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RESEARCH

Tessellations in the Architecture of Pablo Palazuelo

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Abstract

After studying the unpublished sketches of the Spanish artist Pablo Palazuelo, this essay proposes the existence of geometric patterns that order his designs. To illustrate the proposal, this paper selects three representative projects by Palazuelo that attempt to demonstrate the presence of a working process related to a mathematical substrate. Specifically, the use of an irregular tiling is proposed for the creation of the following architectural elements: the scenery for a composition by Kandinsky (1950–1954), and the plan for a hotel on Princesa Street, Madrid, (1961). This study also examines the use of regular tessellations in the design of the ceilings of the Huarte Residence in Madrid, (1965). The treatises by Bourgoin and Ghyka have been selected from the library of Palazuelo as the primary theoretical bases of this study. This methodology constitutes a line of further research to analyze different architectural projects.

Keywords Pablo Palazuelo · Design analysis · Geometric analysis · Harmonic proportions · Geometric patterns · Tessellations

Introduction

Authors considered to be original are those who investigate the origins. This illustrates how later artists borrowed from earlier ones to develop new methods of expression. In the case of Pablo Palazuelo,[1] he attempted to reach a new geometry

[1] Pablo Palazuelo (Madrid, 1915–2007), a painter, sculptor and architect *in pectore*, studied architecture at the University of Madrid and the University of Oxford (1933–1936), studies that he was not able to complete due to the outbreak of the Spanish Civil War. Later, he decided to concentrate his energies on painting, moving to Paris, where he developed a fruitful artistic career linked to the Maeght Gallery. After his return to Spain, he endowed his work with the third dimension through his sculptural production. His designs also generated architectural works in collaboration with other architects. He was one of the most important abstract Spanish artists of the second half of the twentieth century. His work is exhibited in major museums; he received the Kandinsky Prize (1952), the Carnegie Prize (1958), the

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based on arcane knowledge that could be used in his graphic compositions of the twentieth century. Throughout his life, Palazuelo tried to base his thinking on the writings and theories of various authors, whose books he collected to form an extensive personal library (Fig. 1), the main ones of which he acquired from the bookshops in the Latin Quarter of Paris, the city where he developed the works selected for this present analysis.

As a starting point, the premise assumes the repeated unit of a design as a grid generator. Hence, the paper consists of two main parts, depending on the geometric structure used. The book on Arabic art by Jules Bourgoin (1879) became the cornerstone for the two cases of study where the presence of irregular tessellations is considered. The studies of the harmonic subdivision of the rectangle, described by Matila Ghyka (1946), served as a guide to address regular tiling.

This article aims to demonstrate the existence of geometric patterns that structure the apparently arbitrary compositions of Palazuelo, illustrated with three architectural designs. The present text proposes the use of irregular tessellations to elaborate the scenery for *Sonorité Jaune* (Yellow Sound), a synesthetic work by Kandinsky, made between 1950 and 1954 (Fig. 2a), and the design for a hotel on Princesa Street, Madrid, in 1961 (Fig. 2b); as well as the application of regular tiling for the ceilings of the Huarte Residence in Madrid, built in 1965 (Fig. 2c). To support the hypothesis, this essay analyzes the original sources corresponding to the unpublished sketches and books archived in the Fundación Pablo Palazuelo (FPP), as well as his writings, lectures and the classes he taught. The information extracted from these texts has been complemented by the works of other authors—found in the library of Palazuelo—, that help clarify his working process.

Trans-geometry

Palazuelo undertook a journey in search of this new geometry, which he called *trans-geometry*, which served as a structural basis, not only for his artistic production, but also for his architectural designs. In this way, he discovered different geometrical treatises that gave him the instruments for displaying the graphic potential housed in numbers.

For this purpose, Palazuelo understood geometry as the measure of matter by means of number, coagulating in figures that flow dynamically. Palazuelo used Spinoza's texts to uphold the notion of *Natura Naturans* (Palazuelo 1999: 16) that represents the transforming mechanisms of nature, in order to graphically capture the processes of transformation of reality. Thus, Palazuelo defined geometries as "the figures, the marks or traces left behind by number in the movement of its direct creative operation in nature and also through the hands and mind of man" (1998: 97).

Footnote 1 (continued)
Gold Medal of the Fine Arts (1982), the National Prize of Plastic Arts (1999), and the Velázquez Prize (2004). Source: Fundación Pablo Palazuelo.

Fig. 1 Detail of the library of Pablo Palazuelo in Galapagar, Spain, 2007. Photo: Author

Fig. 2 Pablo Palazuelo: **a** *Étude pour une «Sonorité jaune» de Kandinsky,* 1954, FPP 33-017; **b** *Deluxe Hotel Building. Preliminary Plans. Structure Office's floor*, 1961, FPP; **c** Huarte apartment ceilings in Madrid, 1965. Photo: Author

Palazuelo used geometry as the language of architecture and art to attain unity of form. It was a resource that allowed him to order the structural components and obtain non-representational solutions. Although it seems that the use of a method based on geometrical patterns can restrict the freedom of the compositions, Issam El-Said and Ayşe Parman denied this by stating: "Geometric patterns are constructed by the recurrence of geometrical forms, the resultant ordering of which is determined by the creative act" (1976: 114).

Creativity is a complex phenomenon. My study of Palazuelo's architectural designs is motivated not only by his interest in geometry and scientific thought, but also by my search to establish relationships between the mechanisms of Palazuelo's creative thinking and theories and processes in science and mathematics. Palazuelo explained that he immersed himself in a state of twilight consciousness when approaching his work, so he incorporated an unconscious component in conjunction with rational thought within his method of work, in the same way that other authors highlighted these same mechanisms in mathematical thinking.

Among the books Palazuelo acquired and underlined texts, such as one by Seymour A. Papert (1981), used Poincaré's theory of mathematical thinking to

attribute an important functional role to the aesthetic in mathematics, because Poincaré asserted that the mathematical mind is not logical but aesthetic. Papert defended the use of the unconscious as part of the creative process: "A stage of unconscious work, which might appear to the mathematician as temporarily abandoning task or leaving the problem to incubate" (1981: 109).

As intuition and rationality are always involved, Geoffrey Vickers stated that the human mind has available two different modes of knowing. "One of these modes is more dependent on analysis, logical reasoning, calculation, and explicit description. The other is more dependent on synthesis and the recognition of pattern" (1981: 145). Consequently, Palazuelo also seemed to assume the need to include both facets of knowing in his graphic process.

Methodology

Achieving freedom of expression associated with a geometric method requires years of experience. Palazuelo gradually became familiar with the possibilities offered by the various geometric systems. He deepened his architectural training at the University of Oxford in the 1930s and continued it throughout his continuous production of artwork. For example, the use of tracing paper is especially relevant, since its transparency enabled the implementation of transformations that allowed for the evolution of his work.

In 1985, in the courses he taught at the *Círculo de Bellas Artes* in Madrid, Palazuelo recommended that his students draw on graph paper. He suggested doing exercises on a space that has an underlying structure that can be converted into another structure by playing with it, obtaining different structuring patterns. This provided for a wide range of improvisation, an experience that Palazuelo summed up in this way: "when drawing on a lined paper, which can be the graph paper, we are working on a space that is not empty, that is full of structures, of energy manifestations in graphic form" (2018: 149).

As a method of analysis, geometric bases were designed by computer from the original treaties found in the library of Palazuelo. Then, the unpublished sketches by Palazuelo were superimposed on geometric patterns to try to illustrate his working process in this article. This allowed the graphic steps followed by Palazuelo to be reconstructed.

Encoded Plan

After a deep quest, Palazuelo explained that in 1953 there was an inflection point in his research: the discovery of a mysterious ancient document from an Eastern civilization in a Paris bookshop, a book whose identity he never revealed. He defined it as an "encoded plane" (Esteban and Palazuelo 1980: 150) for the rearrangement

of its *trans-geometry*. When we initiated the cataloging of the library of Palazuelo,[2] I found several essays on geometry that he could have acquired in the 1950s. Once Palazuelo had analyzed the possibilities offered by semi-regular or Archimedean tilings, with a high degree of symmetry (Ghyka 1946: 71), he decided to investigate the tessellations in Islamic art.

Among these books is a treatise on Arabic art, *Les éléments de l'art arabe. Le trait des entrelacs* (1879) edited by Jules Bourgoin,[3] in which geometric designs were illustrated and classified according to their structuring pattern. Tiling patterns were organized in groups of geometric families, according to the ordering diagram that dictated the evolution of simple polygons. Quite likely this book opened up a new world of possibilities to Palazuelo, in the same way it did to Broug (2008: 119).

The starting hypothesis for the first two selected works proposes a structuring pattern based on two designs extracted from the aforementioned book by Bourgoin that used irregular tessellations with a hexagonal base. From a cosmological point of view, the spiritual disciplines would try to unite the inner and outer cosmos, governed by archetypal laws, as a result of a numerical pattern.

When dealing with the manifestation of form, the British professor Keith Critchlow specified the concept of symbol and the connection between number and archetype in this way: "Pattern, like number, is one of the fundamental conditions of existence and is likewise a vehicle of archetypes. As arrangements both emerge from simplicity and unity and return towards it, they exhibit some fundamental relationships which become hierarchical" (1976: 24).

In the two cases that are going to be discussed below, the starting point was the drawing of a circumference, which is copied to be placed in tangent and secant positions. Different geometrical figures of diverse complexity are generated by joining the centers of the circumferences, depending on their position. The result forms a juxtaposition of polygons that share common vertices, structured by the laws of plane symmetry, as demonstrated by the Spanish mathematician Antonio Prieto (1977).

[2] Since 2007, together with María Teresa Raventós, I have been preparing the catalogue of the archives of Palazuelo, comprising works, writings and books of his personal library conserved in the Fundación Pablo Palazuelo.

[3] Jules Bourgoin (Join, 1838—Saint-Julien-du-Sault, 1907) was a French architect, professor of history and the theory of ornament at the National School of Fine Arts in Paris, and illustrator. He devoted his research mainly to theories of Arabic, Greek and Chinese ornament, as well as their correspondences to mathematics and geometry. His main publications are: *Les Arts arabes* (1867) with a prologue by Viollet-le-Duc, *Théorie de l'ornement* (1873), *Les Éléments de l'art arabe* (1879), *Grammaire élémentaire de l'ornement* (1880), *Études architectoniques et graphiques* (1901), and *La Graphique* (1905).

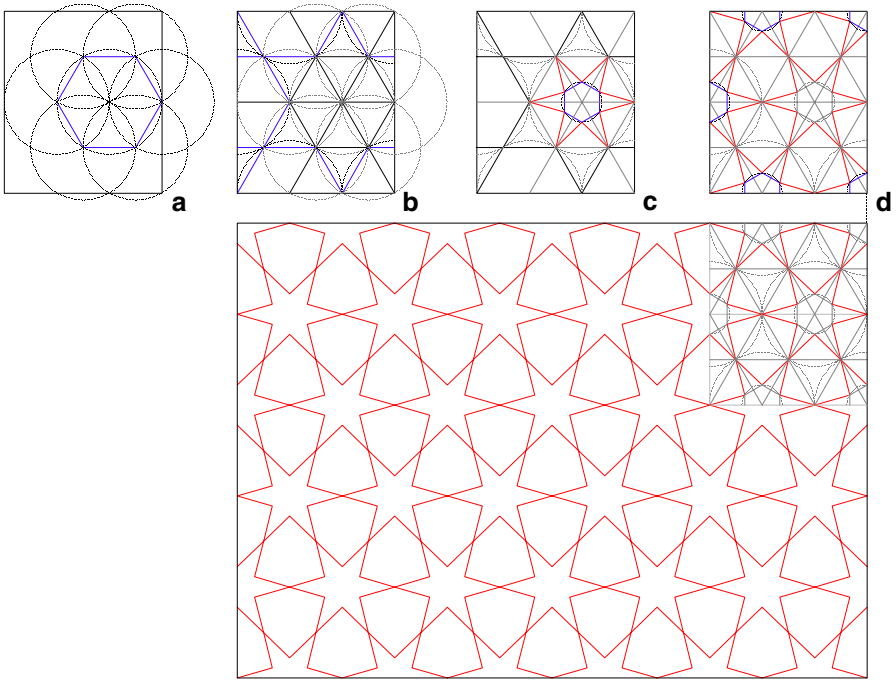

Fig. 3 Analysis of the generative process of the geometric pattern present on plate 12 of Bourgoin (1879) Image: author

Case 1. Design for *Sonorité Jaune*: Polygonal Scenery

After settling in Paris in 1948, Palazuelo continued to search for geometric references that would serve as a vehicle to articulate his newly acquired abstract graphic discourse. Among his first guides, this painter not only mentioned Paul Klee but also selected Neoplasticist artists, as well as another Bauhaus professor, Wassily Kandinsky.

With the support of the Parisian gallery run by the Maeghts, Palazuelo achieved a meteoric recognition and success that allowed him to hold his first solo exhibition. Encouraged by his friendship with Nina Kandinsky, widow of the Russian painter, in 1950 he received the first architectural commission: the design for the scenery of *Sonorité Jaune*, a scenic synesthetic opera composed by Kandinsky in 1909 (Palazuelo 1995: 16).

In order to identify the underlying generative pattern, the first step of the analysis involved selecting the plates of Bourgoin (1879) that Palazuelo had marked in the margins. Later, the analysis focused on designs with a hexagonal base. After trying different geometric solutions, the selected pattern was the one that best fits in with the sketches by Palazuelo. In this case, the chosen plate was number 12; however, it is also worth noting that there are patterns very similar to each other in Bourgoin.

In this case, the study of the geometric structure begins by placing a hexagon inscribed in a circle (Fig. 3a). A progressive process of adding circles occurs, linked

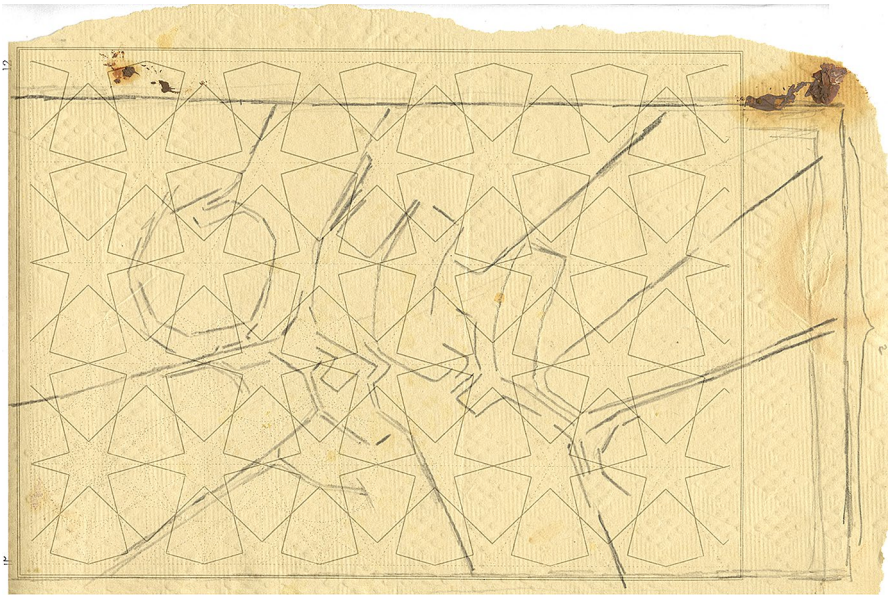

Fig. 4 Superimposition of the geometric pattern extracted from plate 12 by Bourgoin (1879), with the sketch by Palazuelo, c. 1954, *Untitled*, pencil on paper tablecloth, 19.5 × 31 cm, FPP 34-035

to the first one in each of the vertices of the six-sided figure by a tangent position (Fig. 3b). A method that Critchlow described thus: "In the progress of expansion, each additional manifest circle can be expressed as a lateral polarization of its predecessor" (1976: 18).

In the next stage, a second concentric circle is traced with a radius that has a relation of Φ^2 with the previous one. A hexagon is inscribed within this last circumference, rotated 90° with respect to the first one. A star formation arises from the union of the vertices of the two hexagons (Fig. 3c). As a result of a polar copy, the generated master grid is composed of stars with six vertices and irregular hexagons (Fig. 3d). The resulting pattern of this central symmetry configures plate number 12 of Bourgoin (1879).

In the 1950s, Palazuelo drew his graphic sketches on the paper tablecloths of the small bistro near his residence in Paris where he had lunch. In these sketches, he tried new compositions where the diagonal lines collide in the center, forming successive interlocked polygons. The rhythmic embossing of the paper tablecloth served to guide the structure for achieving solutions as defined and shown in the illustration (Fig. 4). Likewise, Palazuelo implemented the new geometry based on the study of the compositions by Bourgoin to restructure his previous designs.

To approach the analysis of the different stages of this project, the unpublished sketches conserved in the Fundación Pablo Palazuelo are superimposed, adjusting their scale and angle of rotation, to reveal their transformations. Arranged in a hexagonal pattern from plate 12 of Bourgoin, the diagonal lines that emerge from the limits of the frame overlap the open polygons, as shown in the first drawing (Fig. 5a).

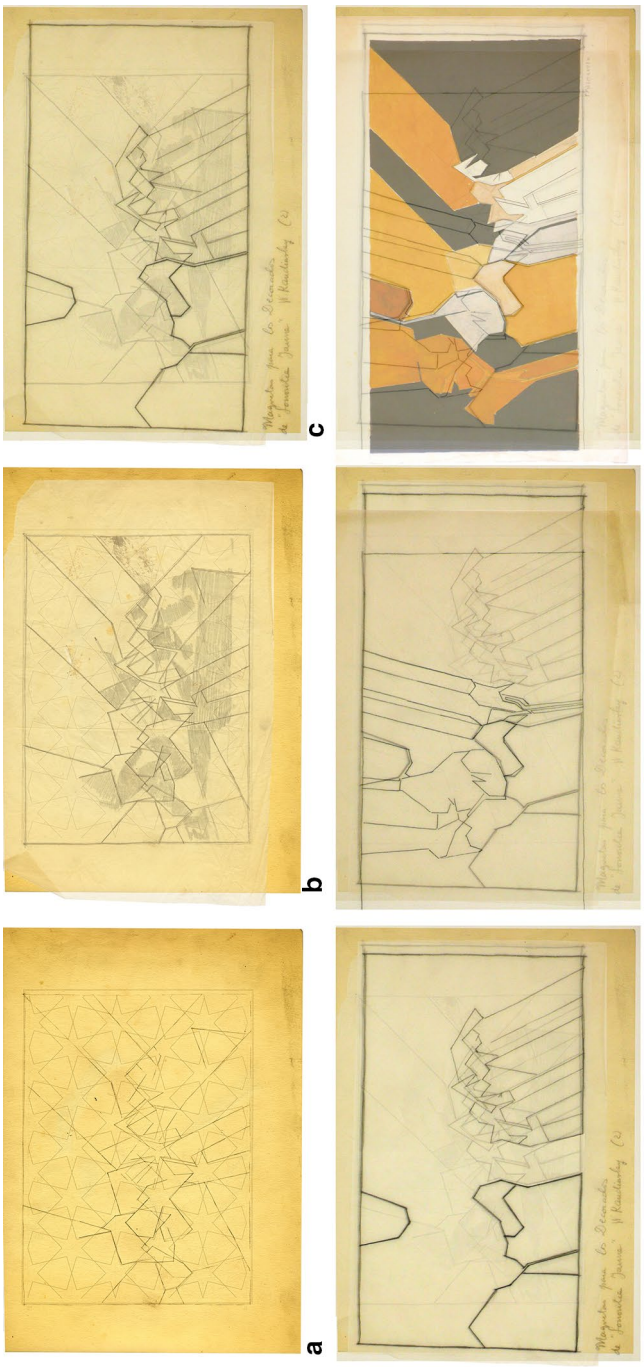

Fig. 5 Analysis produced by superimposing the geometric pattern extracted from plate 12 of Bourgoin (1879) and the sketches by Pablo Palazuelo: **a** c. 1954, *Untitled*, pencil on paper, 23 × 31.8 cm, FPP 34-057; **b** c. 1954, *Untitled*, pencil on tracing paper, 19 × 30 cm, FPP 19-074; **c**, **d** c. 1954, *Maquetas para los decorados de «Sonorité jaune» (nº 1) de W. Kandinsky*, pencil on tracing paper, 35.3 x 34.2 cm, FPP 02-015; **e** c. 1954, *Maquetas para los decorados de «Sonorité jaune» de W. Kandinsky* (2), pencil on tracing paper, 34.7 × 29.8 cm, FPP 02-014; **f** 1954, *Étude pour une «Sonorité Jaune» de Kandinsky*, gouache and ink on paper, 32.5 × 29 cm, FPP 33-017

Once the layout was consolidated and repeated, thanks to the transparency of the tracing paper, Palazuelo began to experiment by hatching the drawings to define the future color surfaces (Fig. 5b). The elements are arranged in an ascending series of broken figures that start from the margins of the paper in a centripetal structure, as seen in the drawing entitled *Maquetas para los decorados de «Sonorité jaune» de W. Kandinsky* (models for the scenery of "Yellow Sound" by W. Kandinsky) (Fig. 5c).

Palazuelo performed two simple operations: he transferred a part of one of the sketches to change its modulation, yet maintaining its internal order (Fig. 5d), and superimposed the designs by rotation and transparency (Fig. 5e). By handling the previous drawings as a work stratified in layers of content, new results are obtained as a coherent whole through the superposition of the previous compositions. In the final result, the gouache entitled *Étude pour une «Sonorité jaune» de Kandinsky* (study for the "Yellow Sound" by Kandinsky) (see Figs. 2a, 5f), the inclusive union of the different designs is verified. Its elements were hierarchized with different colors. Unfortunately, this project was halted at this point, before Palazuelo's resignation due to a complexity that increased exponentially.

Case 2. Design for a Hotel on Princesa Street: Curved Vertices

The proposal presented in February 1961 by Pablo Palazuelo, his brother Juan Palazuelo, Fernando Aguirre, and Ramón Melgarejo for a hotel on the *Centro Princesa* site in Madrid illustrated his first complete incursion into the architectural field. Palazuelo took advantage of this project to continue his formal investigation, the product of the manipulation of the geometric code of pre-existing orders. He focused on a planimetric design to define the perimeter of the floor plans, which would formally determine the volumetric shape generated by the superposition of the various levels. The novelty of the polygons used resides in the roundness of their vertices, by means of curves inscribed in the angles.

Once again, Palazuelo implemented the mechanisms displayed in the preceding case. Like a scientist, Palazuelo emphasized that the work of an artist was to unveil the mechanisms, orders and transformative structures of reality by translating them into a graphic language. He intervened in the definition of the building boundary by working intensely on the floor plans, which is reflected in a succession of sketches and which started with a simple geometric pattern that determined the structuring order of its outline. As in the previous case, the process of selecting plate number 27 of Bourgoin followed the same steps described above. Once again, it's a remarkable fact that there are other patterns could be functionally alike in Bourgoin's book.

As a geometric starting point to compose this design, the analysis again starts with hexagonal figures inscribed in circumferences. When the position of the circumferences varies between the tangents and the secants but the distance remains constant, the resulting patterns display diverse stages of development. Different geometric shapes ordered by hexagons arise depending on the degree of overlap between the round figures. In this case, a hexagon is inscribed within a circle whose center coincides with the vertex of a square (Fig. 6a). Two new circles with a radius

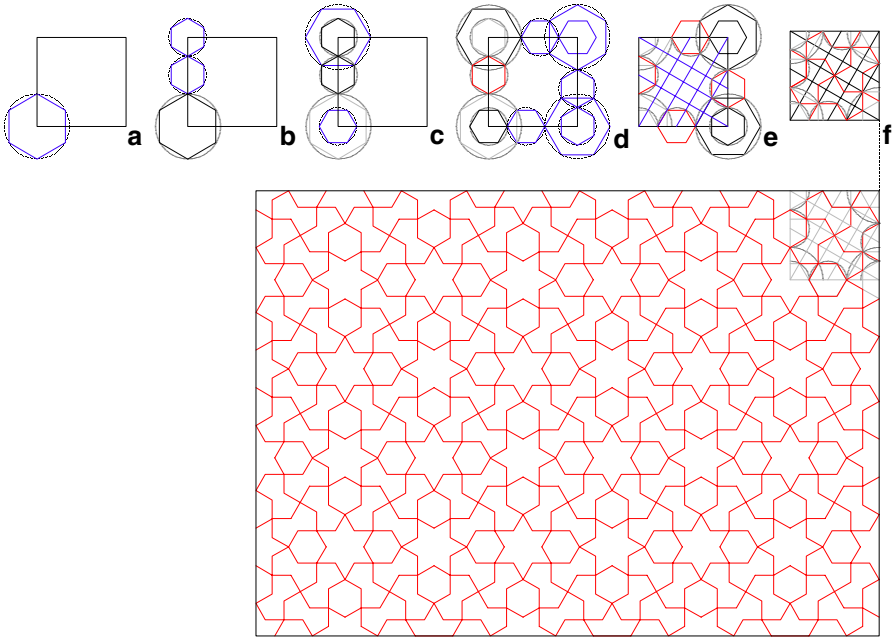

Fig. 6 Analysis of the generative process of the geometric pattern present on plate 27 of Bourgoin (1879). Image: author

of $\sqrt{5}r/4$ are added to this circumference of radius r, aligned tangent to each other (Fig. 6b).

Another circumference of radius r is drawn concentrically at the opposite vertex of the square, in which an inscribed hexagon is rotated 90° to the first (Fig. 6c). New figures are repeated by local axial symmetries on the remaining sides of the square (Fig. 6d). The centers and vertices of the hexagons are used as guides to draw two sets of diagonal lines (Fig. 6e). Star and trapezoidal shapes arise from the lines produced by the ordered union of the midpoints and the centers of the resulting grid (Fig. 6f). Repetition of a base by operating a translational symmetry, as described by Prieto (1977: 84), generates the design of plate 27 extracted from Bourgoin (1879). This design was collected by Bourgoin, but its location is unaccredited, although it could be situated in Egypt or Syria, considering the French writer was working in these countries, as Jay Bonner pointed out (2017: 373).

The transformation processes used by Palazuelo arise with the assistance of the transparency of the tracing papers. In this way, the graphic structures undergo actions such as rotation, translation, copy, symmetry, superposition and scale changes, which always respect the rules of the game established by the triaxial grid. This master pattern is employed to indicate the directions over which the dreaming lines drawn by Palazuelo evolve. They constitute the traces left by number in the movement of its creative operation, to form the footprint of a construction that adapts to the site. Palazuelo even explicitly reveals the

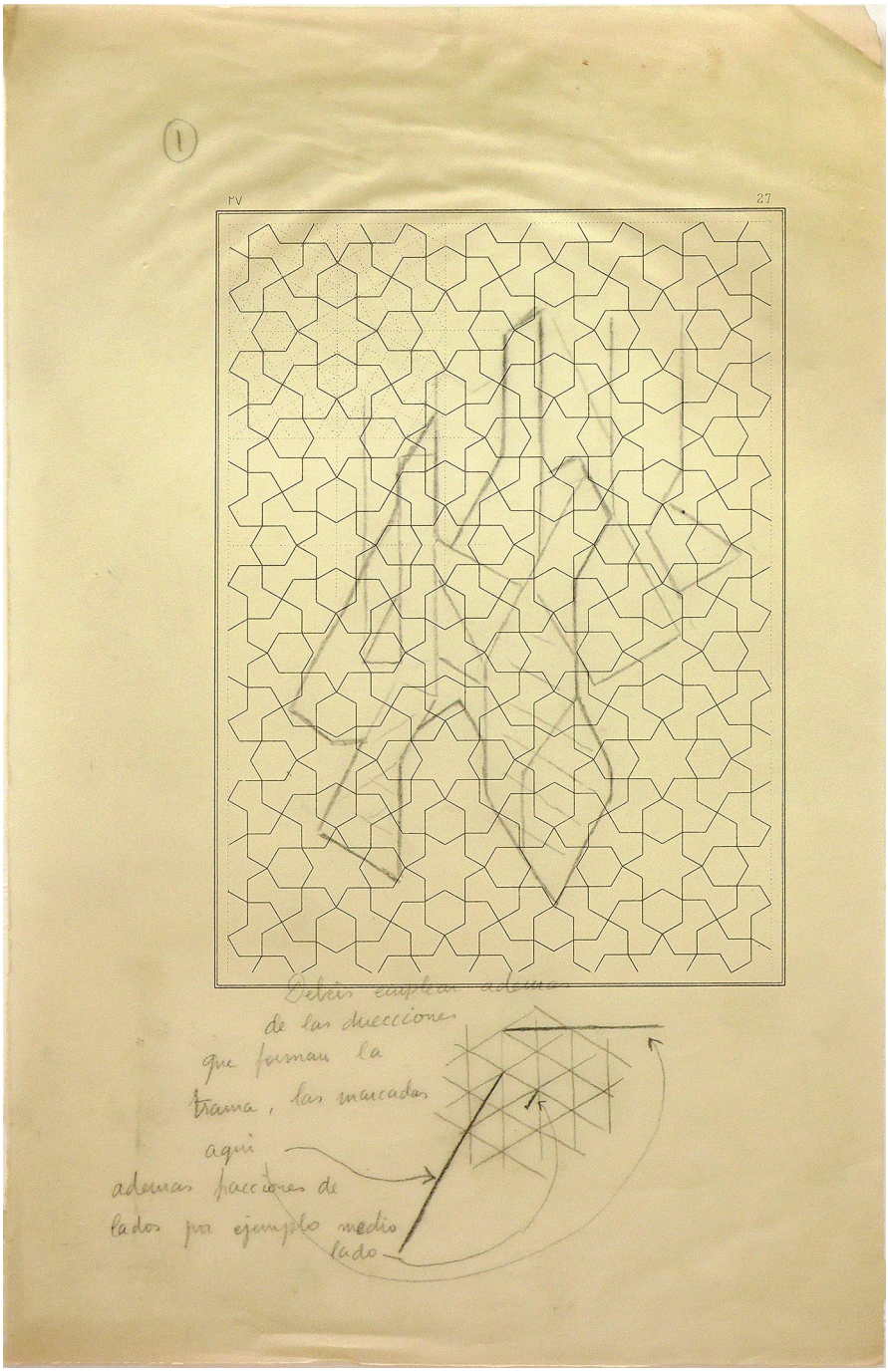

Fig. 7 Analysis produced by superimposing the geometric pattern extracted from plate 27 of Bourgoin (1879) and the sketch by Pablo Palazuelo: c. 1961, *1*, pencil on tracing paper, 24.7 × 38.2 cm, FPP 41-018

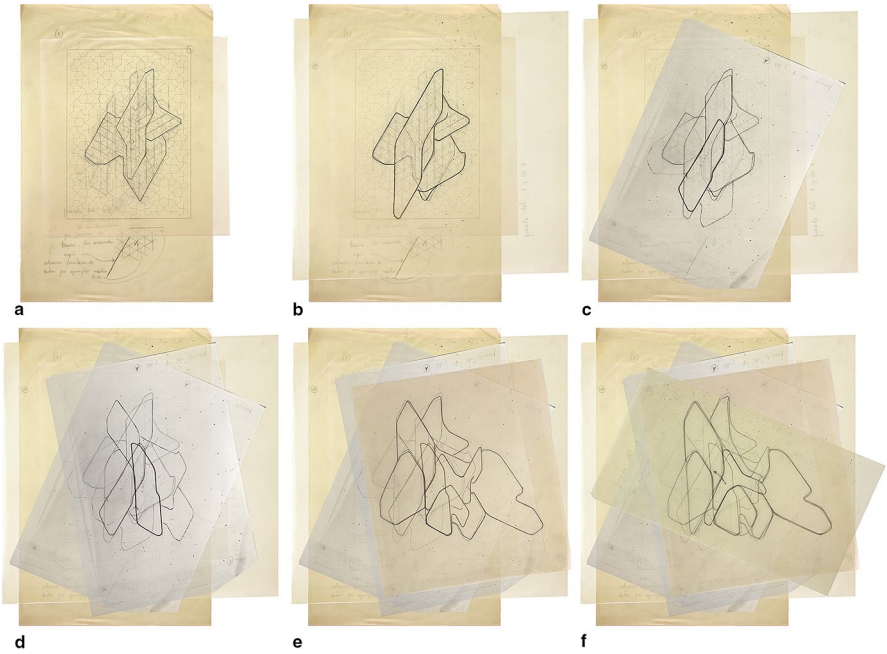

Fig. 8 Analysis produced by superimposing the geometric pattern extracted from plate 27 of Bourgoin (1879) and the sketches by Pablo Palazuelo: **a** c. 1961, *2*, pencil on tracing paper, 25.5 × 24 cm, FPP 36-032; **b** c. 1961, *4*, pencil on tracing paper, 37.2 × 33.5 cm, FPP 36-019; **c**, **d** c. 1961, *5*, silver emulsion photo, 20 × 14 cm; **e** c. 1961. *6*, pencil and ink on tracing paper, 24.7 × 27.3 cm, FPP 36-036; **f** c. 1961, *7*, pencil and ink on tracing paper, 19.2 × 33.7 cm, FPP 41-020

self-imposed rule that would allow the other workers in the office to continue the formal transformations respecting a coherent geometric structure.

Thus, in the lower margin of the first sketch by Palazuelo (Fig. 7) a brief graphic diagram is accompanied by a text that explains: "You must use, in addition to the guidelines that form the grid, those marked here, in addition to fractions of sides, for instance: half side". The lines gravitate around the traces of a triangular grid that form a hexagonal base and are hierarchized according to their length, obedient to the previous structural order. With this premise, the structuring matrix is revealed by superimposing the sketches on the geometric dodecagonal structure contained on page 27 of Bourgoin, which shows that the direction of the lines responds to the guidelines that join the vertices of the starry Islamic pattern.

The determination to establish a dynamic symmetry appears implicit in these sketches, a set of drawings where the forms pivot on a central point, related to each other by homothetic transformations. The progressive modifications of these sketches shape a starry outline whose arms are deformed, taking into account both the needs of the program and the building site.

From the second to the fifth sketch, the contours are hierarchized, highlighting a zigzagging central core marked *torre* (tower) (Fig. 8a), perhaps to indicate a

greater number of floors developed in this volume. Likewise, these drawings show a more centralized grouping than the one observed in the first design (Fig. 8b). The occupied surface was progressively enlarged, although it is difficult to quantify it due to the absence of references regarding its urban connection (Fig. 8c–f). The representation of the aforementioned triaxial grid appears intermittently in the sketches, and it is suppressed in the variants that Palazuelo drew to produce sculptures (Fig. 8e) such as *Rêve de vol nº1* (Esteban and Palazuelo 1980: 188–189). The successive transformations were emphasized by means of brief footnotes that explained their origin and filiation, in addition to the numbering texts.

When comparing the contour of the most defined drawings (undated) and the plans presented by the architects in February 1961, the attentive observer can perceive how the geometric germ contained in the sketches has mutated, adapting to new constructive needs. They showed the potential of linear archetypes that formed the formal language used by Palazuelo, who organized a kind of alphabet that could leap into the third dimension by adding height to his signs. There are also two preliminary floor plans of the building structures (Fig. 2b), that show the distribution of offices and hotel rooms. The refinement of this design went through different phases of growth, but finally the architecture office directed by Antonio Lamela carried out the final project built in 1962, the current *Meliá Princesa Hotel*.

Case 3. Regular Tiling for the Ceilings of the Huarte Residence in Madrid: Harmonic Archetypes

Philip Morrison, in his text "On Broken Symmetries" (1981), assumed that the world is modular, in the sense of Leibniz, and maintained that a broken symmetry is the principle of dynamics and change in the process of both art and science. Palazuelo seemed to come to terms with the same approaches when working with a regular non-periodic tiling, based on a square grid. This analysis is illustrated by Palazuelo's 1965 design for the coffered ceiling in the Huarte Residence in Madrid.

Two archetypal forms, generated from the harmonic subdivision of rectangles, are involved in the composition of this ceiling. Palazuelo tried to endow his work with the property that the Greek canons called "dynamic symmetry", which, as explained by El-Said and Parman, "meant the proportionality between constituent elements of the whole, since the concepts of 'symetria' are based on harmonic proportions" (1976: 6).

Seyyed Hossein Nasr asserted that in the Islamic tradition various authors, such as Avicenna or the Brethren of Purity, tried to combine Greek philosophical notions with the Oriental tradition of *hikmah*. The Brethren believed themselves to be the disciples of Pythagoras and Nicomachus, and considered "numbers as the cause of all things and the key to the understanding of the harmony pervading the Universe" (Nasr 1964: 47).

Geometric figures are considered to be images of unity. The Pythagorean numbers are a quantitative entity, where the pattern is fixed, like a preliminary sketch. They are numbers identified with the "Platonic ideas" or archetypes. "The use of

mathematics in the study of the world of quantity becomes, therefore, a bridge by means of which one can journey from that world to the world of archetypes" (Nasr 1964: 49–50).

Palazuelo was always interested in the graphic representation of the ineffable. For this reason, he studied various texts on the Pythagoreans, because, during a stage of his work, he was fascinated by irrational numbers. El-Said and Parman noted that, "The irrational numbers were called by the Pythagoreans the 'unspeakable numbers' which could be drawn but not expressed numerically" (1976: 6).

On this occasion, Palazuelo tried to explore the possibilities offered by the irrational numbers according to the principles expounded by the mathematician Ghyka,[4] whose influence the painter acknowledged: "At a given moment, and from the reading of Matila Ghyka on the golden number, I became interested in everything related to numerologies especially symbolic, mythical or esoteric, and especially oriental" (Calvo 1985: 1143).

Specifically, the starting shapes are: a rectangle of ratio $1:\sqrt{2}$, whose various properties Palazuelo studied, and a square (Fig. 9a). They are called dynamic rectangles because they are based on irrational relationships, as explained by Ghyka (1946: 126). Both polygons frame a set of graphic archetypes, whose generating strokes come from the geometry of the harmonic subdivisions contained in the writings by Ghyka (1946: 129).

The rectangle is subdivided into two halves on the long side *s* and is extended downwards along the half of mentioned side: *s*/2. A set of horizontal and vertical auxiliary lines are drawn from the intersections of the diagonals of the two resulting rectangles—the original and the expanded (Fig. 9b). These lines serve to establish the position of the vertices of the archetypes. A similar process is implemented in the square that takes the dimension of the short side as a reference (Fig. 9c).

In 1965 Juan Huarte, a Spanish patron of the arts, commissioned Palazuelo to carry out a proposal for the ceilings of the main rooms of his residence in Madrid. After analyzing the irregular perimeter that delimits these spaces in the house, Palazuelo designed a work made of African coral wood and oak.

The Fundación Pablo Palazuelo possesses two general sketches from this work which display the diverse solutions embedded in a simplified envelope. In the drawing *Untitled* (Fig. 10a) there are three distinct geometric proposals, which Palazuelo called *temas* (motifs). The first one integrates the two archetypes reproduced in a monograph edited by Aimé Maeght (Esteban and Palazuelo 1980: 182) and includes a more detailed sketch that separates the different pieces of wood by their thickness, as can be seen in the cataloged drawing (Fig. 11a). This proposal continues with a mosaic of polygonal figures grouped around a leaf-shaped line,

[4] Matila Ghyka (Iáshi, 1881—London, 1965), was a Romanian mathematician, historian, philosopher, diplomat. He attended the High School of Electricity in Paris and doctored at the Faculty of Law of Université Libre de Bruxelles. He was a visiting professor of aesthetics in the United States, at the University of Southern California and at the Mary Washington College, Virginia. His main publications, found in the library of Palazuelo, are: *Esthétique des proportions dans la nature et dans les arts* (1927), *Le nombre d'or. Rites et rythmes pythagoriciens dans le développement de la civilisation occidentale* (1931), *The Geometry of Art and Life* (1946), *Philosophie et Mystique du nombre* (1952).

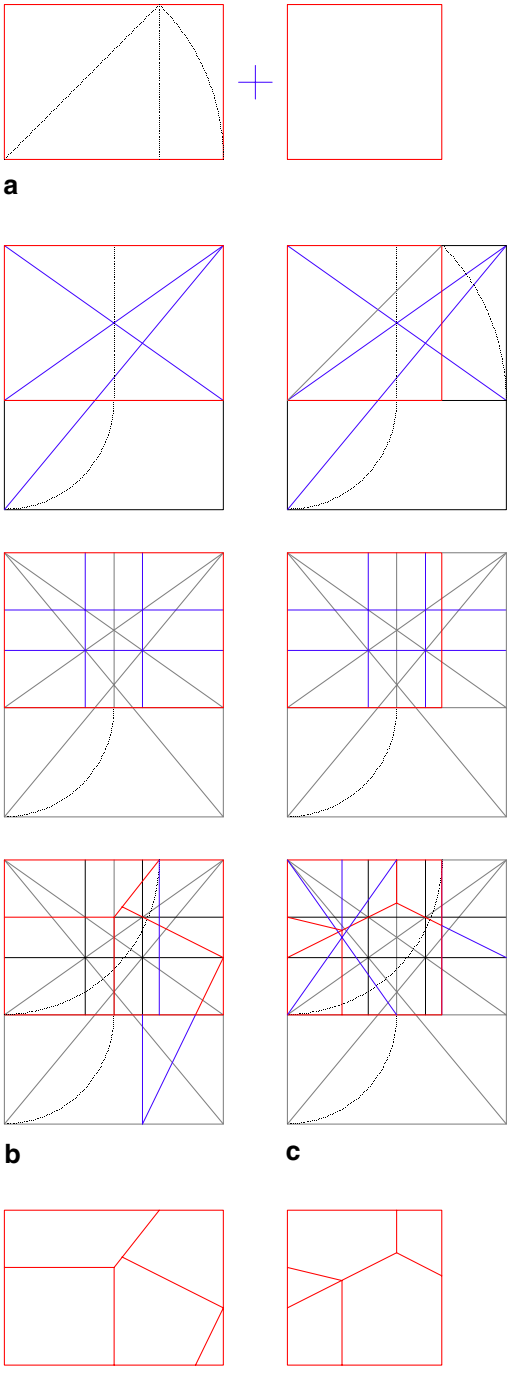

Fig. 9 Analysis of the generative process of the archetypes by Palazuelo extracted from the harmonic subdivision of the $\sqrt{2}$ rectangles (Ghyka 1946). Image: author

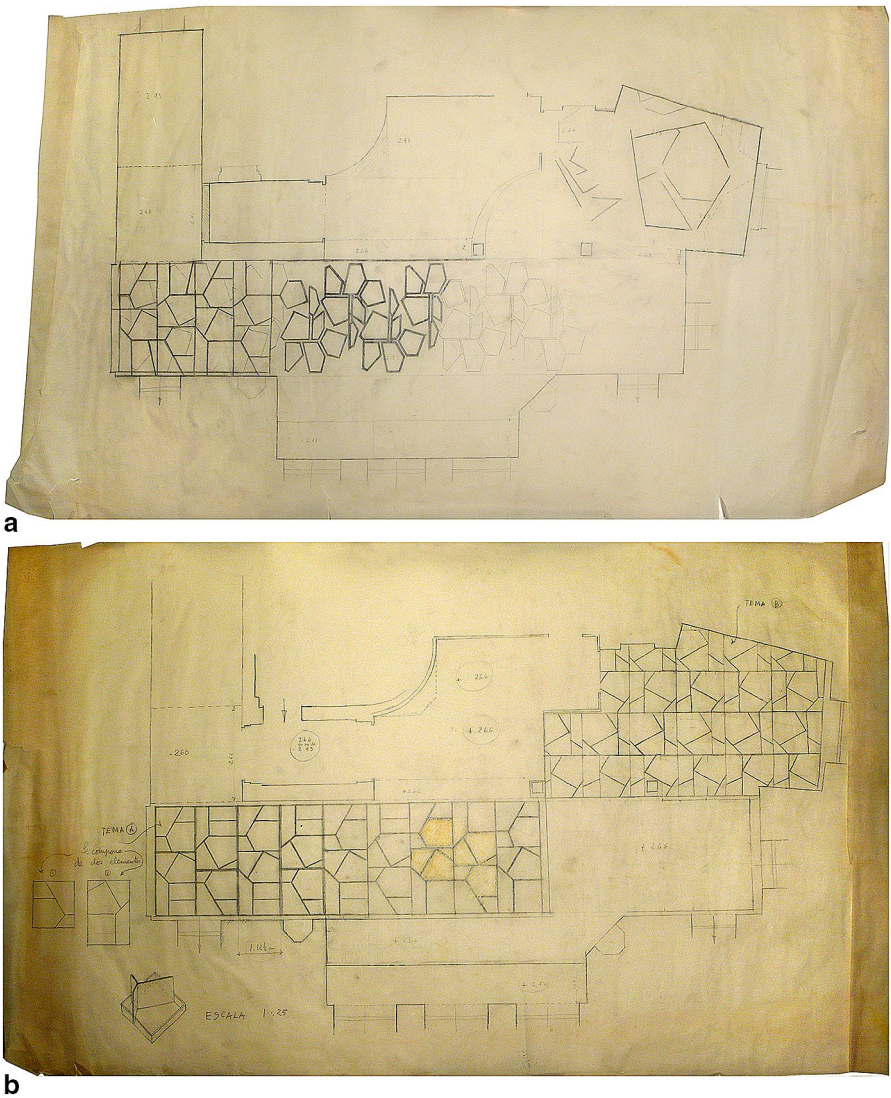

Fig. 10 Pablo Palazuelo: **a** c. 1965, *Untitled*, pencil on tracing paper, 56 × 99 cm, FPP 41-035; **b** c. 1965, *Untitled*, pencil on tracing paper, 56 × 99 cm, FPP 41-036

which fills the space by means of the use of rotation and symmetry. This geometric grid seemed destined to cover the whole ceiling, as can be seen in the corrections of its strokes underneath the previous motif.

In a later phase, a drawing executed on a more detailed plan (Fig. 10b) describes two spaces differentiated by their geometric structure. The planimetry was executed at a scale of 1/25. It not only displays several dimension references, but also the definition of the morphology of the different pieces, reinforced by

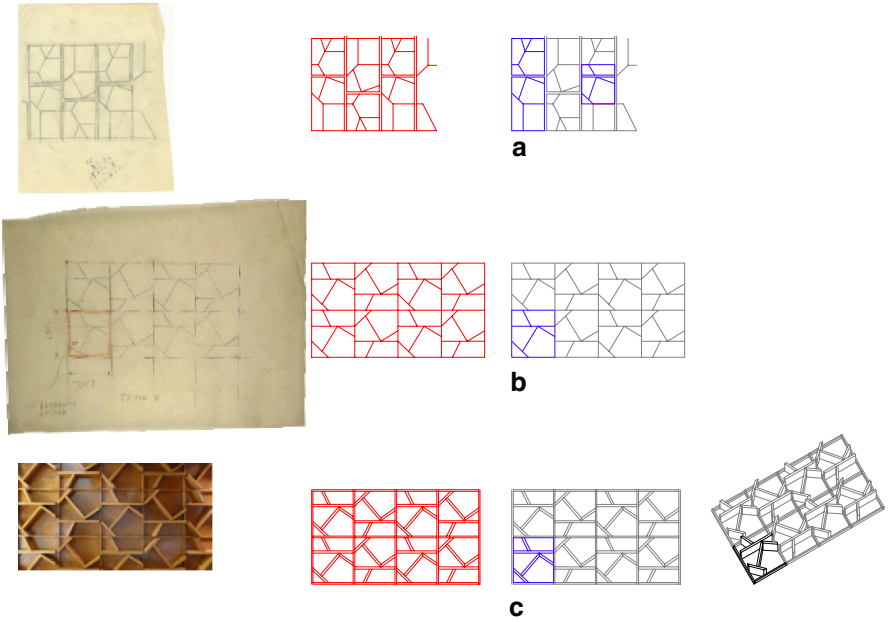

Fig. 11 Pablo Palazuelo: **a** c. 1965, *Tema A*, pencil on tracing paper, 26 × 29.5 cm, FPP 19-091; **b** c. 1965; *Tema B*, pencil on tracing paper, 31 × 24 cm, FPP 20-026; **c** 1965, Huarte Apartment ceilings design in Madrid, plan and axonometric detail, oak and African coral wood laths

chromatic tones and a three-dimensional sketch. The small axonometric drawing details the union and dimension of the unit of wooden slats that would configure a sort of *alfarje*, a type of horizontal wooden paneled ceiling found in Islamic and Spanish Moorish architecture. The first geometric motif, studied previously, now called *Tema A*, was propagated until it covered the whole ceiling of the main room, and stopped after embracing one of the structural pillars of the building to organize the hierarchy of the space. As a result of a geometrical analysis, a second room was solved with another motif, *Tema B*, a smaller portion extracted from the archetypes used in *Tema A*.

After drawing several preliminary sketches, Palazuelo decided to utilize only *Tema B* in the built solution. He resolved to apply a square-based tiling, whose repeating pattern has a module with a base side of 1.25 m, as indicated in the drawing (Fig. 11b).

The various modules deployed their geometry on the ceilings of the rooms, and only broke their rigorous square structure to accommodate it to the intricate perimeter of the smaller room, where two geometric guidelines dialogue with the curved walls. He used the systematic repeat unit of an archetypal design that produces the overall composition. These sketches are closely linked to the designs based on a regulatory layout that Palazuelo repeated in the later development of various sculptures.

Conclusions

This essay has substantiated the existence of an underlying geometry, hidden at first sight, in the selected projects by Palazuelo. The apparent randomness of the composition of their linear architectural drawings belies the structure of the geometric grids in the irregular tessellations, and the decomposition of the golden rectangle in the irregular tessellations.

The designs extracted from Bourgoin served as a reference to guide the hand of Palazuelo on the tracing paper, whose transparency helped him to organize his compositions. Thus, the Arabic geometrical pattern contained in Bourgoin's plate 12 ordered the polygons of the scenery that Palazuelo designed for the musical composition by Kandinsky. The generatrices that shape the building boundary of the project for the *Hotel Princesa* in Madrid emerged from the master grid formed by hexagonal stars, present on page 27 of Bourgoin. On the other hand, this article also explains the generating process of the cryptic tracings of the archetypes present in the Palazuelo design for the coffered ceiling of the Huarte Residence. The geometric analysis reveals the way these archetypes were docilely adapted to the divisions of the golden rectangle described by Ghyka.

This writing does not intend to unveil all the mechanisms used to elaborate the compositions described, since to enter into the creative and unconscious component of the designing processes used by Palazuelo would exceed its proposed goals. However, the proposed methodology has been effective to indicate that the elements that shape these works are closely related to the geometrical and mathematical treatises contained in the selection of scientific books that Palazuelo avidly read.

This paper has verified that geometry may also be used as a base of compositions that do not appear to obey any directing structure, as Palazuelo does to regulate his designs. Finally, this method of analysis provides the possibility of its application in subsequent studies in order to generate new lines of research.

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