

Architectural approach to create sustainable spaces in Mexico

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Abstract. This is a project that seeks to achieve a high level of sustainability. The objective is to make proposals of materiality and architectural accessories that facilitate this scope. This proposal is one with the context of the area because the design of the sports complex and the stadium were born from guide lines that the streets, pedestrian transitions and the land itself has available. The plan of this design is to cover most of the SWOT analysis that the UN has in its 2030 plan. With this said, the stadium and the urban project will follow certain strategies that will be applied so that the new project meets these guidelines.

Keywords: Sustainable, recycled, smart cities, ecosystem, analysis.

1. Introduction

Based on the Mexican sustainability problems and the evolution of national and international architects to create new solutions for a more friendly living space, all this research was redirected to create a relationship between smart cities and a highly sustainable space where the use of electricity is almost zero. [1]

However, these problems were taken into account to then make a site analysis and be able to make a relationship between the two and start creating a proposal with an approach to sustainability and social inclusion. The site analysis was what set the tone for most of the design guidelines, because the project has a concept that is based on sustainability and inclusion. Given that the project is located in a context that is mostly of industrial use, we are looking to create a space where all the

materials used are of recycled origin or components that do not harm the environment.[2]

With this proposed materiality we are seeking to create interior comfort, using elements with thermal and acoustic insulation characteristics.[3] The project also seeks to create a space where all the equipment used are of recycled origin or materials that do not harm the environment.

Speaking more generally about the project, we are seeking to create a public space in which to practice various sports and recreational activities where the space is fully permeable and public.

The project in general focuses on the concept of smart cities, where technology and sustainability are one with the concept and the proposal. The scope of this proposal is to generate an increase in the quality of life of the local people, the tourists of the property and the citizens in general. The public and private areas of the exercise will be creating an implement of natural resources, where we are not only giving relation to smart cities, but also giving credit to the Edible City typology.[4]

2. Analysing the site

Throughout this phase of the project, we begin to question the existing environment of the properties, with the ideal of reaching a solution that is feasible according to a sufficiently wide radius of influence with the purpose of impacting different road, demographic, cultural, ecological aspects, in favor of the area, through the analysis and questioning of the industrial zone in San Pedro Garza Garcia, Nuevo Leon, Mexico. The location of the property has potential, since it can benefit the area and the users who live there or visit it in an impacting way.

An analysis focused on different aspects of the area and of the specific property is generated with the purpose of having a wide and deep knowledge of these, thus generating a proposal that benefits the intervention area in an impacting way.

2.1 Bioclimatic Analysis

Compiling the information resulting from the analysis carried out by the team members, it is feasible to mention that the land is located in a space frequently traveled throughout the day and with a high rate of activity at specific times due to the focus of the buildings around it, of which housing and industry predominate.

After having carried out the bioclimatic analysis by way of mapping, it was possible to observe that from the industrial zone of San Pedro Garza Garcia different views can be taken advantage of, which are focused towards the Huasteca ecological park, the Cerro de las Mitras and the Sierra Madre Oriental. The solar incidence that impacts the property is high in the morning and in the afternoon, when the sun rises and sets. It is important to take this

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analysis into account for the building design process.

2.2 Gap analysis and built space

This analysis serves as a tool to identify the possible available spaces and the problems that this analyzed property may have. First, an analysis of empty spaces was generated to then move on to built spaces and from there begin with the land available for construction, within this the specifications of the property were reviewed to be able to build according to the city regulations.

2.2.1 Nolli

This analysis allows us to appreciate the difference in housing density near the space to be built, where the built environment is totally different from one end to the other, almost as if there was a non-visual border in the center of these spaces. This is what triggered part of the design, we sought to break the edge and create a landmark for both ends of the analyzed area to be positively affected by the project concept. [5]

2.2.2 Urban Morphology

Urban morphology is the external appearance of cities. Through its study, the historical variations in the shape of the city are analyzed, which arise due to various factors, such as: the conditions of the location in a particular territory; the city's planning decisions, taking into account the land uses and human activities that take place in that territory; and the type of plan or weave that structures the urban fabric.

The area analyzed has a mixed morphology, but the predominant one is the broken-plate city morphology. This set the guideline for the urban area proposal within the project. The intention was to continue with this organic style morphology so as not to break with the immediate context. [6]

2.3 Road connectivity analysis

Connectivity is the relationship of one element or place establishing connection with another. Movement is the change of place or position of a body in space. The analysis of these two concepts is related to the purpose of understanding the way in which vehicular and pedestrian flow behaves at different times in the surroundings of the properties. [7]

2.3.1 Street hierarchy

Paths are conduits that are followed by the user in the ordinary way. They are usually represented by streets, paths, transit lines, canals or railways. Such conduits are hierarchically divided into three categories that Kevin Lynch stated in his book "The image of the city";

Primary or metropolitan paths, these types of paths are those that connect one end of the city with another,

generally they are wide roads of three lanes or more.

Secondary or connector roads consist of smaller avenues that connect different points of the city.

Tertiary or local roads are those that connect the secondary roads to each other, which surround the blocks of the urban fabric.

People observe the city as they go through it and according to these paths the other environmental elements are organized and connected. [8]

The property is surrounded by highly trafficked avenues, which creates the opportunity to attract more people to the property by implementing design strategies.

2.3.2 Nodes

Nodes are the strategic points of a city where the user can enter. These elements can be confluences, transport junctions, intersections between two or more paths, moments of passage from one structure to another. In short, nodes are concentrations which are due to the condensation of a certain use.

Confluence nodes are generated at points where there is a certain agglomeration of vehicular and pedestrian traffic at different times of the day, but none of them affect the property in such an impacting way. [9]

2.3.3 Public transportation

In this phase of the analysis, the ideal is to observe the number of bus stops in the area to be analyzed as well as the number of urban routes that pass through it. This analysis is based on information in Google Earth and site visits to have a more precise result.

This analysis provides results that contribute to identify certain factors that affect the property to be intervened, as well as the amount of traffic generated around it, the feasibility of transportation by public means, among others.

The analyzed area has a high availability of urban routes and public transportation stops, which becomes a tool that works as a support to achieve greater use of public transportation in the area.

2.3.4 Walkability

Walkability is the term given to the measure of how friendly a specific area or space is, in which a lifestyle is generated based on the fact that most of the daily activities can be done on foot, without depending on a car.

It can be seen that there are not so many crosswalks or bicycle lanes available for public use, however this should be taken into account when designing the landscape and esplanade of the project. [10]

2.4 Land use and Equipment

The land use and equipment analysis is a study with the purpose of knowing the different types of activities that are taking place or may be happening in the block or specific sector. Prior to the beginning of the design stage of the project, this analysis is performed with the purpose of knowing the permitted uses that can be given to the property; whether commercial, residential, recreational, among others.[11]

2.4.1 Land use

Land uses correspond to a generic set of activities that the territorial planning of each city or state admits or restricts in a property area, with the main purpose of generating a certain balance in the activities that are taking place in different areas of the city.

Regarding the analysis area, the fact that a predominantly industrial land use is present will benefit the project by creating spaces for people to stay and generating a greater flow of people in the area. [11]

2.4.2 Density per Dwelling

The purpose of this study is to understand the number of people living in each dwelling. This analysis includes data on houses per block, gender and age.

A large number of blocks with a high density of inhabitants can be seen, from Jiménez Avenue located in San Pedro Garza Garcia, Nuevo Leon, Mexico towards the southeast of the property, to Cromo Avenue located towards the northwest of the property; however, in the vicinity of the property, it is not possible to appreciate such a high density per dwelling since it is an industrial zone.

2.5 Natural environment analysis

The environment constitutes the unity and relationship of a system that interactively integrates living beings and the elements of natural and social reality. The built environment are all the spaces modified by human beings which provide the scenario for the realization of daily activities, ranging from buildings and parks to subdivisions and cities. The analysis of the natural and built environment is carried out with the purpose of understanding the relationship between natural spaces and spaces that have been built over time.

2.5.1 Green spaces analysis

One of the main objectives of this analysis is to identify the number of spaces that have high levels of vegetation in a specific area, all of which helps to generate an approximation of the amount of vegetation that can be implemented on the property in which the intervention will take place. [12]

In the area under analysis, 33 green spaces have been identified; therefore, it is concluded that the implementation of green spaces and esplanades on the

property will benefit the area.

2.5.2 Biophilia

Throughout this phase of analysis we investigate which species and the quantity of each one of them are found in a specific area.[13]

Within the analyzed area it can be observed that the existing vegetation of the context is very rich since it has been possible to identify various species of plants such as piñolero tree, oaks, durangensis tree, bougainvillea, conical biznaga, carnation, palmilla, petunia, among others...This vegetation includes trees, cacti, shrubs, creeping and ornamental function.

With this said, this is what is being proposed within the green area of the project, so as not to break with the local language of existing vegetation.

2.6 Ethnographic analysis

Throughout this phase of the project, we begin to question the existing environment of the properties, with the ideal of reaching a solution that is feasible according to a sufficiently wide radius of influence with the purpose of impacting different road, demographic, cultural, ecological aspects, in favor of the area, through the analysis and questioning of the industrial zone in San Pedro Garza Garcia. The location of the property has potential, since it can benefit the area and the users who live there or visit it in an impacting way.

3. Case study research

The developed project is based on 3 main items: inclusion, transparency and sustainability. Based on these 3 main elements that govern the development of the project, a research about case studies that had some of these three concepts was generated with the main purpose of absorbing the best of each of them, in which the stadium and the public areas of the project took as a reference some iconic stadiums such as AT&T Park in San Francisco, California. The proposal for this particular stadium helped us create a sustainable solution for the green areas within the stadium. The design of this space was done by Blasen Landscape Architecture and EDG. This idea was taken for the stadium and related to sustainability because this space is planned to be related not only to smart cities, but also to the Edible City typology. This city typology is based on having public gardens in the surrounding area for local consumption. The objective is the creation of vegetable gardens inside the stadium for the consumption of the fans, where these vegetables are also used for the ingredients of the restaurants. This proposal avoids the transportation of food and helps to reduce the carbon footprint and the consumption of unprocessed food. [14]



Fig.1. AT&T Park in San Francisco [15]

The design of the urban space is related to Yankee Stadium because it has outdoor areas for the practice of sports. These spaces have the purpose of relating the sport discipline in all its context, but not only that, the Yankee Stadium itself has a very large field, designed not only to practice baseball but also has the preparations to be a soccer field.[16] The project being developed adopted these characteristics and carried them out in a very similar but not so exact way. The space where the stadium is planned to be built has a multidisciplinary urban area, where not only the stadium will be located, but also a soccer field, basketball courts, and a semi-professional swimming pool. These spaces are completely open to the public, the reason for this is that at the time of the site analysis it was found that there is a lack of green areas in the immediate context. The urban area also has a rear park, where the views of the mountains, icons of Monterrey, can be taken advantage of. This rear park is intended to be a multifunctional space where various activities can be carried out.

4. Needs Program

An investigation of similar projects of other authors was carried out for the generation of a comfortable space for the user. Within this we found the various requirements for the design of a baseball stadium such as a dugout, correct field dimensions, and needs for the team members. So that this project could be carried out correctly and merge with the context, we made a diagnosis of the current situation of the land and the space where we were going to intervene, this in order to understand the space in depth and have a clear view of what has to be done. We began with general proposals for what would be the urban area of the project, due to the lack of green areas and spaces for the practice of sports, we concluded that the space outside the stadium would be a sports complex that includes soccer fields, basketball courts and a semi-professional pool. Specific to the stadium, we started with the user's needs: What do they need? Where would it be located to provide adequate use? How much space would be available? Based on this series of questions, we began to propose commercial and toilet spaces. The vertical cores are strategically located for the fast flow of people. The player spaces were placed in a space isolated from the public to give privacy to the player. The program of needs of the stadium itself is to

have a space for commentators, a field, bleachers, dressing rooms, restrooms, commerce, vertical circulations, ambulance access and first aid. [17]

5. Creating a sports complex

This space seeks a multidisciplinary of disciplines to create a sports complex where you can carry out any sport that the user wants. These physical skills arise from prehistoric times, where people seek a link to be able to meet ancient communities.[18] The purpose of this was to create a space where multiple disciplines could carry out the same objective of a community or culture. This project adopts the concept of the origins and trends of sports facilities to create a complex where the main function is sports in the area. The area where it is located has a lack of sports and green spaces. The creation of this complex is important both for people's health and for the culture of the area. The project seeks to adopt a semi-professional size soccer field, two professional size basketball courts and a swimming pool of the same level.

6. Generation of new ecosystems

This space seeks to be a landmark of flora and fauna, where the spaces are considered green corridors or spots working as islands of vegetation that are distinct from the matrix of the surrounding ecosystem. The corridors are elements that define the landscape and as the name says, they are linear elements that cross or section an area. This system is the one that links the patches. Corridors are extremely important because they serve as vectors for the migration of animals and plants. The patches, like the corridors, their vegetation is different from the surrounding vegetation. They provide a sense of porosity to the landscape, they are responsible for providing ecological balance in that area. They are of utmost importance for green spaces because these patches and corridors serve to have greater biodiversity of flora and fauna. This project works as a corridor and at the same time as a patch. The intention of this is to create not only a landmark for the area but also for flora and fauna, where there is great biodiversity to enrich the area where work is being done. This would not only have an impact on the sports complex, but also on the immediate surroundings. In the end we would be creating a habitat where humans can coexist in a homogeneous way with different species.[19] The project would also create a habitat where humans can coexist in a homogeneous way with different species.



Fig.2. Green corridor.

7. Design strategies

Throughout this phase of the project, we began to question the existing environment of the immediate context. This analysis was done in order to create strategies where every detail of the area could be observed without forgetting anything. The process began by understanding everything that was happening outside the site so that a stage of design could begin, where the context itself is the one that is speaking within the design of the sports complex. These strategies began by taking the axes of exterior roads and the analysis of voids and built space. The intention of this is to create a vegetal, human landmark with sustainability and integrity.

8. Morphology

The morphology of the architectural element is based on the site analysis that was made, where the context gives an explanation to understand the clear rupture that is created through this property. The abandoned property functions as a visual edge at satellite level, this rupture creates a strong visual change from porous to dense. The project functions as a unifier of these two characteristics. The morphology of the site is born from the study of immediate roads and a creation of axes to give the design of the public area of the space. The baseball stadium design began to be analyzed from an aerial view. The intention of this form of design was to make the stadium be appreciated as a common space in this complex. The irregular shapes created by the stadium were already governed by the proposed "HELIO TRACE" wraparound skin that will be explained with the following fig.3.,fig.4. and reference [20].

9. Architectural Skin

Taking into account the morphological study of the architectural element, an envelope proposal is born, which has as one of its main purposes to benefit the interior of the project, through the implementation of strategies that are closely related to sustainable objectives. All this encompasses concepts such as natural lighting, indirect rainwater collection for reuse, efficient ventilation, taking advantage of relevant views, among

others.

After having carried out the morphological study and taking into account the objectives to be achieved, a construction system based on panels that form the skin of the architectural element, Helio Trace, was implemented.

9.1 Helio Trace

The system is designed to significantly increase daylighting while reducing the effects of solar heat gain for building occupants by up to 81% annually. When tested on-site, the system achieved a 42% reduction in total energy consumption for a New York City office tower.

As a kinetic curtain wall system, HelioTrace can literally track the path of the sun over the course of a day and over the course of a year. Three components make up the system: kinetic curtains on the exterior of the building; a prefabricated, thermally efficient building envelope; and interior chilled ceiling panels (more energy efficient than other air conditioning solutions). [20]

The curtains are operated by 'computer-driven ecological models' that take into account the building's seasonal climates and daily solar paths, as well as the building's programmatic use and operating schedules. This means they can be implemented anywhere in the world and allow a building to respond to solar conditions in different climates and orientations.

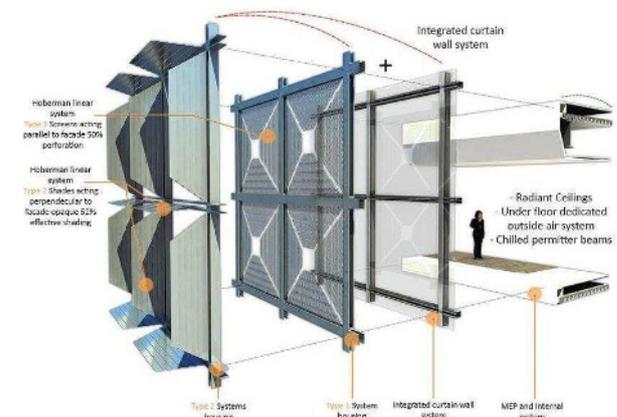


Fig.3. Helio Trace components.



Fig.4. Helio Trace diagrams.

System with 2 types of reaction to the sun. Type 1 gives 50% solar permeability, acting parallel to the facade. Type 2 gives 52% shading effectiveness, acting perpendicular to the facade. It also has a second part of

the system where there are special crystals to control heat.

Its solar protection system evolves when the sensors capture this solar incidence and these panels can change their shape to give better solar protection to the interiors. The curtain wall it has inside gives heat control inside the space. [20]

10. Construction system and its advantages

Throughout this phase of the project, research is generated and certain construction systems are selected to be implemented in different areas of the project, such selection was made taking into account the main objectives of the project and the concept of sustainability.

10.1 Bubble Deck system

Manufactured with recycled materials, it reduces contact formwork, in addition to providing plastic freedom, whether diagonal or curved, it has the best capacity for integration in different construction systems.

Compared to traditional alternatives, the advantage of BBD® is a tangible reduction in construction costs, achieving active construction results in 35% less time and up to 40% less labor costs. [21]

The BBD® system reduces the volume of concrete in the slab and integrates interior beams within the slab cant, resulting in open spaces for greater architectural flexibility.

It has high load-bearing capacity and stiffness, and due to its biaxial behavior, it provides greater flexibility for spans between columns, as well as high thermal and acoustic efficiency.



Fig.5. PET spheres.



Fig.6. Bubble Deck System.

Construction system based on spheres built 100% by recycling PET containers. The resulting slab has lightening properties and significantly reduces the use of standard concrete. [21]

11. Materiality

The project has a proposal of mixed materiality. This proposal is not only for aesthetics but also to create a comfortable space in the interior. Most of the proposed materiality is sustainable and has acoustic and thermal insulation characteristics. The purpose of this proposal is to reduce the use of electrical energy in the stadium. The stadium will be supported by concrete columns without load-bearing walls. The walls will be made of bamboo and rammed earth. These two were the main proposals for the walls because bamboo is a sustainable, light, flexible material that can be used not only in the walls but also in the stadium's furniture. It does not require specialized labor but does require special equipment for cutting or splitting. This same material also has good seismic resistance and helps to create warm spaces for comfort.[22] On the other hand, the construction method of tapial is based mostly on walls and its materiality is of wet clayey soil that is compacted with a rammer to create this wall. This material is widely sustainable because its compressive strength is local soil and its tensile strength can be made of various materials such as straw or horsehair, which replaces the use of steel. This material has excellent thermal behavior and acoustic insulation, it is not combustible in fires, it is a highly economical and ecological material and its demolition is also ecological. [23] In the urban area of the stadium, concrete tiles and concrete pavers will be used for the transition areas. In certain parts of the complex, a system of solar panels that are placed on the ground will be used for street lighting without the need to connect to the power grid. This system, called "PLATIO", is a solar paving for exteriors. Its materiality is totally sustainable because it is created from 100% recycled plastics with photovoltaic plates that are protected by a glass finish that is resistant to human weight and is non-skid. They are easy to install and do not require connection to the power grid, only to the lamps that will be providing energy. [24]

12. Sustainable strategies

The sports complex in the industrial zone of San Pedro Garza García aims to repair the damage caused by the industry in the area. This will be carried out with a large green area of trees that absorb the toxic substances in the area and work as a natural filter so that the air in the area is gradually purified and stops damaging the ecosystem and the locals. It also has solar panels and a mixed construction system where all the proposed systems are sustainable and thanks to them will be creating a zero energy complex. The construction system uses natural and recycled materials. The material that most damages the environment in this project is reinforced concrete, but we did not want to fall into the architectural style of reinforced concrete and zero ornamentation and we wanted to create a construction proposal that was totally sustainable. In order to be able to support the entire stadium, reinforced concrete was sought, but using it in a minimum percentage of the entire project. In the end, the concrete that will be used for the stadium will be created from the rubble of other constructions in order to reuse and avoid further damage to the mountains of Monterrey. The slabs will have a lightening agent made of recycled PET spheres. [25] The stadium will also have vegetable gardens in the terrace and bar area. These gardens will be used for the ingredients for the restaurants in the project, thus avoiding the use of vehicles to transport the ingredients. It also means that the ingredients that the restaurants will have will be totally natural, avoiding the use of preservatives and processed food. For the lighting of most of the project, solar panels will be used without the need to exceed the use of mains electricity and only leave its use for emergencies.

13. SWOT Analysis

The main strength of the project is that it takes into account many of the Sustainable Development Goals proposed in the UN's 2030 agenda such as: Good Health and well-being, Gender equality, Affordable and clean energy, Decent work and economic growth, Industry, innovation and infrastructure, Reduced inequalities, Sustainable cities and communities, Climate action, and Life on land with the purpose of carrying out a sustainable space that preserves and benefits the environment of the area to be intervened. [26]

In the project several opportunities can be observed, among which are that the space to be intervened is trying to create a space that promotes the health and welfare of users. The water to be used is clean water with sanitation, of which a certain percentage is reused and filtered rainwater for irrigation of the urban area and the stadium. Affordable and non-polluting energy will be available for the lighting of the outdoor area. It will generate jobs and economic growth for the area. The stadium has responsible production and consumption with the "Edible City" typology that is being proposed. Since our space is totally clean and our construction systems are predominantly made of recycled materials, we will be taking action for the local and global climate. An ecosystem for wildlife will be created within the project.

After a general analysis of the project as a preview, it is feasible to mention that one of the possible **weaknesses** that the project will face is the amount of investment that will be required for its construction.

After having made a general analysis of the project it is feasible to mention that the possible **threats** that the project will face are:

A I. That the emissions that will be generated in the construction process of the project are not greater than those that are planned to be avoided.

A II. The road traffic that could be generated in the different roads around the site, due to the different events that will be held in the complex.

A III. The deterioration of the quality of pedestrian traffic circulation, due to the traffic that could be generated as a result of the sporting events.

A IV. Deterioration of the infrastructure and facilities of the architectural element due to natural disasters.

14. Conclusion

After having made an analysis throughout the elaboration of the different phases of the project, it is feasible to mention that certain disciplines such as architecture play a very important role in the development of cities and set a certain pattern in the way they will do so over time.

Unlike the last century, in the last few years it has been possible to generate an approach more inclined towards the development and the proposal of a more and more sustainable and sustainable architecture, all this is generated thanks to the needs that arise in a community and the contextual events that are being lived at a certain date. [27]

In the last 10 years there has been a great increase in pollution in general worldwide, which encompasses certain key issues that if not attacked in time could deteriorate the planet in a shocking way.

The fact of creating an architecture that is friendly to the environment and that also benefits it is something that is setting the tone of the architectural typology that should be built and designed today, and in this way also marks a more friendly lifestyle towards the environment. The implementation of sustainability strategies in architecture is something that should not be left behind in the construction and design of each project, each one should generate a benefit for the user who inhabits it and for the community in which it is located.

Inclusion, universal accessibility and community integration is something that should not be left behind, public spaces are areas of opportunity to generate points where people can gather to recreate and coexist in a safe and stable manner.

The project presented above is a project that was born with one of the main purposes and objectives of generating transparency in a space where people can coexist and recreate safely, uniting the community in which it is located. All this hand in hand with the implementation of sustainable strategies that not only do

not pollute the environment but also generate various benefits to the community and the environment in which it lives. Finally, it is feasible to mention that the proposed project efficiently attacks the possible problems that were found in the area, in an effective and friendly way with the environment and the people around it.

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