The use of sheds to promote the natural ventilation: the work of Brazilian architect João Filgueiras Lima, Lelé.

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Abstract

Natural ventilation is an efficient design strategy that reduces the use of air conditioning significantly, especially in tropical countries like Brazil. Among the ventilation strategies, it highlight the sheds, openings in the coverage, which functions as air collector and extractor. The Brazilian architect João Filgueiras Lima, known as Lelé, uses these devices to improve natural ventilation in most of his buildings. Lelé has been designing sheds for almost fifty years and to improve the efficiency of these devices, these geometries have been modified. This paper analyses the Shed designs used in Lelé’s buildings. The analysis is done in three stages. First, a data survey in the collection of the architect’s projects was performed. Second, the architect and his design team were interviewed. Finally, a design analysis was performed. Results show the great potential of sheds for natural ventilation and Lelé’s concern about improving the performance of these devices through the geometric changes.

Keywords: Bioclimatic architecture; Sheds; geometry; natural ventilation; João Filgueiras Lima.

1. Introduction

The sheds are architectural elements on the covering to promote natural lighting and ventilation. The most common examples of sheds are the well-known “sawtooth”, whose shape is rectangular and without many variations (figure 1). However, the work of Brazilian architect João Filgueiras Lima, Lelé, was highlighted whose sheds with aerodynamic shapes are present in most of his projects (figure 2). Lelé started to use sheds almost 50 years ago and based them on his experiences and local climatic factors, the geometry of these devices has been modified over the years, seeking to improve the efficiency of the sheds, in regard to natural ventilation and lighting. According to the architect Haroldo Pinheiro1, “in the1960’s sheds were rarely used, and Lelé started to use them a lot in his buildings. They are devices that have evolved a lot over the years”. Lelé is the Brazilian architect who most uses these devices to promote comfort in buildings.

1 Interview conducted by Marieli Azoia Lukiantchuki with the architect Haroldo Pinheiro, in 06/25/2009, Brasília – DF.
The use of sheds to improve natural lighting isn’t a recent strategy. These devices have been used for centuries in factories during the industrial revolution, and they are ideal for lighting the deep areas and blocking the direct solar radiation (SPADAFORA, 2010).

Besides using the sheds for natural lighting, Lelé uses them for natural ventilation. This occurs due to the Brazilian climate. Brazil is located between two tropics and it has a very varied climate due to its enormous territory. According to Cândido et al. (2010), the bulk of the Brazilian territory is classified as having a hot and humid climate. In these climates, the use of natural ventilation is the most efficient design strategy to achieve thermal comfort without mechanical cooling.

Natural ventilation strategies by the covering are efficient solutions, mainly in regions where there is little existence of external winds. This occurs in cities characterized by weak winds, by periods without winds or by the lack of spaces that are adequate for the circulation of air inside the urban net, due to the existence of external obstacles that block them. This can be improved in two ways: 1) air capting by the covering, whose obstructions to the wind circulation are smaller; 2) air extracting by the covering (stack effect), whose differences in pressure originate by differences in temperature between the internal and external air of the building. It’s important to note that when there isn’t any wind, the stack effect is responsible for air renewal in buildings.

According to Chandra (1989), the sheds can be designed both for the caption and the extraction of air, depending on the orientation of the prevailing winds. In Lelé’s work, the orientation of the sheds isn’t always the same. Based on his experiences and local climatic factors, sometimes he prioritizes the extraction of air and other times he prioritizes the captioning of winds.

Besides changing the sheds orientation, Lelé modifies the geometry of the sheds in each new building, seeking to improve the efficiency of these devices, related to natural ventilation. The concern about the shape of these architectural elements is very important, because according to Hoof et al. (2011) one of the main parameters that influences the natural ventilation is the building geometry. The authors highlight that several studies have been carried out to improve natural ventilation by using devices on the covering.

This paper aims is to chronologically evaluate the evolution of the shed design used in Lelé’s buildings. Although the main objective is the study of these devices for natural ventilation, it’s impossible to ignore the effects generated in natural lighting, because these two aspects are closely related.

2. Methodology

The analysis was performed in three stages: 1) field research in Lelé’s collection of designs, 2) interviews with Lelé and some professionals of his design team; 3)
projectual analysis emphasizing the different shed geometries and how these changes are related to the comfort of buildings.

2.1 Field research
A research about the projects developed by Lelé was carried out in existing books about his work and in his collection of designs in the Technology Center of the Sarah Network Hospitals (CTRS), located in Salvador - BA. First, a chronological analysis of all buildings with sheds designed by Lelé was performed, totalling 39 buildings. It is important to note that projects such as schools and nurseries, which are located in different cities, have similar design sheds and were considered as an only type of building. Then, among these buildings, sheds with aerodynamic shape were selected, totalling 24 buildings. Finally, field research was also performed in some of these buildings along with a photographic survey to illustrate the descriptions and analysis of this article. This stage was very important to understand how the geometry of these devices has been improved.

2.2 Interviews
Interviews with Lelé and some professionals of his design team were performed, seeking information about changes in sheds and how they influenced in the natural ventilation. The interviews were semi-structured.

2.3 Projectual analysis
Lelé’s designs were analyzed through material obtained in the survey and the interviews carried out, having as complement a more specialized literature. Of all buildings with sheds, designed by Lelé, some buildings were selected for more detailed analysis. The analysis was divided into two groups:

1) The first sheds: nine buildings whose sheds have an orthogonal geometry were evaluated: Headquarters of Disbrave (1965), Taguatinga hospital (1968), Planalto auto agency headquarters (1972), DAHER clinic (1977), Brotas Convent (1980), More day nurseries (1987), Schools (in the 1980's), Psychiatric hospital of Taguatinga (1988) and the Integrated Centers of Education – CIACS (in the 1990’s).
2) The aerodynamic sheds: The analysis was emphasized in the buildings with aerodynamic sheds, identifying the geometric changes to improve the natural ventilation: a) Sarah Network Hospitals, b) Union’s Accounts Tribunal e c) Regional Electoral Tribunal. These buildings were more detailedly analyzed by two criteria: a) the sheds are more evolved; b) for the access to digital projects of these buildings.

It is difficult to carry out this chronological analysis in a continuous way, because some buildings were built simultaneously and solutions were incorporated in buildings throughout the process. In this analysis it was considered the year of the building design, because it is at this stage that the geometries of the sheds are designed. Finally, most of the buildings of group 02 are located in regions of hot and humid climate. However, even in different cities characterized by the same hot and humid climate, there were variations that influenced in Lelé’s decisions. As the changes in sheds’ geometry are closely related to the specific climatic conditions of each city, climatic data of the cities were analyzed superficially to complement the design analysis. Figure 3 summarizes this analysis.
3. Results

3.1 João Filguerias Lima’s architecture and the use of the sheds

Since the beginning of his professional career, the concern about comfort in buildings is fundamental in Lelé’s design. The sheds to promote natural ventilation and lighting have been used by the architect for almost 50 years, seeking more economical and more pleasant buildings.

When I started designing sheds there wasn’t any economical problem. What motivated me to make them was the humanization of the environment through natural ventilation and lighting. I’ve always thought that these aspects were healthier for humans than the artificial lighting and air conditioning. So, my initial position wasn’t motivated by concern about energy saving that you should have today due to the high energy costs. I was motivated by the humanization of the spaces. Why would you waste daylighting and ventilation? So, I always design sheds (verbal information).

The chronological study of Lelé’s buildings shows the evolution of the sheds over the years. The first sheds designed by Lelé didn’t have aerodynamic geometries due to materials and construction techniques used at the time. However, because of his several professional experiences, these devices were constantly modified obtaining different aerodynamic sheds. The geometry of the sheds aren’t only aesthetic factors, but mainly due to the climatic conditions of each city, seeking to improve the efficiency of natural ventilation and lighting.

Lelé’s work is known for constant study of his own buildings. It helped him in a continuous design process where each new project is a continuation of the previous one. This process shows his commitment to the final result, where the architect knows the impact of his choices, analyzing the strengths and limitations of each strategy used. The learning from past designs is recurrent in his work and is responsible for the constant evolution of his buildings. According to Lawson (1997) the process to identify problems and propose new solutions is essential. The designs must be a constant return to the previous one, in the form of successive interactions.

3.2 The first sheds

The first building in which the sheds appeared was the headquarters of Disbrane, in Brasília, in 1965. Y-shaped shed beams were made in heavy concrete and their

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2 Interview conducted by Marieli Azoia Lukiantchuki with the architect Lelé, in 11/18/2008, Salvador – BA.
irregular shape prioritizes Zenith lighting and prevents the penetration of sunlight into the internal spaces. The Zenith openings provide a uniform lighting. However, these openings should be protected from direct sunlight because most of the thermal gains come from the radiation that reaches the covering, and, especially in the summer, the sun paths are very high (figure 4a).

Besides natural lighting, these sheds don’t touch each other allowing the natural ventilation of the environment and the air extraction by the covering (figure 4a). However, due to the small size of this passage, the air extraction is impaired. For Lelé, this shed didn’t achieve great flexibility due to the material used at the time.

In 1968, this solution was repeated in the Taguatinga hospital (figure 4b). In 1972, in the Planalto auto agency headquarters, the Y-shape sheds (in this case with a regular shape), were inverted and they have overhangs to prevent the penetration of sunlight into the internal spaces. The sheds are fixed openings for natural ventilation that, due to their small size, impairs the passage of the air (figure 4c). In these three examples, the shed is the covering itself.

![Figure 4: Sheds (a) headquarters of Disbrave; (b) Taguatinga hospital and (c) Planalto auto agency headquarters (LATORRACA, 1999).](image)

In 1977, in the DAHER clinic design, unlike previous designs, the sheds are a separate element of the covering (figure 5a). With this same principle, many schools in the 80’s would be developed. With a building system in ferrocement, the sheds have an orthogonal geometry and they are made of translucent plastic for the entry of light. The opening at the top allows the extracting of hot air through the suction effect. However, because of the small size of this opening - 5 cm – (FREIRE, 2000), the air extraction is impaired (figure 5b).

![Figure 5: (a) Sheds in the DAHER clinic and (b) Schools buildings (LATORRACA, 1999).](image)

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3 Interview conducted by Marieli Azoia Lukiantchuki with the architect Lelé, in 11/25/2011, Salvador – BA.
According to Freire (2000) this geometry avoids the incidence of direct solar radiation in translucent material at angles above 60°. Its protection element has a high shadow factor that obstructs a large part of the sky and explores very little other surfaces as reflective and diffuse elements of natural lighting.

The curved sheds appeared in the design of Brotas convent (1980) for the first time and then, in 1987 in the More day nurseries, both in Salvador – BA. In the first case, the sheds are the covering itself (figure 6a), unlike the nurseries, where these elements are separated from the covering such as in the schools (figure 6b). Although these elements are closer to the aerodynamic sheds, which appear later, they are more restrained and less flexible. Lelé always seeks to improve the shape of the sheds.

Since the beginning, Lelé already had some solutions to the sheds. He’s always used this since the time of the ferrocement schools and the nurseries. And from then, the sheds were incorporated in his architecture in a very strong way. He’s always looked for other solutions. The sheds are always different. The solutions are always different (verbal information)\(^4\).

![Figure 6: (a) Brotas convent, (b) More day nurseries (LATORRACA, 1999).](image)

In 1988, with the Psychiatric hospital of Taguatinga, a different principle appears that will be improved later in the Accounts Tribunal of Aracajú and the last Sarah hospital. Despite having an orthogonal shape (without large changes from what had been done in schools buildsigns), the design of the sheds allows for air intake behind it (figures 7a e 7b). This improves the air extraction through the roof, forming an air current that removes the hot air from the environment. According to Lelé\(^5\), the last Sarah hospital, is based on this principle of having a continuous ventilation in the covering itself.

![Figure 7: (a) Sheds in Psychiatric hospital of Taguatinga and (b) Sheds with com air intake behind it (LATORRACA, 1999).](image)

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\(^4\) Interview conducted by Marieli Azoia Lukiantchuki with the architect José Fernando Minho, in 03/19/2010, Salvador – BA.

\(^5\) Interview conducted by Marieli Azoia Lukiantchuki with the architect Lelé no dia 11/25/2011, Salvador – BA.
In the 1990’s the Integrated Centers of Education – CIACS were implanted in different Brazilian cities. The sheds have an orthogonal shape, but are considered an evolution of the schools designed in the 1980’s. In the earlier buildings, the sheds were used with only one function: either air extraction or air caption. In the CIACS, the sheds favor the air extraction and caption simultaneously. In the windward rooms, the sheds are extractors. On the other hand, in leeward rooms, the sheds are captors. This solution is a good way to increase the air velocity in environments located contrary to the prevailing winds (figure 8).

![Figure 8: Overview of the CIAC in Brasília (LATORRACA, 1999)](image)

### 3.3 The aerodynamic sheds

The highlight of his architectural production is the Sarah Network Hospitals and the Tribunals, located in different Brazilian states. In these buildings, the sheds are completely different from the previous ones, with aerodynamic geometry that improves natural lighting and ventilation. The heavy concrete structure is replaced by steel which allows the use of curved shapes which are lighter. The design of the first Sarah Network hospital, Brasília – DF, was developed in 1975. With a different proposal from later hospitals, this building is vertical with sheds only in the ground floor and underground, whose mainly function is natural lighting. Sheds, used in this building, are made in ferrocement, and they were reproduced later in school designs in the 80’s, as seen previously. It occurs due to the construction technology and materials used (figure 9a). In 1988, the design of a hospital located in São Luís – MA and Salvador – BA were developed together. The geometry of the sheds for São Luís hospital was very similar to the ones in Salvador. However, these elements were built in concrete, which resulted in an orthogonal geometry, different from the aerodynamic sheds that appeared later (figure 9b).

![Figure 9: (a) Sheds in Brasília hospital (CTRS collection, 2008) e (b) external and internal sheds of the São Luís hospital.](image)

The efficiency of the shed improves with the proposal for Salvador hospital (1988 – 1991). Due to the flexibility of the steel, these elements reach different aerodynamic...
shapes with lighter designs in the covering. It is the first building designed according to these principles. The structural engineer Roberto Vitorino⁶ highlights that the result of the geometry of the sheds is also related to the capability of construction techniques and materials used. As an evolution of these techniques, more flexible and aerodynamic sheds that improve natural lighting and ventilation were achieved.

[...] I was very enthusiastic about the design of the Salvador hospital not only about the building system, which is an evolution of the design of schools. This design of the Salvador hospital is an evolution, like everything that Lelé does. [...] But what caught my attention was the system of environmental comfort. It was an innovation. The set of solutions, making the best of materials, the construction processes and the concern about the natural ventilation through the use of sheds... It was a great innovation (verbal information)⁷.

The city of Salvador has a climate characterized as tropical, with hot and humid characteristics. The annual average temperature is above 23.6°C and humidity values are between 79% e 83.2% (INMET, 2012). The high temperatures and humidity indicate that natural ventilation is the most appropriate strategy to solve the problem of thermal discomfort.

This building has larger openings that improve the natural lighting and air extraction. The shed has a metal piece that protects the indoors from the direct solar radiation. The ceiling of this hospital is 3.00m at the bottom of the sheds and 4.50m at the upper (figures 10a and 10b). The sheds favor the hot air extraction by stack effect. It occurs because the openings are located contrary to the prevailing winds.

![Metal piece to protection of direct solar radiation](image)

**Figure 10:** (a) Salvador hospital (CTRS collection, 2008) and (b) external and internal sheds of the Salvador hospital.

In 1992 the design for Fortaleza hospital was developed using sheds with different geometries from those used in the Salvador hospital. The half arch shape is because of the local climate. Located in the northeastern region of Brazil, near the Equator line, the city is in a totally tropical position. The main strategy for achieving thermal comfort is the natural ventilation. Fortaleza is hotter than Salvador, presenting higher average temperatures throughout the year (figure 11). As a result, the architect sought, in this building, a more

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⁶ Interview conducted by Marieli Azoia Lukiantchuki with the engineer Roberto Vitorino, in 11/24/2011, Salvador – BA.

⁷ Interview conducted by Marieli Azoia Lukiantchuki with the architect Haroldo Pinheiro, in 06/25/2009, Brasília – DF.
pronounced effect of convection and larger air circulation. For this, Lelé designed a shed which increased the ceiling of the building for up to 7m (figures 12a and 12b). Thus, the air flow acquires a higher velocity and, consequently, the air extraction by stack effect is facilitated. In addition, the sheds’ concave shape of the Salvador was modified to convex surface to avoid the heat input into the environment. As in Salvador, the element of protection from direct solar radiation is an independent piece, attached to the shed.

The changes of the sheds seek to improve the systems of natural lighting and ventilation. In the Fortaleza hospital we calculate the air flow, while in Salvador it was empirical. The Fortaleza hospital was already calculated to have a larger velocity of air extraction. Because of this, we increased the height of the building. Fortaleza is warmer. I think the result of Fortaleza hospital is much better than the one in Salvador (verbal information). 8

Figure 11: Average temperatures (INMET, graphic prepared by the author)

Figura 12: (a) Fortaleza hospital (CTRS collection, 2008) e (b) external sheds of the Fortaleza hospital.

The study of these different geometries shows Lelé’s concern about the improvement of the sheds, allowing the constant evolution of comfort strategies.

[...] But if I had repeated the shed of the Salvador hospital in Fortaleza it wouldn’t have improved anything. Through research that I have done about its correct application, nowadays I have a larger awareness about how the sheds work. The principle of the sheds is recurrent, but the design of the

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8 Interview conducted by Marieli Azoia Lukiantchuki with the architect Lelé, in 03/162010, Salvador – BA.
coverage isn’t the same. There is always an innovation, some improvement (LIMA, 2007, Apud MENDONÇA, 2007).9

In 1996, the design for Sarah North Lake in Brasília was developed and the building is located on Paranoá Lake due to the hot and dry climate of the city. However, this climate isn’t rigorous as the Northeast and North (figures 11 and 13).

Figure 13: Relative humidity (INMET, graphic prepared by the author)

The sheds of these building are similar to the ones in Salvador. However, the more pronounced shape allows a higher ceiling. In addition, the metal piece attached to the sheds of the Salvador and Fortaleza hospitals is replaced by the extension of the sheds, protecting the openings from direct solar radiation. This change the geometry of the sheds (figure 14a). In the physiotherapy room, the geometry of the sheds are extended due to larger internal spaces and this height (13m) promotes the air convection (figure 14b). According to Risselada and Latorraca (2011) since the early designs for the Sarah hospitals proposals were made to reach at this shape conception that, finally, was performed for the first time in this building.

Figure 14: (a) Sarah North Lake in Brasília and (b) Physiotherapy room (CTRS collection, 2008).

After, the design of Union’s Accounts Tribunal was developed and implanted in different Brazilian capitals. In the Salvador Tribunal (1996), the sheds are equal to the ones in the Salvador hospitals. However, the change of Sarah North Lake has been incorporated and the openings are protected by the extension of the sheds. In addition, there is a larger shed due to the spatial distribution (figure 15).

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9 Interview conducted by Adriano Carneiro de Mendonça with the architect Lelé, in 18/01/2007, Salvador – BA.
In 1996, the design of Natal Tribunal was developed. The geometry of the sheds is equal to the Fortaleza hospital and they were designed based on the local hot and humid climate (figures 11 and 13). However, the city is characterized by a constant breeze and high wind velocities throughout the year, recording an average velocity of 4.42m/s (figure 16).

The typology of the building with a central corridor with rooms on both sides, can hinder the ventilation of rooms located on leeward. Therefore, the solution adopted was to use extracting sheds on rooms located windward and capting sheds on rooms in leeward (figure 17). The use of extracting and capting sheds together is similar to the projects of the CIACS. However, in this case, the aerodynamic sheds intensify the effect of air extraction and captation. Despite the constant and strong winds in Natal, fans located on the roof were provided, to accelerate the air flow during periods without winds. When natural ventilation is used, it is important to provide mechanical ventilation systems to work in these periods. They work as a complement to passive systems of comfort.
Also in 1996, in the Northeast region of Brazil, the Aracajú Tribunal was developed. The climate of the city is hot and humid (figures 11 and 13) and the wind is constant and strong throughout the year (figure 16). In this building, the sheds have a large evolution. The sheds are linked together, creating a fluid structure of the roof that covers the entire building. The openings are located in windward and leeward creating a permanent passage of air through the coverage, that helps the removal of hot air from the environment (figure 18). This system is an advance that was developed in 1988 in the Psychiatric hospital of Taguatinga, improving the air extraction through the coverage.

**Figure 18:** Aracajú tribunal (CTRS collection, 2008).

In 1998, Teresina and Cuiabá Tribunals designs were developed. Despite these buildings being located in different regions (Northeast and Midwest, respectively) the climate of both cities is extremely hot with high temperatures and low wind velocities (figures 11 and 16). In addition, at various periods of the year, the climates are characterized by long periods without winds, mainly for the city of Cuiabá. It prevents the use of natural ventilation to ensure thermal comfort. Because of these climatic conditions, the use of air conditioning in the building was necessary. In Cuiaba and Teresina the sheds provide natural lighting (figure 19 and 20).

**Figure 19:** Teresina tribunal (CTRS collection, 2008).

**Figure 20:** Cuiabá tribunal (CTRS collection, 2008).

The Union’s Accounts Tribunal designs show an improvement in the flexibility of the sheds which are the result of several earlier forms, creating new products. Aspects such as functionality, space and climatic conditions were fundamental to achieve these different geometries of the sheds. In the same year of 1998, with the design of Regional Electoral Tribunal of Bahia, in Salvador, there was a great evolution, presenting a more developed shed. Its design is the combination of past experiences. The several sheds are interconnected as if they were a continuation of the previous one (figure 21).

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According to Meteorology National Institute, 12 months of the year in the city of Cuiabá, 8 months are characterized by periods without winds.
In 2001, the Children’s Rehabilitation Center of the Sarah Network was developed in the city of Rio de Janeiro. Although this city is located in the Southeastern region of Brazil, this climate is characterized as hot and humid, with high temperatures, high rates of relative humidity and intense solar radiation. In the same way as in Salvador and Fortaleza, the natural ventilation is highlighted as an important strategy for achieving thermal comfort for most of the year. However, there are certain periods that the temperature approaches 40°C, making the use of air conditioning necessary.

Although the sheds have a shape similar to the Fortaleza hospital, it can be noticed an improvement in the design of this center. An inverted curve appears on the convex surface for a duct of the air conditioning system. Note the integration of the natural with artificial systems in the design of the sheds (figures 22a and 22b). The openings are located to the West – leeward – allowing the hot air extraction by stack effect. The structure of the sheds accompanies the free span needed for larger spaces, with different configurations. The covering isn’t just a collection of shapes that determine the appearance of the building, but it also represents the functionality and the comfort of the user.

It isn’t a matter of formality, not a matter of the form for the form. It’s about functionality, the cost, the easy assembling and, mainly the comfort of the user. So that’s it. The design of the sheds considers all theses issues (Verbal information) 11.

Space of air conditioning

7.20m

Figure 21: Regional Electoral Tribunal of Bahia - Salvador (CTRS collection, 2008).

Figure 22: (a) Sheds in Children’s Rehabilitation Center (CTRS collection, 2008) and (b) internal photo of the sheds.

11 Interview conducted by Marieli Azoia Lukiantchuki with the architect José Fernando Minho, in 11/24/2011, Salvador – BA.
In 2001, two designs of the Sarah network were developed in the cities of Macapá – AP and Belém – PA, both located in the Northern region. Many precautions were taken into account because of the high rates of relative humidity and high temperatures. Because of its proximity to the Equator line, it has a too hot and humid climate. The high levels of humidity are associated with high temperatures throughout the year (figures 11 and 13), allowing for extreme thermal discomfort. In addition, levels of solar radiation which reach the buildings are too high.

According to Allard (1998) the excess of humidity in these regions generates a large discomfort because of air saturation. To alleviate this discomfort, the natural ventilation is essential. Air currents, in certain velocities, through the physiological cooling, increases the sensation of comfort. Therefore, in these hospitals, the height of the ceiling and the openings of the sheds were enlarged to increase air flow and consequently the evaporation of humidity (figures 23 and 24). The difficulty of high height is to control the openings. However, as all of them are motorized, the control is facilitated.

In the hospitals located in Amapá and Belém I was very worried because there is high humidity. So, we increased the height of ceiling and the openings of the sheds. This decision was determined by the humidity. If you increase the air velocity, you decrease the effect of humidity. When the humidity is very high, its the air circulation that solves this problem with higher velocities to evaporate the humidity. [...] When you make the shed very high, it is difficult to manipulate the openings. But it was motorized (verbal information) 12.

![Figure 23: Macapá hospital (CTRS collection, 2008).](image)

![Figure 24: Belém hospital (CTRS collection, 2008)](image)

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12 Interview conducted by Marieli Azoia Lukiantchuki with the architect Lelé in 11/25/2011, Salvador – BA.
Between 2001 and 2004 the last building of the Sarah network was developed in Rio de Janeiro, which can be considered the most evolved building of his career. As a result of the experience acquired for over 30 years in the Sarah network, Lelé reaches the top of his career in this building, presenting the most advanced comfort solutions.

We are always trying new experiences. You always have to be renewing the sheds. You have to evolve. Sometimes you get better results radically changing that line you proposed. For example, I think that in Rio de Janeiro hospital we changed the proposal completely. The flexibility is much better, because the sheds become independent. The hospital has to be flexible, it has to attend a very diversified space (verbal information). 

Because of climatic characteristics of Rio de Janeiro, the design of the sheds of this hospital is completely different from the other hospitals including the Children’s rehabilitation Center, also implanted in Rio de Janeiro. This was because of the maturation of his own architectural production and his professional experiences.

Unlike previous hospitals, in which the sheds are limited by environments, in this case the covering is totally independent of the internal spaces, creating a large air space ventilated. In addition, this characteristic eliminates the individual sheds, turning it into a single element in the building. Between the sheds and indoor environments, there are mobile liners made of translucent polycarbonate. Besides the covering totally independent, the ceiling of this building is variable and always higher than 8m. It is the geometry of the sheds that have more flexibility (figure 25).

The sheds are oriented to capture the prevailing winds. However, there are also sheds oriented leeward, allowing the continuous air renewal in this space and avoiding the accumulation of hot air. This solution appeared for the first time in Psychiatric hospital of Taguatinga (1988), evolving in the Aracajú Tribunal (1996) and achieving its apex in this building. This layer of ventilated air of about 4m, works as thermal protection for the building, helping to dissipate heat from the incidence of solar radiation on the sheds.

**Figure 25:** (a) Rio de Janeiro Hospital (CTRS collection, 2008); (b) and (c) sheds’ geometry and (d) mobile liners

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33 Interview conducted by Marieli Azoia Lukiantchuki with the architect Lelé in 03/16/2010, Salvador – BA.
4. Conclusions
The chronological study of Lelé’s buildings shows the evolution that occurs in the sheds over the years. The first sheds didn’t have aerodynamic geometries, due to the materials used at the time, such as schools and nurseries. It’s interesting to note the Taguatinga Psychiatric hospital, whose design of the shed allows a passage of air that will be improved in Aracajú tribunal and reaches its apex in the Rio de Janeiro hospital.

As the construction techniques and materials have improved, through the use of steel more flexible sheds were achieved. The efficiency of the shed begins to improve with the proposal of the Salvador hospital, which is the first building designed according to aerodynamic principles. Changes in Fortaleza, Belem, Macapa and Rio de Janeiro hospitals show the close relationship between the geometry of the sheds and the local climate.

The Union’s Accounts Tribunal design shows more flexible sheds which are the result of several earlier forms, creating new shapes. Then, in the Regional Electoral Tribunal design, the shape of the sheds can be considered a combination of past experiences. Finally, all these experiences contributed to Rio de Janeiro hospital design, where the sheds are completely flexible and independent of the building. This design can be considered the apex of the evolution in the shape of the sheds.

These devices were constantly modified through his large professional experiences. The geometry of the sheds aren’t only aesthetic factors. The result of their shapes is also related to the capability of building techniques and materials used, functionality, space and mainly to specific climatic conditions of each site, seeking to improve the efficiency of natural ventilation and lighting.

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