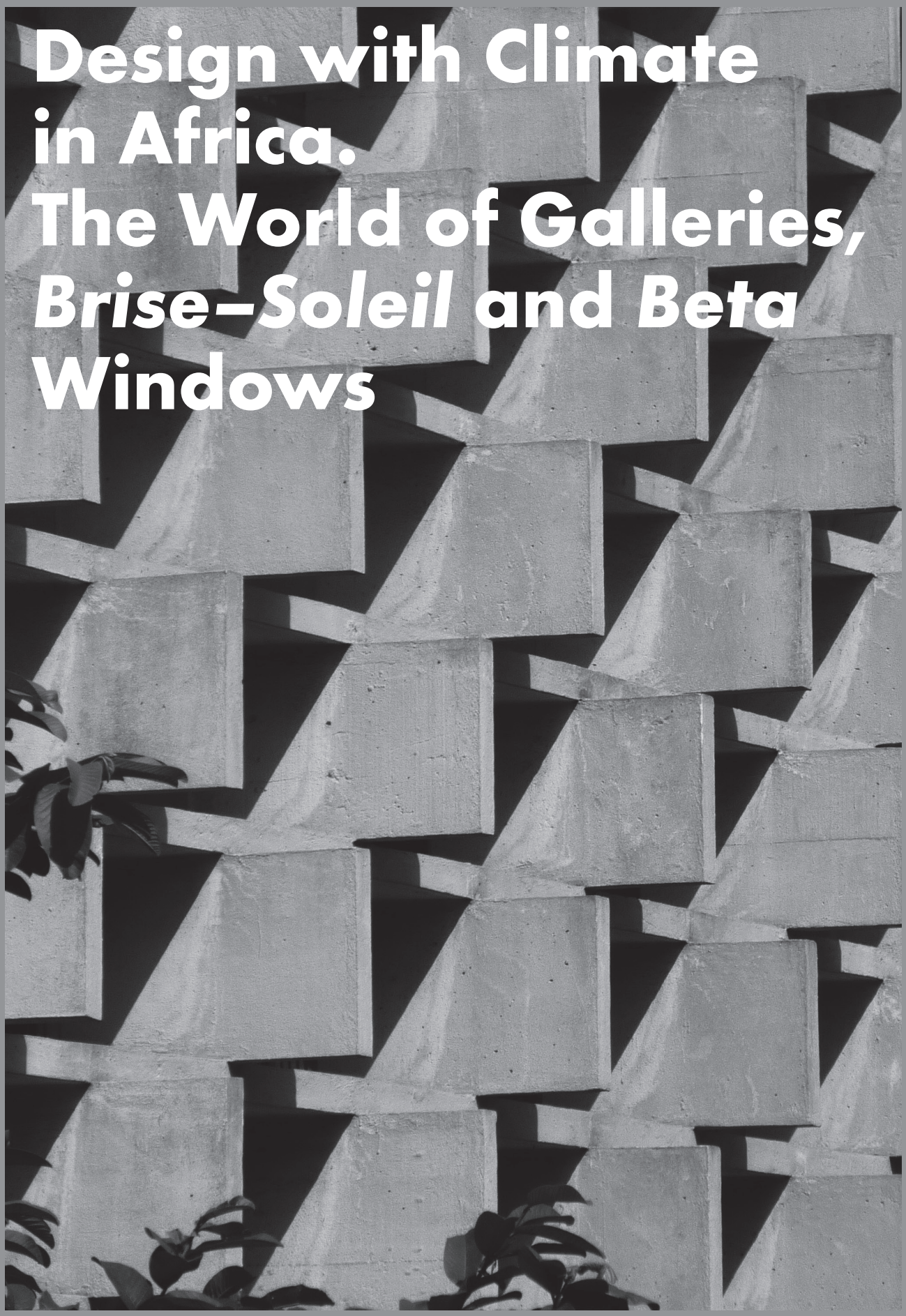
Design with Climate in Africa. The World of Galleries, *Brise–Soleil* and *Beta* Windows



IN the twenty–five years after World War II, Angola and Mozambique were fertile territories for the inception of new urban and architectural projects, in keeping with the principles of the Modern Movement. In the earliest works designed by the architects who moved there in the late 1940s, one can already witness a serious concern with the adjustment to the particularities of the hot and humid climate of the tropics. The Modern architectural idiom was particularly well suited to the local climate building requirements such as solar control and provision of adequate ventilation. Moreover, these architectural solutions were underpinned by sustainable procedures that ought to be re–established in the restoration of Modern buildings of the type presented here.

By João Vieira Caldas

SINCE the late 1990s, and in particular over the past decade, there has been a widespread interest in the study of modern architecture and urban planning in the Portuguese ex–colonies in Africa. This is especially the case with Angola and Mozambique, enormous terrains that witnessed a significant impulse toward development in the period between the end of World War II and the revolution that shook Portugal on 25 April 1974, leading to the independence of these countries the following year. This developmental strain took place against the backdrop of a form of colonialism overseen by a fascist–style political regime. Paradoxically, as has been noted by scholars in the field, young Portuguese architects experienced the African colonies as liberating (Magalhães, 2009; Tostões, Oliveira, 2010).

On the one hand, the African colonies of the southern hemisphere were geographically distant from the repressive control of the metropolis. On the other, these territories constituted a new world, whose dimensions and need to be inhabited sponsored a vast field of experimentation and innovation in the areas of urban planning and construction (Fernandes, 2002). Finally, the lexicon of Modern architecture seemed especially appropriate for dealing with the tropical climate.

The new architecture was to be constructed using industrialised building materials and processes, and these buildings were invariably supported by structures made of reinforced concrete. The challenges immediately raised in attempting to build in sub–Saharan Africa, is that of adaptation to the local climate. Obviously, in this context, the experience of construction in Brazil became an important reference point.

When the wave of migration of European–trained architects to Angola and Mozambique began, in the late 1940s, the experience of the adaptation of modern architecture to tropical climates had already been launched in Rio de Janeiro some ten years earlier, with the construction of the Ministry of Education and Health (1936–1945), immediately followed by diverse experiments in Brazil. This whole process had already been disseminated in Portugal by *Brazil Builds*[1] and continued to receive attention through the exhibition of Brazilian architecture at the *Instituto Superior Técnico* in Lisbon in 1949, as well as the exhibition that accompanied the Third UIA Congress, also in Lisbon, in 1953.

While it is true that what mobilised these architects were the grand ideas of the Modern Movement,[2] such ideas had certainly been tempered by the experience of Brazil. Actually, the necessary means for controlling adverse climactic conditions are already present in many different types of architectural structures, from office buildings to social housing blocks, ever since Modern architects arrived in Angola and Mozambique.

As examples of the application of systems of climate adaptation, I have chosen four high school buildings: two in Angola (one in Luanda and one in Lobito) and two in Mozambique (both in Maputo). They form part of a series of public service facilities that, until now, have not been subject to the economic pressures of capital investments and real estate speculation. Indeed, none of these buildings is situated at the economic hub of its respective city.

Oddly, the oldest of the four examples, the building that is currently the Josina Machel Secondary School in Maputo (formerly the National Salazar School), in a way serves as a bridge between the typically colonial structures and the modern buildings of the 1950s and 1960s, both in terms of methods of construction and response to the climate.

This school was designed by José Costa e Silva in 1939, working from Portugal, and built between 1945 and 1952, the year in which the first projects of the new generation of architects began to appear in Africa.[3] The organisation and arrangement of the pavilion–like spaces of the enormous school building, with a monumentality rigorously planned along a symmetrical axis, is of a rationality still linked to the *beaux–arts* system. But the use of an overall reinforced concrete structure, whose technical and aesthetic implications are keenly understood by the

Figure 1. **José Costa e Silva**, Josina Machel Secondary School, 1939–1952, Maputo, Mozambique. Covered galleries around the building.

Figure 2. **José Costa e Silva**, Josina Machel Secondary School, Maputo, Mozambique, 1939–1952. Ventilated roofing with two slabs.

Figure 3a. **F. Castro Rodrigues**, Comandante Valodia Secondary School, Lobito, Angola, 1966–1967. The shorter building.

Figure 3b. **F. Castro Rodrigues**, Comandante Valodia Secondary School, Lobito, Angola, 1966–1967. Classroom with an open fixed grid.

Photos by Ana Tostões/EWV, 2011.

architect, serve as evidence of a different kind of rationality—a modern rationality—in which forms are practically reduced "to their structural essence" (Ferreira, 2008).

The system of wide, covered galleries wrapping around all the pavilions on all three floors immediately leaps into view. In its modernist expression, with the ample grid formed by the elegant pillars cutting across the horizontal slabs, it suggests an affinity with the porches/galleries that almost ubiquitously surrounded colonial buildings [figure 1].

In effect, these external galleries cling to the longer sides of all the pavilions, giving access, shading and ventilating, on two opposite sides, both to the administrative areas and the classrooms (or even the areas of the gym-

nasium/swimming pool or communal gathering halls). The width of the galleries offer protection against both light and heat, alowing the opening of wide windows on both sides of the rooms. Even so, on the side of the room where the sunlight is harshest, the bottom halves of the windows are protected by wooden Venetian blinds. The upper half is made of moveable, tilting parts, always permitting cross ventilation.

However, the most coherently modern outcome of the use of a structure entirely made of reinforced concrete is the use of roofing with almost flat and impermeable slabs. This option in the roofing over the classrooms on the top floor needed the duplication of the slabs above it in such a way as to facilitate the flow of air between the two levels [figure 2]. In contrast, the galleries are covered in single slabs that, in combination with the columns, more clearly express the modernist ethos of their function.

With the 'new wave' of architects who settled in Angola and Mozambique, working far from the censorious gaze of the central authorities, the precepts of modernism were applied in a way that bears no reminiscence of the architecture of the colonial past, and that makes no concessions to nationalist official taste imported from the metropolis.

Reinforced concrete definitively became the principal material and procedure employed. Adaptation to the climate relied on the use of galleries, and on the introduction of *brise-soleil* (whether in the form of vertical or horizontal fins, movable or fixed, whether as pre-fabricated concrete or ceramic grids) and the so-called *Beta* windows.

The galleries, however, now have little in common with the system used at the Josina Machel School in Maputo. They no longer wrap around the whole building like porches, but rather, now extend along one of the long sides of the building. In accordance with the modernist emphasis on horizontality and on the constructive potential of reinforced concrete, the slabs are no longer traversed rhythmically with the supporting columns, but rather cantilevered.

The *brise-soleil*, made of fins that are movable around a central axis, were innovatively used (though horizontally) on the northern façade of the Ministry of Education and Health in Rio de Janeiro. After that, they were exhaustively employed, especially vertically, in the large public buildings of Brasilia. But in Brazil, other forms of creating shade were also explored, namely the fixed grids made of prefabricated ceramic or concrete units.[4]

Vasco Vieira da Costa took this further, and, as Le Corbusier had done in Chandigarh's High Court Building, brought together the concept of the grid with that of the louvers, designing countless variations of large scale grids with fixed sunshades of reinforced strips of concrete running in both directions (horizontal and vertical), especially when the project demanded combining solar protection with ventilation requirements.

Beta windows is a commercial designation of a type of window with a slim, almost invisible iron frame, fitted with narrow, horizontal, turning slats of glass that allow the user to regulate fairly precisely the amount of air to be circulated, and the angle and speed at which it flows indoors. These windows are still sold in Portugal today under the same brand name, though now mounted in aluminium frames.

But one of the principle means of "designing with climate" consists in choosing the form and orientation of the building in tandem with ventilation devices. Exposure to the low angles of sunlight from the eastern and western sides was avoided by designing blocks with a rectangular plan displayed on the east/west axis, with the areas facing those cardinal points closed off. Cross ventilation was facilitated by turning the longest sides of the building in the direction of the predominant winds. But as it was not always possible to reconcile the best solar protection with the most efficient wind exposure, sometimes an intermediate position was used, what Vasco Vieira da Costa called a *compromise solution* (Quintã, 2007).

The openings were thus made on the long northern and southern walls, where the sunrays fell more vertically (owing to the proximity of the Equator) in such a way that, ideally, the side of the building most exposed to the predominant winds would also be protected from the sun by *brise-soleil*, frequently in combination with *Beta* windows for ventilation. On the less windy side, protected from the sun by a gallery, the use of the *Beta* windows facilitated cross ventilation. These processes of protection against the sun and encouraging ventilation were generically applied to buildings of diverse functions, but were particularly well suited to large apartment blocks as well as schools.

The two school buildings I have chosen from Angola exemplify different solutions for the placement of the classroom blocks.

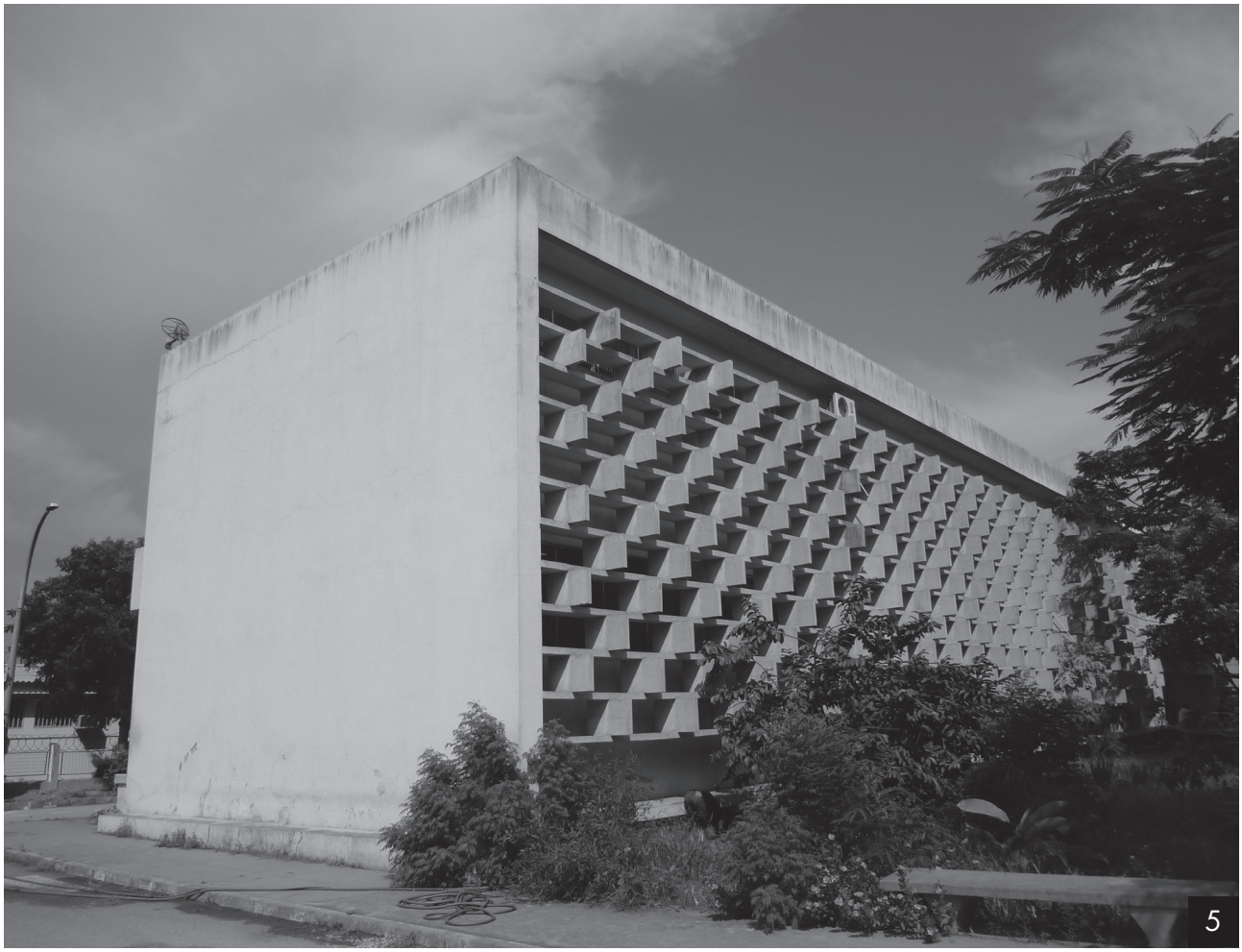
For what was the Lobito School (1966-1967), the architect, F. Castro Rodrigues chose to design two longitudinal, three-storey blocks, each of a different length, sequentially disposed, though slightly out of phase, used exclusively as classrooms.

Both of these blocks are built on a northwest-southeast orientation and elevated on columns, with the classrooms always on the upper floors. These are accessed via the broad galleries that also serve as protection from direct sunlight on the side where it hits hardest. The classrooms are now very dilapidated—all the glass from the original

Figure 4a. **F. Castro Rodrigues**, Comandante Valodia Secondary School, Lobito, Angola,1966–1967. The largest block with the amphitheatres below. Photo by Ana Tostões/EWV, 2011.

Figure 4b. **F. Castro Rodrigues**, Comandante Valodia Secondary School, Lobito, Angola, 1966–1967. Amphitheatre: distance between the grid and the façade surface. Photo by Ana Magalhães/EWV, 2011.

Figure 5. **Vasco Vieira da Costa**, ICRA (former Pio XII Institute), Luanda, 1968. Fixed *brise-soleil*. Photo by João Vieira Caldas/EWV 2011.



windows has disappeared—but one can still see that all the rooms on the gallery side were provided with ample Beta windows running along the walls. The façade on the opposite side essentially consists of a permanently open fixed grid, permitting the free flow of ventilation, but not the control of airflow, complemented by a strip of *Beta* windows close to the ceiling [figures 3a, 3b].

On the shorter building, the ground floor is almost entirely used as a covered area for recreation. In the largest block, the space between pillars at ground level is only open at its ends, and at the opening created by the central staircase. The rest of the space is designed in such a way as to ensure that the main body of the upper two floors appears to be suspended above the constructions at ground level. On this level, the amphitheatres stand out, bound on the gallery side by a wall pierced only by the classroom doors. However, this wall does not rise all the way up to the ceiling, leaving a strip completely open. The opposite façade has the same kind of fixed grid as the upper floors, but here, it stands away from the building, creating the sense of an outdoor amphitheatre (a design made popular with cinemas built in Angolan cities in the 1950s and 60s). Indeed, this distance established between the plane of the grid on the bottom floor and the surface of the façade on the upper floors has no cover at all, thus compensating in light for the darkness of the opposite wall [figures 4a, 4b].

In the case of the old Pio XII Institute in Luanda (now the Institute of Religious Studies of Angola), Vasco Vieira da Costa also amassed the classrooms in two rectangular blocks on two storeys, although these are only raised from the ground at the height of a small ventilation box. In order to achieve the most suitable orientation, the architect had to employ a *compromise solution*, building the two blocks parallel to one another and at a 29° angle to the east/west axis (Quintã, 2007). He designed a third block, smaller and raised on columns, in order to link the two main blocks. The open ground floor of this bridging block functions as a covered passageway between the two classroom blocks. The 'closed' upper floor is traversed by a corridor that leads from both sides to the administrative offices and staff rooms.

Vieira da Costa decided to compensate partially for the 'compromised' orientation of the three constituent blocks of this building using three methods of creating shade. For the classroom blocks, aligned in front of the windows on the south-western façade is a fixed *brise-soleil* composed of continuous horizontal concrete strips, traversed by smaller, vertical concrete fins in alternating positions and projecting out of the external surface of the façade [figure 5].

On the opposite side, facing the garden and the recreation areas, a 'box' formed by the extensions of the concrete slabs and the closed off side façades, casts a shadow over the open corridors leading into the classrooms [figure 6]. The linking section, exposed primarily on the southeast/northwest side, is protected on both sides by vertical *brise-soleil*, movable from the inside [figures 7a, 7b, 7c].

The system of ventilation is based on the substantial use of *Beta* windows, whose glass, in this building, has remained almost intact in the strip of windows running under the ceiling on the walls of the classrooms facing the galleries. They practically replace the side walls in the bridging block, behind the *brise-soleil*. Furthermore, this block contains *Beta* windows close to the ceiling on the walls that separate the central corridor from the offices, thus enabling transversal ventilation.

Finally, the Polana Secondary School (originally the Dona Ana Portugal School) in Maputo was a project dating from the end of the colonial regime (1970), designed by João José Tinoco and José Forjaz. The solution here, however, is not radically different from that employed at Pio XII Institute, except for the larger number and functional diversity of pavilions, as well as in the architectural idiom, which, in Maputo, is clearly brutalist.

The four pavilions containing the schoolrooms are again conceived as long rectangles with an east/west orientation, traversed by a wide covered passage, whose roofing slab permits it to function as an open linking gallery on the first floor [figure 8].

The classroom pavilions are large, three-storey blocks with sloping roofs, where exposed concrete is the principle material used for the finish. As in the two previous examples, the classrooms are aligned along the length of one of the longer façades. They are protected from the sun by *brise-soleil* in the form of vertical fins attached to structural pillars, and therefore in line with the axis of the building's structural frames. The surfaces between each pair of consecutive pillars are filled with large, square *Beta* windows [figure 9].

The opposite façade is protected by the cantilevered galleries giving onto the classrooms, interrupted, near the linking passage between the pavilions, by the abutting volumes of the staircases [figure 10]. Also on the side of the galleries, the rooms are lit and ventilated by smaller *Beta* windows. These more than suffice to create a cross current of air with the large windows of the opposite wall.

In summary in the systems for creating shade and ventilation in Modern and pre-Modern architecture in Angola and Mozambique, natural and sustainable procedures were deployed. But these procedures were associated with the logic of colonialist development. With independence, in 1975, and with the ensuing civil wars, a large

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7a

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number of these buildings—especially those designed for habitation—stopped being repaired, were inadequately used and indeed, were subjected to the direct effects combat.

The end of the wars, especially in Angola, gave rise to economic growth that, in Luanda, expressed itself in the type of urban development that is frequently seen in Asia. Large buildings dedicated to services began to pop up at a hallucinatory pace, replacing the 'old blocks' of the Modern Movement and, with increasing density, occupying the ample breathing spaces of the city.

This growth brought in its wake the tyranny of air conditioning systems, which became widely used, currently extending to individual homes and apartments, besides the big hotels and office and service blocks. Air conditioning is now used not only to correct inadequate systems of shading and ventilation, but also, and above all, to substitute those that had worked properly.

In the school buildings of today, most of which belong to the state, there is little margin for 'improvement'. Of the four examples cited here, only the old Pio XII Institute is in good repair (although there have already been changes made to the frames of some of the windows in the classroom blocks), but this establishment belongs to the Catholic Church.

Owing to their interesting architectural features and the proven efficacy of their systems of shading and ventilation, these buildings deserve exemplary rehabilitation work, including the conservation or re-installation of the natural and sustainable systems of dealing with the climate that were used in their construction.

Figure 6. **Vasco Vieira da Costa**, ICRA (former Pio XII Institute), Luanda, Angola, 1968. Open corridors of the classrooms.
Photo by João Vieira Caldas/EWV 2011.

Figure 7a. **Vasco Vieira da Costa**, ICRA (former Pio XII Institute), Luanda, Angola, 1968. Movable *brise-soleil*.
Photo by João Vieira Caldas/EWV 2011.

Figure 7b. **Vasco Vieira da Costa**, ICRA (former Pio XII Institute), Luanda, Angola, 1968. Detail of movable *brise-soleil*.
Photo by João Vieira Caldas/EWV 2011.

Figure 7c. **Vasco Vieira da Costa**, ICRA (former Pio XII Institute), Luanda, Angola, 1968. Lever of movable *brise-soleil*.
Photo by João Vieira Caldas/EWV 2011.

Figure 8. **João José Tinoco and José Forjaz**, Polana Secondary School, Maputo, Mozambique, 1970. Linking gallery.
Photo by Maria Manuel Oliveira/EWV, 2010.

Figure 9. **João José Tinoco and José Forjaz**, Polana Secondary School, Maputo, Mozambique, 1970. Fixed *brise-soleil* and square *Beta* windows. Photo by Vincenzo Riso/EWV, 2010.

Figure 10. **João José Tinoco and José Forjaz**, Polana Secondary School, Maputo, Mozambique, 1970. View to the cantilevered galleries from the linking gallery. Photo by Vincenzo Riso/EWV, 2010.

Notes

1. Philip L. Goodwin, *Brazil Builds, architecture new and old 1652-1942*, New York, The Museum of Modern Art, 1943.
2. For example, Vasco Vieira da Costa and Fernão Simões de Carvalho worked with Le Corbusier in Paris before moving to Angola (the former between 1946 and 1948, and the latter between 1956 and 1959).
3. 1952 was the year in which the now-demolished market of Kinaxixe—the first work to be designed and built in Luanda by Vasco Vieira da Costa—was completed.
4. These were frequently used in the Portuguese mainland in the 1950s, though usually only to provide the necessary airing for the areas next to the kitchens, dedicated to hanging out laundry.

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This paper integrates the research project *EWV Exchanging World Visions: Modern architecture in Lusophone Africa looking through Brazilian experience* (PTDC/AUR-AQI/103229/2008) developed by IST-UM.