Recycled Architecture: A Passive Design Approach for Existing Buildings in Temperate Climates

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ABSTRACT: Temperate climates present the ideal conditions for passive design. In most cases a 100% passive approach can successfully be implemented. Relatively mild winters, moderate hot springs and rainy summers count for some of the basic climatic characteristics in Mexico’s central plateau. Our paper documents the work on different buildings that have been recycled in Mexico’s central area. We have acted as main architects to modify them and obtain as passive as possible a building, taking into consideration the existing structure.

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Key Words: Temperate Climates, passive design, building recycling, ventilation, daylighting, thermal mass.

INTRODUCTION
It will seem obvious, in a temperate climate, to follow simple rules related to orientation, fenestration, sun protection, daylighting, landscaping and selection of materials to obtain a fully passive comfortable interior space. However, many existing structures present important problems in the thermal or daylighting conditions and solve them with the use of electromechanical systems.

As it had happened in many cities throughout the world, there was a shift between central areas to suburbia in the XX century. None the less, in recent years a pattern to reverse some of this migration has been observed, leading to the re-use of old housing units or the rehabilitation of commercial or even industrial buildings.

This population movement presents a unique opportunity for passive and low energy architecture, because the adaptation of old spaces for contemporary needs requires often additions and transformations of the structure.

Our paper documents the work on different buildings that have been recycled in Mexico’s central area. We have acted as main architects, and sometimes as consultants, to modify them and obtain as passive as possible a building, taking into consideration the existing structure.

2. GENERAL METHODOLOGY
Our approach departs from the building and its context, defining the critical variables and the most potential characteristics of what is already there. Generally the existing conditions can provide a project with valuable elements for passive design such as mature threes, massive materials, fenestration, optical qualities of surfaces, etc.

2.1 Diagnostic
Another unique situation is that an existing building can be measured not only on its dimensions but on its energy and environmental response. Therefore it is possible to know how it behaves to the environment in terms of indoor temperature, humidity, air flow, daylighting, radiant heat, etc. It is also very important to understand the surrounding constructions and natural elements, as often they have a determinant impact on the environmental response of a building.

We believe the first contact with the existing construction is very valuable as it provides critical information about the building, its context and the possible transformations that may happen.

2.2. Passive Design Priorities and General Strategies.
Once a general diagnostic has been made, we establish priorities of action as ventilation, daylighting, direct gain, thermal inertia, etc. We understand that all aspects of passive design are important. However, depending on the type of building, we decide to make special emphasis on some of them in a very early stage of the project.

It has been common in our work to have physical, technical or economic limitations on recycling projects, so it is useful to concentrate the resources on a limited number of strategies rather than a detailed analysis and proposal for every possible element. This approach is useful to us, as it reduces the cost and time of the project and simplifies the
construction of it. We have found in our experience that the time and money available for a passive design architectonic project is exactly the same as for a "traditional" project, however the analysis and proposals require a lot more time and money. Both issues are important, therefore a careful allocation of resources is critical to make the project economically feasible for the design office.

Figure 1: Psicrometric Chart for Mexico City

2.3. Proposals and Laboratory Evaluations

Once the general strategies have been established, a series of proposals are made and evaluated in scale models. When a proposal is selected, we reviewed it with computer models to fine tune its performance.

2.4. Final Drawings and Construction

After that we proceed to definite drawings and construction. A daily supervision and design adjustment on the building site is done for as long as construction takes.

2.5. Operating Building Evaluation

Finally an operating building evaluation is made to compare estimated results with reality and get a proper feedback.

In our society, a well designed passive building still has a limited added commercial value. Our clients and users usually request them because they are sympathetic with an environmental design and are able to appreciate the benefits in quality of life of a more natural architecture.

The use of traditional materials, schemes and techniques is very important to our design approach as we seek for a contextual design combined with the best possible technology. We believe that the use and understanding of existing structures, particularly on those built before 1920, starts with the fact that they have an empirical knowledge of the climate and physical conditions to a site that is usually underestimated in contemporary architecture.

3. SITE ANALYSIS

Our work has been concentrated on central Mexico, particularly in the cities of Cuernavaca and the metropolitan area of Mexico City. In both cases, the macroclimatic conditions are mild throughout the year. Winters are dry and sunny with cold nights, fresh mornings and comfortable afternoons. Springs are dry and the hottest time of the year with pleasant mornings and hot afternoons and nights. Summer is mild and rainy, with very comfortable mornings and rainy afternoons and nights. Autumns are pleasant with temperate days and fresh nights. However, there are significant differences between both cities and within them. So we carry out a microclimatic analysis for each project.

4. CUERNAVACA PROJECTS

Cuernavaca is located on the southern footsteps of the Sierra del Ajusco, sixty kilometers south of Mexico City. Well protected of the northern winds by high mountains, it has a warmer climate than Mexico City. Due to its topography of deep canyons, it is a linear city 12 kilometers long. Its altitude ranges from 1700 meters above sea level (m.a.s.l.) in the fresher and more humid north to 1550 m.a.s.l. in the hotter and dryer south end.

In the City of Cuernavaca, we have done some recycling as well as new projects. Of those we present here the recycling of a storage building into a housing unit (Los Hules), the remodeling of services areas into apartments (Las Palmas) and the recycling of a low cost public housing unit into a two bedroom bioclimatic house (Cuernavaca 7).

4.1."Los Hules"

Los Hules is one of our earliest projects. Located in the hot and dry south end of Cuernavaca, there was a large piece of land of 1200 m2 with several fruit trees: avocado, guava, lemon, mangoes, etc. and a small building used as storage area and bathroom.

We decided to convert the storage room into a one bedroom weekend housing unit and conserve all trees for their environmental as well as landscape value. In the early analysis, it was evident the importance of the existing mature trees as well as the mass storage of the 35 cm. stone masonry walls of the existing construction because of the typical above comfort zone air temperatures in the afternoon and the large daily temperature swing of 17°C.

For this weekend house, we develop an open space house concept. Instead of building a large covered area, we restricted the roofed area to the existing storage room and designed terraces and paths to be used during the daytime. The closed construction would be used exclusively at night and in case of rain. A newly designed terraced garden would have all the daytime activities spaces and furniture.

The land plot had a low area in the center with a large tree. A 20 meter bridge linking both sides of
the land was build. It works as a walking path, houses a bathroom and storage area and shades a lower terrace. We designed under the bridge a large terrace to be used as living room with the canopy of the tree as its “roof”. A mango tree next to the building was used as an open space dinning room with a large round table and another terrace. The existing construction was modified to fit a bedroom, a small kitchen and a bathroom. Full size operating windows and shading devises were added.

Figure 2: Apartment, canyon and natural reserve at Las Palmas

4.2 Las Palmas
Las Palmas is the recycling of a service area into a small guest apartment, a suite and a service apartment. They are additions to a larger weekend house. As in the previous example, the buildings are in a large land plot of 3500 s.m. in the northern area of Cuernavaca. The plot is bordered by a 50 m. deep canyon with a small ravine on its east side. Further towards the east there is an conservation area on the other side of the canyon.

Although it is the same city, the microclimatic conditions are different from Los Hules. This time there was a very convenient cold wind pattern flowing through the canyon, the air temperature is cooler, humidity higher and the temperature swing smaller. This time we decided to give priority to sun shading and cross ventilation.

A section was added on the east side to take advantage of the excellent views and ventilation conditions. A new roof was done allowing large overhangs on the east and west sides for solar protection. All windows were modified without affecting the existing structure to provide a maximum ventilation area.

4.3. Cuernavaca 7
Cuernavaca 7 is the recycling of a low income housing unit built (80 m2) as a part of a small development into a house for an elderly couple. This time the lot is fairly small (8x20m) in a densely built environment in the central area of the city of Cuernavaca. Because of the heat island created by the intensive building, the lack of trees and the obstruction of wind patterns, the average outdoor temperature as high as higher in Los Hules and the relative humidity is low.

As general design strategies we decided to emphasize natural and mechanical ventilation, humidifiers and sun shading.

Perimeter walls were done for privacy and sun shading, a vegetal canopy was grown in the roof, all fenestration was redesigned to allow for natural ventilation, and shading devises built for all windows. Additionally a rain water recovery system was developed and its water used for a back yard.

Figure 3. Indoor fountain at Cuernavaca 7

5. MEXICO CITY PROJECTS

Mexico’s City has a very large metropolitan area of 80 kilometers in diameter. It includes the valleys of Mexico, Texcoco and Chalco and the surrounding hills. Its altitude ranges from 2250 to 2400 meters above sea level. As a result of its large dimension and important altitude differences a series of microclimates are found. On its central area there are “islands of heat” (Jauregui, 1980) with temperatures up to 3° higher than the city’s average. In contrast the hills surrounding the city are cooler with average temperature drops of as much as 2.5 degrees. We would like to comment on recycling projects: Laboratories and Workshops for the UAM, Tepotzotlan I and II

5.1. Laboratories and Workshops for the UAM
Laboratories and Workshops for the UAM was the first large commission for us with a clear bioclimatic aim. We were requested to present proposals for a 2000 m2 addition to an existing building to house school workshops and design laboratories at the Azcapotzalco Campus of the Universidad Metropolitana. The site on the northern edge of the Valley of Mexico is in the mid of an industrial area and exposed to strong northern winds.
We choose a scheme that developed two courtyards to produce a microclimate using vegetation. Because of the nature of the materials used at workshops, we created a natural high speed extraction system for some spaces and promote general direct gain with south fenestration. Another key element was day lighting. These strategies were tested with large scale models.

5.2. Tepotzotlan I and II

In the northwest edge of Mexico City’s metropolitan area is the old town of Tepotzotlan in the footsteps of the Sierra de Tepotzotlan. Its altitude and location on a hilltop give it a colder weather than Mexico City in the winter, with low pollution and intense solar radiation.

The houses in Tepotzotlan are the recycling part of the ancient administration offices of the XVII century college and monastery. In Tepotzotlan I, only one room belonged to the old construction and had a series of XX century additions on a 1000 m2 site. The most relevant features are a irrigation channel (zanja real) that crosses the site dating back three centuries and a series of very old trees. Tepotzotlan II is another part of the same ancient construction on a 360 m2 site. The old building was totally on ruins.

As design strategies, in Tepotzotlan I we decided to recover as much as possible of the original buildings, we also added roof direct gain elements, changed floor materials to low conductance, increased the mass of the flat roofing and installed double pane windows.

In Tepotzotlan II we added a greenhouse, rebuilt the ancient southern portico, restored the highly massive adobe walls (1 m. thickness) and designed a modern version of the ancient doors and their shading devices.

6. CONCLUSIONS

For the last twenty years we have been promoting the use of a passive design approach on buildings. Each built experience has enriched our knowledge and has taught us some new possibilities of use and application of a bioclimatic approach on building recycling. In most cases, buildings have behaved according to what we aimed. However, natural elements and human users are dynamic and change constantly. A well designed building produces satisfaction to its users and leads to new commissions and challenges. None the less, the first person to identify our mistakes is the user, so we always hear carefully their complains and suggestions.

From the examples shown on this paper we can conclude:

- Microclimatic conditions can lead to totally different design strategies within the same city.
- It is possible to develop a fully passive architecture for almost any building type on a temperate climate.
- We avoid movable parts, except for manual window operation by users
- The most simple is usually the most effective solution to technical problems.
- Integrating outdoor space has been very well appreciated by users in the form of porticoes, terraces and gardens.
- Vegetation (trees, shrubs and ground covers) is the most effective and economically sound strategy for microclimate manipulation and sun shading of existing buildings.
- Material selection and thermal mass can have a significant impact on the indoor conditions.

REFERENCES