672: Recycling and Vocational Education Center designed with Low Human and Environmental Impact Principles

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Abstract

This proposal is a Diploma Project developed at School of Architecture and Urbanism at University of Sao Paulo, Brazil, in December 2007. The project is based on principles of sustainable concepts that can be applied for a building. Thus, it has tried to join social, economic and environmental aspects. The construction is composed of three linked up blocks: an educational center, a paper recycling factory, and a restaurant. The needs of the program was defined by the surrounding area context and by researches made at the city hall and some private entities.

The solution chosen for this matter considered the area features. That means that the focus was given to environment, approaching the river to the community and valuing the green area that already exists. Also, it focused on social insertion once it was designed to be a vocational center, helping people to develop their skills and to learn a profession.

In short, this paper shows that sustainable strategies can be taken at any stage of a project, from the choice of materials to the concern for social characteristics of the region.

Key-words: low environmental impact, comfort strategies, sustainability

1. Introduction

At the beginning of XXI Century, questions involving the environment have emerged more often. With the fast and raising consumption of natural resources, like water and energy, the discussion about sustainability in construction has become essential.

But what exactly would define a sustainable project? Even though the discussion has been stronger nowadays than in the past few years, sometimes the concept is not used properly. According to Roberta Kronka [6, 7], sustainability is a wide used word and has lost its real meaning. Questions like comfort strategies and surviving are approached with the same importance. For this reason, Kronka has created the expression “low environmental and human impact architecture”, which would better define the focus of this work.

Another interesting point-of-view used in this work is Richard Rogers concept, in his book “Cities for a Small Planet” [8]. He emphasizes that the sustainability applied to cities and buildings must be coherent to our social, environmental, political and cultural objectives. In addition, the author defends that the economic and physical features from the studied region must be considered. After all, the dynamism of the cities is essential to sustainability, which has to be fast enough to keep up with the society changes.

Many experiences related to architecture, urbanism and sustainability have been made all over the world, especially in Europe. However, this practice is not very common in Brazil yet. Attempting to apply that in the Brazilian architecture, this project includes new technologies to make better use of natural resources, adding project strategies with less impact and then, ways to obtain better energy efficiency.

Finally, there is a social responsibility implicit in this project, once it is conceived to be a vocational center and a recycling factory.

2. The context

2.1 Area features

The area chosen for this project is located in Jundiaí, a city near Sao Paulo, Brazil (Fig. 1). In its perimeter there is an important road axis, a river, a botanical garden and a poor community. The surrounding area is basically compound of commercial and service establishments, and residential areas (Fig. 2).

Fig 1. Project Area.
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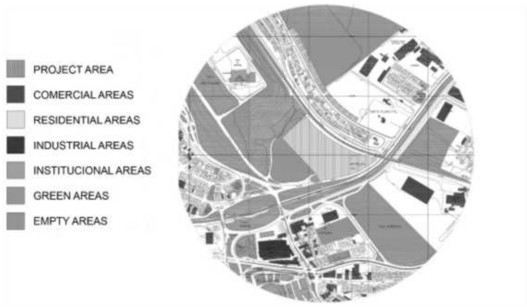


Fig 2. Surrounding Area.

The demographic density of the city is about 770 inhabitants per square meter, and its urbanization index is almost 94%.
The predominant climate is mesothermic. The latitude is 23º 11’ South and its Longitude, 46º52’ West. The annual rainfall is at an average of 400 mm. The annual temperature is at an average of 20.9°C, and the predominant winds are southeasterly.
Other important features are the relative humidity of air, which is about 70% and the annual insolation, which is at an average of 2.480 hours.

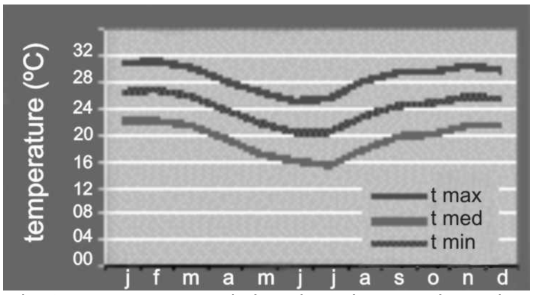


Fig. 3. Temperature variation along the year. (Based on Sao Paulo data- Software Climaticus 4.2)

2.2. Needs of City and Local Population
The first purpose of this project was the development of a vocational center. However, during the research stage, the project program was enlarged due to local needs, resulting to a complex that joins school, recycling factory and a restaurant.
Many public entities were consulted in order to get the diagnosis of the area formulated.
Even with its great logistic potential, the city does not have enough qualified labor. Due to this situation, many companies have to invest in training, and many times those trainings take three to four months what makes the city less attractive to them. So, the implementation of a vocational center would be justifiable.
According to interviewees, the most necessary courses at the area are related to information technology, gastronomy and hotel management courses.
So, the vocational education center was designed according to these needs. In the complex there are blocks designated to each one of these courses.
Also, there is a poor community compound by 1,900 inhabitants around the area and many of them already collect paper on the streets for recycling purposes. Based on this feature, a small recycling factory was designed, too.
Finally, for the gastronomy course, a restaurant was projected near the river area. This can be a profitable activity as well.

3. The Project

3.1 Guidelines for Project
The master plan (Fig. 4) was defined from observing the solar orientation, the land features and the community.
There is a railroad separating the local community and the project area. So, an underpass is proposed to connect both sides. Next to it the recycling paper factory was located.
The attempts to approach the river to the population have made small changes in the main avenue direction, enlarging, therefore, the green area between river and road. The restaurant was located in that place.
Then, a pedestrian awning was designed to connect the school block to the restaurant block. That crosses the avenue and allows the access to both buildings.
In relation to roofs, one of them is used for keeping and reusing rain water and others are accessible green roofs with permaculture areas, emphasizing the social focus proposals.
These green roofs ensure thermal comfort for users and create green areas to be used at free times. They are placed at the second floor of the buildings. So, the connection between constructions is not only at the ground floor, but five meters above, too.
Besides analyzing winds direction and north, the building orientation was defined to value the botanical garden.
To qualify the landscaping design, there are two courts, an arena and woods near the restaurant.
Finally, all the sidewalk area is compound by tiles adapted to blind people, ensuring accessibility. Also, many tiles are permeable to water.

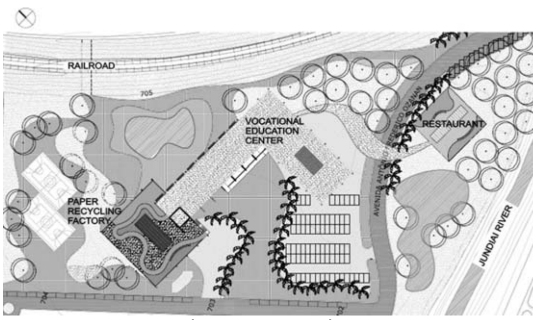


Fig. 4. Master Plan.

Other important decision in this project was the materials definition and construction systems.
The conscious choice of materials is one of the starting points to provide low human and environmental impact [10]. So, an analysis of embodied energy of materials and its toxicity was studied. [6,7] (Tab. 01, Tab. 02).
A software program, called *Bees 4.0 (Building for Environmental and Economic Sustainability) [12],*

was used to evaluate and compare some materials performance, like environmental performance by life-cycle stage, global warming and embodied energy (Tab. 02).

	Brick	Ceramics Covering
Availabiity of raw materials	very good	very good
Environmental Impact of the extraction	excellent	good
Efficiency on embodied energy	good	good
Durability	good	excellent
Maintenance	good	excellent
Reuse	bad	very bad
Recyclability	excellent	good

Table 01. Environmental Impact - Ceramics. Source: Kronka, 2002, p. 117. [6]

Product Parameters		
Parameter	**Anon Brick1**	**Anon Brick2**
Transport Mfg to Use in km (mi)	0 (0)	402 (250)

Ecological Toxicity by Life-Cycle Stage		
Category	**Anon Brick1**	**Anon Brick2**
1. Raw Materials	7,4	3,36
2. Manufacturing	4,41	4,41
3. Transportation	0,13	0,72
4. Use	0	0
5. End of Life	0	0
Sum	11,94	8,49

Ecological Performance by Life-Cycle Stage		
Category	**Anon Brick1**	**Anon Brick2**
1. Raw Materials	0,14	0,01
2. Manufacturing	0,01	0,01
3. Transportation	0,00	0,00
4. Use	0,00	0,00
5. End of Life	0,00	0,00
Sum	0,15	0,02

Economic Performance (Present Value $/ Unit)		
Category	**Anon Brick1**	**Anon Brick2**
First Cost	8,03	8,04

Overall Performance (Score)		
Category	**Anon Brick1**	**Anon Brick2**
Economic Performance - 50%	25	25
Environmental Performance - 50%	44,9	5,1
Sum	69,9	30,1

Note: Lower values are better

Table 02. Analysis of two similar kinds of exterior wall finishes, but from different origins.

Source: Simulation with Bees 4.0 (Building for Environmental and Economic Sustainability) [12].

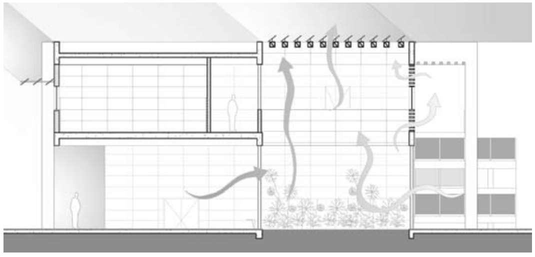


Fig. 5. Section of vocational education center.

From these studies there was an attempt to take advantage of low environmental impact materials existing in the region, reducing damage associated to transportation. Ceramics, as one example, was one of them, due to its large availability in the region, its reasonable cost and good efficiency on embodied energy.

All that makes the construction process faster and cheaper. In addition, there is an important benefit which is the local labor knowledge about constructive systems of local materials [5]. The building components more often used in this project was pre-cast concrete, ceramic panels and wood.

All these elements were applied to ensure rationalization and speed in construction. They also contributed to comfort strategies, like ventilated facades, photovoltaic panels used as brise-soleils, and concrete elements that allow natural ventilation inside.

Also, there was an intention of water and energy consumption reduction. A portion of the energy used comes from photovoltaic panels. The last feature was the physically disabled people accessibility concern. All the buildings were equipped with ramps or lifts for access, and all the sidewalk area has tiles with raised dots and lines to guide blind people.

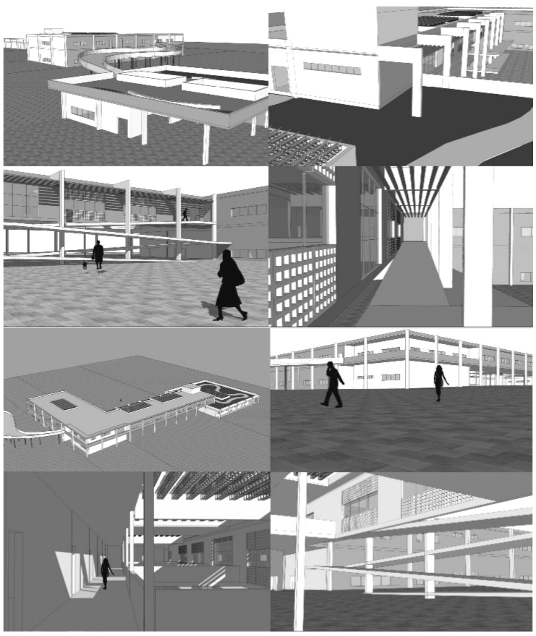


Fig. 6. Perspectives from the project.

3.2. Sustainable strategies

All the sustainability strategies applied were related below. They were divided into social, environmental and economic aspects.

3.2.1. Social Features:

- Local analysis;
- The concern for the poor community from the surrounding area;
- The program of needs based on the context diagnosis;
- The purpose of a Recycling Paper Factory, stimulating cooperativism and of a Vocational Education Center;
- The ISO 26000, that deals with social responsibility;
- Insurance of accessibility to physically disabled people (Fig.7);

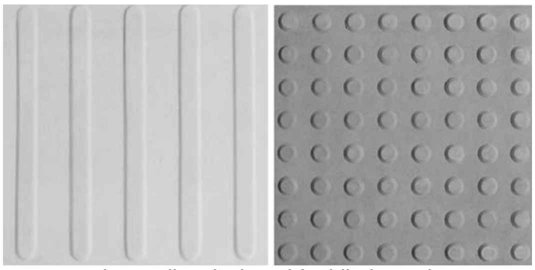


Fig. 7. Tiles designed for blind people..

3.2.2. Economic and Environmental Features:

- The choice of materials which come from the region, like concrete and ceramic.
- Option for concrete tiles with recycled components, and permeable tiles for outside areas;
- Rationalization in construction: all the building dimensions are multiple of 1.25 meters, the length of concrete panel (fig. 8);

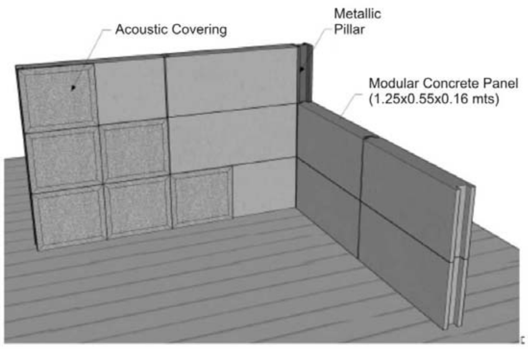


Fig. 8. Modular concrete panels.

- Ceramic Panels on the facades, ensuring ventilation along exterior walls (Fig. 9);

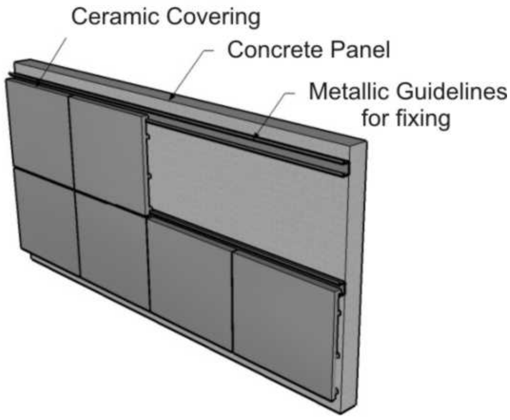
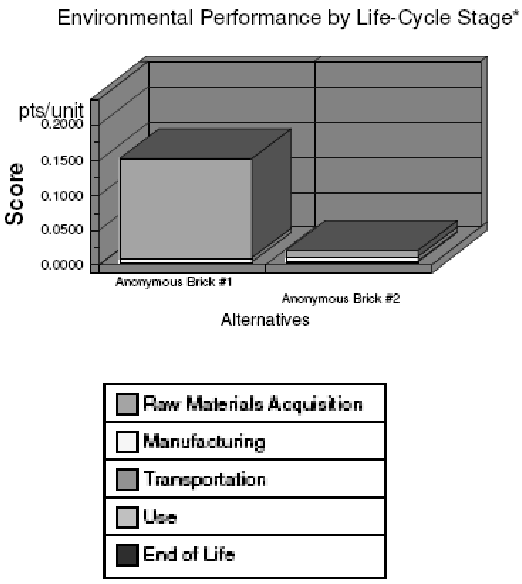


Fig.9. Modular concrete panels.

- Simulations with Bees 4.0 (Building for Environmental and Economic Sustainability) [12], comparing similar constructive materials, but from different origins (Fig. 10; Tab. 02);



Note: Lower values are better

Category	AnonBrick1	AnonBrick2
1. Raw Materials	0.1401	0.0078
2. Manufacturing	0.0072	0.0072
3. Transportation	0.0003	0.0016
4. Use	0.0000	0.0000
5. End of Life	0.0000	0.0000
Sum	0.1476	0.0166

Fig.10. Environmental performance by life-cycle stage, comparing two kinds of brick. Bees 4.0.

- Acoustic panels in the classrooms' walls, library and amphitheater (Fig. 8);

- Photovoltaic panels used as brise- soleil and on the roofs, generating energy to the vocational center and to the recycling factory (Figs. 11,12);

Períodos de sol sem brise na fachada

hora	jan	fev	mar	abr	mai	jun	jul	ago	set	out	nov	dez
5	.	.	.	.	.	.	.	.	.	.	.	.
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10	sol	sol	sol	sol	sol	sol	sol	sol	sol	sol	sol	.
11	sol	sol	sol	sol	sol	sol	sol	sol	sol	sol	sol	.
12	sol	sol	sol	sol	sol	sol	sol	sol	sol	sol	sol	.
13	sol	sol	sol	sol	sol	sol	sol	sol	sol	sol	sol	.
14	sol	sol	sol	sol	sol	sol	sol	sol	sol	sol	sol	.
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19	.	.	.	.	.	.	.	.	.	.	.	.

Períodos de sombreamento da janela com brise

hora	jan	fev	mar	abr	mai	jun	jul	ago	set	out	nov	dez
5	.	.	.	.	.	.	.	.	.	.	.	.
6	.	.	.	.	.	.	.	.	.	.	.	.
7	.	.	sombra	sol	sol	sol	sol	sol	sombra	.	.	.
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9	.	sombra	sombra	sombra	sombra	sombra	sombra	sombra	sombra	sombra	.	.
10	sombra	sombra	sombra	sombra	sombra	sombra	sombra	sombra	sombra	sombra	sombra	.
11	sombra	sombra	sombra	sombra	sombra	sombra	sombra	sombra	sombra	sombra	sombra	.
12	sombra	sombra	sombra	sombra	sombra	sombra	sombra	sombra	sombra	sombra	sombra	.
13	sombra	sombra	sombra	sombra	sombra	sombra	sombra	sombra	sombra	sombra	sombra	.
14	sombra	sombra	sombra	sombra	sombra	sombra	sombra	sombra	sombra	sombra	sombra	.
15	.	sombra	sombra	sombra	sombra	sombra	sombra	sombra	sombra	sombra	.	.
16	.	sombra	sombra	sombra	sol	sol	sol	sombra	sombra	sombra	.	.
17	.	.	sombra	sol	sol	sol	sol	sol	sombra	.	.	.
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Fig.11. First Graphic: Insolation on facade without brises. Second Graphic: Shadows provided by using brises.

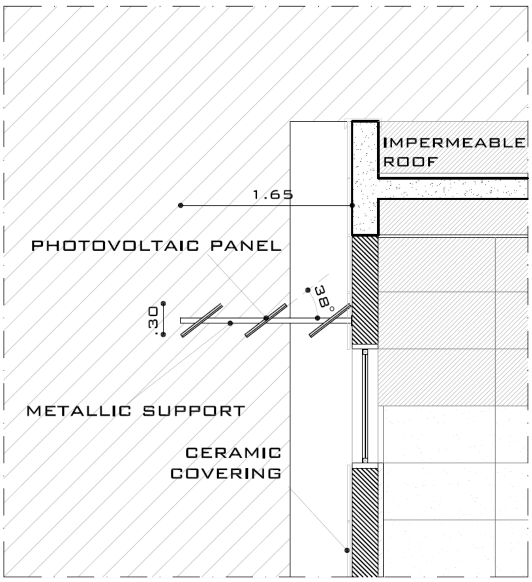

Fig.12. Detail of photovoltaic panels used as brise-soleil.

- Green Roofs, ensuring thermical comfort and allowing permaculture practice (Fig. 13);

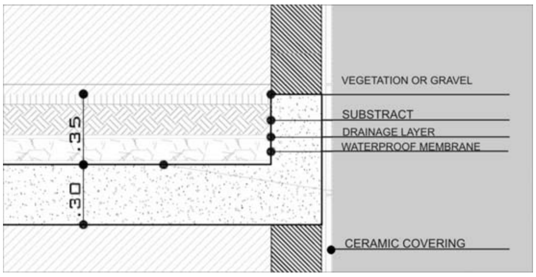

Fig.13. Detail of a green roof.

- The reuse of rainwater collected from roofs;

4. Conclusion

This paper has illustrated that sustainable concepts can be applied at any type of project. Many decisions do not need financial investments, but awareness choices, especially when dealing with social questions. It is possible, nowadays, to project a building taking into consideration many economic, social and environmental features and, at the same time, design good quality architecture, with esthetical principles and functionality.

In Brazil, the usage of sustainable strategies in the cities is very necessary. Although, projecting cities from the sustainability point-of-view will not solve social problems, it certainly will contribute to their growth and maintenance.

5. Acknowledgements

- City hall of Jundiai, that provided useful information about the area's economical and educational contexts;
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6. References

1. Andrade, Nelson; Brito, Paulo Lucio de; Jorge, Wilson Edson (2000). *Hotel: planejamento e projeto*. Senac, Sao Paulo.
2. Comissão Mundial sobre o Meio Ambiente e o Desenvolvimento (1991). *In Nosso Futuro Comum. Informe Brundtland*. FGV, Rio de Janeiro.
3. Costanza R., Patten B. C. (1995). Defining and predicting sustainability. *In Ecological Economics 15*, n. 3, pp. 193-196.
4. Hirata, Marcia Saeko (2000). *Unidade local de reciclagem : projeto para uma cooperativa de reciclagem por processo participativo.* FAUUSP, Sao Paulo.
5. Lengen, Johan Van (1996). *Manual do arquiteto descalço*. Rio de Janeiro: Tibá, 1996.
6. Kronka, Roberta (2002). *Arquitetura de baixo impacto humano e ambiental.* FAUUSP, Sao Paulo.
7. Kronka, Roberta (1998). *Impacto e consumo energético embutido em materiais de construção: técnicas construtivas.* IEE/ USP, Sao Paulo.

8. Rogers, Richard, Gumuchdjian, Philip (1997). *Cities for a Small Planet*. Faber and Faber, London.
9. Silva, Enos Arneiro Nogueira da (1998). *Cozinha industrial : um projeto complexo.* FAUUSP, São Paulo.
10. Yeang, Ken (2000). *The Green Skyscraper: The Basis for Designing Sustainable Intensive Buildings*. Prestel.
11. Yeang, Ken (1995). *Designing with nature. The ecological basis for architectural design*. McGraw-Hill.
12. Bees 4.0e RELEASED (Building for Environmental and Economic Sustainability) [Online], Available: www.bfrl.nist.gov/oae/software/bees/ [16 June 2008].
13. Brise 1.3 [Online], Available: www.usp.br/fau/pesquisa_sn/laboratorios/labaut/conforto/index.html [16 june 2008].
14. Climaticus [Online], Available: www.usp.br/fau/pesquisa_sn/laboratorios/labaut/conforto/index.html [16 June 2008].