390: CASA NAT – Reference Centre for Sustainable Building in Urban Area

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Abstract

Proposal: As cities contribute significantly to global climate change, architecture projects should present solutions to reduce the environmental impacts from buildings. *CASANAT* is an architectural project, based on sustainable principles and technologies, designed to become the headquarter of FoE Brazil (Friends of the Earth Brazil) and Magda Renner Documentation Center, aiming to constitute a Reference Centre of Sustainable Building in Urban Area. The building is located in downtown *Porto Alegre*, southernmost capital city of Brazil, incorporating low impact technologies, viable in the city, integrating aspects of bioclimatic design with the preservation of the historical patrimony, environmentally qualifying the spaces. **Objective:** This paper aims to present the results of a sustainable architectural project in an urban area, developed in a participative process. **Methodology**: The project resulted from a transdisciplinary process, developed in a cooperative experience involving FoE Brazil members and local community. **Results:** Strategies referring to energy efficiency and environmental comfort; appropriate technologies and low impact materials; use of rainwater; wastewater treatment and productive landscape.

Keywords: urban sustainability, sustainable buildings, participative process, design methodology

1. Introduction

Cities result from the way buildings, activities, services and transports are developed.

In developed countries, buildings consume more than half of all energy they use, and produce more than half of the gases which change the climate [1].

CASANAT is an architectural project, which aims to contribute in showing solutions to reduce the environmental impacts from buildings. It was based on sustainable principles and technologies, and was designed to house Friends of the Earth Brazil (FoE Brazil).

FoE Brazil is an environmental non-governmental organization (NGO), with more than forty years of work, and is a member of Friends of the Earth International. The NGO received the donation of a house in downtown *Porto Alegre* from the Brazilian Union Patrimony. It will both house the first headquarter from FoE Brazil and Magda Renner Documentation Center, that includes more than 2,000 titles on environmental and social issues, and the history of the environmental movement in Brazil.

FoE Brazil believes that working upon measures to halt climate change, reduce greenhouse gases emissions, reduce the social and environmental impacts and achieve a peaceful and sustainable world based on societies living in harmony with nature, is (among other things) promoting sustainable cities.

As the house to her donated needed a renovation, FoE Brazil hired a team of architects with previous experiences in sustainability and in social and environmental movements, in order to design a Reference Centre for Sustainable Building. The design team also engaged other professionals, users and the local community, through open activities.

This paper aims to present a practical example of a sustainable architectural intervention in an urban area, developed by a participative process, searching to conciliate the diverse dimensions of sustainability. The project applies low impact technologies viable in an urban context, which integrates aspects of bioclimatic design with the preservation of the historical patrimony, environmentally qualifying the spaces.

2. Methodology

The project method used a transdisciplinary process, that included a group of ten architects, involving FoE Brazil members and local community. It was a collective experience, based on cooperative principles, integrating users and promoting open activities, such as a "*charrette*", and technical seminaries with the local community (Figure 1).

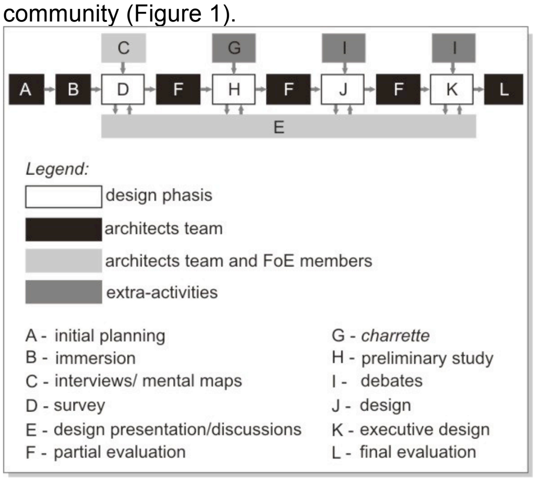

Fig 1. Sketch of the process

2.1 Process phases

This process was divided in four conventional architecture's design phases, adding extra activities, which were organized to encourage the architects team integration and concurrent participation of specialists, collaborators, clients and all others interested in *CASANAT* project.

During all the process the architects met weekly, when they shared the work, according to the time availability and specific skills. The work's phases and other activities are presented below:

a) **initial planning**: initial meetings of the design team for organization and definition of the principles management that would orientate the work, thus setting a working plan proposal;

b) **immersion**: one day meeting, outside the city, with a facilitator, for discussion of the team's vision, mission and glue, as well as defining papers and ways of sharing the remuneration and organization of the work;

c) **interviews and mental maps**: architects team and FoE Brazil members (building's future users) interaction to define the program of needs, through understanding each other´s functions, activities, expectations and needs concerning the future working space;

d) **phase 1- survey**: first phase of architecture design, including interviews, physical and photographic survey of the existing building, neighborhood analysis, feasibility study, references research and *Charrette* organization;

e) **design presentation and discussions**: presentation and discussion meetings with the client, in the middle and in the end of each project phase, evaluation and contribution moments between the architects team and future users;

f) **process partial evaluation**: architects team meetings, at the end of each work phase, to evaluate the work process, to verify how each person was perceiving the process and the evolution of the development of the project;

g) ***charrette***: main collective design activity, which happened during two days, with the participation of 25 people, aiming at raising ideas, concepts and guiding principles to initiate the architectural design;

h) **phase 2- preliminary study**: phase in which *charrette*'s results were systematized and a general guideline was defined for the project;

i) **debates**: activities open to the local community, in which technical solutions were shared and discussed deepening discussions on principles and techniques for a more sustainable house in an urban area. At these moments, specialists in each area made clear the technologies that would be applied in the design, such as photovoltaics, sustainable use of timber and biological wastewater management.

j) **phase 3 – design**: the most challenging phase of the project that raised discussions and required creativity from the architects, so to conciliate the design with lawful requirements, regarding mainly the open areas and volumes, introducing at this point a technical consultancy in wastewater treatment;

k) **phase 4 – executive design**: project's detailing, approval, and partnership with FoE Brazil to divulgate the project and seek financial resources for the construction;

l) **final evaluation**: conclusion, process evaluation and planning of the construction process.

2.2 *Charrette*

This was the richest activity of the participative process; thus, a section of this paper is dedicated to explain it in more details.

Charrette is an expression related to an intensive workshop with specialists consultants and interested in the results or/and planning of a specific project. For green projects, environmental, economic and social issues are considered, searching for a consensus between several ideas.

CASANAT charrette occurred in January 2007, between the first and second phase of the architectural design, aiming at aggregating the distinct visions and solutions at the start of the project. This event gathered 25 people, among them: the architects' team, Friends of Earth Brazil members, specialists and academics. It was the richest moment in terms of ideas, resulting in a rich experience, with definitions that guided the project until the end.

The *charrette* happened in two days, in *Rincão Gaia*[1], a reference place in sustainable technologies and environmental regeneration. The first day was filled with presentations, contextualization, meetings and first information

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[1] *Rincão Gaia* is the rural headquarter of Gaia Foundation, environmental entity founded by *José Lutzemberger,* a former receptor of the *Right Livelihood Award*.

exchanges. On the second day, the first design proposals started to become clear.
During the event, an atmosphere of dialogue was created between the project's pragmatic data and the dreams, based on the experience of each person. Circle format was the most common for better visualization and equality among people in discussions and opinion expressions. Figures 2 and 3 present some of the circle events.

Fig 2. Individual presentation moment

Fig 3. Contextualization and presentation

In the first moment, the whole group was divided in five small groups, called "First Impressions", to discuss the basic design guiding principles. After that, the initial group was re-arranged in other five small groups, called "Thematic Groups", that discussed questions regarding *Sustainability Criteria and Construction Materials*, *Bioclimatic Architecture*, *Water and Waste*, *Energy* and *Uses, Function and Neighborhood*. At the end of the first day, a summary of these discussions were presented to the whole group.
In the following morning, three new small groups presented a general synthesis, regarding the ideas previously discussed and generating the first sketches, including the program of needs and the sustainable technologies. Figures 4 and 5 illustrate some of these moments.

Fig 4. Firsts impressions groups

Fig 5. Participants doing their firsts sketches

After that, the proposals were presented, being evaluated by the whole group. Finally, there was an event evaluation, when the participants expressed impressions about the process and the project. It was verified that the whole group was satisfied, not only with the result of the activity, but also with the process, and in fact, they were not tired, but full of happiness and with renovated energy.

3. Principles, Concepts and Design Guidelines

The design principles work as a guide to reach the balance between the several dimensions of sustainability: social, environmental, economical and cultural. They provide the merging of the architectural design and the context where it's inserted, in systemic process.

3.1 Sustainability principles in the construction

The sustainability principles work as a checklist helping in the design. According to the understanding of the design group, the sustainability principles can fit into the sustainability dimensions in the following way:
- **Social** - when pursuing the participation and the interdisciplinarity, counting with the collaboration of people from many fields, with their different points of view; when considering FoE Brazil headquarters as a space of environmental education for the community; while creating integrative spaces for the interrelation between users and visitors; and providing universal accessibility.
- **Cultural** - when preserving the cultural patrimony; when dignifying the local memory, integrating it harmoniously to the context; when preserving the authenticity, conserving the original characteristics of the existing historical construction.
- **Economical** - when optimizing the planning of the construction, selecting low cost materials, considering its life cycle.
- **Environmental** - when optimizing the use of the resources, using materials of low environmental impact and appropriate technologies; and promoting closed cycles for water, nutrients and energy.

3.2 Generating concept and design guidelines

The design guidelines were elaborated based on the sustainability principles, on the program of needs and on the several ideas resulting from the collective activities. Synthesizing the convergence points among the several aspects involved, Figure 6 illustrates the concept that guides the design.

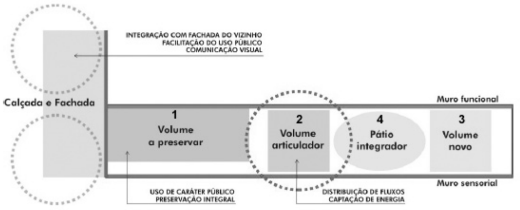

Fig 6: Convergence points for the design.

The main guidelines directing the proposal were the following:

- **Volume to preserve (1)**: *existent construction* to be preserved and restored with public character functions, including reception, library and documentation center; this volume remains with its original facades, but received a mezzanine that required an intervention in its roof;

- Volume of connection (2): *central volume of circulation* - with the stairway, supporting services (restrooms and kitchen), water tanks and access to the central courtyard; connecting and distributing several flows in addition to the collection of energy; except from the bathrooms and the kitchen, this volume is basically built in wood and glass, creating a conservatory; its roof will receive the solar collectors (water heating and photovoltaic panels); the kitchen volume has a green roof that can be accessed through the stairway;

- New volume (3): *new construction, with two floors and a green roof* - the spaces were designed for a multi-functional room on the second floor (meetings and lectures) and for an integrated work room, directly linked to the open areas on the ground floor; the second level of this volume is accessed by a footbridge, creating a covered passage on the ground floor, integrated to the courtyard; behind this volume there's an accessible ventilation backyard, with walls covered with creepers;

- Open areas (4): *sidewalk and courtyards* -: integration of the public sidewalk to the construction; access prominence and valuation through visual communication, and creation of a sensorial welcoming green wall; internal courtyard articulator, with interaction spaces allowing outdoors meetings, productive gardening and wastewater management, soil permeability, cross ventilation and day lighting.

4. Strategies

4.1 Preservation of the Pre-existing Volume

The house donated to FoE Brazil is a simplified example of an eclectic style, combined by two volumes. The main building volume facing the street was kept as it was, and the volume at the back was demolished, as it was too small to meet the NGO needs and had less historical importance.

To value the authenticity of the front volume and considering its conservation state, the design rescued and restored the original constructive solutions, such as: the structural walls, with their massive ceramic brick blocks, the floor and its structure in wood, the paintings, the windows' structure in wood, among other components.

The new elements incorporated into the existing house use a contemporary language, and different materials, to make clear the difference between the old and the new. The interventions made possible to identify the different historical moments from the building. (Fig. 7)

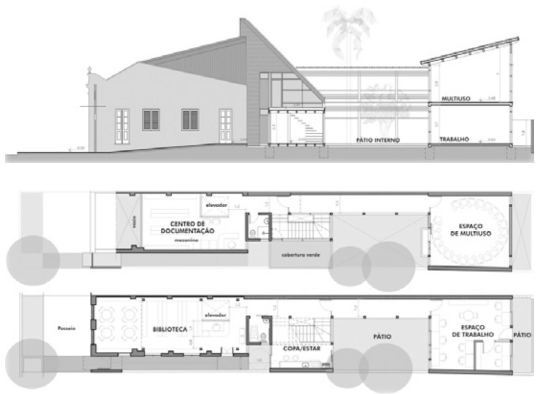

Fig. 7 Longitudinal facade and plan from the second and first floor.

4.2 Selection of low impact materials

Construction is responsible for a considerable part of natural resources consumption. Such impacts require immediate actions to reduce the scale and speed of nature destruction. The criteria for selecting less damaging materials to the environment must consider: the evaluation of its proprieties and the analysis of the whole of their life cycle, since extraction until discarding, mainly of those referring to the use of natural resources [2].

The materials adopted in more sustainable construction should: be with minimal manufacturing energy or effort; allow the building to breathe, be extracted from places near the construction; be tuned to the local culture; be derived from a known technology; and having no toxic elements in their composition [3].

Following the above principles, the structural components used: massive ceramic bricks for structured walls, wood and glass for the others walls. In comparison to other materials, those chosen have low embodied energy, among others advantages. Some materials from the demolished original back volume will be used in the new one. The use of materials such as cement, PVC and aluminium, that are highly intensive in energy, or that emit pollutants and/or toxic gases, was avoided.

4.3 Energy supply

Solar energy is the source of all existing energy on Earth. It's natural, free and inexhaustible. To promote its use, forty 50 Watts photovoltaic panels, and four flat plate solar collectors were specified for use on the roofs of the building. Solar geometry and adjacent buildings were considered in simulations made to identify the areas most likely to have a greater solar incidence. The simulations identified the exact area with a solar window between 12 p.m. and 04 p.m., representing a minimum of four hours of solar radiation incidence in the summer solstice and in the worst situation of winter solstice (Fig. 8).

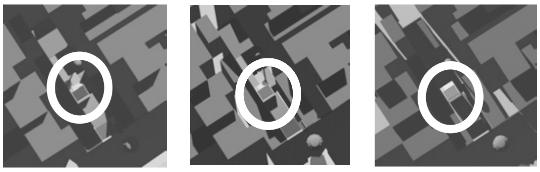

Fig. 8 Solar incidence in winter solstice, noon., 2 p.m. and 4 p.m. (the circle indicates the location of the photovoltaic panels)

4.4 Environmental comfort

Environmental comfort is more likely to be achieved when the construction is designed tuned to the climatic conditions of the area where it's located. A more sustainable design requires the adoption of bioclimatic strategies that minimize energy consumption.

Air temperature in the city of Porto Alegre varies significantly along the year, and relative air humidity is high, both in winter and in summer. In that way, the bioclimatic strategies should provide passive heating in winter and cross ventilation in summer. In addition to this, the construction should include thermal mass, diminishing the loss of heat in winter and the quick rise of temperatures during the summer [5].

As the plot is very narrow, the newly added volumes, the internal courtyard and the small backyard were designed in a way to optimize the use of daylight and cross ventilation in all rooms (Figure 09). Vegetation was also used in every open space, as a strategy for cooling the air in summer.

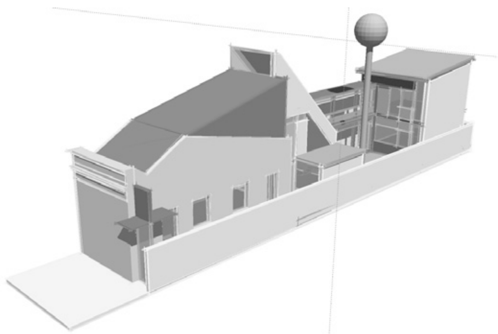

Fig. 09 – Designed volumes for improving daylighting and cross ventilation.

The positioning of openings on the top of some walls allows the exit of the hot air, when necessary - *stack effect*, as can be seen in Figure 10. Tiles and translucent materials receiving the sunlight help trapping the heat in cold days. The vertical circulation volume works like a greenhouse in winter, allowing the heating of the existing building, but protecting it from the incidence of too much direct sunlight in summer. The proper use of materials, such as wood, ceramic bricks and tiles, in addition to the insulation given by green roofs, helps to keep the indoor temperatures within comfort levels. Small openings at the floor level allow convective ventilation indoors, during the summer. Ventilation under the library floor is expected to reduce its humidity.

Minke [5] refers thermal insulation as the main benefit of using green roofs, another thermal strategy adopted in the building. However he mentions others, such as: retention of pluvial waters; reduction of the paved surfaces; production of oxygen and absorption of carbon dioxide; powder retention and absorption of noxious particles; acoustic insulation; fire protection; production of pleasant aromas; aesthetic beauty; integration with the landscape.

The program of needs considered the provision of adequate acoustic comfort. That's why the library and the documentation center, spaces that need silence, share the same volume, while the offices, that unavoidably will be noisy, are acoustically buffered by a courtyard, and house in another volume. Materials chosen due to their acoustical characteristics, as wood and ceramic bricks, and constructions using cavity walls, will contribute to noise insulation.

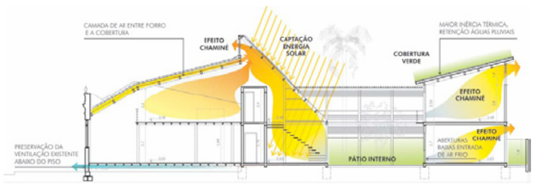

Fig. 10 - Some adopted bioclimatic strategies.

4.5 Wastewater management

The proposed system for managing wastewater, aims at contributing to minimize the environmental damage and uses reused water to irrigate the productive gardens. Wastewater is managed according to its origin: clear, gray or black. The first comes with the rain. Gray water is the residual water that originates from the shower, bathtub, lavatory and kitchen. The third group includes the water coming from the toilets. The splitting of the liquid residues contributes to improve the effectiveness and economy of wastewater management [6].

- Gray waters: the grease trapping and its primary settling constitute the two main steps of the process: a larger camera receive the effluents from the lavatory and shower; a smaller camera collects the water coming from the kitchen sink splitting solids and fat, when let to settle for two hours.

- Black waters: the treatment is constituted of a bi-compartmentalized anaerobic reactor, where the first two tanks work as decant-digesters and the third is an anaerobic filter of descending flow. The effluent wastewater is conduced to a biological filter using vegetation where evaporation, transpiration and infiltration occur. In the first two tanks the bacteria digest the nutrients (what for us constitute an undesired residue), the outflow is wastewater of better quality. The process is optimized with a retention time of at least 24 hours and, practically, there's no need of additional cleaning. The effluent water from the biological filter will be discharged into the public sewers.

- Clear waters: the collection of the rainwater reduces the use of clean water, being fit to be used mainly in the toilets. The collection of rainwater will occur in all coverings of the construction, being directed to a specific reservoir that will supply the toilet and to a cistern in the internal courtyard, contributing to the garden irrigation. In case of drought, the position of the faucet allows pumping a third of the height of the clear water tank capacity, enabling the flow of the water from the public water supply.

4.6 Productive landscape

Productive landscaping is located in the internal courtyard, that acts as a buffer between the volumes, integrating architecture, users and nature. This place will enable leisure activities and meetings.

Some existing native vegetation has been preserved, as the *Jerivá* (*Syagrus romanzoffiana*). Architectural elements were inserted, as permeable pavements, renewable and low impact materials. The landscape elements used were herbs spiral, a flowform [7] and the composting facilities. These elements are identified with the concepts of materials' and flows' optimisation, and respond to the urban life demands, as they require small places and low maintenance [7] (Fig. 11).

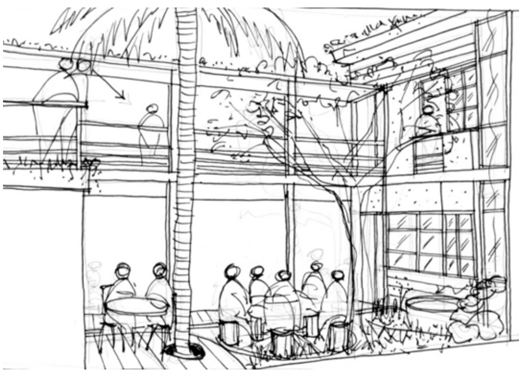

Fig. 11 View of the designed productive landscape.

5. Conclusions

During the design process of FoE Brazil headquarter, the architects' team worked to overcome several challenges. In the architectural design the challenge was to rescue and restore the existing building volume, adding new constructions and aiming at generating the minimum impact possible, in a small and urban area. In the design process, the challenge was to integrate a team of ten architects, users and the local community, by means of open activities.

The project shows viable alternatives in the current context, looking for technologies which can be easily replicated in other projects, considering both their costs and accessibility. The expectation of the authors and all of the project team is this demonstration project to become a reference for other buildings to apply appropriate technologies to their local environment, hoping that such actions might contribute to the movement aiming at a more sustainable urban planning that will lead us to more sustainable cities.

The "Reference Centre for Sustainable Building in Urban Area" aims at becoming a built example of environmental education, able to demonstrate sustainable technologies and concepts which can be used in ordinary houses, delivering the message that actually there are alternatives for improving our health, quality of life and the respect for the environment.

6. Acknowledgements

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