GEOMETRIC DESIGN FOR BUILDINGS WITH INNER COURTYARDS

PROIECTAREA GEOMETRICĂ A CLĂDIRILOR CARE AU CURȚI INTERIOARE

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Abstract. *In the case of large public buildings, inner courtyards provide optimal solutions for space lighting and ventilation. In relation to height and surface area parameters, space geometry has to take into account that vegetation must develop under good conditions. Shaded and sunlit areas, determined by courtyard's geometry, have direct implications on the spectrum of plant species that can develop. In turn, grown tree canopies cast shadows that hinder the ground vegetation development. Landscaping design of inner courtyards should take into account the force fields specific to the basic shapes and their impact on human behavioral patterns. The article presents general considerations on the topic of inner courtyard's geometry, in relation to landscaping possibilities, as well as a case-study.*
Key words: *geometric design, inner courtyards, landscaping solutions.*

Rezumat. *Curțile interioare reprezintă soluții optime pentru asigurarea iluminării şi ventilării naturale pentru clădirile publice cu o amprentă la sol mare. Geometria spațiului trebuie proiectată în relație cu înălțimea pereților şi aria desfăşurată la sol, astfel încât vegetația să aibă condiții bune de creştere. Zonele umbrite și însorite, determinate de geometria curții, are implicații directe asupra spectrului de specii de plante care se pot dezvolta. La rândul lor, coroana copacilor care au crescut, proiectează umbre care limitează evoluția vegetației de pe sol. Amenajarea curților interioare trebuie să țină cont de câmpurile de forță specifice fiecărei forme geometrice și impactul acestora asupra tiparelor comportamentale umane. Articolul prezintă considerații generale privind tema geometriei curților interioare, în ceea ce privește posibilitățile de amenajare peisagistică, precum și un studiu de caz.*
Cuvinte cheie: *proiectare sustenabilă, clădiri sociale, curți interioare, geometria spațiului, soluții peisagistice.*

INTRODUCTION

Geometric patterns fulfill an important role in the composition of architectural space, structuring and representing information. Even from antiquity, the basic models have marked the limits of spaces which were a symbolic landmark to a certain culture or civilization. Starting from the irregular shapes of

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the first spontaneous settlements until the abstract lined spaces of the modern times, the historical analysis individualizes certain basic geometric patterns which are repeated throughout time: the circle, the square and the triangle. These suffer materializations and geometric transformations which differ according to various social, spiritual and aesthetic premises of the era that generated them.

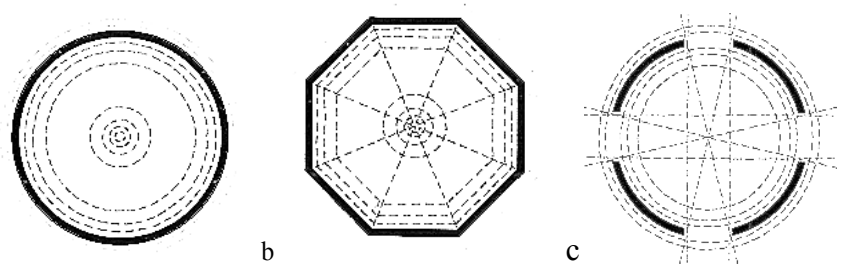
MATERIAL AND METHOD

Each basic geometric shape generates specific force fields and spatial patterns. Thus, according to each inner courtyard form, the design will propose optimal visual perspectives, areas of interests and circulation directions. The landscaping design is determined by the overall proportions of the space and consequently proposes possible activities within an courtyard and the ratio of plated and paved areas.

Starting from the principle according to which the image of architecture can be reduced to its essential elements which, in turn, can be represented through basic geometric models, an argument can be made for the existence of repetitive patterns, found in various historical stages. The phenomenon is referred to as *"shape persistency"* in the field of visual arts and architecture (Conversano *et al.,* 2011).

RESULTS AND DISCUSSIONS

Apart from their purely scientific characteristics, the primary models of the circle, square and triangle have the capacity to relay a state or idea, having significations associated to them which denote the profound side of the human being and which have, in time, concentrated ideals, superstitions and various forms of abstraction. After a formal synthetic evaluation of the progress of geometric patterns and transformations in the architecture of inner courtyards, various manifestations of the primary geometries of the circle, square and triangle are particularized.



a b c

Fig. 1 - Centralization degree for the circle and octagon: a. Closed circle model; b. Closed octagon model; c. Symmetrical opened circle model (Von Meiss, 1986)

Considering these three basic patterns, Pierre von Meiss analyzes separately the radiance (force) fields inherent to each geometric shape.

In the case of octagon and circle patterns, the force fields act in the centre and at the periphery. So if we intervene on the basic model by creating symmetrical openings, more subspaces will be defined as disk sectors (Fig 1).

Three-dimensional extensions of the circle may be represented by models such as cylinder, sphere or dome, all of these maintaining the concept of centrality for the interior space (Fig. 2) .

Fig. 2 - Traditional houses of Hakka, China, Seventeenth century - earth architecture

The square holds different intensity radiance fields, which are acting in the corners, on the outline, diagonally, and in the centre, Fig. 3a. If the square corners are explicit we are witnessing a perfect closed space definition and its default subspaces are also squares that, through similarity, help focusing and emphasizing the basic model, Fig. 3b. When the square corners are missing, the resulting shape suggests space openness and the basic model is no longer as conclusive, Fig. 3c. The vertical spatial extensions of the square are the cube (Fig.4), tetrahedron and prism.

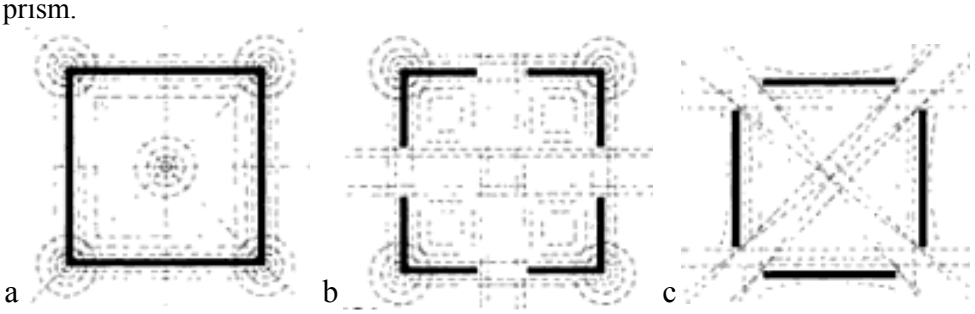


Fig. 3 - Centralization degree for the square: a. Closed model; b. Model emphasizing the centrality of the basic pattern due to elimination of median part sides; c. Decentralised model (Von Meiss, 1986)

Fig. 4 - Traditional roman villa

The equilateral triangle features a hidden centre because it lacks diagonals and the bisectors have no precise reference to the midpoint of the opposite sides. Therefore, the triangle is less centralized than the octagon or square, but at the same time, defines an enclosed space, almost claustrophobic due to its sharp angles (Von Meiss, 1986), Fig. 5a. Pierre von Meiss also mentions the difficulty of designing spaces with explicit sharp angles. When the angles are kept and the mid sections of sides are eliminated, the centre of the triangular pattern is emphasized, Fig. 5b. If the angles disappear and mid sections of sides are maintained, the concept of the triangle becomes elusive, referring rather to the geometric model of hexagon, Fig. 5c. Depending on the edges inclination degree, the final image can either remind of the triangle pattern, or the hexagon. (Fig. 6)

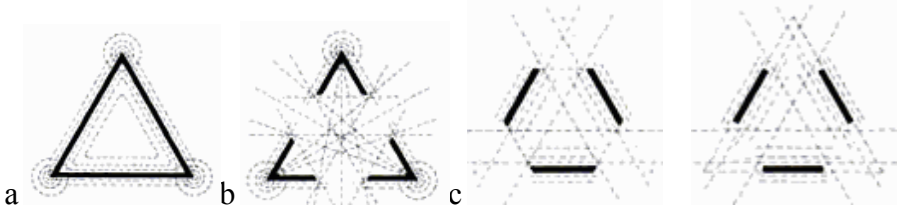


Fig. 5 - Centralization degree for the triangle: a. Closed model; b. Emphasizing the triangle centre by abolishing the mid section sides; c. Elimination of angles – definition of hexagon and triangle models (Von Meiss, 1986)

Fig. 6 - Kyoko Ikuta house, Nagano, Japan (2010) - Ozeki Architects & Associates

In the modern and contemporary period, the evolution of the circle, square and triangle models oscillates between primary, abstract (legible) and composite, complex (difficult to decipher), these geometric materialization states being found at a plan, facade and volumetric level. Considering these aspects, we can state that the circle, square and triangle patterns cross an initiation path, passing through different stages of geometric experimentation, from the purity imposed by machine standardization, to complex methods of mapping the virtual reality.

The geometric pattern of the circle is the most frequent one in the context of digital design, constituting a departure point for spatial materializations based on curved surfaces.

The results of our research on geometry and space proportions can contribute to the sustainable design of an landscaping project. A case study on the interior courtyard of the Faculty of Architecture of Iași is designed to illustrate the role of geometry in landscaping projects. The preliminary phase of the project consists of a sun study meant to determine the possible location of planted areas and the suitable plant species.

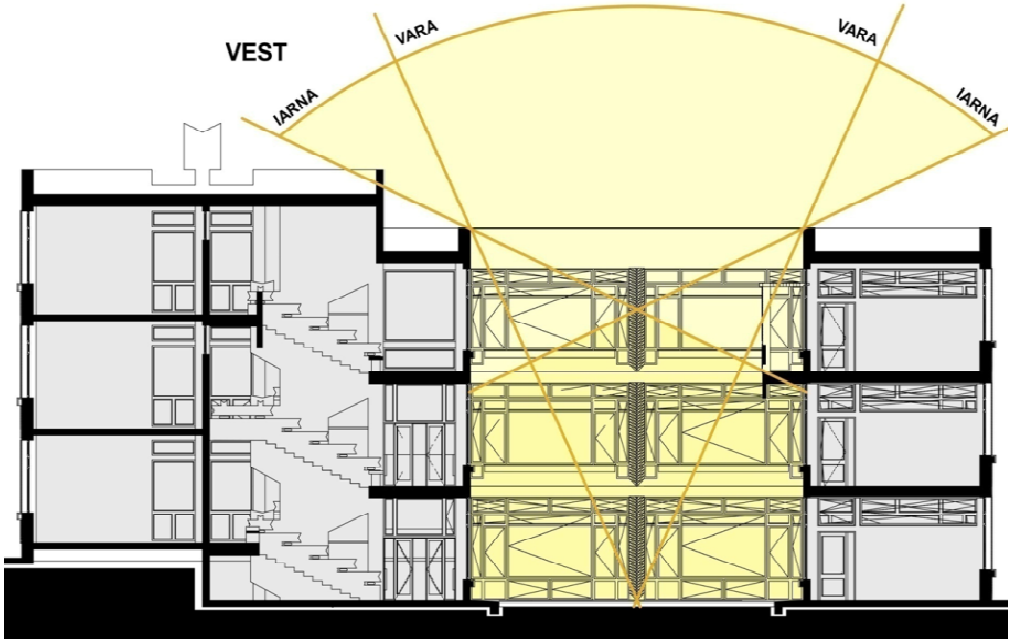


Fig. 7 - Sun study of the interior courtyard of the Faculty of Architecture from Iași

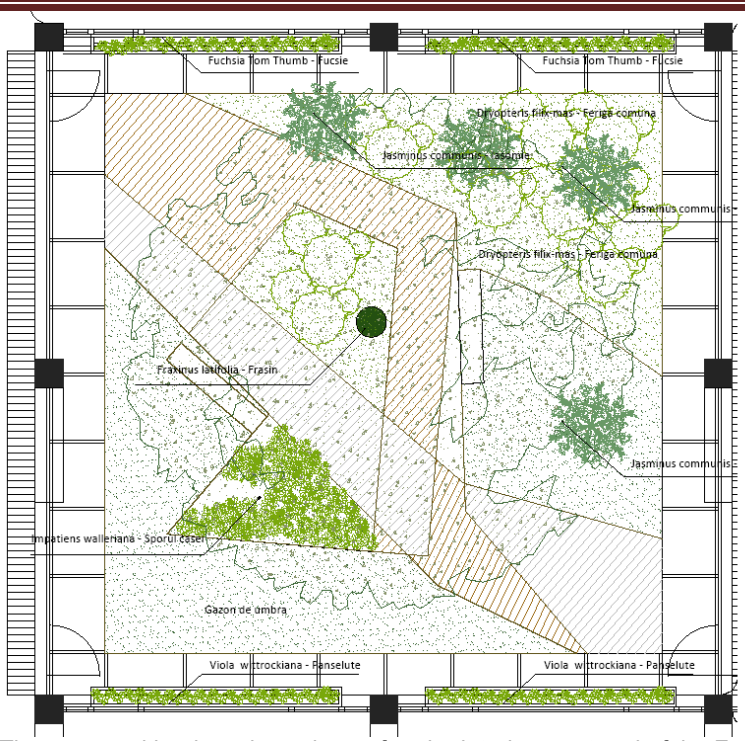


Fig. 8 - The proposed landscaping scheme for the interior courtyard of the Faculty of Architecture - Iași

CONCLUSIONS

The perception of a model depends on the visual contrast that exists along the separation line between figure and background, or between form and its field. Taking into account theories enunciated by Gestalt theory, which state that the human mind simplifies visual environment for a better understanding, the conclusion is that a model is easier to be perceived, the more simpler and regular (Ching, 2007). This category includes the primary models of the circle, square and triangle, each with its own derivatives, whose presence has been continuous in architecture (Thiersch, 1883).

REFERENCES

1. **Conversano E., Francaviglia M., Lorenzi M.G., Tedeschini Lalli L., 2011 -** *Geometric Forms that Persist in Art and Architecture,* Bridges 2011: Mathematics, Music, Art, Architecture, Culture
2. **Ching, Francis D. K., 2007 -** *Architecture. Form, space and order*, 3rd edition, John Wiley & Sons, Inc., 2007, pp. 34 - 88
3. **Von Meiss Pierre, 1986 -** *De la forme au lieu: une introduction à l'étude de l'architecture*, PPUR presses polytechniques, Lausanne, 1986, pp. 113 – 118
4. **Thiersch August, 1883 -** *Die Proportionen in der Architektur*, în *Handbuch der Architektur*, partea IV, vol. I, Darmstadt.