Planaltina – A low carbon campus for the University of Brasilia

Introduction

In 2008, the authors have designed a new Campus for the University of Brasilia, in the satellite city of Planaltina. It is 40 km away from the metropolitan centre (Figure 1). The project's *inputs* may be summarized as follows. The site comprises 29 hectares (Figure 2), presents a slight slope (4% towards west) and has a *cerrado* type vegetation, predominant in Brazil's Central Plateau: small trees, sparse foliage, low levels of carbon absorption (Figure 3). The project had to consider a pre-existent building with 2,073m^2 of built area (Figures 4 and 5, bottom right corner). The briefing established a population target of 12,000 students, beyond which environmental quality might be jeopardized. This means circa 58,000 m² as maximum built area.
Along the design process we have considered two kinds of the project's *performance*: 1) how it impacts people, by means of the satisfaction (or otherwise) of social expectations and 2) how it impacts the natural environment. (Of course this separation is done for analytical purposes, because affections on the environment – e.g. impact on soil temperatures – also impact people's comfort.)

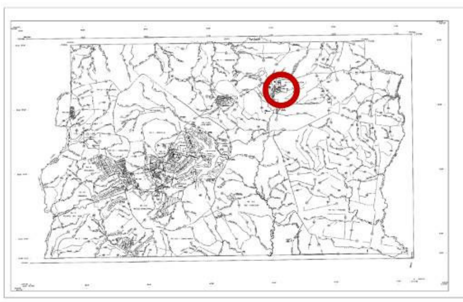

Figure 1. Planaltina Satellite City, in the Federal District, Brazil.

Figure 2. Planaltina Campus Site.

Figure 3. The site's savannah type vegetation.

Impacts on people concern the design proposal evaluation along eight dimensions of performance, expressed in terms of questions that the project has to answer, as follows:
Functional aspects. Does the place satisfy the practical exigencies of daily life in terms of the type and the quantity of spaces required by the necessary activities, and their relations?
Bioclimactic aspects. Does the place provide adequate conditions of lighting, acoustics, and air temperature, humidity, speed and quality?
Economic aspects. Does the project imply a sustainable campus based on a model capable of minimizing maintenance costs?

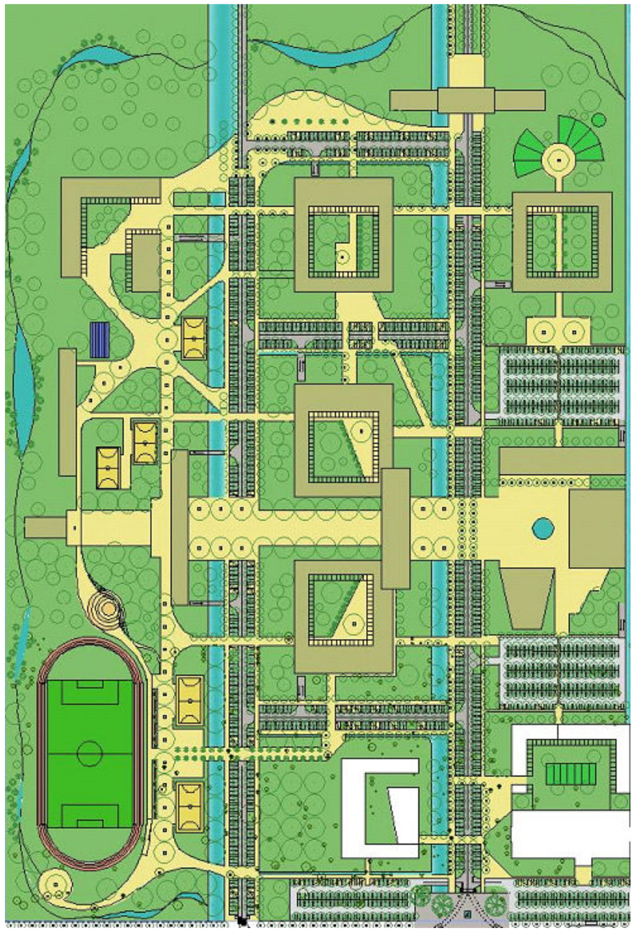

Figure 4. University of Brasilia Planaltina Campus. General Plan. Pedestrian pavements in yellow; eco-troughs in blue.

Sociological aspects. Does the project's configuration (solids, voids and their relations) imply desirable ways of individuals and groups (social classes, genders, generations) deploying themselves in places and moving through them, and, accordingly, desirable conditions for encounters and avoidances and for the visibility of the other? Do the type, quantity and relative location of activities imply desirable patterns of place utilization, in space and time?

Topoceptive aspects[1]*.* Is the place visually *legible*, i.e., does it have a clear identity? Does the place offer good conditions for *orientability*?

Affective aspects. Does the place have a pleasant *affective personality*? How does it affect people's emotional state – e.g. *vis-à-vis* solemnity, grandeur, coldness, formality, intimacy, informality, simplicity etc.?

Symbolic aspects. Is the place rich in architectural elements that remind us of other elements, on a larger scale than that of the place in question (e.g. a building representing the whole city), or of elements of diverse nature – values, ideas, history?

Aesthetic aspects. Is the place *beautiful*, i.e. are there characteristics of a structured whole and qualities of simplicity/complexity, evenness/dominance, similarity/difference, that evoke qualities of clarity and originality, and in turn *pregnancy*, implying autonomous stimulation of the senses beyond practical matters? Is the place a *work of art* conveying a *world view*? Does its configuration express a *philosophy*?

Figure 5. University of Brasilia Planaltina Campus. Electronic model.

Impacts on nature concern the design's consequences in terms of: earth cuts and infills; vegetation maintenance, removal or improvement; change in levels of carbon absorption; change in soil temperatures; absorption of rainfall on site.

After brief comments on the overall design principles, this paper discusses 1) building types, 2) open space elements, 3) land uses, 4) sustainable design, 5) bioclimatic control in public space and 6) botanic principles.

Overall design principles

Urbanity. This is one of the main ideas behind the design choices we have adopted. Built units clearly configure spaces onto which doors and windows open: atriums, avenues, streets, plazas, esplanades, green areas. A *sense of place* is conveyed by means of spaces suited to meet acquaintances, to a pleasant stroll, or to work in tables and chairs in the open air under shady trees, particularly in the atriums, where students may find internet and power sources – the mild climate of Brazil's Central Plateau, with a long dry season, favours this use.

Flexibility. The implementation of the campus is highly flexible. Atrium-like buildings allow the construction bit by bit (part of one of the blocks' side, a whole side etc., in various combinations), as well as vertical expansions until the limit of three floors, according to the needs of the campus' development. The main issue is the observation of the overall spatial structure. This implementation process is already under way.

Pedestrians. Great attention has been paid to pedestrians and their comfort. Buildings will have underground garages, so that a maximum amount of free space for sidewalks and greenery at ground level is guaranteed. Pavements suited for walking allow pedestrians to move in all directions (Figure 4 shows pedestrian pavement – in yellow – and how surfaces suited for vehicles are interrupted at crossings where important pedestrian flows are to happen).

Legibility. Solids and voids are organized according to its functional and its symbolic importance. Places are differentiated by volumes and spaces that vary in size and form, conveying a hierarchic order that favours formation of clear images on our minds, and also a sense of beauty.

Friendly design with the environment. The architectural solution's flexibility permits the avoidance of large earth movements: blocks can be divided into contiguous segments that follow closely topography. Flexibility will also allow the preservation of large trees observed in the site – sadly enough, not in great numbers anymore (Figure 3). Green infrastructure will minimize runoff: permeable and semi-permeable surfaces whenever possible will absorb a large amount of rainfall on site; ecological open drains, like rain gardens (in blue, Figure 4) will also contribute to this, besides constituting an interesting landscape device; an agro-forest will reconstitute a largely degraded area and will be an important resource for scientific research.

We will now proceed to comments on the project's attributes and how they fulfil the objectives and principles expressed above.

Building types

We have aimed at a system of building types that permits a good composition of public spaces and a great flexibility in the campus' implementation along time. There is a system of *generic blocks* inspired by many examples around the world. The width of the peripheral built strips varies, from a minimum of 10m to a maximum of 20m, depending on the building program. They surround open spaces – the *atriums* – with fixed dimensions – 50m x 50m – thus guaranteeing the necessary unit across the campus, within the variety of the built forms around them (Figure 6). Façades that turn to the atriums have galleries, covered circulations and pergolas, which contribute to the bioclimatic comfort of internal spaces. These atriums reminds us of the famous Cambridge's Colleges, but in our project they are instrumental rather than expressive, i.e., people may sit around fixed tables under shady trees, to study, read, socialize or rest. Green strips' width outside and around blocks also vary, but they are never less than 10m wide.

Figure 6. Images illustrate the atrium-like building type.

Building height varies from one to three stories. In exceptional cases it may reach four or even five stories. It is the case with the buildings around the Main Plaza: Auditorium, Rectory, Library and Restaurant. Of course, the plan only suggests the approximate size, form and localization of these buildings, in accordance with the design principles of the campus. Variety in volume forms implies a variety in green strips' width around them, which confers a desirable variation in streets' and plazas' cross sections. We trust that this variation in volumes and voids will be responsible for stimulating spatial sequences.

Open space elements

Open space elements are identifiable in the general plan (Figure 4). They are classified into axial elements (avenues and streets), atriums (as above), a plaza and an esplanade, an agro-forest, and remaining greenery. *Avenues* run in north-south direction. They are 60m wide and include an ecological open drains 12m wide,

sidewalks, car lanes, parking spaces, and green strips. *Streets* run in east-west direction. They are 40m wide and also include sidewalks, car lanes and parking spaces. Here, ecological open drains are reduced to 3m wide.
A central esplanade runs along a differentiated east-west axis, approximately dividing the campus in two halves, characterized by a wider pavement (in yellow, Figure 4). It starts at the Main Plaza, passes under the restaurant, continues in between two atrium-blocks, passes under the residential building and finishes in a smaller square (which may be used as an open-air amphitheatre because of the topography), crowned by an ecumenical chapel (Figures 7 and 8).

Figure 7. The eastern end of the Esplanade (on top, with the Main Plaza).

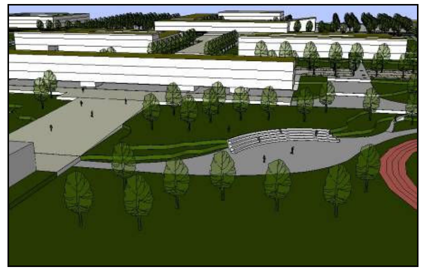

Figure 8. The western end of the Esplanade and the amphitheatre (middle left shows a bit of the ecumenical chapel).

The chapel mingles with the agro-forest, which runs along the western and northern borders of the campus. It aims at environmental education related with sustainability, responding to the main objectives of the Campus, where a course on agro-business management is held. The concept behind the agro-forest is the sustainable management of forested areas, considered as an economic resource, the exploration of which, however, is guided by preservation criteria. The agro-forest here is also a control device over the space and the vegetation that surrounds the campus' site. It may also constitute a solution aiming at renewable resources, and it may be seen as a bridge between the University and Planaltina's community, in projects aiming at improving low income social layers' life quality.

Land uses

Table 1 shows land uses per category. The area occupied by buildings, after the campus is completed, covers only 10.9% of the site. These numbers are similar to those of the Brasilia's superblocks and of the Darcy Ribeiro Campus (the University of Brasilia central campus in the Pilot Plan). The important difference, however, is the treatment of the free space available: it is clearly configured in terms of open space units, as commented, not as the residual space typical of modernistic solutions. Another important difference is that the total surface occupied by vehicles has fallen from 22.6%, in the Darcy Ribeiro Campus, to 14.9%, in the Planaltina Campus. It was thus possible to increase the total green area, plus pedestrian pavements and sport/leisure facilities, to 74.1% (instead of 66.2% in the Darcy Ribeiro Campus). Observe that green areas in the Planaltina Campus also benefit from the large number of trees in the parking lots (at least two trees for every three parking spaces).

Sustainable design

Atriums, ecological open drains, greenery, minimization of earth movement and design flexibility, maximize preservation of natural vegetation. Despite the degradation observed at the site, beautiful species, 20 metres high, still exist (Figure 3). A detailed survey of existing trees has been made. The built periphery of the atrium-like blocks, traffic lanes and parking spaces may be interrupted whenever they coincide with an important tree.

Surface areas by category	**m^2**	**%**
Total Green area	157883	53.48
Pedestrian pavement	55243	18.71
Parking áreas	33179	11.24
Built areas	32335	10.95
Streets	10930	3.70
Soccer field	3027	1.03
Athletics Lane	2278	0.77
Swimming pool	324	0.11
Total	**295200**	**100**

Table 1. Land uses.

Minimization of earth movements also respond to “universal design”, maximizing accessibility possibilities.
Landscape design has aimed at a maximum absorption of rainfall on site. *Run-off* ratios in the Federal District vary from 0.15 to 0.90 (natural soils are reasonably permeable). From direct observation, absorption in the campus’ site seems satisfactory for, despite degradation, no erosions are noticed. In here, we estimate a *run-off* of 0.25 to 0.30. Green areas and ecological open drains work as important drainage and rainfall absorption devices. Preliminary estimates suggest that, after completion, the site will absorb as much rainfall as it absorbs today, perhaps more. Buildings shall have green roofs, and atriums inside them permit the absorption of the remaining rainfall.
Treatment of hard surfaces (e.g. traffic lanes and parking spaces) also considers environmental factors. Asphalt is avoided, for it absorbs less water and radiation heat is high, causing discomfort. Instead, cement tiles are employed. Further, in parking spaces, tiles are hollow, and holes are planted with grass, thus diminishing radiation and also improving rainfall absorption.

Bioclimatic control in public space

Remote sensoring has contributed a lot to the knowledge of the relations between objects and surface phenomena. One of the most common utilizations is the analysis of land use and occupation, and, as part of this, the mapping of green areas. The development of techniques and sensors facilitates the identification of spectral properties of different vegetal species and the definition of various vegetation indexes. One of the most commonly used is the *Normalized Difference Vegetation Index* (NDVI), developed by Rouse *et al.* (1973, quoted in MENESES & NETTO, 2001), which calculates photosynthetic activity by measuring the intensity of light absorption in the red spectral region in relation to the reflection of the near infrared.
NDVI permits differentiating groups of vegetation according to their photosynthetic variation. We have used an ASTER sensor for NDVI calculation, so that we can measure the photosynthetically active vegetation and thus evaluate potential carbon absorption in the area of the Planaltina Campus (more in Ribeiro and Holanda, 2009).

Because NDVI is capable of measuring phosynthetic activity, it can be associated with the capacity of CO_2 absorption by vegetation. The NDVI measurement for the Planaltina Campus aims at evaluating the distribution of photosynthetic efficiency across the various subareas of the site.
NDVI calculation was made 1) for the present situation's image, without the project's buildings and 2) with the new facilities to be built, so that we can evaluate how the interference will affect the present site and people. Inquiries have shown that NDVI can detect vegetation photosynthetic activity even in minimum quantities. After calculating average NDVI for the two situations, we realized that the design for the campus (Figure 9) implies a gain in photosynthetic activity of 7.09%.

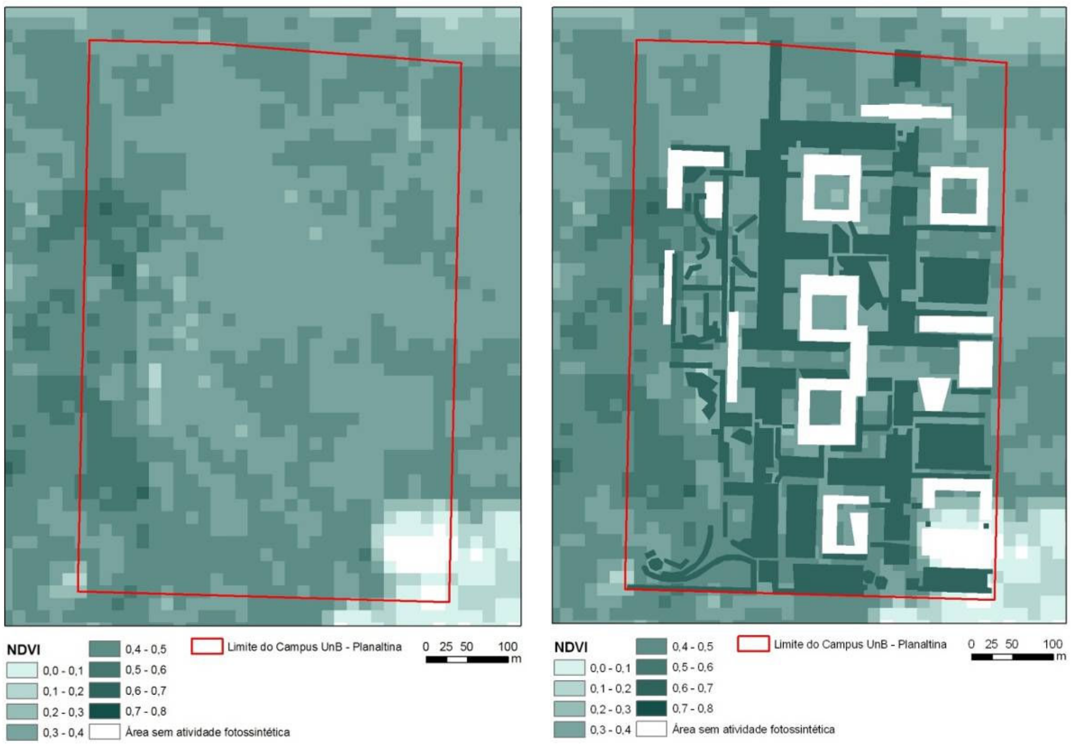

Figure 9. Levels of carbon absorption, measured by the Normalized Difference Vegetation Index, before (left) and after (right) implementation of buildings and landscape design. An average gain of 7.09% in carbon absorption was detected between present and future conditions.

This happens because a good lot of the present site is degraded, occupied by a particular sort of exotic graminea (Brachiaria). A good part of the natural *cerrado* vegetation was pulled down and a significant area has been burned. Our design proposes intense reforestation by medium and large size trees in parking lots and along sidewalks, thus augmenting the number of trees and, accordingly, photosynthetic activity in the area. NDVI, while measuring vegetation, also manages to indicate that places with better performance in this index are also places with better air quality.
To obtain estimated surface temperature after the campus' implementation, we have used product 8 (on demand) of the ASTER sensor, which provides earth surface radio-metric temperature. After a series of conversions (more in Ribeiro and Holanda, 2009), the surface temperature values for the present situation and for the future scenario have been obtained. The result is that we will have 5.15°C lower in average, i.e. a reduction of circa 13% (Figure 10). This is an important accomplishment: if we consider that Planaltina is one of Federal District's warmest regions (RIBEIRO, 2008), this will imply a significant improvement in people's thermic comfort. The campus'

morphological principles and landscape design have been greatly responsible for this performance.

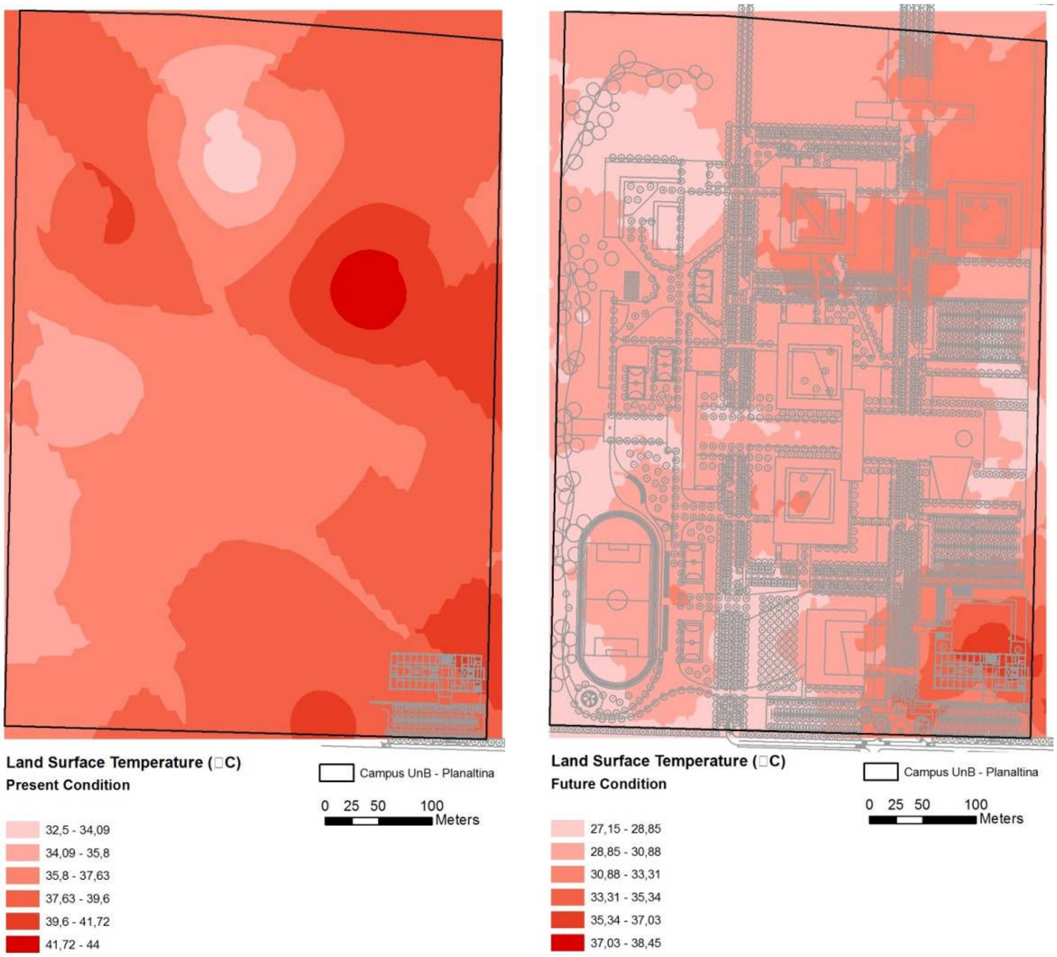

Figure 10. Surface temperatures, before (left) and after (right) implementation of buildings and landscape design. An average decrease in 5.15°C was detected between present and future conditions.

Botanic principles

The project intends to integrate landscape design with the drainage system. The main concept is to make most profit from rain water concerning natural irrigation. Green areas are an important element in the formal composition and also fundamental devices of the drainage system, as already commented. Green areas can be classified according to their function, as follows.

There is a large amount of permeable surfaces within the block atriums, to where water from the surrounding buildings' roofs is directed. Ecological open drains and green roofs, to be used atop singular buildings, are examples of green technology.

Landscape treatment is defined according to the site's natural characteristics and its environmental conditions, ranging from a more bucolic ambience to a somewhat urban atmosphere, thus creating pleasurable conditions for pedestrian flows, staying put and sitting around.

The agro-forest plays an important role as it integrates the campus with its fragile environment, considering that 40% of the campus' area is located inside the Fumal

River Protection Area. Smaller scale special landscape spots like orchards and vegetable gardens contribute to this bucolic ambience. The management of these areas will constitute the subject matter of outdoor classes as part of agro-science courses, as well as research projects.

The Esplanade, while having an important symbolic value, will be distinguished by a peculiar urban ambience, with a generous pavement and two lateral rows of tall trees. It is crossed by a sidewalk that distributes pedestrian flows along sports' facilities – a swimming pool, multifunctional small playing fields and a soccer field. This pavement constitutes the border between a more bucolic and a more urban approach to landscape design.

The idea of having flowered trees the whole year round has led to a selection of different species according to its flowering period. Exotic species tested and adapted do the *cerrado* soil (e.g. Flamboyant) and native species (e.g. Ipê, in all colors), compose a diverse vegetation distributed according to specific characteristics of each particular spot (see illustration of such trees in Figure 11).

Figure 11. From left to right: Flamboyant (Delonix regia), Ipê branco (Tabebuia róseo-alba), Ipê amarelo (Tabebuia serratifolia), Sapucaia (Lecythis ollaria).

Conclusion

This paper reflects on a "philosophy" behind the Planaltina Campus design, rather than on project details – this was not the case in the present phase of development. The main interest was on general design principles, not on minute particulars.
The proposal aims at a maximum of flexibility under conditions of scarce briefing information. This is the case in Brazilian reality, concerning university campi planning. In our country little can be precisely predicted in the long run – at least this is the tradition so far, a condition that only recently, with a greater economic stability, is being slowly overcome. This condition has to be taken for granted. It has been like this concerning the main campus in the Capital's Pilot Plan, it is like this in the present case. General principles substitute for precise predictions.
However, *flexibility* does not imply omission about precise aspects of spatial configuration. Occupation ratio may vary, but this will vary according to rigorous configurational attributes, meaning atriums, avenues, streets, an esplanade, the central plaza, underground parking, generous reforestation, ecological open drains, agro-forest etc. Symbolic buildings have their localization clearly defined and their peculiar volumes shall reflect their emblematic importance.
The proposal aims at maximizing people's expectation and the minimizing impact in the natural setting. More than that: we have shown that the proposal may compensate for the degradation we find today in the site and in its immediate surroundings – the Planaltina satellite city urbanized areas. Carbon absorption will be higher than now, average temperatures will be lower, implying greater comfort and lesser impact in the atmosphere.
In the end, an *architectural proposal* as a *result* of people's wishes, defined by means of an institutional and communal participatory process that has constituted a basis for

design and that is going on; a proposal as a *source* of human well-being and amelioration of the natural environment.[2]

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[1] *Topoceptive* is a neologism created by Maria Elaine Kholsdorf (KOHLSDORF, 1996), meaning *space perception*, i.e. according to the Merriam Webster Dictionary, “the perception of direction, distance, size, and other spatial facts”.

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