

## MODULAR COURTYARD SCHOOL: ONE CONCEPT, TWO PROJECTS

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### ABSTRACT

The design challenge behind the elaboration of this paper aimed at the conception of a public school to be built in Rio de Janeiro, which should foresee its reproducibility in several contexts. The work performed extends beyond that scope and discusses the possibility of designing a school from a modular reproducible system tailored to the uniqueness of its context. The research is underpinned by two design projects following a common and single design concept. The projects are based upon the exploration of the courtyard school type and the study of new models of spatial and functional organization in order to test the adaptability of this approach in two distinct urban contexts, in different countries: Brazil and Portugal.

The rationale was founded upon research themes concerning the school's brief, the modular design issue and the adopted type solution; and was consolidated by analyzing four case studies and the characteristics of each location, which have converged to the design concept and contributed to the decision-making process.

KEYWORDS: school design; courtyard school; modular system; adaptability

### INTRODUCTION

The work described in this paper resulted from an initial brief aimed at designing a public modular-based school, dedicated to the 2<sup>nd</sup> and 3<sup>rd</sup> cycles of elementary education, which is to be located in the Gávea neighbourhood, Southern Zone of Rio de Janeiro. This was a challenge for a specific project – to create school equipment for a previously defined location – which should foresee its reproducibility in several contexts. Faced with this challenge it was questioned whether it was possible to find a solution conciliating the design of a repeatable modular system and the willingness to give the school its own identity. The analysis led to a concept conceiving the school as a particular element, inextricably bound up with its context. In this regard, it was decided to test the adaptability of the initial proposal, starting from the exploration of the courtyard school type and the study of new models of spatial and functional organization in order to develop a second solution, thought up for a distinct urban context in Portugal.

This paper is based on the Master on Architecture's final report (Heitor, 2013) which includes the detailed research and designs.

In order to structure the work, school space organization and construction models and practices observed at international level have been analyzed, with particular focus on Portuguese and Brazilian contexts, as follows:

- *Parque Escolar*, in Portugal (and DfES, Department for Education and Skills, in the United Kingdom), under which an investment plan was established for the modernization of existing school equipment, by proposing open spaces adapted to the current pedagogical trends and practices, focusing on the diversity of active learning processes; on the interaction of informal learning methods outside the classroom space; and on opening up of the school's grounds to the community.
- *FDE, Fundação para o Desenvolvimento da Educação*, in Brazil, which relied on a catalogue system of standardized spatial and construction components, from which more than 800 schools have been designed by a number of teams of architects (Timbó, 2009).

#### SCHOOL SPACE ORGANIZATION MODELS AND PRACTICES

There has been a growing trend toward decentralization of the teaching-learning process regarding the space and time of classroom usage (Hertzberger, 2008). The widespread use of new information and communication technologies (ICT), associated with a gradual portability of electronic devices, is reflected in the unprecedented possibility of acceding, processing and sharing information anywhere, and is not limited to space and time of classroom use (Dudek, 2008).

There has been a need for creating formal learning and interaction opportunities between the different members of the community by conceiving premises that are appropriate to non-traditional learning methods. (Parque Escolar, 2009). School circulation and meeting spaces are deemed critical in the school dynamics, such as libraries, which play an essential role in spatial, social and educational structures, establishing themselves as catalyst centres of a learning culture within communities. There has been a trend to break up the traditional formalism and rigidity of the library, seeking the creation of an open, multifunctional space, and adapted to diversified forms of knowledge access, generation and sharing (Stack, 2012).

Additionally, there has been a concern about opening the school's facilities to local communities after class periods, functioning as active urban equipment. This process has a direct bearing on the school's functional organization, such spaces playing a central role in the school which must be allowed to become autonomous outside periods of academic activities (Dudek, 2008).

## MODULAR SOLUTION WITHIN THE SCHOOL CONTEXT

The design of a modular project entails the establishment of repetition patterns that contribute to creating coherent wholes. These patterns come up at different stages of an architectural project – from design to construction – and cover different scales – from space typologies to construction components.

With regard to school architecture, the central idea of *repetition* can be considered in the functional organization itself, which is normally connected with repetition of a basic use unit – the *classroom* (Alegre, 2012). In addition, space repetition may be transposed to the construction scope foreseeing its rationalization, giving way to a standardized production process which is expressed in the regular repetition of the construction elements – *construction pattern*. The adoption of a metrical model allows for establishing a dimensional coordination from the design to the outline of the final product, making it possible to establish a systematic methodology of industrialized construction processes (Greven and Baldauf, 2007).

Industrialized construction started to be widely developed in the aftermath of World War II as a response to the need to build new school equipment in quick, effective and economic manners. Different pre-fabricated modular systems thrived, which were based on different materials – wood, reinforced concrete, steel etc. – and construction technologies.

Both standardized projects carried out in Portugal in the 1960-80s, and systems developed in Brazil, namely the Niemeyer project for the CIEPs - Integrated Centres of Public Education (1983) in the State of Rio de Janeiro or the FDE system (1990), in São Paulo, were conceived from pre-fabricated reinforced concrete component systems. The system developed by FDE is structured into a number of technical catalogues which define in detail the specifications of the school building. The model starts from the minimum module of reference of 0.90 m – which is a commonly used measure of windows, doors etc. – giving rise to a spatial modeling of classroom of 7.20x7.20m and a structural modulation of 7.20x10.80m. The construction regulations established have been adopted by different teams of architects for the design of diversified projects, appropriate to each construction site (Azevedo, 2009; Hazan, 2009).

The use of standardized solutions under school construction has reappeared as a relevant solution in the contemporary context, not only in Brazil, but at international level. Development programmes entailing modular solutions in distinct countries have been presented worldwide. They show the possibility of using modular solutions and creating a diversity of educational environments to comply appropriately with the requirements of educational contemporary projects (OECD, 2011). This issue is closely linked to the challenge proposed for the development of this work: to design a school with its own identity, tailored to its context, from a repeatable modular system. From the research carried out, it is possible to anticipate that the solution for this challenge should foresee the adaptability of the conceptual pattern established, the flexibility of the modular solution adopted and the versatility of the spaces created.

## THE COURTYARD AND THE HALL IN THE SCHOOL CONTEXT

For the project design, it was found to be appropriate the exploration of a school design type structured from the courtyard space, a recurrent solution in the context of school architecture. In fact, the courtyard design type has been explored from ancient times as a privileged space of meeting, circulation and interior lighting. With regard to school buildings, this design type dates back to the early educational institutions, based upon the monastery architecture organized around the cloister; it can be seen in the organization of the French *lycées* of the 19<sup>th</sup> Century; and is reinterpreted throughout the 20<sup>th</sup> Century.

The courtyard design type emphasizes how important outer spaces are in the students' cognitive and social development process, and in the collective environmental awareness. It stimulates group dynamics, which are specific of school communities and promotes an informal interaction culture that assumes a significant importance in contemporary educational projects. Therefore, it is the formal essence of the courtyard as *an outer space inside* which will ensure its relevance as a school building design type for today and the future (Rigolon, 2010).

The courtyard typology appears in the context of this work as a coherent response to the demands of modulation; to the specificities of designing inside of a confined urban lot; to the needs of environmental comfort in different climates; and to group dynamics associated with the school programme.

In addition to the courtyard layout, another school building design type can be identified, which has proved important for the construction of the design concept: the one organized around an enclosed central space, which can take different shapes and house distinct functions, but is commonly designated as the *school hall*. This centralized design type or block type perfectly suits the trend of enhancing school's meeting spaces in order to promote informal learning and interaction between the school community members.

There has been progressive decentralization of school activities regarding the classroom space. As a result, school types which are shaped around meeting spaces for the school community, whether inner or outer spaces – *hall or courtyard* – gain particular relevance in contemporary educational contexts.

## CONCEPT

### COURTYARD(S) TYPE

The Courtyards School type is structured from a number of volumetric compositions with an inner *void* – the courtyard-module. This *void* may be open and materialize, in fact, into the courtyard space, or be enclosed and house one of the meeting spaces which are critical to the school dynamics: the library, the auditorium, the canteen, the sports facility. The resulting set may have different shapes, combining a varied number of these modules in different relative positions. Thus, the articulation of the different courtyard modules allows for a compact building setup – linear, centralized, irregular, at height, etc. – or disperse, almost similar to the pavilion design type.

The concept was initially developed to adapt to a confined urban lot, hence the need to create open inner spaces. Nevertheless, the flexibility of this pattern allows for creating enclosed and open spaces for the exterior, shaped by partial U- or L-shaped volumes, depending on the characteristics of the surrounding area.

#### PERMEABILITY AND INTEGRATION

When defining the relationship of permeability between the school's space for public and private use, seeking to conceive the School as a link between students, teachers, family and neighbours, the aim was to find a commitment between the willingness of public inclusion and the need for the school's safety. It is proposed that this relationship is translated into a storey-based separation, defining that each school is organized in a two-storey building. Classrooms are arranged, destined exclusively to be used by the school community, at the upper floor, where circulation is made through galleries open to central double height which spans through the ground floor spaces. This organization allows that beyond term time – i.e. night periods, weekends and interruption of school activities – the ground floor can be open to the community, working as a public equipment; and that, during school time, outer spaces for public use remain accessible to the public and the other spaces cater for the different school's activities, contributing to a dynamic reading of the internal spatiality.

#### FLEXIBILITY AND ADAPTABILITY

The flexibility of the proposal is closely linked to its modulation, which was based upon the spatial and construction component system defined by FDE, *Fundação para o Desenvolvimento da Educação*. Thus, from the minimum module of 0.90x0.90m, a three-scale modular system was established:

- The classroom scale, 7.20x9.00m with an adjacent circulation gallery and spans in opposite sides, allowing for cross-ventilation;
- The linear body volume, composed by  $n$  rooms;
- The courtyard scale, which combines four linear volumes with a different number of rooms, defining a central space of variable dimensions, adaptable to the different functions they can host.

The building solution adopted is based upon a pillar-beam reinforced concrete system and 0.90 metres wide pre-fabricated dividing panels and the pillars' modulation coincides with the spatial modulation of the classroom.

## SITE ANALYSIS

With the purpose of testing the adaptability of the design concept, the option was to develop two solutions adapted to two lots of distinct characteristics, in extremely diverse urban contexts: the Bairro da Gávea (Gávea Neighbourhood) in Rio de Janeiro, Brazil, and the Bairro do Rosário (Rosário Neighbourhood), in Cascais, Portugal. The lot in Cascais includes the current Secondary School of Cascais where the existing premises are planned to be torn down in order to build a new school in the near future.

Whereas the city of Rio de Janeiro is a large city with approximately 6.300 million inhabitants, Cascais is a county located in the metropolitan area of Greater Lisbon, with only about 200 thousand inhabitants. The Gávea neighbourhood is located in the southern area of Rio de Janeiro, Zona Sul, and stands out for having the city's largest Human Development Index. It is a consolidated urban area with a high population density, very heterogeneous uses, where different public facilities are located, such as schools, theatres, cultural areas and shopping centres. In turn, the Rosário neighbourhood is located next to the centre of the Cascais, and is an entirely residential area, mostly made up of single-story housing and with a lower population density. It includes a few hotel equipments and vacation houses, as it is an important coastal resort on the outskirts of Lisbon.

The chosen lot for the development of the Gávea design proposal has an area of 7.647sqm and is located in Marquês de São Vicente Avenue, the structuring axis of the neighbourhood. It consists of an elongated lot, confined between a housing complex, an office building and the foothill of a large peak, with only one of its smallest fronts accessible, open to the Avenue. The topography of the land is plain, with a three-metre gap near the foothill, and the lot contains a large mango tree, next to its only access.

In turn, the elaboration of the design proposal for the Rosário neighbourhood was based upon a trapezoid shaped, non-directional lot with an area of 22.630sqm and is delimited by four street layouts, defining a whole block. Inside the lot, there is a pine forest which occupies nearly a third of the total area, delimited by a slope with a three-metre gap, overlooking the Atlantic coast.

The design brief for the Gávea School was set up to host two day shifts of 300 pupils of the 2<sup>nd</sup> and 3<sup>rd</sup> cycles of elementary education, estimating an area of construction of 4000sqm. Meanwhile, the Cascais School is designed for nearly 800 pupils of secondary education, in two-day shifts for daily operation, and 240 at recurrent education, during the evenings. The existing school has a gross area of 4800sqm and the tendering programme for the new school provides for an increase for 9540sqm, in order to host 1060 pupils in 44 classes (totaling an average of 25 pupils per class and 530 pupils per shift).

## DESIGN PROJECTS

The two design proposals considered resulted from a strong concern with their integration in the urban dynamics of each neighbourhood. They offer not only the school premises, but also an active and qualified public space for the use of local communities. Additionally, the pre-defined school briefs were readjusted to the urban needs identified, at educational, cultural and leisure levels.

The composition of both schools starts from a set of several courtyard-modules, which are arranged according to relative positions, resulting in distinct setups that accommodate to the layout of each lot. The setup of the Gávea School is conditioned upon the size of the lot, consisting of a linear volume over the street and frees the top of the lot near the hillside. On the other hand, the Cascais School starts from the composition of two linear orthogonal volumes which cross near the turning point of the Av. Pedro Álvares Cabral, freeing the pine tree space.

In both cases, the entrance of the school is made through a large public space which is shaped by the boundaries of the lot and the hanging volumes that define the upper level of the first courtyard-modules. At Gávea, the school boundaries impose themselves in the public space while expanding it, giving way to a decompression space, already within the lot, around the leafy mango tree. This space includes a playground, a free time workshop and a playroom at the service of pupils, residents and bystanders. At the Cascais School, given the age range of pupils, between 15 and 17, it was created a public space that might be attractive to young people, namely creating a skate park and an outdoor auditorium overlooking the large façade of the building, adapted to outdoor projection. These spaces, as well as the new kiosk and the respective outdoor café area, are key drivers of urban life of this entirely residential neighbourhood.

As previously mentioned, both schools are organized into two-storey buildings, with the school's common spaces distributed in the ground floor, and the classrooms located on the upper floor. Circulation is made by galleries open to central spaces with a double storey height. Vertical circulation is ensured by ramps in order to allow for universal accessibility.

The spatial and organizational layout of the Gávea School is conditioned upon its linear layout, and shows the sequence of several common spaces at ground level, along its longitudinal axis. The square, which is of spontaneous public use, gives its way to the library, which in turn is linked to the auditorium. This space is followed by the courtyard and the canteen, which opens to the sports field that is situated at a slightly lower level. Finally, at the upper level, there is a large outdoor space next to the foothill of the slope. Access to the upper floor, which houses the classrooms, is made by a ramp that surrounds the auditorium, leading to a waiting area near the administrative offices.

The Cascais School is considerably larger than the Gávea School, taking into account the extent of the programme and the area of the lot. The volume parallel to Av. Nossa Senhora do Rosário follows the steepness of the land, subdivided into three levels that house respectively the auditorium, the library and the sports facility. The orthogonal volume is shaped around the voids of the square and the courtyard

which opens to the pine forest and covers the area of the canteen and the cafeteria. From the ample public space situated near the Av. Pedro Álvares Cabral, it is possible to enter the building through three distinct accesses. The northern entrance, which links the parking lot, leads directly to the administrative area and to the auditorium. The access to the library is on the center of the school, which is open outside the classroom periods for the local community. Over the hanging volume is the main school entrance. Access to loading and unloading services are offered near the south boundary of the lot through the Rua Guilherme Salgado. This area of the land also includes the outdoor sports fields.

Among the several meeting spaces of the school, which are critical to the construction of the conceptual design, particular emphasis was placed on the library. More than defining a specific area to perform its traditional role, it was thought to create a multipurpose, flexible and diverse space, which was established as the school's hub, promoting informal learning and the interaction with the local community. These spaces coincide with the main hall of each school, hardly described as a traditional school library. In both cases, the school's main access gives directly way to the module that contains the library at its center. This large space is divided into different settings. In the central area, with double height open to the galleries of the upper floor, there is the large space for informal reading, meeting and socializing for the school community; and at the borders there are various spaces that complete the library.

In both schools the courtyard appears as being associated with the canteen. Both outdoor and indoor areas surrounding it can be used as informal eating areas. Additionally, the functions attached to the courtyard make it, in both cases, the main recreational space of the school. At the Gávea School, where the lot's area is considerably limited, the courtyard is interior, shaped by covered open spaces at the ground floor and by the circulation galleries at the upper floor. This space is enclosed by the building but its boundaries are permeable and generate a large space for leisure with different ambiances, which are associated not only with the canteen but also to the sports field and the green areas. Meanwhile, in the Cascais School, the courtyard is not entirely closed, but open to the pine forest, making the transition between built and natural environment.

At the Gávea School the public-private hierarchy is materialized into a horizontal progression, due to the sequence of various spaces of a more public nature which gradually filter the fluxes. At the Gávea School each access allows for the independence of a functional sector of the building. This flexible design of access control allows for greater adaptability of the school's different spaces to distinct uses both by the school community and the local community, contributing to the recognition of the school as active public equipment in the surrounding urban fabric.



## SUMMARY

This article is aimed at presenting, explaining and discussing the principles, strategies and decisions taken in the design of two distinct courtyard-schools, driven by a common and single concept.

The investigation has made possible to draw a number of trends which reflect the demands of current learning environments; extend the comprehensiveness of the modular solution in the school context; and contextualize the type solutions explored, taking into account their evolution and pertinence under contemporary school architecture.

The analysis of several case studies created a link between the subject matter analyzed and the designs, contextualizing the current architectural practice in Europe and South America. It has pointed out: i) different layouts and space uses of courtyards or central atriums; ii) different forms of application of compositional or construction module systems; iii) different forms of creating informal learning spaces; and iv) and different forms of integrating local communities into schools.

The site analysis was also important for the establishment of the conceptual design and elaboration of the proposals. It helped to understand and compare the constraints of each project at different levels: geographical, environmental, social and demographic, historic, cultural and urban.

From different research and analysis perspectives it was possible to achieve the main objective of the work by defining a compositional, formal and functional modular system, which can be manipulated according to each site rules. Two compositions were designed with the same number of basic units which suggest distinct dynamics, being associated with their environment and having their own identity that transposes the repeatable value of the sum of the parts. This *compositional* system was conceived according to a metric modulation which helped lay the foundations for the definition of a standardized *construction* system.

As a possibility of future developments, the creation of a full construction system is suggested, which should be developed locally, like the FDE catalogue-system. Under the academic context, it would be also stimulating to test the system development in other places, integrated in distinct contexts and different characteristics which motivated the definition of varied compositions, with a view to consolidating the main objective of the work.

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