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SPACIAL CONFIGURATION IN SINGLE FAMILY HOUSES

Study about the work of Marcos Acayaba

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ABSTRACT

The present paper is based on the analysis of the spatial configuration of single-family houses designed by Marcos Acayaba, between 1970 and 1996. Acayaba's work represents a moment of maturity of the Brazilian Modern Architecture, specifically the one produced in São Paulo. Starting his career during the 1970s, when the Paulista Brutalism movement was at its apex, his projects show the interest in the construction details, incorporating different technologies and using the materials characteristics to generate the desired geometry associated with an identifiable structural system. The buildings' plans allowed the development of justified graphs, considering the depth from the exterior space by two different paths: one representing the users from the main access, and another representing the users from all existing accesses. All the spaces with some kind of roof, inside or outside the houses, were considered. The spaces were categorized as sectors, as function and as spaceness. The development of digital plans of the dwellings, allowed the study of Space Syntax using the software DepthmapX for the calculation of the Integration HH values of each system, based on the convex representation of the selected spaces. The calculations were done in two steps: first, considering the exterior as another space; and second, disregarding the exterior space. Isovists were developed, staring on the living room, to complete the analysis and observe privacy concerns. The Space Syntax Theory was used to comprehend in which aspects the houses are similar or different, and how the design decisions influence the user's movement, the permeability, the privacy and the space appropriation. The topological proximity, the different possibilities of accesses and connections of the studied spaces, directly affects the use of these buildings. The analysis of these dwellings shows that during a period of more than twenty years, the architectural programmes changed very little, being composed of almost the same main spaces, and the separation of functional sectors has been done in a very defined way. Despite of that, it is possible to observe distinct organizational characteristics influenced by the period the house was designed, the built area, and most importantly, the selected structural technology.

KEYWORDS

Single-family Houses, Brazilian Modern Architecture, Spatial Configuration

1. INTRODUCTION

The present paper is based on the analysis of the spatial configuration of single-family houses designed by Marcos Acayaba, during the decades of 70s through 90s. Acayaba's work represents a moment of maturity of the Brazilian Modern Architecture, specifically the one produced in São Paulo. He graduated at the end of the 60s and starts designing houses in the 70s, strongly influenced by the acting architects of the moment and the main characters of the Brazilian brutalism. His projects show the interest in the construction details and in incorporating different technologies to generate a geometry associated with the structural system.

A Milan - 1972   B Pindorama - 1974   C Köu - 1981   D Kovadloff 1985
E Olga - 1987   F Baeta - 1991   G Acayaba - 1996

Figure 1 - Studied houses. Source: www.marcosacayaba.arq.br

Considered one of the variations of a late modernism, the movement called Paulista Brutalism started in São Paulo and was disseminated in the following years throughout the country. This movement, empowered by Brazil's economic and industrial development, was associated with an excessive formalism and usage of apparent concrete structures. It is important to notice that the diffusion of this architectural ideas in the Brazilian territory allowed a great variety of experimentations, and subsequently influenced back the acting architects in São Paulo (Bastos; Zein, 2010).

This paper started by the selection of a group of 7 houses (Image 1): MILAN (1972), PINDORAMA (1974), KÖU (1981), KOVADLOFF (1985), OLGA (1987), BAETA (1991) and ACAYABA (1996). It is important to note that both MILAN and ACAYABA are houses owned by the architect and represent distinct moments in his career. The first one incorporating characteristics of the Brazilian Architecture done in São Paulo and the last one representing his research in wood structures.

2. DATASETS AND METHODS

The buildings' plans allowed the development of justified graphs, considering the depth from the exterior space by two different paths: one representing the users from the main access,

and another representing the users from all existing accesses. All the spaces with some kind of roof, inside or outside the houses, were considered. The spaces were categorized as sectors, as function and as spaceness (Hillier, 2007). The development of digital plans of the dwellings, allowed the study of Space Syntax using the software DepthmapX for the calculation of the Integration HH values of each system, based on the convex representation of the selected spaces. The calculations were done in two steps: first, considering the exterior as another space; and second, disregarding the exterior space. Isovists, staring on the living room, were developed to complete the analysis and observe privacy concerns.

3. RESULTS

			MILAN 1972	PINDORAMA 1974	KÖU 1981	KOVADLOFF 1985	OLGA 1987	BAETA 1991	ACAYABA 1996
Spaces	Convex*		28	26	35	18	33	29	22
	Functional		21	21	29	14	28	20	20
	Transition		7	5	6	4	5	9	2
	Social ○		7	7	14	6	10	8	7
	Service ○		12	8	7	2	3	2	5
	Private ○		9	11	14	10	20	19	10
Sectors									
Accesses			3	3	9	3	2	2	2
Depth	Main access		8	8	7	11	10	12	7
	All accesses		5	4	5	6	6	7	5
Links	Main access		29	30	45	18	35	31	23
	All accesses		32	33	53	20	36	32	24
SL**	Main access		1.03	1.11	1.28	1.00	1.06	1.07	1.04
	All accesses		1.14	1.26	1.47	1.11	1.09	1.10	1.09
Space type*	Main access	A	14	14	6	6	15	11	9
		B	4	3	3	12	8	4	9
		C	7	7	18	0	9	14	4
		D	3	3	6	0	1	0	0
	All accesses	A	13	14	4	5	15	11	9
		B	0	2	3	3	6	1	6
		C	11	5	12	9	9	12	6
		D	4	6	15	1	3	4	1

* Number of convex spaces disregarding the external space
** Space-link ratio: number of links plus 1 divided by the number of convex spaces plus the exterior
*** The number of spaces is disregarding the exterior

Table 1 - Spatial characteristics of the houses

The main access of the buildings has a very important role in the paths done by the users. In six of the seven studied houses, the user's access to the indoor space can be done by social and service sectors. Hidden from the main entrance, the private sector is also connected to exterior in all of the houses. OLGA and ACAYABA houses, built in a very steep terrain, have connections to the exterior through two spaces: one at the main access level and the other at an inferior level, preventing an exterior path between the two accesses. Considering the main access, in every house the social sector acts as access control for the other two sectors in all of the houses.

It's possible to observe in Table 1 that these houses present depths that varies from 7 to 12 steps considering the main access path. When considered all accesses possible in each house, all houses have their depth reduced. Five of the seven houses, reduce to about 50% to 60% of the original depth. KÖU and ACAYABA houses reduce their depth only from 7 to 5 steps. It is important to note that the first one has 9 points of access.

Permeability was analysed from the arrangement of the justified graphs and using the space-link ratio concept (Hillier et al., 1986) to determinate the relation between spaces and connections on the system. Table 1 shows that considering the main access path, 6 houses present values between 1.00 and 1.11, and only KÖU present 1.28. This confirms that the great majority of the houses have more tree-like configuration. When considered all the accesses, all space-link ratio values increase, confirming that the exterior acts as space of connection, increasing the ring-like characteristics in all the houses. However, the values stay between 1.09 and 1.26, and only KÖU presents 1.47.
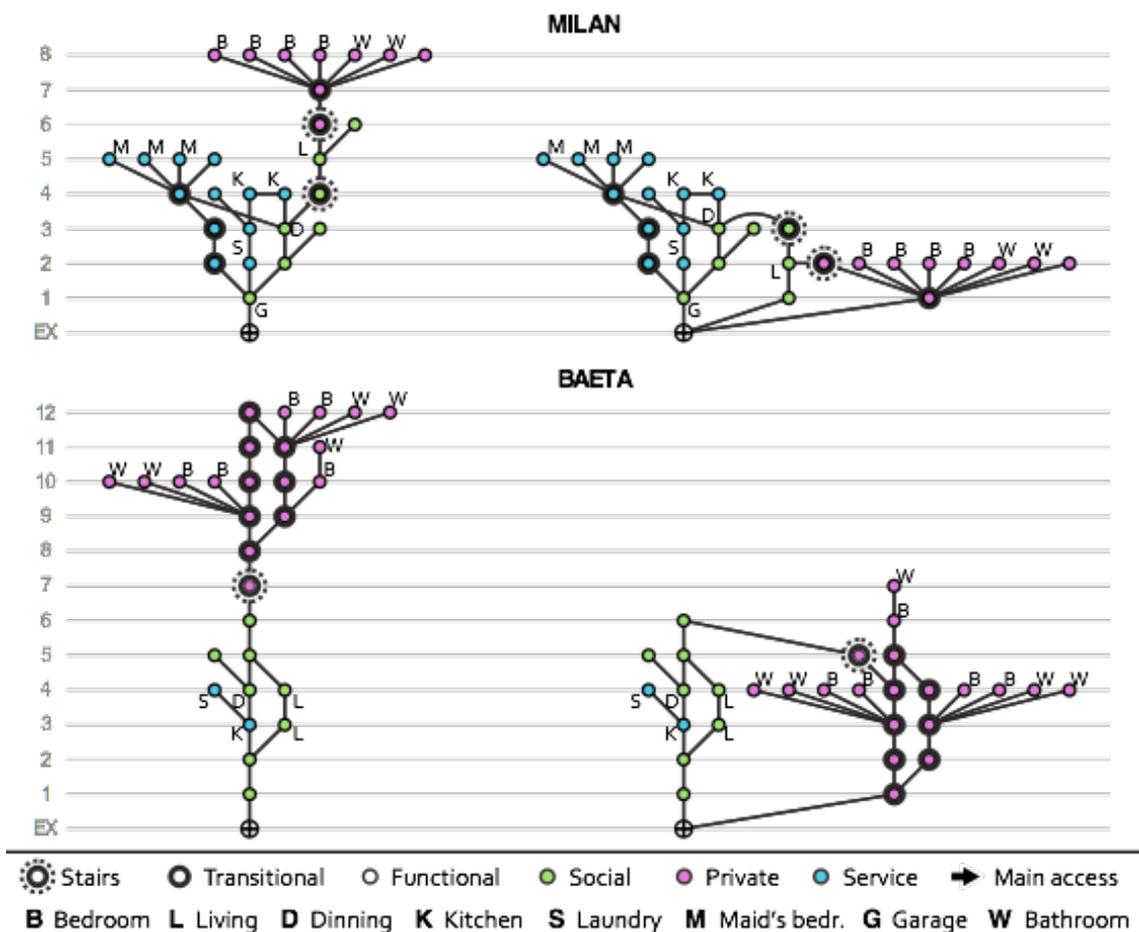

Figure 2 - Justified graphs showing the influence of the exterior in MILAN (1972) and BAETA (1991)

Another important point to analyse is the number of a, b, c, d-type spaces (Hillier, 2007). In two houses is possible to identify the decreasing order of a>c>b>d, and in a third, a>c>d=b. In four of the houses, a-type are the highest number of spaces; and in the other three, a-type are the second highest. At the same time, in six houses, d-type are the lowest number of spaces; and three of these presenting 0 and another presenting 1. These characteristics implies that the houses present a great number of dead-end spaces, generally bedrooms and bathrooms, and that the other spaces serve as circulation, associated to rings, that generates possibilities of movement. When considered all accesses, a-type spaces are still the highest in four of the houses. Now, d-type spaces are the lowest in only three houses, and b-type are the lowest in four houses. Although the exterior creates new possibilities of movement, there are still a great number of dead-end spaces, but the rings become more complex.

All of the houses present the relation between functional spaces and the total number of convex spaces varying from 75% to 91%, and four of these houses present a relation above 81%. The

houses present very few spaces exclusively for transition and the circulation is mainly done through functional spaces. The most common transition space exists to connect the private to the social spaces.
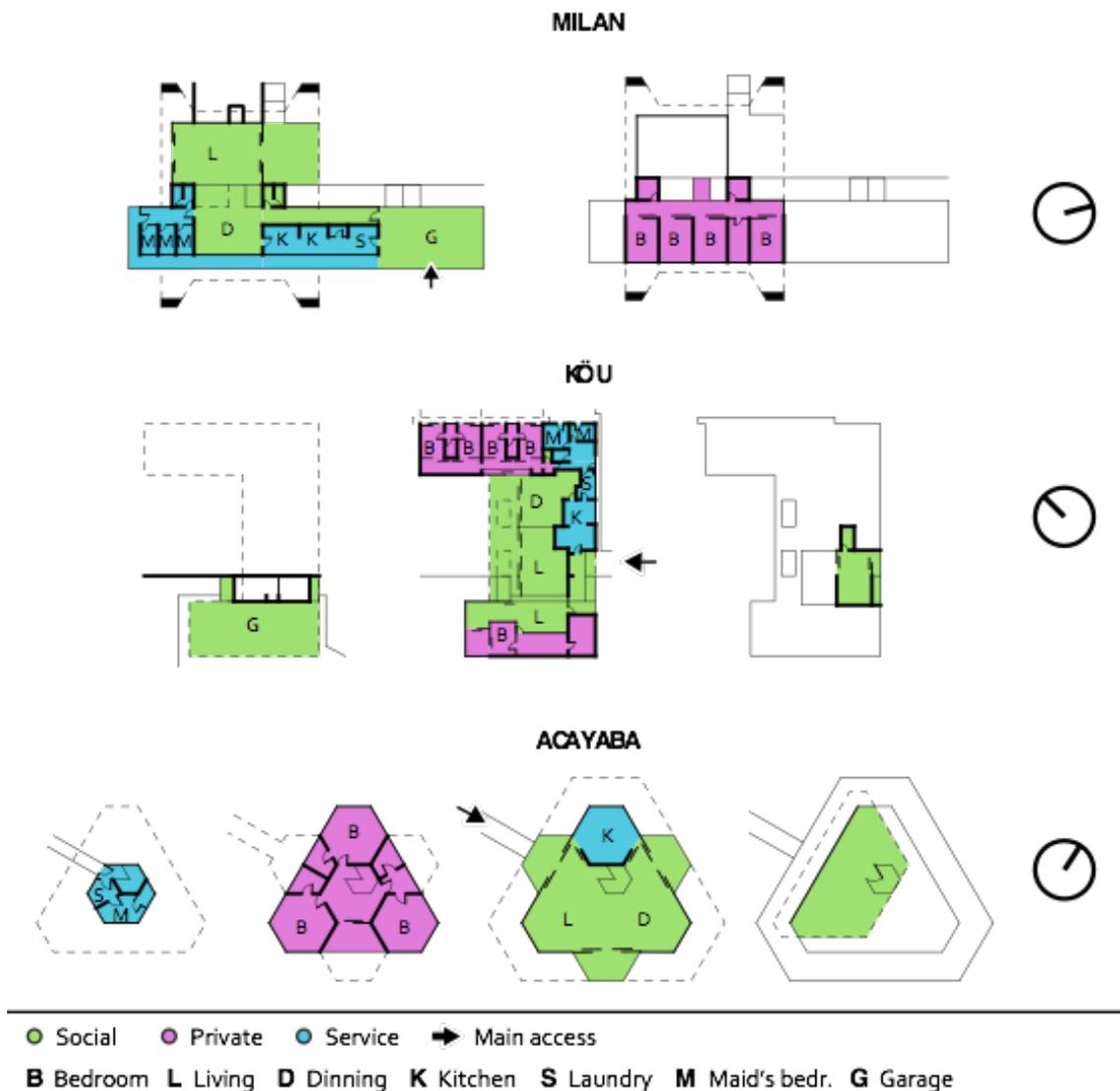

Figure 3 - Separations of sectors in more than one nucleus in MILAN (1972), KÖU (1981) and ACAYABA (1996)

Regarding the sectors, when considered the main access, six houses present all spaces from the same sector grouped together, as displayed in Table 1. In all of the houses, social sector is the first step. In five of them private and services are not connected to each other, and are placed as a second step, both directly linked to social sector. KÖU house have two groups of private sectors connected to social, and one of them connected to service. ACAYABA house present the service sector split in two groups, with one of them as a third step connected only to private. The separation of sectors in more than one nucleus can be seen in Image 3.

The study demonstrates that a characteristic that changed through the years is the decreasing number of service spaces, and the increasing number of private, shown in Table 1. MILAN (1972) presents a proportion for social, service and private spaces of 25%, 43%, 32%. BAETA (1991) presents 28%, 7%, 65%. ACAYABA (1996), the last house in the sample, is a bit different in the trend, with the number of spaces more balanced, presenting 32%, 23% and 45%.
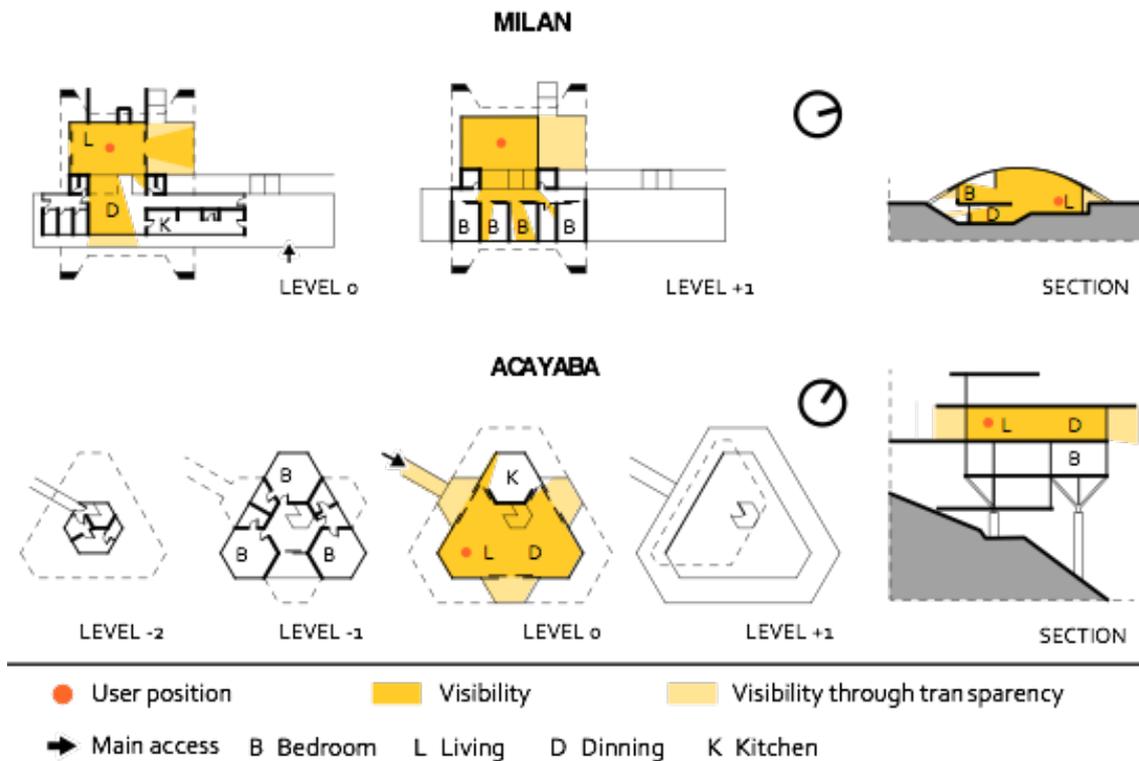
Figure 4 - Isovists from living room for MILAN (1972) and ACAYABA (1996) houses

As seen in Image 4, when it's analysed the isovists from the centre of the living room, the houses present a great possibility of visualisation of the exterior, allowing different views of the garden in almost all façades. But when the isovists are used to understand privacy, another characteristic stands out: MILAN is the only house that allows the visualisation of the interior of the bedrooms and of a major part of the circulation that connects to the bedrooms. Four of the houses, including ACAYABA, separate the private sector from the rest of the house by floors differentiation. MILAN is the only house that separates the private sector in another floor, but still allows the visualisation of the bedrooms.

As seen in Table 2, in six of the houses, the most integrated space is a transition space, when considering the main access. MILAN is the only house in which an indoor functional space (dinning) is the most integrated one. However, in this house, dinning acts as a space that controls the horizontal and vertical circulation. When the exterior space and all the accesses are considered, now four houses present a transition space as the most integrated. In one of houses the exterior is the most integrated space.

The Table 2 also displays the Integration HH values of the main spaces of the houses for comparison: exterior, living, dining, kitchen, laundry, main bedroom and maid's bedroom. Considering the main access, living or dining are the most integrated spaces in five of the houses; and the exterior is the most segregated in four of the houses. It is important to notice that even when these social spaces are not the most integrated ones, they present a very high value in the system. Laundry and maid's bedroom are, in general, very segregated spaces. The main bedroom is very segregated in the first three houses, and in the other four this value increases.

	MILAN 1972	PINDORAMA 1974	KOU 1981	KOVADLOFF 1985	OLGA 1987	BAETA 1991	ACAYABA 1996
MAIN ACCESS							
Minimum	0.520207	0.536699	0.489226	0.346468	0.4884	0.360055	0.478758
Average	0.76121	1.01385	0.939173	0.586205	0.784677	0.623228	0.835561
Maximum	1.26984	1.78416	1.42451	0.883494	1.36752	1.02015	1.6674
Order	D>L>K>M >S>X>B	K>L>S>D >B>M>X	L>K>D>S >B>X>M	L=D>K>B >S>X	D>B>L>K >S>X	B>D>L>K >S>X	L=D=B>K >S>X>M
Exterior (X)	0.627998	0.488992	0.536699	0.346468	0.4884	0.360055	0.636244
Living (L)	1.04041	1.04784	1.04784	0.736245	0.880086	0.633199	0.948129
Dining (D)	1.26741	0.857324	0.892081	0.736245	1.09739	0.655814	0.948129
Kitchen (K)	0.929437	1.0156	1.06474	0.631067	0.830736	0.565009	0.879174
Laundry (S)	0.670267	0.956724	1.00021	0.484106	0.673309	0.464881	0.792698
Maid Bedr (M)	0.718637	0.694884	0.717543	-	-	-	0.604432
Main Bedr (B)	0.590744	0.776635	0.776635	0.49083	0.935671	0.68003	0.948129
Most integ.	Dining	Circulation	Terrace	Stair	Stair	Circulation	Stair
ALL ACCESSES							
Minimum	0.651475	0.680557	0.795349	0.447339	0.555555	0.532255	0.498501
Average	0.965836	1.00182	1.14647	0.746698	0.854517	0.746638	0.868548
Maximum	1.51539	1.65035	2.06294	1.13999	1.53256	1.1129	1.72695
Order	X>D>L>S >K>B>M	X>L>K=S >D>B>M	X>S>K>L >D>B>M	X>L=D=K =S>B	D>B>X>L >K>S	X>B>D>K >L>S	B>L=D>X >K>S>M
Exterior (X)	1.39416	1.50032	1.50032	0.929993	0.966182	0.895745	0.91235
Living (L)	1.14275	1.04784	1.04784	0.736245	0.897866	0.655814	0.948129
Dining (D)	1.26741	0.880186	0.904301	0.736245	1.09739	0.680103	0.948129
Kitchen (K)	0.929437	0.929774	1.13817	0.736245	0.830736	0.667737	0.879174
Laundry (S)	1.05618	0.929774	1.15814	0.736245	0.68906	0.532255	0.848326
Maid Bedr (M)	0.718637	0.680557	0.795349	-	-	-	0.632244
Main Bedr (B)	0.810556	0.74173	0.814987	0.569996	1.0101	0.720109	0.967091
Most integ.	Garage	Terrace	Exterior	Circulation	Stair	Circulation	Stair

Integration HH values generated by the software DepthmapX

Table 2 - Integration HH of the houses

When it is considered the main spaces and all accesses, in five of the houses the exterior becomes the most integrated, and in the other two houses this value increases. Social spaces are still very much integrated. In the four houses that exists maid's bedroom, this space is the most segregated. The main bedroom is very segregated in the first four houses, even when it's considered all the connections to the exterior and all the new possibilities of movement. However, the last three houses present an increase in the main bedroom integration, even existing only 2 points of access to the exterior. Considering all spaces, four of the houses still present a transition space as the most integrated.

4. CONCLUSIONS

Modern buildings were designed based on the idea of the 'machine for living', producing and organising spaces for each own functionality and removing everything that were deemed unnecessary for the living. It was imperative the organisation of groups with similar function together, described as the 'sector's paradigm' (Amorim, 1999). And the circulation space was incorporated to connect several different functions together.

The society of Brazil, created over slave work and social segregation, absorbed the Modernism as an idea of development but kept, comfortably, traditional ideas of social and work relations (Marques; Trigueiro, 2000). Differently from studies that show similarity between functionalist architecture around the world, Brazilian Modern Architecture clearly displays social codes imprinted in the domestic space organization. Hanson (2003) affirms that it is possible that the modernist houses in some parts of the world present the invariance of the vernacular residences.

In Brazilian houses, from colonial to modern, circulation is done in most cases through functional spaces, presenting very few spaces used exclusively for transition. In these houses, service quarters are very segregated to hide the workers, as it happened in slavery time. This remains true even in contemporary architecture, generally associated to middle and upper classes. The main bedroom changed from a more centralised space, with the possibility of controlling the life of the inhabitants, to a more secluded location to achieve more privacy, specially when it's considered the main bedroom. All the bedrooms stopped being interconnected and started being dead-end cells. The Modern Architecture brought a valorisation of the social spaces with less compartmentalisation, supported by advances in building technology. With time, the lack of physical divisions reduced the possibilities of formal and informal differentiation (Trigueiro, 2015).

The residential architecture in Brazil changed during the 20th century, with the valorisation of the family life towards a spatial organisation of interconnected social rooms as opposed to the physical separation found before. The spaces were designed to guarantee spatial continuity as a substitution to the excess of walls or doors. In some cases, this continuity extended beyond the social sectors, valorising and connecting the kitchen (Reis Filho, 2013).

The buildings that represent the Paulista Brutalism movement were organized on a single block under one massive concrete roof, but were characterised by spatial richness on the interior with physically and visually connected spaces separated by level differences (Bastos; Zein, 2010). MILAN, the first house of the studied sample is a very clear example of the Brazilian Brutalist movement, presenting all characteristics and mainly organised under a single concrete arc. Privacy is achieved by closed doors only, and it's much weaker than the other houses. From the living, the users can visualise all the external entertainment area, but also, most of the private circulation, bedrooms, dinning and services spaces doors. The envelope transparency guarantees almost the same visualisation quality of the living room from the main terrace. The physical separation is done by doors on each bedroom and the service spaces. Even the lavatories of the private spaces are placed on the circulation and outside of the bathroom, and can be partially seen from the living.

The visualisation of the private circulation and bedrooms continues in the next two houses but with a dramatic reduction, disappearing completely on the last four houses, where the private space is in another floor, separated by the staircase. In six houses, the bedrooms are accessed through a single continuous private circulation. Furthermore, the relation between bedrooms and bathrooms in the private sectors modifies during the years, representing the valorisation and individualization of the private spaces. In the houses built before the 80s all the private bathrooms are directly connected to the private circulation and they are not accessed through the bedrooms. This reaffirms a trend for individualisation and segregation of the private spaces.

Only one of the houses presents a traditional service sector, grouping kitchen, laundry and maids' bedrooms. Three houses don't present maids bedrooms and two houses present the kitchen disconnected from the rest of the service. Differently from what is expected in modern dwellings (Trigueiro; Marques; Cunha, 2001), the service is not always connected to the rest of the house through the kitchen. However, the laundry and service bedroom are generally very segregated. The kitchen has a much more important role, always directly connected to the continuous social space. It's important to notice also the reduction of service spaces, and the simplification of this sector, representing the changes in work relations in Brazil.

It is clear that Marcos Acayaba has been influenced by an architectural movement, developing his own design process, and always heavily based on the chosen technology. The spatial organization are very related to the structural solution implying a certain variety in the configuration. However, it is also possible to observe certain characteristics presented in Brazilian Modern Architecture as a whole, that reflects the society codes and traditions of the period that these houses were designed. The houses' configurations confirm the continuity of social spaces and the addition of transition spaces that leads to private or segregated rooms. The exterior is an important area for the resident, once allows other paths through the domestic space, connecting different sectors and reducing depth.

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