Chapter 6
Shading in Architecture and its Relation with Natural Cooling: Learning from Maputo, Mozambique

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Shaded areas around built structures is an effective strategy in reducing direct sunlight inside buildings located in countries with hot climates. In regions of hot humid climate, shade has the effect of reducing the air temperature of the surrounding area and enhancing natural cooling. This is increasingly relevant in times of climate change because buildings are requested to lower CO_2 emissions. This chapter aims to give an overview of twentieth century architecture in Mozambique and provide information to architects of the twenty first century that intend to continue this tradition and expand bioclimatic solutions that succeed in lowering the consumption of energy. The focus on Pancho is due to the excellence of his work in the panorama of modern architecture, the diversity of his design merging local traditions and new technologies, and the cultural impact of his work in Maputo, Mozambique.

Architecture solutions of shading, cross ventilation and thermal control have been refined in recent years, improving performance by developing a bioclimatic quality, which is influenced by the exchange of best practices from around the world. In Mozambique, and mainly Maputo, there are several examples of architecture that adapt and interact with the tropical climate. Throughout the twentieth century, with population growth, Maputo experienced an unprecedented urban development, where a number of bioclimatic strategies were tested, namely, the extension of roofs, the use of balconies that bring shade to façades, ventilation of ceilings, roof covers, vertical and horizontal shade blades to induce ventilation, shade grill façades (cobogós), division of windows in areas of lighting and ventilation, semicircular frameworks with brise-soleil shades and façade elements realised as closets or joists to increase the cooling of buildings. All of these elements are present among the solutions used by modernist architects and were particularly well illustrated in the works of architect Pancho Guedes, a member of Team 10 (often referred to as Team X), who lived and designed many buildings in Maputo.

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Climate of Africa

The continent of Africa presents a uniform climate, making it unique compared to other continents. Its particular location, with the crossing of the Equator and the two tropics, allows the whole territory to be considered a low latitude climate zone, according to the classification of A. N. Strahler (González and Javier 2004, p. 21). The low latitude zones form the part of the world where the sun's rays focus more perpendicular to the surface of the Earth and in a very uniform way throughout the year (González and Javier 2004, p. 13). Most of the territory is covered by a warm climate, divided into humid equatorial climate, wet dry tropical climate and hot dry desert climate (Fig. 6.1). These climates are characterised by high temperatures and humidity variation between very dry and very wet. The equatorial climate, between 10° N and 10° S, is the one in which the temperature and humidity are more constant throughout the year. The wet dry tropical climate lies between latitudes 5° and 25° both north and south of Ecuador, benefits from the presence of tropical forests and has different levels of humidity at different times of the year, with wet summers and dry winters. The desert climate that lies between the latitudes of 15 and 30° N and 15° and 30° S is characterised by being extremely hot and dry, with few temperature variations during the year.

The dry subhumid tropical climate region is the main climate zone in the Portuguese-speaking countries of Africa, covering most of the area of Angola and Mozambique. However, São Tomé and Príncipe and Guinea-Bissau are in the equatorial climate zone. Cape Verde, which is the northernmost Portuguese-speaking country, is already in a hot and dry desert climate zone. So, with the exception of Cape Verde, the climatic characterisation of Portuguese-speaking areas in Africa is hot and humid. The architecture designs for these countries value shading solutions to achieve an efficient improvement of the feeling of thermal comfort, associated with the ambient temperature and air humidity concentration. The replacement of blind façades for shading systems enhances natural ventilation, which is essential in order to reduce the levels of humidity in buildings.

Climate of Maputo

Maputo is located in southern Mozambique on the southwest coast of Africa, between parallels 25° 40′and 26° 30′ south and meridians 32° 35′and 33° 10′ east. Summer is a hot season with precipitation; the dry season presents high winds and no clouds. Throughout the year, the weather is warm and the variation in temperature is between 16 °C and 29 °C, and is rarely less than 14 °C or more than 33 °C. The rainy season lasts for approximately 5 months, from November to March. The dry season lasts for almost 7 months, from April to October. The duration of the day in Maputo ranges between the shortest day on the 21 June, with 10 h 30 m of sunlight and the longest day on the 22 December, with 13 h 46 m of sunlight.

The annual relative humidity ranges from 65% in summer, where February and March are the wettest months, and 45% in winter, where August and September are the least humid. The average wind speed in Maputo undergoes significant seasonal variations throughout the year. The season with higher levels of wind during the year lasts for 4 months, from August to December, with average wind speeds of up to 17 Km/h. The strongest winds usually occur in September, with an hourly average wind speed greater than 19 Km/h. The calmer season of the year lasts about 8

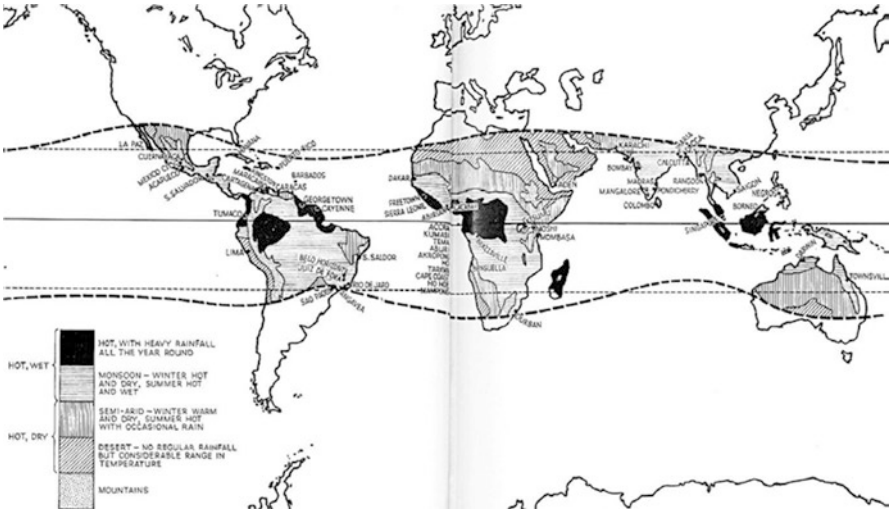

Fig. 6.1 Intertropical area of planet Earth: tropical architecture in the dry and humid zones (Source: Fry and Drew, 1964)

months, from December to August. The lowest average wind speed occurs in May, being about 15 Km/h, which is not actually considered to be wind. The most frequent wind comes from the east for most of the year. It may blow predominantly from the southwest with a proportion of 15% (weatherspark.com).

The city of Maputo is located on a plateau with a coastline, has a constant topography, with slopes to the south and east, and ending in coastal shallows. This orography ensures good sun exposure but mainly good ventilation in the area of the plateau and slopes, oriented in the direction of the prevailing winds to the east, taking advantage of the presence of the Indian Ocean (Morais 2001, p. 52). The city has evolved from the initial core area, located in the south. This area was initially an island that was then later attached to the coast by landfill, developing gradually by soft slopes located southwest of the plateau, first extending to the east and later to the north. The city's density is very low, which, along with the design of the urban plan, ensures good urban ventilation.

The initial plan of the city of Maputo, the Araújo plan, dated from 1900, is characterised by the design of large blocks and wide avenues organised in an orthogonal mesh. This grid was oriented with a rotation of about 28° to the north–south axis, which allows for the implementation of buildings close to the ideal in the north and south sides of the blocks, since the windows are mostly to the north façade.

6.1 Shading Typologies in the Architecture of Maputo

In hot and humid climates, there are fundamental requirements for temperature control of the built environment: avoid direct sun impact on windows, enhance the concept of opaque envelope, reduce the air temperature surrounding the building

and promote cross ventilation to reduce the internal temperature and humidity levels. The thermal inertia of the materials associated with appropriately designed shade ensures an effective feeling of thermal comfort. For this, shade systems are critical and various types of devices can be used according to the situation or orientation of the building. In hot regions, a well-shaded building can be between 4 °C and 12 °C cooler than one without shade (Guedes 2011, p.40). Shading systems should block the incidence of the sun's rays before they pass through the glass, thus avoiding the greenhouse effect. Some distance should also be kept between the shading element and the glazed area, so that thermal radiation captured by the device does not heat the interior of the building. The shading of the outside world that envelopes the building can be done through fixed or adjustable devices, by vegetation or surrounding shaded areas. Another technique that helps to lower internal temperatures is the creation of cooler environments around the building, which can include solar protection of balconies, patios or atriums.

The efficiency of fixed devices varies according to the solar orientation. They can be: horizontal blades, ideal for the protection of glazed surfaces in façades oriented to the north; vertical blades, ideal for protecting windows from solar radiation in façades oriented to the east and west, due to the low angle of the sun in the early morning and late afternoon; or combined horizontal and vertical shades, such as the projecting frames of windows. Fixed grids are effective for enhancing indoor ventilation. Fixed shades are prominent elements of façades, such as beams, eaves, wardrobes etc.

Mobile devices include adjustable vertical and horizontal blades or blinds, or even mobile grills, shutters and lattices, which are used mainly in façades oriented towards the east and west, hiding the entire glazed surface. Mobile devices change the visual appearance of buildings and are managed by users to keep the temperature at a comfortable level. Without them, it would easily lead to overheating of the building.

Neighbouring buildings can promote shade on façades, mainly on the lower floors, but cause, as a side effect, a reduction of natural light in the rooms. Vegetation also promotes a better environment around the buildings, having a dual purpose of shade and reduction of temperature through an evaporative cooling effect. In hot climates, the use of evergreen trees constitutes a preferred solution.

The creation of cooler surrounding intermediate spaces also allow lower temperatures inside the building. This could be achieved by verandas, patios, sheds, roofing over floor extensions and galleries or arcades. This is the traditional method to cool buildings, by casting shadows over the exterior areas around it, thus constructing a sort of thermal envelope. In Portuguese-speaking countries with tropical climate, in the architecture of the nineteenth and early twentieth centuries, this process was often used, as can be seen in the "Roças" architecture in São Tomé and Príncipe or in downtown Maputo.

The island at the mouth of the Espírito Santo River is where the settlement of Maputo was initially established in 1544 as being a Dutch, English and Austrian trading post successively, until it was taken by a Portuguese expedition originating from Goa in 1781. In this place, a Portuguese presidium (establishment of military colonisation) was settled, under the command of Joaquim de Araújo. After 1902, because of the railroad connection and the pacification of the interior of South

Africa, the city of Lourenço Marques later became known as Maputo and evolved into an important business centre, mainly due to its role in importing and exporting goods from South Africa. The urban expansion of the city developed during the transition of the centuries, on one hand from a plan of 1887 by the engineer António Araújo, to the slope to the north of the downtown, and simultaneously in the "Ponta Vermelha", from a plan by MacMurdo. This plan was initially separated and later became integrated in the urban design of the city (Fernandes, p. 59). The great urban expansion took place in the 1920s and 1930s, based on the plan, designed in 1903, "Insurance Plan of Lourenço Marques, Delagoa Bay", in which the urban grid extends to the north, to the current Av. Mao Tse Tung and the circumvallation, which was already included in the plan, thought to be built only later on.

Architecture of the late nineteenth and early twentieth centuries

Downtown Maputo and the central area are the places where it is still possible to find buildings from this period. Unlike the capitals of other Portuguese colonies, where the influence of Portuguese architecture has a greater presence, here, we find colonial buildings of the late nineteenth century influenced by South Africa. Large balconies made from wood and wrought iron characterised these buildings, with covers suspended by columns in metal or wood and, later, concrete. Prefabricated wrought iron pieces such as pillars, porch grills and stairs were imported in order to quickly assemble buildings, built in traditional British colonial style or Victorian style (Schauer 2016, p. 12).The colonial style is visible, for example, in the building of the old offices of Delagoa Bay in the street Rua Do Bagamoyo (Fig. 6.2) or in the residence of the director of the central hospital in Av. Eduardo Mondlane. Some commercial buildings in the downtown area feature long galleries with neoclassical columns and concrete slabs. Some of these galleries were added later, as in the case for the commercial building of Tobler's house built at the beginning of the century but with a gallery of neoclassical columns from 1929 (Fig. 6.3). This period of iron-based architecture produced two important buildings: the central railway station (Fig. 6.4) of 1908/1910 from a project by Alfredo Augusto Lisboa de Lima and José Cristiano de Paula Ferreira da Costa with a central turret and two lateral arches surmounted by balconies, an element that allows it to adapt to the climate, and also Vila Jóia (Fig. 6.5) from 1890, with a design by the architect of Pretoria, F. A. Bodde, which has a metallic structure with Hindu-inspired staircases and classic arcade (Fernandes, p. 149). This building, one of the oldest in the city, belonged to Gerard Pott, Consul of the Transvaal in Lourenço Marques, and is a great representative of the Dutch colonial architecture (Lima 1966, p. 56) of neoclassical style. Two works in the Polana area from the early twentieth century represent the first uses of reinforced concrete and utilised the same morphology as the large galleries of colonial architecture. These are the Nautical Guild (currently the Naval Club), artwork between art nouveau and art deco, and the Tea Pavilion, a typical concrete architecture on balconies and consoles" (HPIP - Heritage of Portuguese Influence, HPIP.org).

Art deco architecture and "Português suave" style

As with the "Victorian" style of balconies and iron pillars, imported from England, which was used in several colonies, art deco was also imported from Europe and the

Fig. 6.2 Former offices of Delagoa Bay

Fig. 6.3 Tobler's house

USA and became popular in the African colonies (Schauer 2016, p. 12). Some cities like Asmara in Eritrea or Casablanca in Morocco are known for this architecture. In the case of Maputo, the art deco is of British origin and will have come via South Africa. This style, together with the first modernism, still has a significant presence in the city of Maputo today, due to the population expansion in the city in the 1930s and 1940s. However, while in the metropolis and in other Portuguese colonies the

Fig. 6.4 Central railway station

Fig. 6.5 Vila Jóia

"Português suave" style was of greater importance, in Maputo, the English influence was stronger. According to the opinion of José Manuel Fernandes, *"Maybe we can even say that the more dynamic modernizadora? (...) along with a cosmopolitan internationalism, powered in direct relationship with the Anglo-Saxon neighbour, have led to a smaller dimension of the architecture phase neotradicionalista?"* (Fernandes and Janeiro 2006, p. 165).

We can find some of these examples in Maputo, namely in two types of art deco: one of more volumetric character, with vertical bodies of pure geometry (Fig. 6.6) more connected with the English art deco, and a later one marked by the cantilever slabs and blades of reinforced concrete (Fig. 6.7), influenced by the American art deco. Although it became a truly popular style, even among the builders, many architects of this time are not known, as most of the buildings had designs sometimes coming directly from South Africa (Schauer 2016, p. 13). In single-family

Fig. 6.6 Villa art deco

Fig. 6.7 Villa art deco

Fig. 6.8 Villa art deco

dwellings, this style was characterised by high ceilings and small openings to control solar radiation. For the purpose of ventilation, most of the dwellings had small grates next to the ceiling in order to expel the warm air. The adaptation to a tropical climate is recognised in some dwellings with deep balconies, designed as a negative of the volume (Fig. 6.8) or balanced in cases in which the construction already used reinforced concrete. In the first phase of art deco, the blades of shade on the windows, when they existed, are still small due to the difficulty in construction and because they are mostly constructions built before the use of reinforced concrete. In the second phase, we found a greater volumetric freedom, lower wall surface and larger openings, although covered with blades of shade. The characteristics of this style, sometimes called "streamline modern", are the use of curved shapes, protruding volumes and rounded corners, elongated horizontal lines and surfaces, and, sometimes, nautical decorative elements, such as round windows and protection rails in metal tubes (Fig. 6.9).

Some of the most notable equipment buildings in Maputo are from this time in an art deco style or from early modernism: the Scala cinema and the Scala café building, built side by side in 1931, are joined by galleries covered with a reinforced concrete cantilever slab, which extends over the two streets (Fig. 6.10), probably the first to be built in Maputo. The Cathedral of Maputo was built between 1936 and 1944 (Fig. 6.11) following the design of engineer Freitas da Costa "recalling churches by Auguste Perret and Pardal Monteiro" (Fernandes, p. 165), namely the Church of "Notre-Dame du Raincy" and the Church of "Nossa Senhora de Fátima" in Lisbon. Constructed entirely of reinforced concrete, it presents with horizontal blades in the central tower that accentuate its tropicality. The "Casa Hillman" (Fig. 6.12) on Av. 25 de Setembro, built in the 1940s as a building materials store on the ground floor and an English club on the upper floors, is now the ministry of

Fig. 6.9 Villa art deco

Fig. 6.10 The Scala cinema

energy. In an art deco language, it is "formally almost a reduced version of the headquarters of the newspaper 'Diário de Notícias' in Lisbon" (Fernandes, p. 167), presenting, however, recessed windows in order to create deep shading galleries on the main façade. Also, the bay windows in the main tower are transformed into small horizontal slots. The Hotel Cardoso built in 1938 (Fig. 6.13) by the Italian architect

Fig. 6.11 The Cathedral of Maputo

Fig. 6.12 The "Casa Hillman"

Paolo Gadini, located on Av. Martires de Moeda, presents, on the façade facing the bay, cantilever balconies and recessed windows recessed for shade. However, because it is oriented to the west, vegetation is also used to enhance temperature control. But it is the blades of concrete to the west and the grilles to the east, both of which fulfil the purpose of ventilation, that characterise this building. The 1948

Fig. 6.13 The Hotel Cardoso

Cine África (Fig. 6.14), at Av. 24 de Julho, is a building from the end of the art deco period and shows the same type of blades on the main façade, with the double function of shading and ventilation, as well as a gallery on the first floor. The Radio Palace of 1949 (Fig. 6.15), also by the architect Paolo Gadini and engineer Pardal Monteiro[1] (Schauer 2016, p. 44), already built during the transition to modernism, is made up of three different bodies: the first apparently cubic with a shading grid consisting of squares, the second a vertical tower with vertical blades and the third is lower with horizontal blades, form an imposing ensemble. Other buildings in Maputo during this transition period between art deco and modernism show other types of vertical, horizontal or combined blades of shade, such as an office building on East Timor Street (Fig. 6.16), which has vertical blades but oblique in relation to the façade plan, which protect it from direct solar radiation.

Modern architecture between 1950 and 1974

In this period, there was a significant population growth in Maputo, from nearly 100,000 inhabitants in 1950 to 350,000 in 1970, which resulted in expansion of the city and increase in construction activities. Many architects from mainland Portugal were attracted to the colonies, seeking more opportunities, on one hand more commissions and on the other more creative freedom. Although in mainland Portugal

[1] By the dates referred, the engineer Pardal Monteiro is likely the son of Porfírio Pardal Monteiro, the very known Portuguese architect Pedro Kopke Pardal Monteiro (1920–1984), who finished the course in civil engineering at Instituto Superior Técnico in 1944 and may possibly have spent a period in Mozambique before returning to Lisbon to work in his father's workshop. Due to the fact of being from this period, it may not be a coincidence that two important buildings in Maputo are clearly influenced by the architecture of Pardal Monteiro, the Cathedral of Maputo and the Casa Hillman.

Fig. 6.14 The Cine África

Fig. 6.15 The Radio Palace

there was great development in the post-war period, architects were pressured by the conservative government to practice a restrictive architectural style widely known as "Português Suave", which means smooth Portuguese. In Angola and Mozambique, the distant central government did not have as much control as in the metropolis. Therefore, the architects in Mozambique allowed themselves to experiment with the principles of the Modern Movement with much more freedom,

Fig. 6.16 Office building on East Timor Street

adapting them to the tropical climate, similar to what had already happened in Brazil since the 1940s. The exhibition by MoMA in 1943, followed by the catalogue edition that same year under the name "Brazil Builds: Architecture New Old 1652–1942" by Philip L. Goodwin and G. E. Kidder Smith, showed modern architecture works of recent years, but also a whole historiography of Brazilian colonial architecture since 1652. In Portugal, as in the rest of the world, the showcases of the Brazilian architectural scene triggered a critical reflection among architects that questioned how to follow the international language. At the 1st Portuguese National Congress of Architecture in 1948 in Portugal, a radical message had emerged against the traditionalist political regime "Estado Novo". Following this, in the 1950s, though mainly in the 1960s and 1970s, the colonies emerged as a privileged location for architectural experimentation with a production of Portuguese architecture of great quality, mainly in Mozambique and especially in Maputo. The influence of modern Brazilian tropical architecture increased the size of windows, often using the entire façade, increasing all types of shading elements, with brise-soleils built in concrete with vertical, horizontal or grid-like blades. Buildings rose from the ground, releasing the ground floor, with services or garages on the lower floors and housing on the higher floors, being able to take advantage of cross ventilation (Fig. 6.17). The windows have a projecting concrete frame to avoid direct radiation and the floors and balconies extend beyond the façades of buildings, to shade them. Open and shadowed galleries are created to access the various spaces, especially in public buildings, such as schools. Stairwells are either opened outwards or with blades to allow vertical ventilation through the entire interior of the building. The number of available examples is so vast that their exhaustive study becomes difficult. However, some buildings from this period stand out in the city of Maputo.

Fig. 6.17 Residential building in Maputo

The headquarters of the Bank of Mozambique, the former Banco Nacional Ultramarino from 1956 to 1960, with the project managed by José Gomes Bastos and follow-up work by Marcos Miranda Guedes, is one of the most sumptuous buildings in the Portuguese colonies, not only for its architecture but also for the quantity of works of art, which includes the ceramic panel of Querubim Lapa next to the entrance on Av. 25 de Setembro (Fig. 6.18). The building is inserted in the discourse of the Modern Movement, referring to the paradigmatic building of Brazilian modernism, the Ministry of Education and Health in Rio de Janeiro by Lúcio Costa, with Affonso Reidy, Carlos Leão, Ernâni Vasconcelos, Jorge Moreira and Oscar Niemeyer, who had Le Corbusier as a consultant. In Maputo, the brise-soleils are inserted on the inside of windows, this method being more discreet than in Rio, where they are the main element of the façade, hiding the pavement slabs, in contrast to what happens at the Banco Nacional Ultramarino building, where the slabs, oriented to the north, contribute to the shading of the main façade. The TAP-Montepio building of 1960 (Fig. 6.19) by Alberto Soeiro is a corollary of the current elements of modern buildings in Maputo: an elevated ground floor with parking under the building, two service floors with façades of vertical blades and ceramic grills (cobogós), elevated floors of housing; south façade more open with galleries to access the apartments and the façade to the north more closed, with kitchens and WCs, facing away from the sun and facing the river. The east façade facing Av. Samora Machel is a huge and colourful tile panel, presenting a strong image of this building.

Not only did the private commission promote architecture of the Modern Movement in Maputo, but also public works, especially in the areas of education

Fig. 6.18 The Bank of Mozambique, former Banco Nacional Ultramarino

Fig. 6.19 TAP-Montepio building

and health, where experimentation with modern precepts had very fruitful results, are still visible today throughout the city. The block of Maputo Central Hospital has several buildings that date back to its foundation in 1900, having a series of buildings in art deco style from the 1930s that still exist. However, the building of the general hospital north of the plot, constructed in 1958 (Fig. 6.20) in a project by

Fig. 6.20 Maputo Central Hospital

Luis de Vasconcelos and Francisco Assis, is a modern building of generous size that contains several wings organised in a symmetrical, classicist and monumental base structure, implanted in order to configure four pleasant interior patios, for ventilation and shading. This building uses the lexicon of Brazilian modernism in its architectural composition (Ferreira 2008, p. 198), with elements such as access ramps in glazed volumes, blades indicating accesses and brise-soleils of various types. The current maternity wing that began as the European pavilion, designed in 1940 by Antonio Rosas in an art deco style, was expanded in 1966 (Fig. 6.21) by Fernando Mesquita to a hospital school. With the addition of two floors, the building now has continuous galleries on the first and second floors, and large blades with grid shades on the third and fourth floors. These blades that accompany the design of the art deco plant, including the cylindrical body, overshadow the north-facing façade and contribute to the strong image of this building. The current Ministry of Health, built in 1971 for the provincial health department in a project by the architect Francisco Assis, stands out for its creative design of the access tower, its natural ventilation devices and the galleries that it forms on Av. Eduardo Mondlane, in the south of the building.

In the architecture of educational buildings, Mozambique is a success story in the colonial landscape, mainly due to the actions of Fernando Mesquita and the type of projects of the schools he designed in the "Secção de Estudos e Projetos dos Serviços de Obras Públicas", starting in 1955, "receiving like no other functional program, the influence of its architectural ideas, based on the ideological principles of the Modern Movement" (Ferreira 2008, p. 170). The type model of Mesquita's schools was characterised by the north–south orientation (circulation gallery), contrary to

Fig. 6.21 Maputo Central Hospital: maternity wing

the orientation of most of the urban plans where the schools were inserted, thus occupying the centre of the wooded blocks, with a design of exterior spaces adapted to each specific case. The southern façades contain large glazing, protected by vertical protruding planes on the north side, and access to the rooms is protected by covered galleries. Environmental control is ensured by the long inclined roofs covered with fibre cement, which protect all spaces from the sun and by the continuous circulation of air inside the rooms and in the playground (Ferreira 2008, p. 171). In 1959, Fernando Mesquita would use these models in his most important school project: the Governador Joaquim Araújo Elementary Technical School (currently Red Star Secondary School). Cardoso Alves, who designed many of the projects of Fernando Mesquita in several type schools for the province, stands out as a designer from the 1970s on the development of school programmes, starting from Fernando Mesquita's appointed head of the Studies and Projects Division. Its most important project was the Dr. Azevedo e Silva Commercial School (now Maputo Commercial School) in 1972 (Fig. 6.22), on Av. 24 de Julho, characterised by a design of great functionalist simplicity, with raised stairs in the gables of the pavilions and exterior galleries on large consoles.

In the set of administrative buildings also stands the headquarters of Cambios, Statistic County and Historical Archives of Lourenço Marques (currently National Direction of Geology), with its original construction in 1939 in art deco style, which underwent profound change and enlargement in 1970 (Fig. 6.23) in a project by the architect Marcos Miranda Guedes. This enlargement was characterised by the replacement of the original cylindrical body containing the entrance and the vertical circulations by a new one, divided into two volumes: the corner volume with six floors and a bigger volume built in the centre of the set with 12 floors. This second

Fig. 6.22 Maputo Commercial School

Fig. 6.23 National Direction of Geology

volume is rectangular in shape and, from the sixth floor standing outwards, is made up of a parallelepiped in a reinforced concrete structure and glass clearly inspired by the principles of the Modern Movement, as is recognised in some of its elements, such as sculptural coverage in the terrace, the rear façade protected by brise-soleil and the free plan. On the east façade, clearly unprotected from solar radiation, the architect opted for large glazed surfaces, offset by large openings that allow cross ventilation. The western façade consists of vertical brise-soleil with reduced spacing between them for window shading. The south and north façades are mostly blind, although there is a ventilation grid that runs vertically throughout the building.

6.2 The Architecture of Pancho Guedes

For most researchers, Pancho Guedes is not only one of the most important architects of the modern tropical climate in Maputo, but he is one of the Portuguese architects that stand out internationally. According to architect Ana Milheiro, "In the colonial authors (Portuguese and international), Pancho's work remains unique" (Milheiro 2012, p. 81). According to Nuno Grande, curator of the exhibit *Os Universalistas* that celebrates the excellence of Portuguese architects of the twentieth century, Pancho is described as the most universal architect of his generation and "this singular character Amâncio Guedes, with his unique work, wrote an unpublished page in the history of Portuguese architecture" (Grande 2016, p. 15). His architecture is beyond the adaptation of the Modern Movement to the tropical climate, though it has remarkable solutions of natural cooling while absorbing the African culture and local tropical climate. While most authors at present agree that Pancho's work is highly relevant and among the most influential of the modern generation, the quality of his design solutions cover technical and efficient patterns of thermal behaviour, while reaching a higher level of complexity. The strength of his architecture relies on his ability to dissolve the borders between architecture, design and sculpture.

Biographical data

In 1953, Pancho Guedes received his degree in architecture and in 1954, travels to Europe request the validation/recognition of his diploma in Portugal. He took this opportunity to visit several European cities, which allowed him to learn about post-war architectural production before returning to Lourenço Marques. From 1955 onwards and in the years that followed Mozambique's independence, it had a vast production, mainly on the capital, drawing nearly seven hundred projects among dwellings, housing, facilities and tourism, and commercial buildings (Revista Construir 14/5/2010).

Along with the intense professional activity, he developed relations with other architects and artists that he met during his college years in Johannesburg and travelled extensively, namely, several trips to Europe. In 1961, he participated in the 6th

Bienal de São Paulo, where his work was exhibited, and took the opportunity to visit modern Brazilian architecture, namely Niemeyer's works. Following his publication in the Architectural Review of London in 1961, his work was widely published all over the world.

In 1962, he participated in the first Team 10 encounter with Christopher Alexander, Jaap Bakema, Georges Candilis, José Antonio Coderch, Christopher Dean, Giancarlo De Carlo, Ralph Erskine and Aldo van Eyck, among others. Also in 1962, he participated in the First International Congress of African Culture in Rhodesia, where he met several personalities linked to culture. It is in the 1960s that he became a prominent figure in the architecture and cultural scene and emerged, as Nuno Grande argues, the most universal among the generation of universalists.

In 1975, after the independence of Mozambique, he left the country and moved to South Africa, where he took on the position of Head of Department of Architecture at the University of the Witwatersrand. In 1988, he and his wife Dori moved to Europe and took residence in Lisbon. It is during this period that he received honours: Doctor Honoris Causa (Pretoria, Johannesburg, Lisbon) invitations; second participation in the Biennale for Architecture in Venice, 2006; and retrospective exhibitions: Swiss Architecture Museum. He died at the age of 90 years old at his daughter's home in South Africa.

In 1985, the Portuguese journal "Arquitetura Portuguesa" dedicated an entire magazine to Pancho Guedes, where his autobiography "Vitrúvus Mozambicanus" was published. Here, his architectural production is organised into 25 books, with 25 groups of works divided by styles or programmes. The publication presents the theoretical basis that supports the architectural solutions he pursued during his lifetime.

These biographical data were collected in the thesis of Miguel Santiago titled "Pancho Guedes Spatial Metamorphoses", which is a fundamental text for the understanding of the work of this author.

Shading devices in the work of Pancho Guedes

The first projects of architecture present systems for overshadowing and ventilation of the façades. From the early stages, Pancho introduced these strategies in his designs to further explore his own interpretation, turning them into singular objects with strong artistic expression. An example is the series of buildings implemented in the downtown of Lourenço Marques, which he named "temporary towers, blocks and slices of front run". The first project of this group is the Joosub building constructed in 1951, where the Tamariz Hotel operates (Fig. 6.24). Here, there are a series of devices typical in modern tropical architecture that we will often find in his works. The main façade, oriented to the south, is in line with the street Rua Consiglieri Pedroso. It has generous glazed spans that are overshadowed by vertical blades, with small spaces between them. This type of shadow prevents direct radiation on the glazing. On the west façade, the ceramic shading grids, common in modern tropical architecture, are located in front of the balconies of the rooms. The arrangement of the two volumes on top of the commercial floors, and the separation between them, reinforce the shading system of the windows. At the Mann George

Fig. 6.24 Joosub building: Tamariz Hotel

Fig. 6.25 Mann George building

building dated in the same period (Fig. 6.25), the vertical shades use marble stone plates fixed to the building structure with bronze pieces. The Octávio Lobo building, constructed in 1967 and located in the same area of the city, used a similar solution on its south façade, proving that good thermal solutions are repeated in his work. The Mann George building still has a cantilever shading blade on the ground floor of the street Rua Bagamoyo with a polychromatic geometric decoration, which

Fig. 6.26 Abreu, Santos e Rocha building

contributes to making this building one of the most relevant in the city. The Abreu, Santos e Rocha building in MacMahon Square, built in 1953 (Fig. 6.26), consists of two blocks of eight stories high, one with a north–south orientation and the other with an east–west orientation. In the Joosub building, the volume on the north side provides shade for the volume the southern façade, which holds a vertical concrete shading, while the west has a grid system that closes the circulation galleries and features a decorative panel of rolled pebbles. This building presents inventive solutions for solar protection, interior temperature control and natural light. Across Rua Consiglieri Pedroso, the 1957 Spence e Lemos building (Fig. 6.27) presents a different solution: the retreat of narrow and high gaps in the northwest and northeast façades in order to reduce direct radiation. Together, they reveal a systematic and simultaneously creative group of solutions to design shading devices.

According to Miguel Santiago, the "Dragon House" building from 1951 (Fig. 6.28) follows the precepts of the Modern Movement, but with a new grammar in the use of materials, textures and themes of the murals (Santiago 2007, p. 74). This building, the first of the group "habitable boxes and shelves for many people", presents a system of double pilotis and a wall that runs along a mural, which gives the building its name. The wall divides the public area from the private area, generating a shadowed zone where the stairs of the building begin. The building has the main façade to the east, where the living rooms and bedrooms are oriented. This elevation with the recessed spans alternates between open balconies and balconies enclosed by ceramic grids of geometric design, systems that ensure good protection from sun exposure and maintenance of temperature stability. The stairs to the apartments are ventilated with vertical blades in the same façade to promote natural ventilation. The building reached international awareness for its uniqueness, though its main features encompass a variety of efficient solutions to enhance shading

Fig. 6.27 Spence e Lemos building

Fig. 6.28 Dragon House building

devices and natural cooling. The combination of different systems and building technologies were exposed during the meetings of Team X, where Pancho's buildings were cherished and published, becoming important references to twentieth century architecture.

The building for housing dockers, dated from 1953, located near Maputo's downtown, on Av. Josina Machel (Fig. 6.29), stands out due to its large cantilever

Fig. 6.29 The building for housing dockers

Fig. 6.30 Tonelli building

flap that provides shade to the ground floor and the ventilation grills that overshadow the central staircase, made from concrete pipes of various sections and lengths. The Tonelli building, dated from 1954 (Fig. 6.30) and located on Av. Patrice Lumumba, belongs to modernist architecture. On the western façade, the few narrow openings are framed by systematic concrete frames, elements commonly used to ensure control of solar heating and thermal stability of the interior. The 1963

Fig. 6.31 Police orphans and widows building

Police orphans and widows private building (Fig. 6.31) presents a simple composition of volumes, in which the main one is a concrete box with workshops and shops on the first several floors and dwellings in the remainder. It uses two types of balconies fronting the bays: either by adding concrete volumes that frame the windows but also serve as balconies or subtraction to the main volume creates deep balconies in the living rooms of the apartments. The open staircase is overshadowed by horizontal blades. As Pancho himself puts it, the building had only basic finishes, which reduced the cost of its construction (Guedes 2009, p. 209), though the complexity of the architectural elements assembled to control heat and provide thermal comfort emerged from years of research and building practice, where he had the opportunity to test his ideas and continuously challenged his architecture to attain better results.

In the book "pieces of village, to remember other villages far away in my land", Pancho presents several sets of row houses, most from the 1950s, where influences of Portuguese vernacular architecture became tropicalised. In the 12 houses for COOP of 1954/1956, the windows feature concrete frames, some of which are inserted into perforated moulded concrete walls, which function as ventilation grilles (Fig. 6.32). In another project, the house of Judge Camara (Fig. 6.33), completely enclosed balconies with wooden mashrabiya were designed. The use of sheds, reinforced concrete pergolas or advanced volumes on the upper floors to create shaded areas on the ground floor are solutions implemented in these small single-family dwellings. Similar features can also be found in larger dwellings, such as the house of the three giraffes (Fig. 6.34), whose name is given by the three generous chimneys. Designed in 1953, it follows the principles of the Modern Movement but in an alternative way. It consists of two volumes: the living rooms on the ground floor and the bedrooms raised on stone planes, creating shady areas. The volumes

Fig. 6.32 Twelve houses for COOP

Fig. 6.33 House of Judge Camara

are crowned by gable roofs that refer to the Mozambican vernacular architecture. Local, primitive and vernacular elements are combined with the rational elements brought forward by the Modern Movement. In Pancho's architecture, low- and high-tech solutions are combined to produce a unique vision of the twentieth century architectural culture.

Fig. 6.34 House of the three giraffes

Fig. 6.35 The red house

The red house of 1966 (Fig. 6.35) uses a precise mesh in the design of the plant, in which the walls are thickened in an expressive way to allow the windows to be receded in relation to the façade. On the exterior surface are the wooden shutters that give character to the image of this house, widely diffused by the strategy of protection to solar irradiation. From the same period, a group of houses that Pancho

Fig. 6.36 The pyramidal nursery

named "family of Euclidean palaces" is located in the neighbourhood of Sommerschield, in the north area of Maputo. Like the previous example, they are drawn on a precise geometric mesh, but make use of great spatial complexity. They have a clear volumetric definition, though the structure loosens from the volume of the house fragmenting the façades, usually from the side view, offering outdoor areas that are sometimes shadowed by architectural elements. The windows include gaps for natural ventilation, revealing the great technical advancement of carpentry for that time, which were carefully designed (Guedes 2009, p. 225).

The pyramidal nursery (Fig. 6.36) belongs to the group of works called the "American-Egyptian style", influenced by the American architect Louis Khan. The Khovolar Residence at the Swiss Mission designed in 1966 (Fig. 6.37) bears similarities to the Police orphans and widows private building, both of which implemented Beta opening systems to increase natural ventilation.

In his final thesis of architectural school, Pancho presented a project inspired by the geometric variations of Frank Lloyd Wright. During his years at architectural school, he developed projects inspired by Le Corbusier and became interested in architects as diverse as Mies, Aalto and Goff, all of whom helped him to develop the exploration of his own architecture of 25 styles. Stiloguedes is one of those styles that he referred to with greater intensity and that he pursued over the years. From his participation in the meetings of Team X in 1962, a visit to Maputo was organised, among which were Alison and Peter Smithson, who went to Mozambique to visit his recent works, namely the Stiloguedes.

Stiloguedes

The first book of Pancho Guedes' autobiography is the Stiloguedes, which contains the works from 1951 to 1958 that the architect considered more emblematic and

Fig. 6.37 The Khovolar Residence at the Swiss Mission

representative. These projects show their way of interpreting the Modern Movement, to which the author adds unique figurative elements that make their buildings expressive and unique. For the most part, it has fairly rational plants and integrates principles of the Modern Movement. This family has several types of buildings, including single-family dwellings, collective housing, schools and industrial buildings, so it does not follow a typology or specific programme. The first project of this group is the Leite Martins house (Figs. 6.38 and 6.39), "the plane house", modern "with something of a case study house" (Magri and Tavares 2011, p. 26). What characterises this house are the soft curvature covers coated with a waterproofing mortar of lime and white stone (Magri and Tavares 2011, p. 28). The raised bedrooms volume creates a living area covered by the same area of the room but without walls, a space that, along with the inner courtyard, denotes the tropicalisation of the architecture of the Modern Movement.

The Prometheus building (Figs. 6.40 and 6.41) is one of the works of this family. Contemporary construction of the Unité d'habitation in Marseille by Le Corbusier shares with this the clarity in the structure and the use of the brise-soleil. However, it has distinct characteristics: the seven structural elements function as "trees" constituted by pillars and beams with large consoles that cross the façade of the building. In addition to the structure, the building is made up of "a specific number of different and precise concrete parts" that were assembled "by carefully fulfilling the instruction book" (Magri and Tavares 2011, p. 31). The final effect is a volume that illustrates how it was constructed by coupling, allowing a lightness effect reinforced by the spacing between parts, filled with empty and full volumes, with balconies and windows connected, which, by the chromatic differences between the structure and the other elements, make their constructive method known. According

Fig. 6.38 The plane house

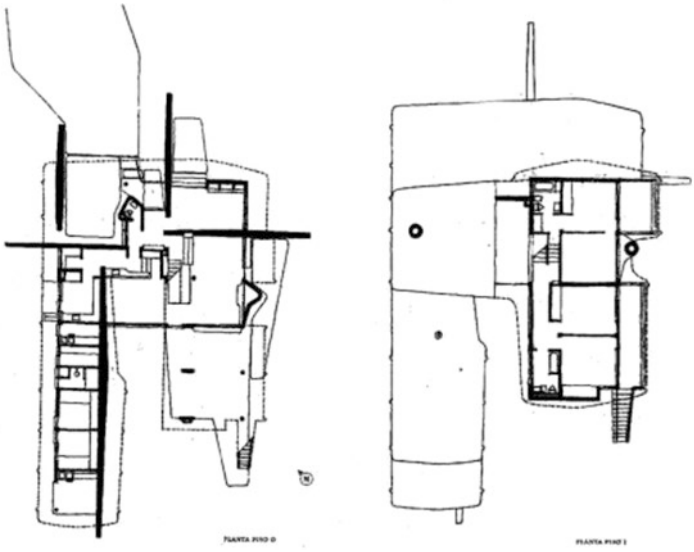

Fig. 6.39 The plane house: plans

to Pancho on the Stiloguedes: "it is a bizarre and fantastic family of buildings with beaks and teeth, with beams ripping the spaces around, invented as if some of the walls were about to separate" (Guedes 2009, p. 79). The loose elements promote greater cross ventilation of the interior of the volume, the large console balconies

Fig. 6.40 The Prometheus building

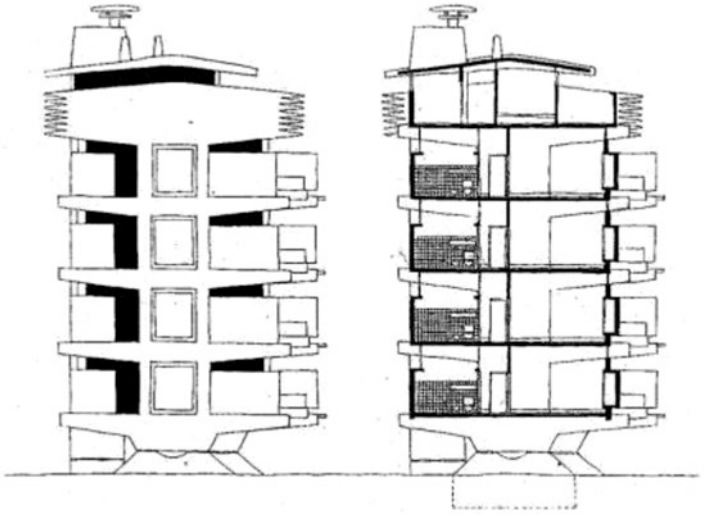

Fig. 6.41 The Prometheus building: elevation and section

give shade and the small openings allow interior ventilation, mainly in the lower phases of the slabs, and enable the exploration of constructive elements in the architecture of this building, to jointly adapt to local weather conditions.

The house Matos Ribeiro built in 1952/1953 (Fig. 6.42) applied some of the elements used in the Prometheus building, like the balconies supported by cantilever

Fig. 6.42 House Matos Ribeiro

beams and the double windows with ventilation next to the ceilings. The main spaces of the houses are oriented to the southeast, to guarantee a reduced exposure to solar radiation. The use of a patio allows the main bedroom to be oriented to the interior, protecting it from the low radiation of spring. This interior patio, the ground floor and the verticality of the volumes that make up the houses contribute to thermal cooling of the whole building.

The Otto Barbosa Garage constructed in 1952 (Fig. 6.43) stands out mainly for the biomorphism of its design, with its enormous teeth of vertical shading that protect the windows from the blunt light from the west, the only one that reaches the façade due to its orientation. The building is described by Pancho as having teeth: "It is a deep, square mouth with angular brise-soleils that crunch space immediately ahead" (Guedes 2009, p. 90). The oversized teeth and claws used in several buildings ensured improvement in the control of temperature variations inside the buildings and, consequently, the feeling of thermal comfort.

The building named the "Smiling Lion" of 1956/1958 (Figs. 6.44 and 6.45), probably his most emblematic work, presents a summary of the aspects previously described and that were tried in other works, used here with greater freedom and expressiveness, due to the fact that the client is also the architect. The structure follows the same principle of the structure of the Prometheus building, an element composed of pillars and beams that repeats according to a module supported in two points and that resolves all the sustentation of the building, raising it out of the ground. On the top façades to the north and south, the structural element is replaced by a concrete wall with a suggestive configuration, inspired by the children's drawings of his son Peter. It is the concrete walls that suggest the name of the building and protect the building from sun exposure to the north and south. The building

Fig. 6.43 Otto Barbosa Garage

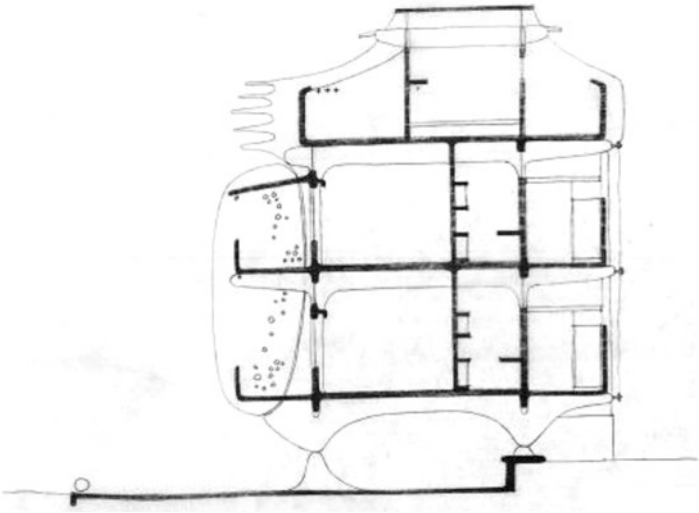

Fig. 6.44 Smiling Lion: section

opens to the east and west, protecting the interior with vertical blades of shade that delimit the balconies in the façade. They are attached to the structure but are presented as independent elements that seem suspended, an effect reinforced by the chromatic difference and the joint that separates them from the structure. The balconies supported by the balanced beams are surrounded by blades and horizontal

Fig. 6.45 Smiling Lion

shading on the second floor, creating cool outdoor seating areas. The vertical blades also serve to reduce direct radiation in the windows and balconies. The galleries open to the west, already tested in the Tonelli building, solving, with the boxes of stairs in the two tops, the whole circulation system. These galleries also prevent the penetration of direct radiation in the few windows, from the kitchens and bathrooms, existing in this façade. All the windows in the east have a separate flag, which allows the entrance of light even with the rest hidden, as was already happening in the Prometheus building and in the house Matos Ribeiro. The coverage of corrugated domes is similar to the projects of the Tabosa Vaz building and Barclays Bank, but, in both cases, it was never built. The vaults appear at the top of the service floor, in conjunction with the two huge parapets/murals that mark the building's east and west façades.

It is in the sections, rather than in the plans, that we understand the whole functioning of the building. "The plans in the Stiloguedes buildings are simple, very direct and functional. It is the sections that are decorated, contorted and full of exaggerations. These are their reflections on the façades that make them architecture" (Guedes 2009, p. 79). The volume of the building raised in relation to the ground allows its natural ventilation predominantly from the east. The garden at the rear of the building guarantees the constancy of this ventilation. The galleries open to the west, cool in the morning, force cross ventilation in the building and refresh it during the part of the day when the radiation reaches the east openings. During the rest of the day, this façade is shadowed. The façade to the west, due to being the hottest, is retracted, being completely overshadowed by the galleries and stairwells. The large panels obscure the terraces on the roof floor, making this space cool. The roof

vaults, built from of thin slabs of concrete and aerodynamic in shape, are ventilated on both sides. The living spaces of this floor have openings only near the roof, which causes them to be ventilated, forcing hot air to rise and be expelled outwards. The constructive elements of expressive character and that cause great visual impact are, in its genesis, the efficient application of architectural components that guarantee thermal optimisation without unnecessary energy expenses. The use of accumulated knowledge through the observation and implementation of solutions already tested in previous buildings allowed for a practical combination of the elements used in this internationally celebrated project.

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