit to be able to observe the expenditure of the different groups of inhabitants when following the rules of this method.

Systems Based Multi-Agent Method (MAS)

This method uses Artificial Intelligence mechanisms to make the use of electricity in homes more efficient, maximizing the comfort of all inhabitants and minimizing electricity consumption.

The proposed MAS is composed of agents that interact under the Contract Network Protocol assuming 3 different roles:

- Person. Represents the interest of one of the inhabitants.

- Service provider. Control one of the appliances or elements of the house (door, window or blind).

- Administrator. Take into account:

    - The needs of the people in each room.

    - The credit that people have to invest in services.

    - The costs of available services, to choose the work plan with the agents “Service Providers” that maximizes the social welfare of the inhabitants based on the utility that the agents “Person” who are in the room can achieve.

ISSN 2531-2162

Usefulness of the agents when using the objects of the house

To calculate the profit that an agent "Person" would obtain from the "Service Providers" work plan, the following function is proposed:

$$U_{i(CA_i,\ CE_i)} = \varepsilon_1 CA_i - \varepsilon_2 AE_i \quad (4)$$

We say that $U_{i(CA_i,\ CE_i)}$ It is the utility of one of the plans created by the Administrator for the ith Person given the Environmental Comfort CA and the Economic Impact AE that this plan provides according to the cost of this.

Since there are currently people who prefer comfort rather than looking after the economy or vice versa, the coefficients ε_1 and ε_2 with rank [0,1] represent the level of importance that the Person gives to each of the variables. In this case, the result of the sum of the coefficients ε_1 and ε_2 must be 1.

It should be noted that in this control method all simulated devices and elements in the home can be used. Although the MAS adapts by itself to the different conditions established by the independent variables of the experiment, there are two ways to influence the behavior of the MAS: the available credit of the inhabitants to spend on electrical energy and the way in which the that the MAS will be able to spend that resource by simulating the Economic Impact of humans.

Agents' feeling of economic affectation

To provide the MAS with a mechanism to make decisions about how much money the personal agents are willing to spend at each moment of the experiment, it is proposed to model the Sense of Economic Affection AE as the annoyance that a “Person” agent could feel when spending 1 unit of your credit due to the cost C_j of activating household items and the remaining credit D, which is determined by the following equation:

$$AE_i = \begin{cases} 100000 \cdot C_j, & if \quad D = 0 \\ \frac{C_j VT}{G_d^i - G_i}, & if \quad D > 0 \end{cases} \quad (5)$$

In this function if the available credit of a person $\left(G_d^i - G_i\right)$ is equal to zero, the cost of activating objects will be multiplied by a value that is too high, this in order to subsequently produce a negative profit if the price of the plan is greater than zero and cannot be chosen, or else the impact will be zero if the plan has no cost.

The level of economic impact depends on the value assigned to the variable "VT" and the desired expense, when these are equal, the agents will think that the cost of the services is correct (equal to the real cost), according to the credit available decreases, concern will increase in relation to the division of these values. As can be seen in the previous function, the Administrator can know the different degree of affectation that the same plan (its cost does not change) causes each person according to the desired Expense, the expense registered up to that moment and the value assigned to VT.

At this point we must mention that the rate system used by CFE is expected to have effects on user behavior, while initially each kWh has the minimum price, as the consumption limits established by each rate are crossed. the value of the following kWh will be more expensive, therefore, G_i will increase faster when each limit imposed on the CFE rates is crossed.

Design of the experiments

To know the effectiveness of the proposed solution, it is proposed to carry out two experiments using the housing simulator at the end of which it is desired to observe the amount of money that a group of inhabitants would have to pay for the amount of electrical energy consumed and the average comfort obtained during a bimester.

First Experiment: imitation of current behaviors

The first experiment consists of initially assigning to the MAS a fixed amount of available money of $ 1,200.00 Mexican pesos distributed equally among the inhabitants of the house, taking as a reference the consumer attitudes of the Monterrey Metropolitan Area (ZMM) reflected in the study by Morales et al. (2015).

ISSN 2531-2162

With this particularity of the experiment, different scenarios will be run varying the characteristics of the inhabitants shown in the study groups described later within the specification of the study case.

The experiment should be repeated with the 3 control methods proposed in this investigation to compare the results: MAS, Manual and automatic.

Second Experiment: adaptation and improvement of the MAS

As a second experiment, it is proposed to observe the results of the previous experiment and take the value of the expenditure obtained by the best method in those cases where the MAS has not been able to exceed the efficiency.

Once the amount to spend available for the MAS has been modified, it will be divided equally among the members of the group and they will run the scenarios again to see if the MAS is capable of achieving better efficiency when receiving more specific rules from the the inhabitants of the house.

Case study

As mentioned at the beginning of the Methodology, the research will focus on the study of homes located in the Metropolitan Area of Monterrey (ZMM), which is why the simulator proposed for the experiments will be fed with the records of the meteorological station 763940 (MMAN, Latitude: 25.86, Longitude: -100.38, Altitude: 448) located at the Monterrey International Airport, Nuevo León. (Tutiempo Network, S.L., 2015).

People's behavior will be based on the National Survey on Time Use (National Institute of Statistics and Geography, 2014).

In the ZMM the rates applied by the Federal Electricity Commission are: 1C, 1D, 1E and 1F, therefore, they are the ones that will be taken into account to calculate the amount of money that the group of inhabitants would pay at the end of the simulation of a two-month period.

The average size of households in the ZMM is 4 inhabitants according to the last Population and Housing Census (INEGI, 2010), therefore, there may be discrepancies between the level of lighting and temperature preferred by each person, as well as between the budget that each one has to pay for the service.

Based on the above, for this research 6 different study groups are proposed where different types of people are represented, which are described in Table 3. The Table records the importance that each person gives to both lighting and to temperature, adding one unit between both variables; The same is true when deciding what would weigh the most in your decisions about comfort and power consumption. The data expressed in the Table were randomly generated, seeking to represent the diversity of groups of inhabitants of the City of Monterrey.

Role	Temperature			He prefers to sacrifice:		You prefer to take care of:	
	Desired	Minimum	Maximum	Illumination	Temperature	Comfort	Spending
Study Group 1							
Adult 1	24	8	38	0.5	0.5	0.5	0.5
Adult 2	21	12	34	0.5	0.5	0.5	0.5
Student 2	23	8	33	0.5	0.5	0.5	0.5
Student 2	20	10	30	0.5	0.5	0.5	0.5
Study Group 2							
Student 2	24	8	38	0.4	0.6	0.2	0.8
Student 2	21	12	34	0.2	0.8	0.4	0.6
Student 2	23	8	33	0.3	0.7	0.8	0.2
Student 2	20	10	30	0.3	0.7	0.7	0.3
Study Group 3							
Adult 1	24	8	38	0.5	0.5	0.9	0.1
Adult 1	21	12	34	0.5	0.5	0.5	0.5
Student 1	23	8	33	0.5	0.5	0.8	0.2
Student 1	20	10	30	0.5	0.5	0.7	0.3
Study Group 4							
Adult 2	26	8	38	0.7	0.3	0.4	0.6
Adult 2	28	12	34	0.6	0.4	0.9	0.1
Student 1	30	8	33	0.5	0.5	0.3	0.7
Student 2	32	10	30	0.6	0.4	0.6	0.4
Study Group 5							
Adult 1	18	8	38	0.2	0.8	0.3	0.7
Adult 1	19	12	34	0.6	0.4	0.6	0.4
Adult 1	16	8	33	0.4	0.6	0.7	0.3
Adult 1	15	10	30	0.8	0.2	0.2	0.8
Study Group 6							
Adult 1	18	8	38	0.2	0.8	0.3	0.7
Student 2	19	12	34	0.6	0.4	0.6	0.4
Student 2	25	8	33	0.4	0.6	0.7	0.3
Student 1	24	10	30	0.8	0.2	0.2	0.8

Table 3 Study groups for the simulation of people in the house
Source: Own elaboration

Execution and collection of results

Results of the first experiment: Imitation of current behaviors

Table 4 below presents the results obtained in the first experiment. For each case, the method with the best result in terms of method efficiency is highlighted with "*".

Study	Manual method			Automatic method			MAS		
Group	C.A.	C.A.	C.A.	C.A.	Spending	Efficiency	C.A.	Spending	Efficiency
1	0.75	343.95	0.22*	0.78	$5380.16	0.01	0.78	$785.57	0.1
2	0.81	325.7	0.25	0.82	$4966.54	0.02	0.82**	$275.34**	0.3*
3	0.76	273.25	0.28*	0.86	$4979.44	0.02	0.78	$693.45	0.11
4	0.88	147.83	0.60	0.84	$1698.4	0.05	0.88**	$124.54**	0.71*
5	0.62	330.34	0.19*	0.66	$6815.41	0.09	0.66	$677.13	0.1
6	0.75	326.49	0.23*	0.78	$4628.81	0.01	0.76	$700.47	0.11
Average	0.76	291.26	0.26*	0.79	$4744.79	0.02	0.78	$542.75	0.24

Table 4 Comparison between Manual, Automatic and MAS control methods (* Represents the method with the highest efficiency, ** Optimal values of the experiment)
Source: Own elaboration

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When comparing the results, we can see that the MAS achieved an average comfort 1% lower than the Automatic method, however, it is much more efficient.

On the other hand, when comparing the MAS with the manual method, we can observe an increase in comfort of 1% but a decrease in efficiency due to a greater use of electrical energy.

In this experiment, only two cases can be observed in which one of the methods was the optimal of the 3 and occurred in study groups 2 and 4, both with the MAS, since there is no other method that offers an improvement so much of Environmental Comfort and Expense.

Results of the second experiment: adaptation and improvement of the MAS

The results of the second experiment appear in Table 5. Since the only method that obtained greater efficiencies in the different study groups was the Manual method, the results of the Automatic method no longer appear in the Table.

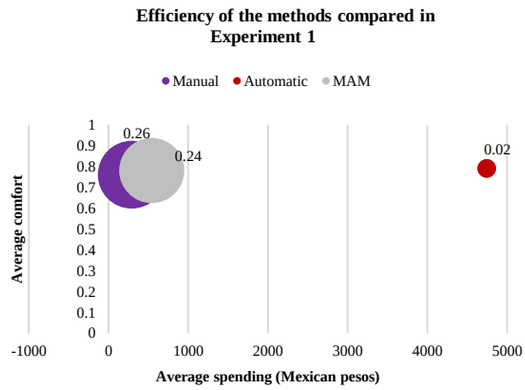
It is necessary to remember that the resource available to spend by the MAS was obtained from the expense generated by the Manual method in the previous experiment.

In this experiment, it is observed that when modifying the resource available to spend from the MAS, its efficiency was greater than that of the manual method in all cases and, in the same way, the expenditure was lower in the MAS in all cases.

It should also be noted that the MAS manages to achieve Pareto Optimality in 66% of the cases with respect to the Manual method (double with respect to the previous experiment) and in 100% of the cases with respect to the Automatic method as already stated. had also observed from the previous experiment.

Study Group	Manual method			MAS		
	C.A.	Spending	Efficiency	C.A.	Spending	Efficiency
1	0.75	343.95	0.22	0.75**	294.71**	0.25*
2	0.81	325.7	0.25	0.82**	275.34**	0.30*
3	0.76	273.25	0.28	0.74	245.16	0.30*
4	0.88	147.83	0.60	0.88**	124.54**	0.71*
5	0.62	330.34	0.19	0.62**	229.75**	0.27*
6	0.75	326.49	0.23	0.72	222.58	0.32*
Average	0.76	291.26	0.29	0.755	232.01	0.36

Table 5 Second comparison between MAS with parameter adjustment and Manual method (* Represents the method with the highest efficiency, ** Optimal values of the experiment)
Source: Own elaboration



Graphic 1 Comparison between control methods
Source: Own elaboration

Analysis and discussion of results

As mentioned at the beginning of the document, the purpose of this experiment has been to observe if a MAS helps to consume electrical energy in homes more efficiently than the traditional methods described in the Methodology: Manual and Automatic.

To resolve the doubt raised, in this research two experiments were carried out, from which the following analysis is derived.

Comparison of current consumption behaviors with the results of the MAS.

In Graphic 1, with results of the first experiment, it is observed that the MAS obtained an average expenditure much lower than the Automatic method, coming very close to the Manual method which represents the method used for extreme energy savings.

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The MAS spending was also lower than the average consumption of households in the Monterrey Metropolitan Area, indicating that, although the MAS had the resources to spend, it only used what was really necessary; This has been achieved by taking advantage of the idea of Suástegui (2014) on the constant monitoring of consumption and of using the minimum amount of energy required to achieve people's comfort, but in a totally autonomous way.

Contrary to popular belief, it is also surprising to see that the two methods with the lowest cost achieved almost the same comfort for people as the most expensive method, thus indicating that it is not necessary to sacrifice comfort to use less electricity.

The low efficiency of the Automatic method also indicates that reactive automatic devices are capable of providing comfort to people, but they do not have sufficient intelligence to take care of other important aspects such as electricity consumption and, therefore, the economic expense that this implies.

Likewise, it can also be seen that the manual method turned out to be more efficient than the MAS, despite having obtained a slightly lower environmental comfort, therefore, it cannot be said that the MAS has obtained optimal levels in terms of comfort and spending.

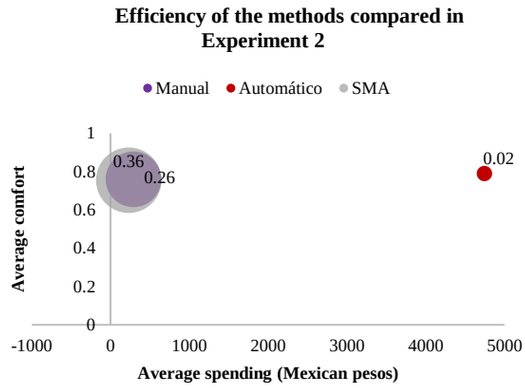
Improved MAS results

Before continuing with the analysis, at this point it is necessary to remember that both the Manual and Automatic methods simulate extreme conditions of human behavior which are very difficult to achieve, that is, in the Manual method, humans will never light a air conditioner, while in automatic mode the air conditioner turns on every time someone enters the room.

Having modeled the controls in the previous way, allows us to have an own appreciation of the range of spending (271 to 4745 Mexican pesos) and environmental comfort (76 to 78% of comfort) that families in the ZMM can reach using the methods traditional.

To say that the MAS improves electricity consumption with respect to current methods and according to the concept of efficiency presented in this work, the MAS must strictly equal or exceed the value of Environmental Comfort and equal or decrease the expense obtained through another method.

Based on the above, it will be interesting to observe in this last experiment whether the MAS will be able to find better work plans and adapt its behavior to achieve the comfort levels established by current methods, or else, the MAS will simply drop the environmental comfort levels. not having the same budget as in the previous tests.



Graphic 2 Comparison between control methods when modifying the MAS parameters
Source: Own elaboration

As can be seen in Graphic 2, with the results of the second experiment, after having reduced the MAS budget in those cases in which this method did not obtain better results, the agents adopted a behavior similar to that of the Manual method, reducing spending opting for new alternatives for air conditioning and lighting the house without lowering the environmental comfort of the inhabitants. Due to the above, the MAS improved the efficiency of its actions, in such a way that it is verified that the MAS will always look for the best solutions according to the working conditions given to it, with the great advantage of operating autonomously.

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With these new results, 66% is obtained in cases where the MAS reaches Pareto optimality with respect to the manual method, thus increasing the probability of success of using this method not only in homes where the inhabitants have high consumption, but also in places where the inhabitants are already concerned about having low electricity consumption.

Conclusions

After having observed that the efficiency achieved by the MAS is the highest compared to the other methods and that the experiments were carried out with groups of people with different preferences, it can be stated in the first instance that: the MAS is the best of the three methods to resolve conflicts of interest between people.

Regarding the interest in the rational use of electrical energy, thanks to this research and based on simulated experiments with study groups of homes in the Monterrey Metropolitan Area, it could be shown that:

- Monitoring and rational autonomous decisions through MAS are a very good alternative to reduce the consumption of electricity in homes in Mexico.

- It is not necessary to sacrifice the comfort of people to reduce electricity consumption if one has the ability to imitate the intelligent behaviors of humans through autonomous systems.

- Of the compared methods, the proposed MASturns out to be the most efficient to provide comfort to people generating the least possible expense.

Given that the MAS is more efficient than the Automatic method in all study groups, and more efficient than the Manual method in 66% of the cases (based on the Pareto optimality concept), the use of this method is a good alternative as a strategy to generate rational electricity consumption in the Monterrey Metropolitan Area.

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Conceptual development for the design proposal of the botanical garden of the academic unit of agrohydraulic in San Juan Acateno, municipality of Teziutlán, Puebla

Desarrollo conceptual para la propuesta de diseño del jardín botánico de la unidad académica de agrohidráulica en San Juan Acateno, municipio de Teziutlán, Puebla

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Abstract

The project and construction of the Agrohydraulic Botanical Garden, the Benemérita Universidad Autónoma de Puebla (BUAP) in San Juan Acateno, in the municipality of Teziutlán, was developed in collaboration with teachers from the Faculty of Agrohydraulic and the Faculty of Architecture of BUAP, as well as undergraduate students, social service and professional practice of architecture schools, graphic design Urbanism. The botanical garden project is located in the reserve category, to protect species of medicinal, ornamental, tingling and regional interest and thematic level of species of interest, to disseminate botanical knowledge of the region. The development of the project was based on qualitative research, interested in capturing the reality of users to determine the needs to be solved; in this process the designer applies the knowledge he develops in vocational training and induces the characteristics and conditions of the study problem. All this is done through different techniques and research tools such as interview, systematic observation, topographic survey, as well as the climatic conditions of the place, topography and conditions of existing buildings contrasting with documentary research.

Project, Intervention, Development

Resumen

El proyecto y construcción del jardín botánico de Agrohidráulica, de la Benemérita Universidad Autónoma de Puebla (BUAP) en San Juan Acateno, del municipio de Teziutlán, fue desarrollado en colaboración de docentes de la Facultad de Agrohidráulica y la Facultad de arquitectura de la BUAP, así como de alumnos de licenciatura, servicio social y práctica profesional de los colegios de arquitectura, diseño gráfico, urbanismo. El proyecto del jardín botánico está ubicado en la categoría de reserva, para proteger especies de interés medicinal, ornamental, tintóreo y regional y de nivel temático de especies de interés, para difundir el conocimiento botánico de la región. El desarrollo del proyecto se apoyó en la investigación cualitativa, interesada en captar la realidad de los usuarios para determinar las necesidades a resolver; en este proceso el diseñador aplica los conocimientos que desarrolla en la formación profesional e induce las características y condiciones del problema de estudio. Todo esto se realiza por medio de diferentes técnicas e instrumentos de investigación como la entrevista, la observación sistemática, el levantamiento topográfico, así como las condiciones climatológicas del lugar, la topografía y las condiciones de los edificios existentes contrastando con la investigación documental.

Proyecto, Intervención, Desarrollo

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Introduction

Botanical gardens have been defined as spaces that allow recreation, which can have a recreational, thematic and educational purpose; These areas are developed according to the type of collections they house. These flora collections are used for the development of scientific research, education and conservation, which in turn have the function of conserving natural heritage and promoting agriculture, protecting the different species. In a country that has around 18,000 species, therefore, conserving the natural heritage is a priority of the Mexican government and universities. For all the above, the Benemérita Autonomous University of Puebla recognized the need to promote the teaching and conservation of species and created in Teziutlán, Puebla the botanical garden at the agrohydraulic school. The Teziutlán Botanical Garden, has as its main objective, to safeguard the species of economic and sociocultural interest in the northern region of the State of Puebla and to protect the species of great importance for daily life and endemic species for the development of science and that they are part of the culture of the region. The municipality of Teziutlán is a word that comes from Nahuatl and means: place where it hails, it is located in the northwestern part of the state of Puebla. In this transition zone of temperate climates of the northern highlands and warm climates of the decline of the Gulf of Mexico. Teziutlán is located in large wooded areas where trees such as ocote, oak, red pine, sweetgum, pear, avocado and peach trees stand out. Teziutlán, being a strategic point in the region, at the beginning of the 1980s, the first buildings of BUAP's Faculty of Agrohydraulic Engineering were installed, located at Avenida Universidad s / n, San Juan Acateno, Teziutlán, Puebla, postal code is 73693.

The garden project was developed as a cultural complex with a regional ethnobotanical Botanical Garden in whose design teachers and students participated in response to the needs of the Faculty of Agrohydraulics, supported by the programs of social service and professional practices of the Faculty of Architecture of the BUAP.

For the project, spaces for research, education, culture, recreation, commerce and scientific collections, main, secondary and service accesses were considered; visitor, employee and vendor parking; self-sustaining infrastructure for research, educational spaces for induction in research and educational management, spaces for culture, for recreation and open spaces for the benefit of recreation and leisure. This last space is the one that was analyzed because it is an area that starts from the concept of design in current botanical gardens where it focuses on functional and geometric design that solve the needs arisen in the user's analysis process. The project is of conservation to maintain alive specimens of interest of the regional flora; exhibition, propagation, research, education, Recreation and rest, reception to the public, access and lobbies, spaces for complementary services such as ticket office and information, area for dissemination of knowledge, service area.

Project conditions

With this research and design project, the area destined for the Agrohydraulic area was recovered, to reforest and restore the areas surrounding the building, considering legal, cultural and architectural aspects in the solution to the problem. The work was supported by students of social service and professional practices, who participated in the development of the project; It was an integration project that benefited the institution, students from different academic units, and the surrounding populations. On the other hand, the project allowed the development of works to extend the knowledge acquired in congresses, forums, undergraduate and graduate conferences of our institution and other universities; as well as the inclusion of Ethnographic and Permaculture aspects in undergraduate and graduate thesis projects, promoting heritage conservation.

The objectives agreed with the School of Agrohydraulics were met, which are:

Promote the study, use and conservation of regional ethnobotanical flora, as well as associated traditional knowledge.

ISSN 2531-2162

Develop the comprehensive architectural and landscape design of the Botanical Garden, with the support of the BUAP Faculty of Architecture.

Achieve the unification of the Botanical Garden project with the existing infrastructure of the Faculty of Agrohydraulic Engineering such as orchid gardens, nursery, vermicompost area, hydroponic crops and greenhouses, among others.

Establish itself as a regional center for the conservation, promotion and sustained use of the biodiversity of the northeastern region of the State of Puebla.

Promote the study and use of renewable resources in the construction of the Botanical Garden by implementing ecological technologies (enotechnics) typical of the region.

As for the project, it has allowed the integral development between the building and the environment, as well as the incorporation of technologies for the capture of water, because despite being an area where there is a strong rainfall, for a long time they lacked water service; The monitoring and supervision of the construction of the buildings and their facilities was also carried out, as well as the garden with walkways, covered paths, areas according to the types of species, the facilities and the signage developed by the graphic design students.

The project also helped to strengthen one of the areas, where there are the most vulnerable ecosystems in Puebla, which are the Mesophilic mountain forests in the northern Sierra, and to conserve the native flora of the region, as well as to allow Agrohydraulics students obtain study spaces and practices that allow them to obtain a development related to the precepts and objectives of the MUM. Meanwhile, the project allowed the participation of farmers to expose the students to the treatment of the species and their production to improve the characteristics of the vegetation.

It was a multidisciplinary work, where everyone involved in the problem was incorporated to provide a solution according to the needs of the users; resulting in an architectural project, landscape project, in support of the community most affected by the destruction of native flora. The conservation of the biodiversity of the place was achieved through the location of the buildings and cultivation areas, since we found eroded areas, where it was decided to locate the construction area and in the area with cultivation possibilities, the garden was placed, as well as the selection of the species that had the best possibilities to develop. The guiding idea of the flower was established, the topography of the land, the construction regulations, the botanical garden regulations and, above all, the participation of the students were considered.

The development of the research project yields the following results according to the architectural design proposal.

Regarding the project and in accordance with the analysis of the urban context, the main areas of architectural domain and growth were located, adapting the modifications of the proposed projects, proposing the primary flower as a space in which the main views would benefit, achieving perspectives of urban enhancement that contributes to the growth, profit and improvement of the faculty both internally and externally.

After carrying out the contextual analysis of the location and updating of the physical space of the FIAH, we have evoked the proposal of creating a new zoning in which the different spaces required for this project are located in which they can be justified and adapted from Correctly shape the buildings and planting areas of the species. The area where the new Flower is assigned is recovered, where the plant species can be shown, as well as the reforestation areas in the surrounding areas as a proposal for the improvement of the area in vegetative and bioclimatic issues, considering the normative aspects in the management of the form and protection of endangered species, in which the quality of life of its inhabitants is integrated as students and visitors in the solution to the sustained problem.

ISSN 2531-2162

A first proposal is achieved for the administrative areas, which integrate cubicles to support research, teaching and maintenance of the "Flower" area and spaces that cover the research shelter of the Botanical Garden, restrooms and observation areas through another cultural building with sheltered warehouses, spaces for the diffusion of culture and knowledge connected through the terraces that promote the predominant and pleasant views of the surrounding landscape and the delimiting of the flower as the primary view of the project and of those derived from the project . As well as its contextual integration in the future growth of the needs of the faculty.

Areas of Intervention

The different areas were analyzed in the whole of the Faculty of Agrihudráulica, and of the main area as designated for intervention for the improvement proposal towards the design and distribution of planting of the various species in order to give a useful use, to the spaces designated for the performance of students and people interested in the field of botanical species. This space, they adhere to the guiding idea of representing an icon and image for the faculty, with a diverse sample of species from the region, native plants and their benefits in different uses.

This area has fields, production areas, fruit trees, conservation and reinsurance of the care of native plants: ornamental, medicinal, tinctorial and fruit plants.

Its condition was not optimal for the imminent intervention of the site; Before carrying out a detailed analysis of the needs in infrastructure, equipment or complementary services, which together receive a new architectural design proposal; and thus, cover all your requirements. All because of the lack of maintenance, a lack of planning in development - the growth of the faculty, as well as the a priori intervention of man.

The deterioration due to the lack of the necessary care due to an erroneous intervention, product of the lack of coordination - experience in the biological and botanical field is exposed.

Figure 1 FIHA Complex Plan Area of intervention
Source: (Ilustration. S.S. FABUAP 2016 students) (2016)

Figura 2 Species area, Botanical Garden
Source: (Photo: Alumnos S.S. and P.P. FABUAP, 2016)

Figure 3 Sowing area, Botanical Garden
Source: (Photo: Students S.S. and P.P. FABUAP, 2016)

ISSN 2531-2162

Figure 4 Access to the Sowing Area, Botanical Garden
Source: (Photo: Students S.S. and P.P. FABUAP, 2016)

Classroom area

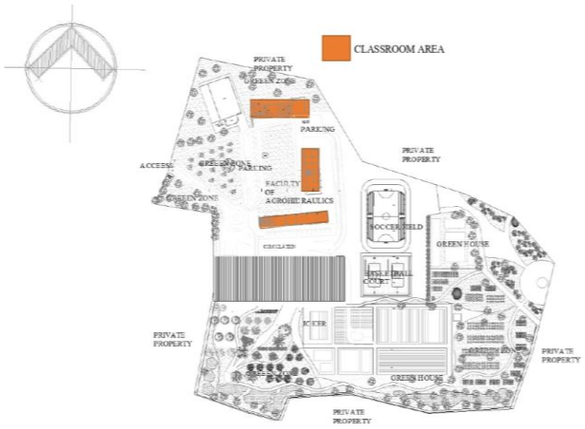


Figure 5 Aréa de Aúlas, Botanical Garden
Source: (Photo: Students S.S. and P.P. FABUAP, 2016)

There are three buildings where the teaching of the Agrohydraulic engineering career takes place. The rectangular buildings are connected by means of a central corridor that unifies them for a single distribution and access.

Building A has a teachers' lounge, multipurpose room, restrooms and school classrooms.

Building B, has a library, graduate classrooms, English areas, computer, general and hydraulic laboratories, as well as infrastructure, has special drainage for laboratories, heaters, ventilation and refrigeration. The C has cubicles, general management, warehouse, atomic absorption laboratory and an in vitro propagation culture area.

The connection of the three classroom buildings is through a distribution corridor, along with recreational gardens, as well as furniture and lighting.

Exhibition area

Figure 6 Auditorium Area, Botanical Garden
Source: (Photo: Students S.S. and P.P. FABUAP, 2016)

The auditorium of the faculty of agro-hydraulics, intended for presentations and exhibitions, as well as meetings, has toilets and a cafeteria.

Public areas

Figure 7 Esplanade Area, Botanical Garden
Source: (Photo: Students S.S. and P.P. FABUAP, 2016)

Open space for the recreation of students, field practices, crops and crops of ornamental plants, space for the meteorological service and its analysis.

ISSN 2531-2162

Suource: (Photo: Students S.S. and P.P. FABUAP, 2016)

Production and plantation areas

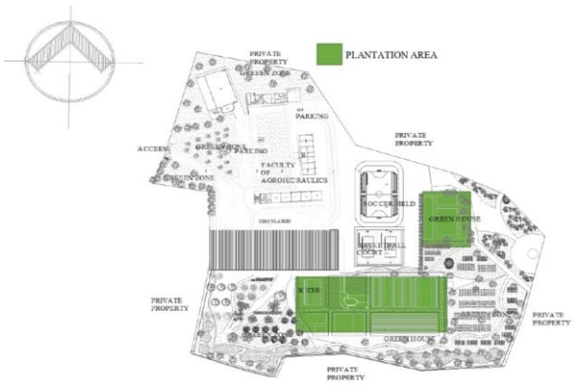


Figure 8 Greenhouses and Crops Zone, Botanical Garden
Source: (Photo: Students S.S. and P.P. FABUAP, 2016)

Open space for the multiplicity, care, reserve and planting of native species; has the facilities and services necessary for the care and maintenance for production of new species.

Leisure and sports promotion area

Free space designed to promote sports activity within the campus, divided into sports such as soccer and basketball.

Territorial reserve space

Natural reserve area, where there is little intervention, intended for production, this lack of intervention is caused by the topographic conditions of the land. It has a minimum space for the multiplicity of ornamental plants for planting and care, although with a specific maintenance a greater area of use of this sector could be achieved.

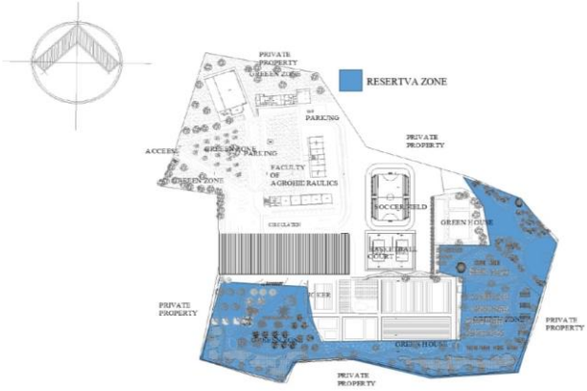


Figure 10 Resertva Zone, Botanical Garden.

Analysis, for the development and proposal of architectural design.

- The deterioration of the mentioned areas is exposed, due to the lack of planning and development; of the necessary care in maintenance, due to an erroneous intervention, product of the lack of experience in the design and programming of the biological and botanical activities.

- The access avenues lack regulatory measures in garrisons, sidewalks and streets in accesses or connections. Affecting vehicular circulation; because the street is very narrow allowing access to a car or truck in each direction. In addition to the lack of parking areas and space for visits to the different areas for the garden proposal.

- It shows the deterioration of the old botanical garden where it is proposed to carry out the intervention of the same, improving the current affectations in circulation since they are organic designs, not well carried out, lacking a good distribution and organization in classification of the species.

- The lack of design and style in the execution of roads and circulations is observed; due to deterioration; Lack of care to the area due to the growth of the plants in increasing causing a visual loss of the original photo.

- Limited space for the growth of cacti plants, the constant growth in the number of these species has caused the loss of organization and the combination of species that are not of the same genus.

- The growth of the weed is observed causing the loss of null circulations.

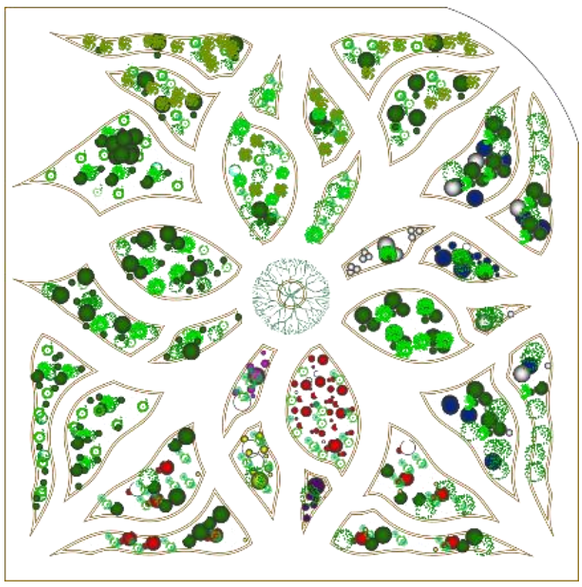
- Main vegetable production area, currently destroyed due to poor use of the facilities and lack of maintenance of the faculty and students.

ISSN 2531-2162

Figures 11 Zones described in the Botanical Garden.
Source: (Photo: Students S.S. and P.P. FABUAP, 2016)

Conceptualization

Botanical gardens are areas of interest for playful recreation - passive, in thematic designs and educational contribution, for housing valuable collections of flora; with the purpose of doing scientific research, and contributing in the education of the higher level for the FIAH, a support to the conservation of the species of the region. It was proposed to meet the requirements that allow the protection and recognition of endemic species, as well as to identify the climatic characteristics for their development in practical learning ORC ID ctic for the areas of agrohydrahulica.



Figures 12 First Design Proposal of "La Flor" for the Botanical Garden
Source: (Student Illustration S.S. 2017)

At the beginning, a representation in a figure is proposed, which illustrates the first design proposal of the conceptual distribution of for plant species in the Botanical Garden. It is a visibly attractive flower due to the soft forms and the sinuous handling, but in the absence of a formal study. It was applied poorly in the facilities, without having exact measurements; that would allow to assign or group the species appropriately, so a rethinking is continued, in order to improve the conditions.

It is proposed to list actions that organize the activities for the design and conceptualization of the designs, from different elements in serial analysis through successive plans, which justify the forms, of the concept that is the basis for the project.

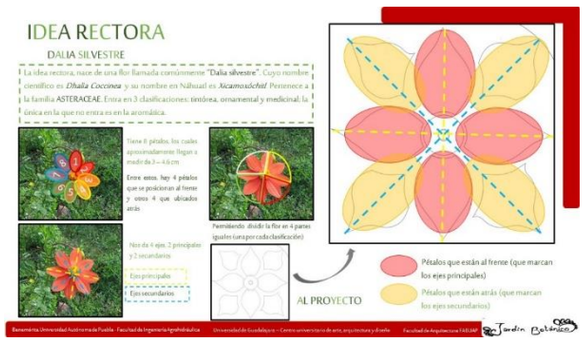
Taking the 4 basic species: Ornamental, dye, Medicinal and Fruit, as the main base of the studied plant species, in the distribution of the proposal for the new design.

The ethnobotanical species that directs this study is assigned to the dyer, as the representative axis of the region in the regional embroidery and the crafts of its communities; in the Teziutlán area, as a living example of the conservation of the species that dye the threads that are used for these crafts; as well as the vegetal representation of flowers with a varied catalog of species. Thus, a "wild dahlia" is assigned as the design basis for formulating the design.

Determined from the contextual analysis of the physical space of the FIAH, the proposal to create a new zoning will be enunciated in which the different spaces that house the four species are located, adapting them correctly. From the guiding elements of the "Dalia", the geometric shapes in lines and various designs of the pentagonal shapes will be attributed as guiding elements for the generation, location and relationship between the spaces. When locating the zoning, in a spatial relationship by species, classification and adequate dimension.

ISSN 2531-2162

A first proposal is presented in the analysis of attached sheet 1; where a formal decomposition of the flower is made by sub-dividing the petálos; in geometric shapes and strokes; of the 8 leaves the 4 rays are established in equal parts; that will start to assign a section for each classification in 8 parts of the same section. At the center, the radial axis of circulation would be located, which unifies the distribution and thus zoning other sub-areas outside the center.



Figures 13 Plate 1 Guiding Idea "La Flor Dalia"
Source: (Students of S.S. and P.P. 2016)

It is proposed to use another sheet that radially gives a more aesthetic shape to the whole of the "Dalia", choosing a Red Teshuate, they consist of 4 main divisions, which would be located in the radial distribution to receive the external areas and take advantage of the circumstances of the corridors as seen in the following images:

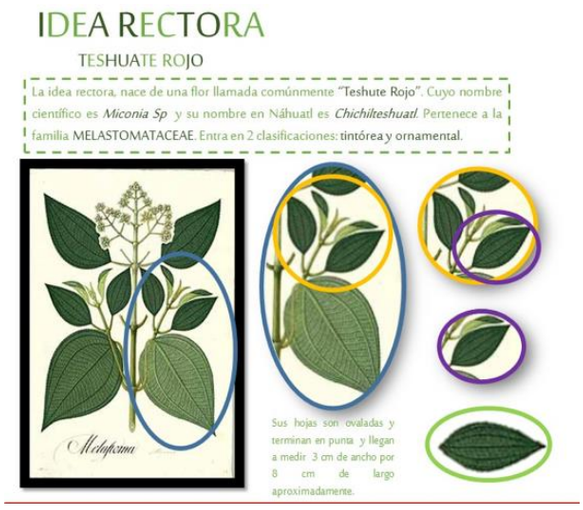


Figure 14 Lá Mine 2. Guiding Idea "Teshuate"
Source: (Students of S.S. and P.P. 2017)

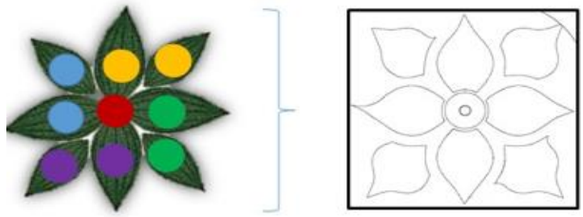


Figure 15 Plate 3. Guiding Idea "Teshuate"
Source: (Students of S.S. and P.P. 2017)

Flower design process: In the process, the measures required for the species and allocation of the zones were determined - with the areas determined for the four species of the garden project, of the corridors in the appropriate dimensions for the circulation of the people in the use, route and maintenance in balance with the guiding idea in not losing its original to the project.

Returning as the beginning the morphology, among its formal characteristics in order to allow free access between the plantations, due to the fact that the dimensions in the new location were smaller than the current dimension of the previous one, appropriate to the size and proportion.

A pentagonal shape containing five petals is assigned primarily; in order to be able to designate radial planes according to the appropriate orientations to the vegetation, and successively assign intermediate spaces to reduce spaces to open new parts to space at regular dimensions in planting or manipulating.

Generation of the formal composition of the flower: It begins by designating a figure inscribed in a circular shape. Starting from a radial center that leads to the pentagonal lines of radioconcentric elements, playing with the composition in fractal shapes, obtaining: crystals that wrap their geometrization towards the flower. Subsequent circles are then generated in the radii to determine rotating sections, thus successively elements that distribute division or union spaces would be generated. Until the final design effect is achieved. As below are shown in the following illustrations described:

ISSN 2531-2162

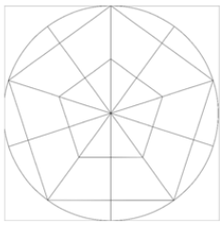


Illustration 1. Geometric stroke of the flower for its compostive axes and according to them raise the distributions in addition to being able to plot the drawing on the digital plane easier.

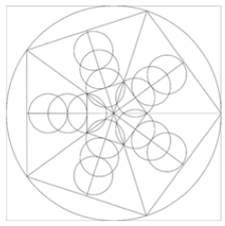


Illustration 2. The circles allowed us to locate the center part of each section so that from them, the arc is drawn or the circle that was subsequently transformed into the petal.

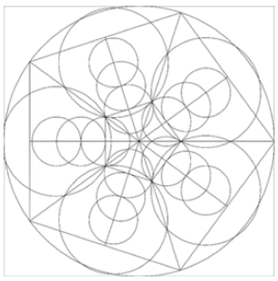


Illustration 3. First stroke of the circles that would form the petals, leaving marked the intersections that would later be the separation between the petals and in our case, the corridors.

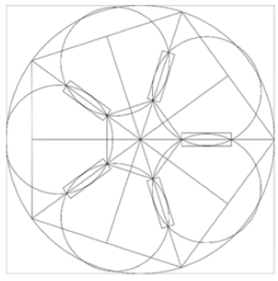


Illustration 4. The previous stroke was cleaned, only small circles. Then we marked the corridors and separation between the petals, the intersections of the large circles gave us the relevant measurements for the projection of each step board.

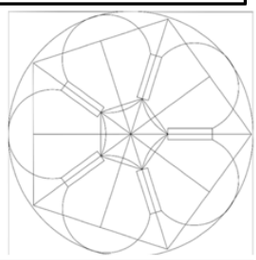


Illustration 5. We draw the petals from the steppes, each vertex of the rectangle would be the starting and ending point of the arches that would give its shape

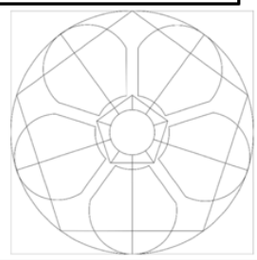


Illustration 6. A center was drawn, which had been proposed to place a tree as a landmark and nodal point in the original design, from this we projected another that you would cut and finish forming the petals, in addition to acting as a "circulation belt". Done these, we erase the leftover strokes to clean the plane.

Successive tests are carried out until the following illustrations are reached:

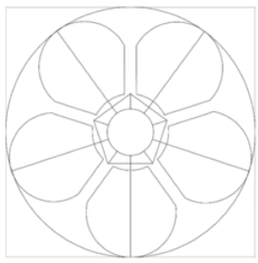


Illustration 7. We continue now to erase the remaining primary strokes, such as the pentagon that initially delimited the shape (the one observed in Figure 1) to leave only the pentagon of the center and the main center axes.

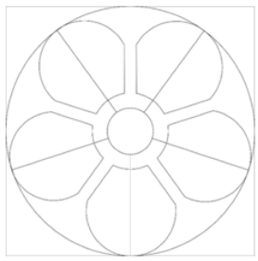


Illustration 8. Completely cleans the flower, along with the center axes

Illustration 9. First planning steps between the petals. It was proposed that between each petal there should be a corridor that would allow us to circulate in and around the garden to make contact with the garden more comfortable and dynamic.

Illustration 10. We decided that a fractal spiral would be the best way to cut the interests, according to it and the corridors we had marked in Figure 9, because even though we had already marked the circulations, how could we better circulate through them?

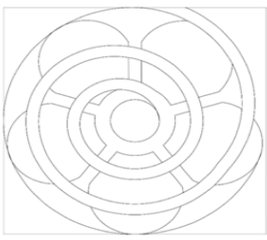


Illustration 11. We remove the basic strokes to clean the path and spiral spasm, but we can't leave it at that, we have to open the spiral to the steps between the petals.

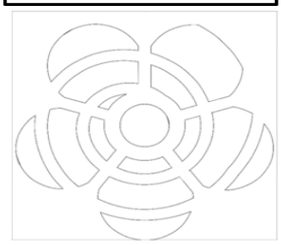


Illustration 13. Clean flower with open steppes and there is a better possibility of circulations. The downside with this proposal is that it greatly reduces the planting space and subtracts us from the exhibition area.

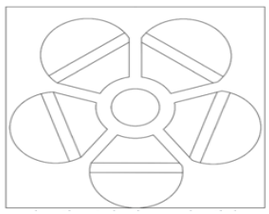


Illustration 14. A second option of circulations was raised, more friendly with the green area that we want to have and without subtracting visitor mobility through the green display. The pentagon in the center was re-designed and climbed until it passed a little higher than the intersection between the petal arch and the spasm and one more passing under it.

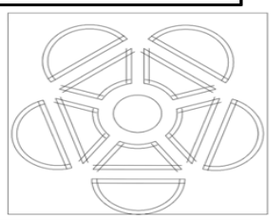


Illustration 15. The limiters were cut to the sides and circulation is free. Offset is the consideration of each gardener's dividing fence. It was first raised at 0.40 meters and then 0.15 meters.

Illustration 16. Erasing the strokes of the limiting bards of 0.40 meters reduces the planting area however we could lose care with the thrust of the earth.

Illustration 17. 0.15cms clean limiting barda. It offers us greater planting area. But we'd have to study the thrust that the gardener's subtractor will have.

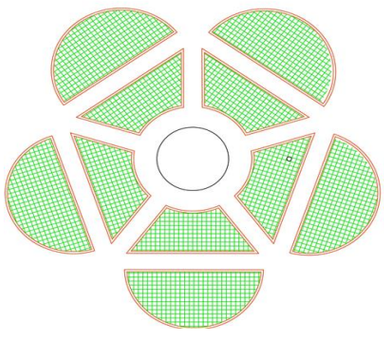


Illustration 18 Clean flower with planting grid and 0.15 meter delimiting fence

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The previous process is the result of the analysis process of graphic drawing in digital software, prior to it in designs to sketches, pertinent until reaching the final proposal that they could see in illustrations 17 and 18. For the illustrations of the spiral line fractal, it was justified that the first idea coincides in important points with the same spiral. For the distribution, some inconveniences had to be resolved on the original structure, which was to adapt its size to the forms of the "Dalia", as a conflict at the beginning, when trying to incorporate the form to the appropriate dimensions, in efficiently distributing the four classifications plants (dyeing, ornamental, fruit and medicinal); Having only five petals, we would have to play with the distribution of the plants, then another question arises to be solved: How can we carry out the organization of the plants so that the sample book and green showcase is the most appropriate for their appreciation.

Two proposals are made, the first one was that in each one of the "petals" a classification of plants should be sown, deepening or widening by putting one of them in two petals, which in this case; It is proposed that it be the dyeing because of the antecedents it has in the region, as it is used as the main one for the handicrafts carried out in Teziutlán. The second proposal is to divide the 5 petals into four equal parts from the center and in each one of them, plant each classification. And mediate the planting areas between the petals in order not to be confused and separate them by: classification, size or growth between one or the other..

Elaboration of descriptive sheets

The following descriptive sheets of the listed species were made, as a suggested basic guide, for the allocation of the spaces of the "Flower" design, making the clarification that the study, classification, cataloging of the species; it is part of another study by the FIAH; in the four classifications: medicinal, ornamental and tinctorial, incorporated from 2006 to date. Includes the common name, scientific name, family to which it belongs, brief botanical description, usable part of the plant, place of collection, among others.

Medicinal plants planted in the JB of the FIAH in 2016			
No.	**Family**	**Common name**	**Applications**
1	Liliaceae (1)	Aloe	Regenerates skin cells
2	Lips (7)	Horehound, peppermint, rosemary, oregano, thyme, lemon balm, mint.	It helps you lose weight
3	Umbellifera e (2)	Parsley, green anise.	Combat menstrual disorders
4	Composite (7)	Cempasúchil, santa maría, chamomile, arnica, dandelion, mullein, master herb	Helps fight cancer, helps indigestion,
5	Polygonacea e (1)	Cow tongue	Purifies the air we breathe
6	Rutaceae (1)	Rue	Helps with hemorrhoids
7	Lythraceae (1)	Hit grass	disinfectant and healing
8	Lauraceae (1)	Avocado	Nourishes and moisturizes the skin
9	Nyctaginace ae (1)	Bougainvill ea	Control respiratory conditions
10	Verbenaceae (1)	Lemongrass	Decrease fever, fight colds
11	Poleminiace ae (1)	Spinosilla	Prevents hair loss
12	Myrtaceae (1)	Eucalyptus	Control respiratory conditions
13	Malvaceae (1)	Mallow	Control respiratory conditions
14	Caprifoliace ae (1)	Elder	Control respiratory conditions
15	Chenopodia ceae (3)	Epazote, epazote skunk, spinach	Stomach pain and indigestion, dewormer, liver, gallbladder
16	Solanaceae (2)	Nightshade, florifundio	Headache
17	Cactaceae (1)	Nopal	Control intestinal pain
18	Grasses (1)	Corn hairs	Deflate the kidney
19	Squares (1)	Horse tail	Improves the circulatory system
20	Agavaceae (1)	Izote palm	Earache
21	Cucurbits (1)	Hedgehog leaf	Kidneys pain
22	Hamamelida ceae (1)	Sweetgum	Regenerates the epidermis
23	Logania (1)	Tepozan	Helps healing

Table 1 Medicinal plants planted in the JB FIAH in 2006, in the region of the Municipality of Teziutlán, Puebla. (Students S.S - P.P. 2017)

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Ornamental plants sown at the JB FIAH in 2006			
No.	**Family**	**Common name**	**Applications**
1	Polipodiaceae (1)	Male fern	Flower arrangements, flower pots
2	Drypteridaceae (1)	Pezmilla	Flower arrangements
3	Liliaceae (2)	Bad mother, ducking	Flowerpots, gardens
4	Composite 2)	Margarita, cempasúchil	Flowerpot, gardens, cut flower
5	Saxifragacea (2)	Millionaire, hydrangea	Flowerpots, gardens
6	Araliaceae (2)	Ivy, aralias	Covers walls, gardens, natural barriers, arrangements
7	Rosaceae (2)	Piracanth, roses	Natural barrier, cut flower, gardens
8	Cupresaceae (2)	White cedar, Tulia	Natural barrier, Gardens, flowerpots
9	Araceae (1)	Alcatraz	Cut flower, gardens
10	Onagráceas (1)	Aretillo	Gardens, flowerpot
11	Ericaceae (1)	Azalea	Flowerpot, gardens
12	Purple (1)	Thoughts	Flowerpots, gardens
13	Nictaginácеae (1)	Bougainvillea	Gardens
14	Iridaceae (1)	Lilies	Gardens
15	Bromeliads (1)	Bromeliad	Pots
16	Euphorbiaceae (1)	Good night	Flowerpot, gardens
17	Cannaceae (1)	Platanillo	Gardens
18	Buxáceas (1)	Myrtle	Natural barrier
19	Agavaceae (1)	Yucca	Gardens
20	Betulaceae (1)	Aile	Natural barrier
21	Oleaceae (1)	Golden thunder	Natural barrier, gardens
22	Mytaceas (1)	Swab	Gardens
23	Hamamelidaceae (1)	Sweetgum	Natural barrier

Table 2 Ornamental plants planted in the JB IAH in 2006, in the region of the Municipality of Teziutlán, Puebla. (Students S.S - P.P. 2017)

Conclusions

In conclusion, it can be stated that the project in its different stages allowed to support the teaching activities of the Faculty of Agrohydraulics and in the dissemination of endemic species and their cultivation to the population that carries out agricultural activities. involved in the problem to provide a solution according to the needs of the users; resulting in an architectural and landscape project and, above all, in support of the community most affected by the destruction of native flora.

The architectural project of the botanical garden is a recreational space fulfilling the purposes for which it was designed that strengthen the development of scientific research, education and the conservation of natural heritage. The Teziutlán Botanical Garden currently complies with safeguarding species of economic and socio-cultural interest in the municipality of Teziutlán. It is an especially useful project for the region and a contribution from the Benemérita Universidad Autónoma de Puebla with the participation of students in all stages of analysis and design, exposing them to real conditions that allowed a greater understanding of the activities of their profession.

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Architectural design with bioclimatic elements for thermal comfort in homes in Hidalgo

Desarrollo conceptual para la propuesta de diseño del jardín botánico de la unidad académica de agrohidráulica en San Juan Acateno, municipio de Teziutlán, Puebla

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Abstract

A bioclimatic housing architectural design was made with cooling or passive heating, considering these as elements that help control the indoor climate improving the welfare of the occupants. The study was mainly based on achieve the thermal comfort through constructive aspects. This thermal comfort helped users in the aspect of physical, psychological, economic, health etc., on the premise that nice atmosphere from other point of view, the thermal, helps the suitable development of the person. The climate, hydrography, ground, flora, etc., were analized and the climatic conditions of the region were shown with graphs, charts and images. An architectural model was set up and was simulated with a program for thermal characterization. A decrease of 40% of energy gains was obtained in the results of the simulation for a housing. The energy efficiency of housing was improved and was developed a sustainable building model.

Bioclimatic, passive system, model, thermal characterization

Resumen

Se realizó un diseño arquitectónico bioclimático de vivienda con sistemas de enfriamiento o calentamiento pasivo, considerando estos como elementos que ayudan a controlar el clima interior mejorando el bienestar de los ocupantes. El estudio se basó principalmente en la búsqueda del confort térmico a través de aspectos constructivos. Este confort térmico ayudó a los usuarios en el aspecto de salud física, psicológica, económica, etc., partiendo de la premisa que un ambiente agradable desde el punto de vista térmico ayuda al buen desarrollo del individuo. Se analizaron los antecedentes de la región como el clima, hidrografía, suelo, flora, etc., mostrando gráficos, cuadros e imágenes relevantes de las condiciones climáticas del lugar. Se desarrolló y simuló un modelo arquitectónico con un programa para su caracterización térmica, se encontró que se pueden reducir las ganancias o pérdidas de energía en la vivienda en un 40%. Esto mejoró la eficiencia energética de la vivienda y permitió desarrollar un modelo constructivo sustentable.

Bioclimático, sistema pasivo, modelo, caracterización térmica

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Introduction

Since the establishment of human beings in small groups and the construction of communities, it has been necessary to create comfortable homes. The latter as a response to climate changes, predators, among other needs for the population and that depend on the region and its surroundings. Given this, "vernacular architecture" was born, a term that describes the process of how the evolution of architecture has occurred with the aim of raising comfort levels in interior spaces [1]. Process in which civilizations, over time, found ways to deal with and counteract the effects of climate change in their homes, using materials from the region and studying the orientation with respect to the sun, among other elements of its structure. Over time, the fast-paced lifestyle of recent years has produced changes in the basic needs of the population. Given the rapid demographic growth and the lack of spaces for housing and work, spaces known as "social interest houses" and multi-level buildings are built, which solve the problem of demand, however, these new constructions do not provide the comfort desired by users, causing the people who reside in them to use active systems for the conditioning of the place and improve the internal environment.

Triggering an excessive rise in energy consumption, and in turn damaging the environment [2]. Mexico is not an exception to such a situation, and it is that only in the state of Hidalgo there were 2,858,359 inhabitants for 2010 [3], the population doubled from 1970 to 2010.

Therefore, the demand for energy continues to increase and current housing models do not consider bioclimatic elements for their efficient performance.

As a solution to such a problem, researchers have devoted themselves to the study of constructive elements in buildings that function as passive systems and help reduce thermal loads inside buildings, just as our ancestors used different techniques and materials from the region to condition their homes and increase thermal comfort.

Among the investigations carried out towards the development and improvement of the thermal efficiency of buildings with bioclimatic elements and passive systems, is the work of Omrany et al (2016), in which the different types of walls are mentioned as "Trombe", " Green Wall ",“ double wall ”, among others, which have been used to improve thermal comfort and which are the latest trends on this in the future, however, it does not obtain results regarding the performance of the aforementioned walls. Soutullo et al (2016) conducted an investigation focused on comparing the energy performance of a conventional building against a bioclimatic building. The bioclimatic model of this work was built taking into account the orientation of the façade, the insulation in external walls, shading elements, air conditioning systems, lighting and solar panels. The results showed that there was a 35% reduction in primary energy consumption.

This work presents the design of a house with bioclimatic elements under the meteorological conditions of the state of Hidalgo. A simulation of the model was carried out with a program for its thermal characterization, with the aim of evaluating energy efficiency and developing a sustainable construction model.

Method description

Case study

The properties of the place were studied. The study area is to the west of the state of Hidalgo, near the municipal seat of Huichapan, with an altitude of 2,100 meters above sea level, this region is characterized by being an extension of the plain, in which it is you can observe the mountainous region in the surroundings.

The climate is temperate cold, with an annual temperature of 16 ° C and a rainy period between the months of May to September [6].

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Figure 1 Coyote. Part of the fauna of the region

In figure 1, part of the flora and fauna that characterize the region are shown.

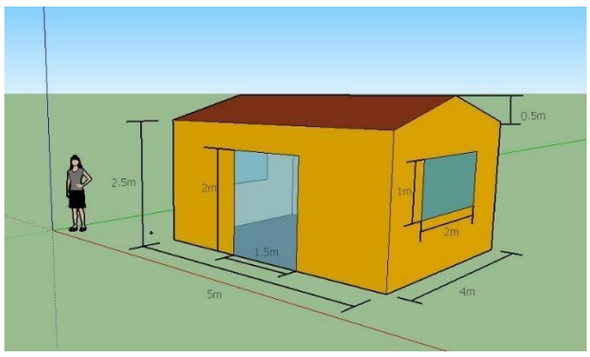


Figure 2 Basic housing model

Figure 2 shows a basic house model, which has elements of any building such as walls, roof, etc. For the analysis, the thermal loads due to activities carried out indoors were not considered; the orientation of its walls with respect to the cardinal points was random, and the distribution was in such a way that the front wall, where the door is located, is in a southerly direction; the windows are located one to the east and the second to the west; Shading elements or internal sources of thermal energy were not considered. The materials that make up the walls, roof, floor and windows, and their physical properties are shown in tables 1 and 2:

Material	Thermal conductivity (kJ / hmK)	Density (Kg / m^3)	Specific heat (KJ / kgK)	Thickness (m)
Walls				
Gray plaster mortar	0.028200	1400	0.83716	0.01
Solid brick	21	2312.5	1.05	0.12
Gray plaster mortar	0.028200	1400	0.83716	0.01
ROOF				
Gray plaster mortar	0.028200	1400	0.83716	0.2
Solid brick	21	2312.5	1.05	0.12
Ground				
Concrete	0.03	1600	0.83716	0.05

Table 1 Physical properties of the materials used for the walls and ceiling

Glass type	Global heat transfer coefficient (W / m^2K)	Solar gain coefficient	Thickness (mm)	Area (m^2)
Simple clear glass	5.74	0.837	6	2

Table 2 Physical properties of window glass

This model was compared to a design containing bioclimatic elements. The architectural design was proposed as an alternative to improve thermal comfort, this means a warm home in the winter season and cool during the summer. This model consists of components that are supported by bioclimatic elements. As shown in figure 4:

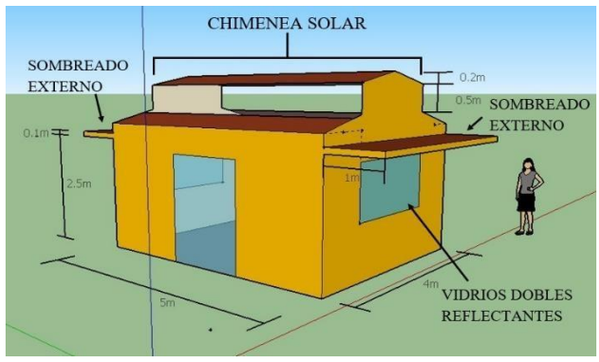


Figure 3 Architectural design with bioclimatic elements

Figure 3 shows the design of a house with the same dimensions as the model presented in figure 3, however, unlike this, the design of figure 4 was added external shading elements, solar chimney, the windows of the The windows were changed to reflective double glazing and it was considered to place the walls with a smaller area towards the south. The latter is due to the fact that in the northern hemisphere and during most of the year, the inclination of the Earth with respect to the Sun allows the orientation of the solar radiation that falls on the surface to be to the south [7]. The materials that were considered in the new design do not change with respect to the previous model, so the data in table 1 also correspond to the new architectural design, otherwise when referring to glass.

Glass type	Global heat transfer coefficient (W / m^2K)	Solar gain coefficient	Thickness (mm)	Area (m^2)
Reflective double glass	2.54	0.466	20	2

Table 3 Physical properties of window glass

Table 3 shows the properties of the glass used for the windows of the proposed design. To make the comparison of thermal efficiencies and to know the thermal comfort of these buildings, both models were simulated in a program for thermal characterization called "Simulation Studio" of TRNSYS 17.

The simulations were carried out under the aforementioned climatic conditions of the state of Hidalgo, where the simulation time was 7 days.

Governing equations

TRNSYS is a platform for the simulation of thermal systems. Its programming is mainly based on the solution of transfer functions of the systems to be solved [8]. Although the existing analytical and numerical solutions are of the differential equations of conservation of energy, mass and momentum, TRNSYS is based on a solution model from an energy balance:

$$\dot{Q}_i = \dot{Q}_{surf,i} + \dot{Q}_{inf,i} + \dot{Q}_{vent,i} + \dot{Q}_{g,c,i} + \ldots + \dot{Q}_{cplg,i} + \dot{Q}_{solair,i} + \dot{Q}_{ISHCCI,i} \quad (1)$$

Q_i : represents the total heat flow into the home.

$$q_{s,i}^{k} = \sum_{k=0}^{Sa} b_s^{k} T_{s,o}^{k} - \sum_{k=0}^{Sa} c_s^{k} T_{s,i}^{k} - \sum_{k=1}^{Sa} d_s^{k} q_{s,i}^{k} \quad (2)$$

$$\dot{q}_{s,0} = \sum_{k}^{n} a_s^{k} T_{s,o}^{k} - \sum_{k}^{n} b_s^{k} T_{s,i}^{k} - \sum_{k}^{n} d_s^{k} q_{s,0}^{k} \quad (3)$$

$$\square \quad \square \quad \square$$

$$0 \quad 0 \quad 1$$

$Q_{surf,i}$: gain by convection of interior surfaces.

$Q_{inf,i}$: infiltration gain from outside air flow.

$Q_{vent,i}$: ventilation gains due to user defined source.

$Q_{g,c,i}$: internal gains such as lïghting, equipment, people, etc.

$Q_{cplg,i}$: earnings of rooms adjacent to the one in the analysis.

$Q_{solair,i}$: fraction of solar radiation that is transferred through windows and by convection to indoor air.

$Q_{ISHCCI,i}$: solar radiation absorbed by the internal shading elements and passing through convection to the indoor air.

The walls are modeled according to the relations obtained from the Mitalas and Arseneault transfer functions [8]:

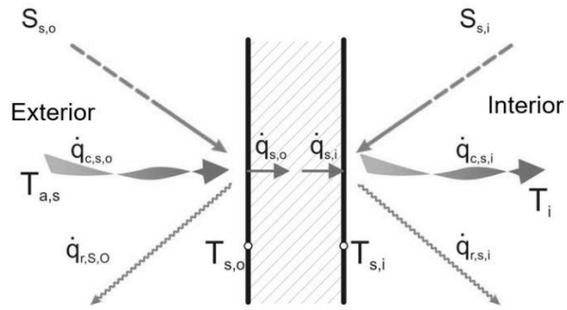


Figure 4 Wall modeling in TRNSYS

Equations 2 and 3 are the heat flux relationships obtained from the transfer function relationships. Where:

$q_{s,i}$: is the heat flux of the interior surface. $q_{s,0}$: is the flux of heat from the outer surface. a, b, c and d: are the heat transfer coefficients.

k : refers to the end of the discrete time in which the function is evaluated.

For window modeling, the sum of the short wave radiation absorbed by all the windows distributed around the evaluated room is considered.:

$$\dot{Q}_{abs,i} = U.C \begin{pmatrix} \dot{Q}_{abs} + h_i(T_i - T_{zone}) - \ldots \\ \ldots - h_{cp,o,amb,sky}(T_{cp} - T_{amb,sky}) - \dot{Q}_{sun} \end{pmatrix} \quad (4)$$

Where:

Q_{abs} : is the rate of change of the heat flux absorbed by the glass.

h_i : is the convective coefficient to the interior.

T_i : is the interior surface temperature.

T_{zone} : is the indoor air temperature.

$h_{c,o}$: is the outer convective coefficient.

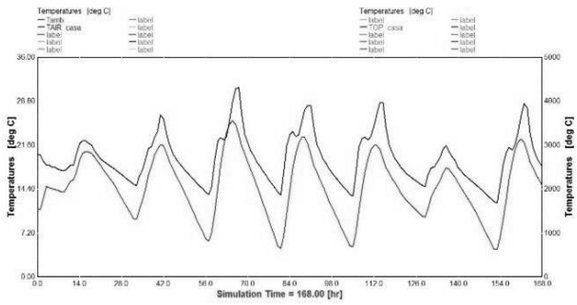
T_o : is the outside surface temperature.

T_{amb} : is the room temperature.

Q_{sky} : is the rate of change of the heat flux of the celestial dome.

Results

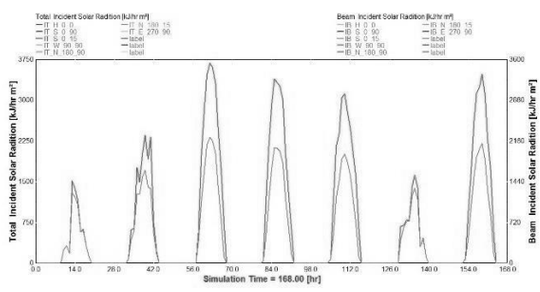
The first simulation that was carried out was the model in figure 3, the basic housing model. The results were the following:



Graphic 1 Exterior and interior temperature of the basic house

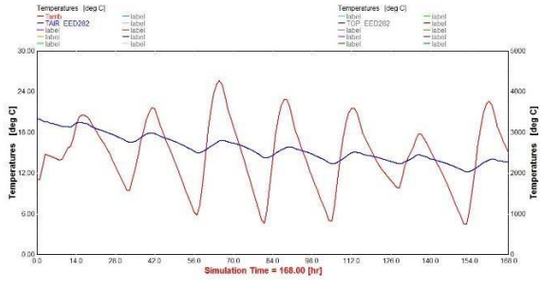
Graphic 1 shows the fluctuations in the indoor and outdoor temperature of the home due to changes in solar radiation between day and night. The maximum outdoor temperature (red line) recorded during the simulation is 25.2 ° C and the minimum is 3.6 ° C, while the maximum indoor temperature (blue line) recorded was 30.6 ° C and the minimum 14.4 ° C.

These results show that the room is outside, however, in broad daylight, the temperatures inside can be intolerable for those who inhabit it, reducing their thermal comfort.



Graphic 2 Maximum and minimum total incident radiation

The second simulation that was carried out was based on the proposed architectural design. This simulation was carried out under the same climatic conditions of the previous model. So, the radiation indices for both analyzes are the same. These radiation levels are those represented in graphic 2.



Graphic 3 Exterior and interior temperature of the architectural design with bioclimatic elements

From the addition of climate elements to the new design, the results shown in graph 3 show changes in the interior temperature of the building. As in the values recorded in graph 1, the maximum outdoor temperature (red line) recorded is 25.2 °C and the minimum is 3.6 ° C, however, the maximum indoor temperature (blue line) is 16.5 °C and the minimum of 12.75 °C.

Therefore, this new design is capable of offering stability in the interior temperatures of the house, increasing thermal comfort even when high temperatures are registered without losing the quality of being a warm place at times when the outside temperature decreases. There is an increase of more than 40% of efficiency in the system by being able to increase its capacity to stabilize the interior temperature without the need for active systems.

Conclusions

In this work, a proposal for an architectural design with bioclimatic elements was presented in order to evaluate its thermal efficiency, improve thermal comfort and develop a sustainable construction model for homes in the state of Hidalgo. The results of the simulation of the basic housing model and the proposed architectural design were shown. The results showed an increase of more than 40% of thermal efficiency only with passive systems, a better stability of the interior temperatures and greater thermal comfort were also obtained.

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The design proposed in this work is a sustainable alternative to the current needs of housing, energy consumption and protection of the environment; It is not limited to only one region, so, in the future, the application of these new designs would improve the quality of life and benefit the communities.

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[Title in Times New Roman and Bold No. 14 in English and Spanish]

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Abstract (In English, 150-200 words)

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* Correspondence to Author (example@example.org)
† Researcher contributing as first author.

Introduction

Text in Times New Roman No.12, single space.

General explanation of the subject and explain why it is important.

What is your added value with respect to other techniques?

Clearly focus each of its features

Clearly explain the problem to be solved and the central hypothesis.

Explanation of sections Article.

Development of headings and subheadings of the article with subsequent numbers

[Title No.12 in Times New Roman, single spaced and bold]

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Including graphs, figures and tables-Editable

In the article content any graphic, table and figure should be editable formats that can change size, type and number of letter, for the purposes of edition, these must be high quality, not pixelated and should be noticeable even reducing image scale.

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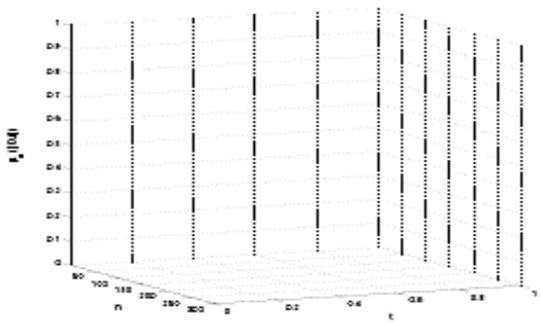

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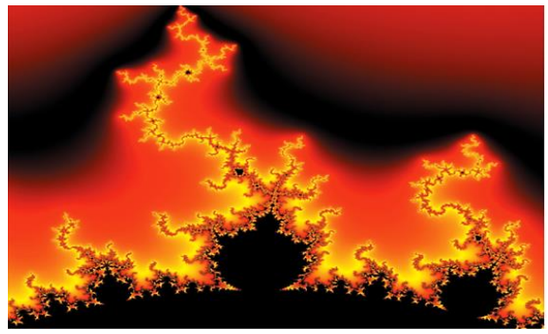

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For the use of equations, noted as follows:

$$Y_{ij} = \alpha + \sum_{h=1}^{r} \beta_h X_{hij} + u_j + e_{ij} \quad (1)$$

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Methodology

Develop give the meaning of the variables in linear writing and important is the comparison of the used criteria.

Results

The results shall be by section of the article.

Annexes

Tables and adequate sources thanks to indicate if were funded by any institution, University or company.

Conclusions

Explain clearly the results and possibilities of improvement.

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3. Analysis from the regression demand curve
4. Results
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Efficient use of electric energy in homes through multi-agent systems, case study Monterrey N.L., Mexico
RAMOS-NOLAZCO, Jesús Alejandro, SILVA-AVILA, Alicia Elena, CASTORENA-PEÑA, Jesús Abraham and BRENA-PINERO, Ramón Felipe
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Tecnológico de Monterrey

Conceptual development for the design proposal of the botanical garden of the academic unit of agrohydraulic in San Juan Acateno, municipality of Teziutlán, Puebla
NAVARRETE-GARCÍA, Mónica, VÁZQUEZ-TORRES, María de Rayo, CASTILLO-REYES, Alberto Rosendo and NAVARRETE-GARCÍA, Martín

Architectural design with bioclimatic elements for thermal comfort in homes in Hidalgo
TORRES-AGUILAR, Carlos, SERRANO-ARELLANO, Juan, MACIAS-MELO, Edgar and AGUILAR-CASTRO, Karla
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