Sarah Kubitschek Hospital-Salvador, Brazil: principles for a *healing architecture* at latitude 13°

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ABSTRACT: The Sarah Kubitschek Hospitals Chain in Brazil have been in operation since early 1990's. Today, with 9 hospitals designed and constructed throughout Brazil, the chain deliver high quality treatment for social disadvantaged patients with locomotor apparatus problems. For this paper, the pioneer of such buildings, the Sarah Hospital in Salvador – Bahia, located in the tropical northeast coast of Brazil (latitude 13°S) will be discussed. This is a building that runs almost completely without air conditioning in a city that more than 70% of the new residential apartment buildings are fitted with small air conditioning units. On the other side of the globe, also at latitude 13°S we find the Royal Darwin Hospital, located in Darwin, capital of the Northern Territory, Australia. The hospital was initially built in the early 1970's (based on a Canadian design typology) and had an additional wing built between 2003/04. This is a building that runs completely with air conditioning in a city that 90% of residential buildings are fitted with air conditioning units. The implications of such initial design decisions are extensive, and have significant impact on the psychological, social and environmental well being of users along with their ability to recover and heal. The direct relationship of a person to the environment (e.g.visual, thermal, acoustic comfort) and the way the spaces mediate the relationship with people (e.g.use of spaces, privacy, views) are the two main features in which architecture plays an important role on the design of healing spaces.

This paper discusses through comparisons of design principles and processes, along with monitored data (on aspects of thermal comfort), how the architectural design of two places, with similar climatic conditions, at same latitude, have resulted on very different responses to its environment and users.

Keywords: healing architecture, thermal comfort, bioclimatic analysis

1. INTRODUCTION

The Sarah Salvador hospital was the chain's first unit to be constructed during the validity of the contract between the Foundation of the Social Pioneers (private institution) and the Federal Government. Because of the extent of this initiative, approved by National Congress special law, the building of the Sarah Salvador became the embryo of a technological centre (created in parallel with the hospital) whose principal objectives would be to plan, execute works for the chain's implementation, based on industrialization principles aiming at economy, speed in building, and creation of convenient constructive unity among all of the association's buildings. Along with that, also design hospital equipment; carry out maintenance, training and promotion of the work developed throughout the chain. The architect in charge of this experience is Joao Filgueiras Lima, (LELE), one of Brazil's most well known and experienced architects who currently is based in Salvador [1]. The paper discusses the site context and bioclimatic approach which dominates the scheme (no air conditioning is to be used, exception being the operating theatres) comparing qualitatively such design implications with another case study found in Darwin, the Royal Darwin Hospital, Australia. A working space at the Sarah Kubitschek Hospital (pharmacy room) was chosen to demonstrate quantitatively the levels of thermal comfort achieved and the levels of satisfaction of their users for different periods of the year: winter and summer in Salvador. No permission was given from the Royal Darwin Hospital to conduct evaluation studies at their premises or access data in regards to their energy use.

A climatic analysis of both Salvador and Darwin is presented along with a description of the design concepts and implications not only from a bioclimatic perspective but as a healing space, or fulfilling their role as a healing architecture.

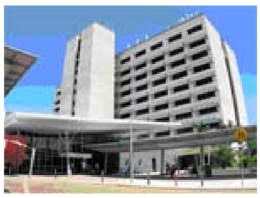

Figure 1. (left) Sarah Kubitschek Hospital Salvador-BR; Photo from Lele's archives. (right) Royal Darwin Hospital, AUS.

2. CLIMATIC ANALYSIS: SALVADOR & DARWIN

Salvador-Brazil is located at latitude 13° 0' S, longitude 38° 30' W and Darwin – Australia is located at latitude 12° 28' S, longitude 130° 51' E. With almost equal latitudes, the climatic conditions differ given its particular geographical location, land mass exposure, land form, distance from coast, among other factors.

Salvador at the Northeast of Brazil, has a typical warm-humid climate, with not much seasonal variation. Table 1 summarizes the meant monthly temperatures and humidity values for the TRY (test reference year) for Salvador.

Darwin at the 'Top End of Australia' has a wet and dry season. Table 2 summarizes the mean monthly temperatures and humidity values for the TRY in Darwin.

Passive design strategies for Salvador and Darwin would differ during the dry season in Darwin, as evaporative cooling could be used to provide comfort for 6 months of the year (given the low humidity levels). Avoidance of heat gains and passive cooling (through natural ventilation) is than the main focus for bioclimatic design for both climates during the other six months of the year. (Nov-Apr).

Table 1: Climatic conditions for Salvador (TRY Salvador/monthly averages Temp (C)/RH %)

Month	Aver	Max	Min	RH 9am	RH3pm
JAN	26.4	29.8	22.7	89	64
FEB	26.6	29.9	22.2	89	63
MAR	26.8	29.9	23	91	65
APR	26.1	28.7	23.2	90	71
MAY	25.2	28	21.9	90	67
JUN	24.3	26.9	22.1	87	70
JUL	23	25.9	20.2	88	68
AUG	23.2	26.4	20.5	85	63
SEP	24.1	27.5	20.2	87	61
OCT	25.2	28.1	22.8	83	64
NOV	25.8	29	21.8	86	61
DEC	25.8	28.6	22.5	88	65

Table 2: Climatic conditions for Darwin (TRY Darwin monthly averages Temp (C)/RH %)

Month	Aver	Max	Min	RH 9am	RH3pm
JAN	29.1	31.8	24.8	81	76
FEB	28.8	31.4	27.7	83	72
MAR	29	31.9	24.5	83	67
APR	29.4	32.7	24	75	53
MAY	28.2	32	22.1	66	43
JUN	26.3	30.6	20	62	38
JUL	26	30.5	19.3	62	38
AUG	27	31.3	20.5	67	41
SEP	28.9	32.5	23.1	70	48
OCT	30.2	33.1	25	70	53
NOV	30.4	33.2	25.3	73	59
DEC	29.9	32.5	25.3	77	65

For both climates however, it is possible to provide thermal comfort using passive design strategies for most of the summer and winter periods, as per Auliciem's adaptive model [2].

For summer & winter periods:

$$Tn = 17.6 + 0.31\ Tmean$$

Where, $18 \leq Tn \leq 28$, $Tn \pm 2.0$

Tneutrality Salvador:
Tn January:: 25.8
Tn July: 24.7

Comfort zone January: 23.8-27.8
Comfort zone July: 22.7-26.7

Tneutrality Darwin:
Tn January: 26.6
Tn July: 25.7

Comfort zone January: 24.6-28.6
Comfort zone July: 23.7-27.7

When considering the physiological cooling effect of ventilation (natural ventilation/mechanical fans), an additional 5K/1.5m/s air speed) [3] can be achieved and passive design strategies can be successfully applied for both climates, throughout the whole year.

3. SARAH KUBITSCHEK HOSPITAL, BRAZIL

2.1 Sarah hospital: site, context, construction processes and design principles (minimizing capital and operational energy)

Accessibility & urban site: The Sarah hospital is located at the Central commercial area of Salvador, within easy access to major public transport in the city. The site itself, excluded the entrance of buses, with the exception of the Sarah's designed bus transport for patients (Figures 10, 11). The exclusion of public transport to most areas within the site has allowed for extensive creation of interactive spaces and green areas.

Green spaces: The characteristics of a hospital demand as a therapeutic complement and by the very concept of training technicians, the easy access of patients (both outpatients and in-patients) to green spaces adjacent to the treatment and internment areas to enable access to fresh air and exercise.

Flexibility and expandability of the building: The condition of the architectural programming, which is determined by a pre-established work routine and based on the use of techniques and equipment (which are constantly changing), made it desirable that the construction system adopted should allow for obtaining flexible spaces. Each sector might be able to grow independently, without detriment to internal circulation along with the possibilities of increasing in the future the number of beds, provided that the operational capacity is maintained and the rational occupation of the site is ensured. (Figure 12)

Flexibility/accessibility of the facilities: The use of easily accessed piping, required for the flexible utilization of internal spaces. Ventilation tunnels are also service tunnels, connecting to the entire structural modules of the hospital.

Thermal and visual comfort: The indispensable proximity of some fields of activity with a consequent reduction in circulation areas partly explains the great tendency in modern hospitals to transform certain floors into a compact mass of cubicles with artificially controlled lighting and air conditioned spaces. The generalized use of such systems to ensure visual and thermal comfort has been excluded as much as possible at the Sarah Hospital Salvador, adopting natural ventilation and daylighting strategies. Surgery centre, sterilization centre, x-ray, and auditoriums had A/C and artificial lighting. The remaining rooms were designed considering shape, fabric, ventilation and fenestration for appropriate climate control (avoidance and dissipation of heat gains: surface-volume ratio, orientation on site, shading devices, cross ventilation, ventilation tunnels and extraction vents on roofs/light sheds, operable windows, low absorptance materials and reflective+bulk insulation on roofs, lightweight construction (ferro cement panels) (Figures 4,5,6, 7, 8).

Standardization of construction elements: The working characteristics of a hospital and in this case the large size of the building creates difficulties for maintenance services. To facilitate this type of administrative routine, a strict study of the standardization of construction elements was essential (structure, divisions, fixed and movable equipment, lighting fixtures, etc). The principle of repetition of the elements, reduced labour costs, initial capital costs and has given the production of most of the partitions on site, reducing also costs for transport and embodied energy of materials.

2.2 The pharmacy room: monitored data

Froom 31st August 2005 until 3rd October 2005, 6 data loggers (Escort temperature/Humidity) were placed at the pharmacy room and intermediate areas (Figure 2) at Sarah Kubitschek Hospital – Salvador. Further data has also been collected for summer period but have not been yet processed and validated. The purpose of the data collection was to evaluate the temperature and humidity levels of this specific room, after some modifications on the layout and on the ventilation system.

Figure 2. Pharmacy room at Sarah Kubitschek Hospital – Salvador.

Temperature control is necessary for most of the drugs kept in the room, as over 30°C is not considered an acceptable environment for storage. For some periods of the year, temperatures were over 33°C. A decision was made to attempt to minimize loads (artificial lighting), also changing the layout of the room and attempting a system using indirect evaporative cooling. Humidity levels for the TRY (test reference year) indicated 70-85%, which would make the system not feasible. However, measurements taken on site, has given daily averages for August-September 50-65%, and given the fact that possibly only lowering the temperature 1-2C would solve the problem, an attempt was made to implement the system.

The room's main entrance faced the circulation hall (Figure 5 – left) and had the service entrance facing an external patio.

Table 3 shows the temperatures taken inside the room along with humidity levels, compared to outside figures. (before and after the system was implemented).

Given the fact that thermal comfort of the users was not the main principle driving the implementation of the system, but rather the standard temperature limit level of 30C, only informal questionnaires were given to the technicians using the pharmacy room. After a period of one month of the implementation of the system, 95% of the users stated that they thought the changes (layout) improved the thermal comfort of their workspace.

Table 3: Monitored period: pharmacy room. Outside Temp, Inside Temp, RH (3pm) -(after the system implementation – September 2005)

Day	Tout	RHo (%)	Tins	RHi (%)		
01	28.5	59	28.7	61		
02	27.1	67.5	26.9	76.5		
03	27.4	68	29.3	68.5		
04	27	64	27.1	74.5		
05	26.9	60	26.9	72		
06	26.1	68	28.2	66.5		
07	23.7	89	26.6	79		
08	26.7	66	26.9	75.5		
09	26	68	26.6	75		
10	29.3	56	28.5	74		

Essential analysis of data for summer period is necessary to establish a profile of temperature and humidity levels throughout the year, and evaluate the effectiveness of the system for more critical periods of temperature variation.

The system as it is, has successfully achieved its main goal, which was for 97% of the monitored time, has lowered internal temperature levels just below the set limit of 30C.

3. ROYAL DARWIN HOSPITAL, AUSTRALIA

3.1 Darwin's hospital background: historical aspects

" Welcome to the Casuarina Hospital Project: You are joining a project that is vital to the community of Darwin. Before Cyclone Tracy on 24th December 1974, the Darwin Hospital (Fig. 3) was fast becoming too small for the rapidly growing modern city. The cyclone has shown that a modern hospital with its advanced medical facilities is now all the more important. The success in completing this project on time and with a high standard of finish will be your success. Services include: 10 lifts, air conditioning, hot and cold water reticulation, chilled water, steam…"

At the time, the new hospital was meant to serve as an object of pride to the community, with all the technological comforts that could possibly be installed in such facilities, as per quote of the distributed pamphlets of the construction developments at the time[4]. The old hospital, (Fig. 3) designed horizontally, adaptable to the climatic conditions as no air conditioning was installed, and situated within good access to central Darwin had not much extensive use with the plans for construction of the modern Royal Darwin hospital. After Cyclone Tracy, which devastated Darwin in 1974, a restricted building code also reinforced ideas of enclosed design of spaces for protection from wind forces and debris.

Figure 3. Lambell Terrace Larrakeyah Darwin (The nurses quarters, Darwin Hospital). N.T. Souvenir Collection. Northern Territory Library.

The Royal Darwin hospital design was based on a set of plans from a Canadian building. Completely inappropriate for tropical climatic conditions, in terms of shape (orientation, surface to volume-ratio, deep plans, excessive levels of thermal mass, among others). Perhaps the most problematic of the design problems is the verticality of the construction. It creates all sorts of problems, in terms of circulation of patients, services, maintenance, use of energy and not to mention the lack of identification of the spaces from indigenous communities who do not identify themselves with vertical constructions.

Designed to become a symbol of technology and progress at the time, the Royal Darwin hospital today is attempting to act towards energy efficient measures of the plant system, so energy use can be minimized. However, the design of the building is responsible for 50% of its response in terms of energy efficiency, and as it is now, it is obsolete. The new wing added in 2003-2004, has been designed with an horizontal emphasis, has incorporated natural lighting as part of the brief but used air conditioning as an essential part of the design. Figures 4-5,8 compare entrance and circulation areas of the Sarah Hosptial in Salvador and the Royal Darwin hospital. From the pictures and the visits during last February 2006 in Darwin, it was clear that people not necessarily were happier or preferred air conditioning. Because of the extensive and excessive use of A/C, transitional areas were not part of the design of the new wing building. An inclusive design, which caters for a health environment, filters the external elements and provides spaces environmentally and culturally diverse, were not found on the new facilities. From personal conversations with different members of the community, it was said that *"Consider 10 years of operational energy costs for this hospital. With this money, we could possibly build a new one…"*

Estimates of current energy use for the facilities to confirm such statements were attempted, but given lack of access to essential data, a number of assumptions would have to be made, so this was not pursued.

Apart from the environmental impact of such architectural decisions, the extensive use of air conditioning and its implications at local and global levels, there is the extensive detachment and loss of acclimatisation and contact of users (patients and non patients) with its surroundings. In the case of healing environments, this analysis brings It as an essential condition for recovery, for reestablishment of the sense of well being amongst and between patients.

4. CONCLUSIONS: HEALING ARCHITECTURE

What is it that architects should concentrate on to stand the best chance of promoting this healing architecture?

Good design for long time seemed to improve patients well being. On Lawson's studies [5], he reports on how patient treatment and behavior can be improved by good architectural design. He also indicates what are the aspects of good architectural design, viewed by patients.

Below are few quotes from this study:

"…patients showed very significantly higher levels of satisfaction with their surroundings. Ratings given by patients in the newer hospitals were significantly higher for appearance, overall design and spatial organization…"

"…many patients agreed on the desirability of high and airy spaces…"

"…What matters most here seems to be to have some degree of control. Both patients and the staff mentioned this about such things as heating, the lighting, windows and blinds as well as noise…"

Lawson's results offer interesting lessons for architects and their clients. The architectural factors that appear to be responsible for increased patient well-being are generally universal rather than specific. They could be seen to apply to many environments rather than being particular to the hospital. As well as visual appearance, they concern such general matters as privacy and community, view, environmental comfort and control of the environment.

"Such factors taken together could surely be thought of as a mater of good place-making. Sadly in the highly technical world of contemporary medicine, place-making, often seems to come low down if at all on the list of considerations. Perhaps its frequent neglect in recent hospital design is as much a result of the tyranny of the functionalist view of architecture as it is of overly technical briefs. An yet our results *show that not only is place-making very important to the well-being of patients but that good architecture may turn out to extremely good value for money* *compared with the highly expensive treatment that are administered in our hospitals.”. Lawson, 2002.*

Figure 4. (left) Entrance to Sarah Kubitschek hospital. (right) Entrance to new wing, Royal Darwin Hosptial.

Use of landscape design to filter outside/inside environmental elements (sun/rain) along with use of extensive and continuous roof design and paving areas at Sarah Kubitschek Hospital.
Lack of transitional spaces at Royal Darwin hospital.

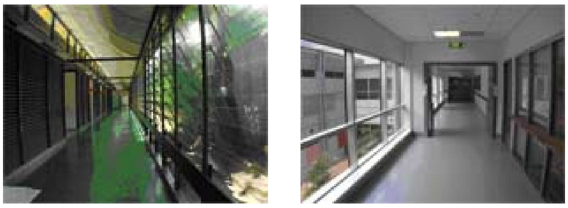

Figure 5. (left) Circulation hall at Sarah Kubitschek hospital. (right) Circulation hall at Royal Darwin hospital.

Enclosed glass box of Royal Darwin Hospital, good access of daylighting but no use of internal courtyards, because of air conditioning use.
Use of adaptable glass louvers allow good cross ventilation, daylighting and contact with outdoor environment at the Sarah Kubitschek hospital.

Figure 6. (left) ventilation/service tunnels at Sarah Kubitschek hospital. (right) Lower level plant rooms, Royal Darwin hospital.

Modular structure and sizing of ventilation tunnels, planned in contrast with the excessive use of space and mechanical systems scattered around the lower floor at the Royal Darwin hospital, Darwin.

Figure 7. (left) view from inside corridors towards patio and curved roof (vents/daylighting) at Sarah Kubitschek Hospital. (right) Top view from Royal Darwin hospital, looking towards flat roof of new wing.

Figure 8. (left) One of the entrance halls at Sarah Hospital. Photo from Lele’s archives. (right), Main entrance hall Royal Darwin Hospital.

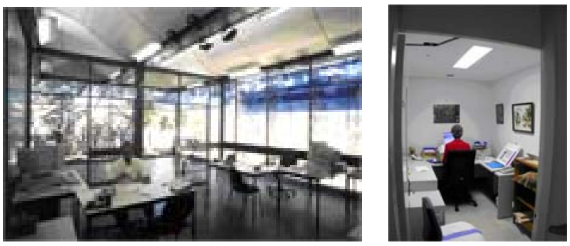

Figure 9. (left) workplace at administration block, Sarah Hospital. Photo from Lele’s archives. (right). Workplace at administration block, Royal Darwin hospital.

Access to daylighting, natural ventilation, visual contact with co-workers, and outdoor environment. Main conditions for a healthy work environment, at Sarah Kubitschek hospital.

Figure 10. (top right/left) Views of parking areas distributed around the Royal Darwin hospital. (lower right/left). Parking areas are kept far from the vicinity of the hospital. Patients have priority in such areas. Photos from Lele’s archives.

Surroundings of buildings are designed as extensions of the internal spaces. Patients have access to such areas for regular contact with the outdoor environment, water activities (swimming pools), playground for young patients, sun bathing, walking [6].


Figure 11. (left) designed bus at Sarah Kubitschek hospital. Photo from Lele's archives. (right) bus stop with public transport at Royal Darwin Hospital.


Figure 12. (left) Pre-fabricated lightweight construction system used at Sarah Hospital. Photo from Lele's archives (right) Royal Darwin hospital and its vertical concrete structure.

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