Discovering the Sansalvador Villa through the Superposition of Photogrammetric Point Cloud Surveys and Original Jujol Plans

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Abstract: The Sansalvador villa, the first project exclusively designed by Josep Maria Jujol in Barcelona, is a unique architectural complex that piques curiosity about its origins and conception. Its incomplete state, limited documentation, and blend of modernist and organic elements contribute to its exceptional nature. This article delves into its history and conceptualization by examining original documents and conducting a detailed photogrammetric survey of the built architectural complex as it is today. By overlaying new planimetry derived from fieldwork onto the original plans, certain peculiarities, discrepancies, and unforeseen changes emerge, shedding light on Jujol’s creative process. The Sansalvador villa reveals the profound connection between the project and its surroundings, showcasing Jujol’s keen awareness of the site’s pre-existing conditions. His architecture is defined by a critical approach to these conditions, integrating them as essential elements in defining the project’s character.

Keywords: Josep Maria Jujol; Sansalvador villa; planimetric restitution; photogrammetric survey; genius loci; vestige

1. Introduction—Jujol and the Sansalvador Villa

One of the greatest difficulties in trying to describe Josep Maria Jujol’s architecture lies in the fact that it does not belong to any identifiable style within conventional definitions. Among the experts who have written about this architect, there seems to be some consensus in determining that he lies between the creative inertia of Art Nouveau and Catalan Modernisme [1]. Although some classify him as a modernist, others consider him clearly antimodernist [2]. Despite the divergence of opinions about Jujol’s architecture, the vast majority of experts coincide in defining him as eclectic, non-mainstream, and even as a timelessness personality.

Josep Maria Jujol was a singular architect who always lived in the shadow of Gaudí’s magnificent figure. Born in Tarragona in 1879, his family moved to Barcelona in 1886, to the neighborhood of Gracia. He studied at the Architecture School of Barcelona until 1906. During his studies, between 1903 and 1905, he worked for Josep Font i Gumà, and afterwards he worked for Antoni Gaudi, with whom he maintained a professional relationship between 1905 and 1913 [3]. In 1909, Jujol started working independently, showing clear influences from Gaudí, although some experts have noted that Gaudí influenced Jujol as much as Jujol did Gaudí [4].

One of the firsts projects carried out by Jujol as an independent architect was the Sansalvador villa. Both Antoni Sansalvador and Josep Maria Jujol lived in the neighborhood of Gracia in Barcelona, so they knew each other from childhood and attended the same school. Although this project is usually considered a secondary and youthful work, indeed, it contains the seeds of much of the personality of Jujol’s mature architecture. Its main
feature is the consciousness of the importance of the place. Understanding the place as the genius loci, pre-existing qualities are derived from Mediterranean weather conditions as much as Catalan culture. When studying the work of Catalan artists such as Miró, Jujol, or Brossa, Perejaume identifies an underlying form and significance that, although it has never been said or taught and does not have linear connections, gathers all of them as part of the same thing [5]. This gathering is characterized by the use of ground, stones, and sand, i.e., nature itself as part of the definition of materiality and form.

Since the Sansalvador villa is considered a secondary work, few original drawings have been preserved, and no monographic studies about it have been carried out until now. To the best of our knowledge, for the first time, this article focuses on trying to understand the creative process involved in the Sansalvador villa, first by compiling and chronologically exposing all the existing drawings and plans of this project and then by contrasting this information with the existing building.

The Sansalvador villa was built in Barcelona’s El Coll district, in the neighborhood of Gracia, between 1909 and 1924, located in a mountainous area behind the Park Güell [6]. It is a narrow and long plot with a pronounced slope, facing southeast and divided by Pineda Street (Figure 1). The lower part faces Passeig de la Mare de Déu del Coll, where the guard’s pavilion and the perimeter fence of the entire site were first built. The domestic house, which was never built, was planned in the upper part of the site, facing Pineda Street. In 1915, a well was dug in order to find a potable water supply. Instead, water with traces of radium (which had been discovered by Marie Curie in 1898) was discovered. Convinced that radium had healing properties, the Sansalvador family created the company Aigua Radial SL, in order to commercialize bottled radium water [7]. Therefore, they changed the initial commission of a second family summer residence to a commission of a healing water company with the appearance of a bathing establishment. Thus, they invested the project’s budget to make grottoes that allowed the extraction of water and external visits. Some years after, in 1917, they commissioned Jujol to build a house to rent, as an investment, in the separate plot, which they called the Queralt house [8]. In 1921, the Sansalvador family asked the architect to remodel the guard’s pavilion in order to transform it into their own home. Finally, in 1924, access to the upper part of the plot, where the initial house was planned but never built, was consolidated. Over the years, the water ran out of the grotto, the company was dissolved, and with the death of the owner in 1932, the property passed into the hands of his sisters [7]. Eventually, the property was sold to the quarry next to it. In 1987, it was acquired by the city council. During all these decades, the Queralt house was rented, while the Sansalvador villa was abandoned, repeatedly occupied, and vandalized to a state of ruin. In response to residents’ complaints, the city council commissioned Calbet–Elias–Gruartmoner Architects to rehabilitate the villa, which they did between 2005 and 2015. It currently houses the Taller d’Història de Gràcia office.

Figure 1. Aerial view of the site. Source: Google Maps.
Throughout this brief history of the Sansalvador villa, we may appreciate its several changes in terms of use, owners, and state of conservation. Nevertheless, the character of the place and of the architect are still visible in its construction.

2. Materials and Methods

The significance of this villa lies in its elusive entirety, intentionally fragmented by Jujol’s approach. The site’s topography, the unpredictable evolution of the commission, and Jujol’s methodology all contributed to this fragmented yet harmonious composition [9], emphasizing the idea of the genius loci, understanding the use of existing materials in the site as part of a cultural vestige. Remarkably, Jujol never depicted a longitudinal section, a deliberate omission that underscores the project’s enigmatic nature. Despite its complexity, Jujol’s vision accentuates the interplay between fragment and whole, between land and site, defining the essence of the Sansalvador villa.

The complexity of the cultural and physical context of this project is important. The project itself is composed of fragments within a global sense, as a juxtaposition of ideas, responding to Jujol’s way of working. The villa’s life in itself has been erratic, a fact that supposes the interruption of some ideas to develop others. Not many plans have been conserved, and Jujol’s way of working was eminently in situ [10], so usually there is a big gap between what was drawn and what was built. Despite these adversities, the essence of this project remains tangible.

This paper aims to delve into the creative process of the ideation and construction of this project. To do so, the method used is divided into two steps that follow a chronological sequence.

The first step is the understanding of the project’s historical process. For this, it was necessary to gather all the documents that today are spread between the Barcelona and Tarragona Jujol Archive, the Arxiu Historic de Barcelona, the Colegi d’Aqruitectes de Catalunya Archive, and other independent organizations. The chronological explanation written by Jujol’s son has been adopted as the main storyline [7]. Alongside this timeline, the drawings have been displayed chronologically with the narrative to juxtapose architectural evidence with historical memory [11].

The second step is the contrast of the drawn and the built environment. This has consisted of photogrammetric point cloud mapping carried out by the authors in order to gain the most realistic and reliable idea of exactly what was built. The precision of this instrument in measuring and drawing this kind of architecture is important because we are appraising organic forms that were built on a mathematical basis; however, we are essentially relying upon hands-on experience [12]. After generating the 3D drawing, interpretation involves extracting the same dihedral drawings made by Jujol by hand. While these drawings may differ from what was built, they provide insight into the architect’s intent. The final step involves superimposing Jujol’s original handmade drawings onto the authors’ computer-generated drawings to enhance understanding of the project’s historical process, physical construction, and underlying purpose.

2.1. The Historical Process

In the plans submitted to the town hall in 1909, Jujol delineated a squared single house in the elevated section of the plot, oriented to the rear street and featuring lateral access, and leaving the remainder of the plot undeveloped (Figure 2-left). These plans, singularly proposing a solitary building, conspicuously lacked any delineations concerning the surrounding land. What initially appeared straightforward in its layout, however, concealed a multifaceted undertaking that was regarded more as a manipulation of the landscape than a mere architectural pursuit, hence obviating the need for detailed architectural drawings [13].
This approach afforded Jujol the creative freedom to devise the layout of the remaining plot on-site, in collaboration with the skilled laborers. Consistent with the prevalent methodology influenced by Gaudí’s modus operandi at the time, numerous design decisions were made during the construction process, in situ, through collaborative efforts with the craftsmen, a methodology Jujol also adopted. It is pertinent to highlight that the architectural ensemble primarily employed brick or stone masonry in its construction.

The elevation facing Pineda Street (Figure 2-right) presents the façade of the house, exhibiting a semblance of symmetry, notwithstanding the asymmetrical placement of the main gate. This particular plan merely outlines the alignments indicative of a prospective project rather than a finalized design. Notably, from the vantage point of the street, the structure rises to two floors and is capped with a sloping roof.

According to this same documentation, Jujol’s intention was to carry out a simple project distributed across three levels and to allocate the rest of the plot to a garden (Figure 3). The basement floor would contain the kitchen, dining room, and main access from the garden. The first floor, at the same level as Pineda Street, would have bedrooms and an office. The second floor would contain bedrooms and the staircase to the rooftop, while the roof would only have the indication of the outward staircase.

During the years spanning 1910 and 1911, Jujol remained engaged in the ongoing design and development of the house. Illustrated through his freehand sketches, these designs reveal nuanced intricacies contributing to the elevations’ depth and relief (Figure 3). Variations within the sketches depict the house as either two or three stories high, featuring a centrally positioned staircase adjacent to the secondary access point of the plot. This layout conforms to the common architectural configuration of communal spaces occupying the lower floor, while bedrooms are situated on the upper level.

Examining the west elevation (Figure 4-left), a notable “difference of 3′40′′” is observed, denoting the vertical disparity between the street level and the plot. The basement area is delineated with horizontal lines, indicative of exposed brickwork, while the upper part is depicted in white, embellished with quadrilobed crosses and pointed lintel windows, and executed in a Mudejar style (rendered freehand) [14]. Additionally, the depiction of the land beneath the house is represented as a sloping line, annotated with the term “orchard”.

Conversely, the south elevation (Figure 4-right) affords a clearer view of a cantilevered veranda on the first floor, adorned with heraldic and religious motifs such as a sloping shield, crosses, and arabesques. We can also appreciate in more detail the pointed lintel windows that pronounce their verticality, the existence of a hipped roof with various
additions (such as a five-pointed cross and a parapet formed by twelve stone points), and the placement of skylights and stairs. On the right side, there are also external stairs that ascend directly to the upper entrance.

**Figure 3.** Town Hall plan, 1909. Source: Arxiu Contemporani de Barcelona.

**Figure 4.** (left) West elevation and (right) south elevation of the house. Undated. Source: COAC Archive.
The cross-outs and doubled lines in these two elevations reveal the most intriguing aspect of the project: the undefined sections that were in the process of conception but never materialized. In the south elevation, it is evident that Jujol attempted to extend the cantilevered volume. Additionally, the upper parapets appear slightly tilted, and the right boundary of the building extends behind the lattice. These observations suggest that Jujol was likely experimenting with rotating the second floor.

Concerning the use of rotated directions that come together in a unitary structure, we can appreciate several examples in Jujol’s later works. The Serra-Xaus house (Figure 5-left) was built in Sant Joan Despí when Jujol was the municipal architect between 1921 and 1933. This is one of the most interesting examples for this case study [15], as the extension Jujol created in 1927 follows exactly the same logic: the ground plan structure is an orthogonal square, while the first floor is a 45°-rotated square supported by two lower pillars, reinforcing the character of the structure by indicating the direction of the vaults. In the Vistabella church (Figure 5-right), the structure of the whole building is the superposition of two squares rotated 45°.

The hypothesis concerning the 45° rotation is reinforced when looking at the west elevation (Figure 6-left). This particular depiction exhibits a heightened level of precision and detail compared to previous renditions, and bears the date 1915. It presents the west elevation of the house, delineating the placement of windows, the height of slabs, and the configuration of stairs. Notably, only the first three runs of the stairs maintain orthogonality, while the fourth run is depicted as rotated 90°, and the final two runs are shown at a 45° angle. This evolution from initial simplicity (embodied by the squared structure atop the hill) towards increasing complexity over time becomes evident.

The roof shown in the aerial perspective (Figure 6-right) corresponds to the roof drawn in the west elevation. Therefore, these two drawings are probably contemporary, from 1915. The axonometric viewpoint accentuates the significance of the west façade, prominently featured in the foreground. The outstanding volume that seems like a skylight is indeed the last run of the staircase poised over the roof. Therefore, we can determine the position of the stairs.

In the drawing of the north façade (Figure 7-left), we may observe that the stairs that connect the second floor and the roof surpass the limit of the façade in three runs. We also see, for the first time, the roof with an inclination of 60° and the detail of the triangular steps that are poised the four-hipped roof. This plan also shows a thorough study on the forge
fence work for the entrance gate and for the windows, in elevation and section, providing an accurate image of how the final house would look.

Figure 6. (left) West elevation and (right) perspective of the roof. 1915. Source: COAC Archive.

Figure 7. (left) North façade. Undated. Source: COAC archive. (right) Forge detail. Source: Author.

In his studio drawings, Jujol used to juxtapose other drawings in the paper margins, usually freehand and in watercolor. These drawings, which may seem haphazard, contain
Jujol’s hidden ideas. If we pay attention to the figure of the red flower (probably a carnation) and we turn it upside down, we can appreciate that it is in fact the design of the floral pattern of the main gate (Figure 7-right). From the flower, a white grape form is suspended, with two crosses and a conical form similar to a morning-glory flower. Jujol’s interest in natural forms such as animals and flowers is always present, evident even in early works [16]. Therefore, despite the erratic disposal of marginal drawings, each one of them is likely an external idea or reflection that holds in the architect’s mind and sometimes crystallizes in architectural form [17].

Although the initial project left the whole plot blank and Jujol worked hand in hand in situ with his confident mason [10], the garden also underwent a designing process. Only the plan entitled “second garden project” from 1911 was conserved (Figure 8-left). In this drawing, we can see some calculations of the terrain’s embankment and the different treatment of straight cylindrical metal railing (when covering straight runs) and more complex wrought forge railing (when treating the end of the stairs). The stone pilasters are specifically drawn and numbered one by one. Jujol topped each pilaster with a specific stone, which was extracted from the same plot and chosen by its form in relation to its function. As we can see in the photograph taken by the Sansalvador family (Figure 8-right), each stone was left poised over the steps, waiting for the moment to be placed by Jujol.

In 1915, a well was opened to serve the planned house at the top of the plot, and it was discovered that the subsoil water contained radium, supposedly with healing properties. As a consequence, the dwelling project was abandoned, and the Agua Radial grottoes project began [7]. This second project involved the opening of several underground grottoes, both at street level and the first level, until reaching the well.

The freehand sketch dated 1915 (Figure 9) shows for the first time an elevation of the main façade of the villa from the Passeig de la Mare de Déu del Coll. Indeed, in this drawing, you can see two façades: that of the street and that of the grottoes. The first one had already been built, but the rear façade, that of the grottos, had not been. Therefore, this is probably a sketch of an idea of how the grottoes’ façade might be designed in accordance with the Mare de Déu del Coll façade. Both façades are drawn in detail: the first one is composed of straight and triangular alignments, representing the aristocratic face seen from the street, while the grottoes’ façade is composed of curved lines and shadows, representing the smooth and relaxing connotations of the bathing establishment.

In the building permit presented to the town hall in October 1915 (Figure 10-left), the new entrance and window positions are indicated in red. The interior of the store is labeled with “dismantling for the final cover that is projected” and the surrounding walls
are labelled “retaining wall”. The section indication schematically shows that the façade wall supports a slab that is 4'50 m from the ground.

**Figure 9. Aigua Radial project elevation, 1915. Source: Colegi d’Arquitectes de Catalunya Archives.**

**Figure 10. (left) Agua Radial façade and floor e: 1/50. Source: Arxiu Municipal Contemporani de Barcelona. (right) Agua Radial sketches. 1916. Source: Colegi d’Arquitectes de Catalunya Archives.**

Additionally, the 1915 sketches reveal openings at the back of the store (Figure 10-right), with one of these openings irregularly shaped and resembling a carved rock. The plan illustrating the direction of the beams supporting the Catalan vaulted roof also depicts the continuity of a straight step, coinciding with the future stairs that would connect with the upper grottoes. Hence, it is highly probable that by 1916, this section had already been constructed, and that the opening of a continuation of the grotto connecting to the upper part was underway.

The plan entitled “works of extension of the spring-grottoes under the mountain”, allows us to confirm that by 10 March 1916, the terrace had already been built at an altitude of 4'30 m, alongside the main access staircase and the guard pavilion. Meanwhile, the construction of the grottoes was in progress. In the plan, three colors are depicted: gray, black, and red. According to the convention in the representation of architectural plans,
gray indicates that it is a construction outside the scope to be treated, in this case, everything that is not the grottoes. Black represents the consolidated part (the part of the grotto already built), and red indicates the new work, i.e., the grotto projected by Jujol (Figure 11).

The grotto depicted in black is identified as “old gallery”, and constitutes a tunnel that communicates straight from the small access door to the spring. This was the first grotto that was dug in the rock, with a purely functional purpose: to reach the water source and verify the viability to tap it. This gallery, on its way, encounters a protrusion and a cavity, which are indicated as “sink” and “tool deposit”. This area connects by the lower floor, by means of a staircase depicted in gray, as shown in the previous sketch (1916).

The old grotto, halfway along its rectilinear path, has a metal gate. At the end, there is a pillar that allows the tunnel to widen; behind it, there is the water well consolidated by two lateral pillars. On the other hand, the grotto designed by Jujol communicates with the terrace and with the old gallery through four contact points. The narrowness of the old gallery is amplified by the possibility of multiple routes, while the new gallery presents two openings to the terrace: an oval oculus and a catenary-shaped door [18]. Both openings are composed of a series of arches in plan that convey the walkabout, inviting the visitor to explore the curvilinear forms of the grotto.
Inside, the contour of the grottoes is formed by polygonal and curvilinear lines that invite the visitor to an infinite-shaped tour; the stone is supported on two points, highlighting this form. The first support is polyhedral in shape, reproducing both the straight shape of the old gallery and the curvilinear shape of the new gallery. The second support hides the “new spring” to which it gives access.

In 1917, the Queralt family commissioned the architect to design their house (Figure 12) on a portion of the plot that had been segregated by the upper road [8]. This building had a modest budget and consisted of a two-story parallelepiped with one dwelling on each floor. Its most characteristic element is the opening of the south corner, where it features a glazed tribune rotated 45° and a balcony on the top floor. It has relatively complex brick bonding, forging, and details between the different angles. On its rear façade, there is also a staircase that provides access to the roof and serves as a porch for the second-floor entrance.

In the city council plans, we observe the position of the single-floor building with respect to the plot as well as its interior distribution. In this plan, this house is presented as a single floor.

As the guard pavilion of the Sansalvador villa had already been built, the Sansalvador family commissioned Jujol to remodel it and to transform it into their home. As noted by Ignasi de Solà-Morales, who also cites Carlos Flores on Jujol, the creativity and inventiveness of the architect are most evident in the transformations of existing buildings [19]. Thus, in 1921, twelve years after its conception, Jujol began to intervene in his own project (Figure 13). As can be seen in the plan, the architect adds two gallery volumes to the parallelepiped: one in the central part (which he defines as a portico) and the other in the corner (the bathroom). He also adds a volume of two floors that contains a wardrobe and upstairs a room.

Up to now, we have analyzed the original plans drawn by Jujol and preserved until today. One of the distinctive features of this villa (which is probably caused by the project’s nature and because of the architect’s modus operandi) is its incompleteness. The long term in which Jujol was working in this project, his personal experience during the process, and the changing commission in each phase mean that this project was destined to be unfinished, always left open to new refurbishments [2].

In 1987, the city council commissioned an architectural plan survey to Francesc Gruartmoner (Figure 14) to assess the state of the villa and provide insights for potential future rehabilitation projects. Unfortunately, this project could not be carried out until 20 years later. This is the time in which the villa was seriously ruined and vandalized. Therefore, the survey became an important document informing us of the original state of the construction.
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Figure 12. Queralt house's situation and plan. 1917. Source: Barcelona Contemporary Archive.

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Figure 13. Rehabilitation of the guard's pavilion. Source: Contemporary Archive of Barcelona.

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2.2. Superposition of Historical Plans and a New Survey

While the few preserved original plans offer historical insights into the project, they do not provide a comprehensive understanding of the decisions made during its construction.
A reliable handmade survey of this villa and its complex environment would take years to complete and would likely be imprecise. Instead, a point cloud survey will allow us to capture all these complexities in a few sessions, which are then easier to assemble. Therefore, in order to provide a wider vision of the villa, a new survey was made by the authors through photogrammetric point cloud mapping.

In this work, we generated the models of the Sansalvador villa using the photogrammetry technique of structure from motion (SfM) and multi-view stereo (MVS). SfM-MVS photogrammetry is a technique that uses multiple photographs to reconstruct the three-dimensional structure of an object or scene [20]. It is based on finding IP correspondence points in the images and calculating their relative position in space to generate a 3D model (Figure 15a).

![Figure 15. (a) Positioning of cameras in the façade socket (b), façade point cloud (c), polygonal mesh (d), and textured façade. Source: authors.](image)

After obtaining the three-dimensional structure with SfM, the point cloud was generated by triangulating the 3D points (Figure 15b). A polygonal mesh was then created by connecting these points to form a surface (Figure 15c). Finally, the textures of the original images were projected onto the mesh to give color and realistic details to it (Figure 15d).

In SfM photogrammetry, several algorithms are used, like (1) the feature matching algorithm (such as SIFT or SURF) to find corresponding points in images, (2) the fundamental matrix estimation algorithm to calculate epipolar geometry, and (3) the structure fitting algorithm to estimate the three-dimensional position of points from images.

Feature matching algorithm: This algorithm is used to find matching points in images, allowing us to establish correspondence between them. The most common algorithms are SIFT (scale-invariant feature transform) [21] and SURF (speeded-up robust features) [22]. These algorithms extract features invariant to the scale and rotation of the image to find matching points with high accuracy.

Fundamental matrix estimation algorithm: This algorithm is used to calculate epipolar geometry, which describes the geometric relationship between two images viewed from different positions [23]. The fundamental matrix is calculated from the correspondences of features found in the images [24].

Structure fitting algorithm: This algorithm is used to estimate the three-dimensional position of points from images [25]. The most common approach is the simultaneous adjustment of the structure and the camera, which estimates the position of the points and the orientation and position of the cameras [26].
The survey of the point cloud involves systematic captures in different sequences of images at varying distances, with overlapping intervals. These are then processed and converted into a polygonal mesh. The resulting three-dimensional model, with detailed textures of the buildings and grottoes, is simplified for greater operability, preserving in any case the resolution of the original texture obtained in the survey. The mesh obtained is used as a geometric basis for choosing sections and plans through orthogonal projection of the model.

The fieldwork consists of four sessions, each lasting 8 h. It is worth mentioning that the set presents great difficulty due to the configuration of the building, its adaptation to the terrain and its steep slope, and the inclusion of abundant vegetation. The survey combines high-resolution photography (24.1 Megapixel Nikon D5200: Nikon, Barcelona, Spain) with drone aerial capture (DJI Spark 12 effective Megapixels (3969 × 2976)) and additional detailed captures of the courtyard and grottoes (18.2 Megapixel Sony DSC-H80) coupled with spot video footage taken in dark areas. After two sessions, the processing of a total of 3985 images begins using Reality Capture software 1.3, resulting in the alignment of the captured images and the creation of a model consisting of 290.9 million polygons.

The resulting mesh does not process the deep grotto together with the first grotto, and the façade with shadows is not correct (Figure 16).

Figure 16. Model resulting from the survey; Frontal view from Mare de Déu del Coll Street. Source: authors.

With the intention of incorporating into the model the current geometry of the grottoes, the well, and the upper building of Pineda Street 9, and redoing the lower façade of the set, two additional work sessions were carried out. The captures were incorporated into the previous processing, resulting in a final total alignment of 4283 photos (RAW + JPEG) and a resulting mesh of 427.1 million polygons, which show the two villas in their entirety, the two grottoes joined and the façade without remarkable shadows (Figure 17).

The next step is to superpose the most relevant Jujol plans with the new photogrammetric survey in order to establish relationships between them and try to better understand this architectural complex.

The superposition of the photogrammetric and original Jujol’s plan of the grottoes level (Figure 18) allows us to see that there are some general misalignments in the older plan. This is quite normal; in this sense, the bigger difference is visible in the real angle between the street and the site, which is narrower. On the other hand, the grottoes are completely misaligned, although the main factors are comprehensible. The old grotto is not so regularly straight and is narrower; the width of the oval window and the catenary...
entrance are deeper and slightly acuter; the angles that form the perimeter of the grottoes are gentler. The middle pillars are wider, and the well is precisely positioned.

Figure 17. Model resulting from the survey, aerial view of the Queralt House. Source: authors.

Figure 18. Superposition of photogrammetric images and Jujol’s original plan of the grotto level. Source: authors.
In the superposition of the photogrammetric image and Jujol’s original plan of elevation from the main street (Figure 19), we may observe that the general dimensions of the first façade are exactly the same; therefore, they were probably already built in 1915. We see the attempt to position the right door and window of the store that was defined in 1916. We also see an oblong window at the left, at 2.1 m from the border, which indicates that at some moment, there was the idea of occupying it with another room. Over the guard pavilion, as we had mentioned, the drawing shows the idea of covering the pavilion with a hipped roof, while the construction is flat.

![Figure 19. Superposition of photogrammetric image and Jujol’s original drawing of the elevation from the main street. Source: authors.](image)

In a second plane, the grottoes’ façade, the main elements are the three openings. The door for the first rectilinear grotto today does not exist anymore. It was smaller and more modest, and it was bricked up because of its irrelevant use in the 20th century or during the 2015 works. The catenary door is completely centered to the main door access in the drawing, while in reality, it is bigger and slightly decentered to the left, conserving its origin in the right lower basis point. The oval window also coincides at the right, but was actually built bigger. The lateral staircase and plateau at the right coincide in the superposition, although in the drawing they are presented more as sketches, neither horizontal nor with a 45° chamfer. Therefore, this part was probably not yet built in 1916.

3. Conclusions

This study, through precise comparison between the photogrammetric point cloud and archived graphical documentation, has revealed a significant disparity between the constructed reality and Jujol’s original designs submitted to the city council. This mismatch does not stem from negligence on the part of the architect or builder, but rather from a construction approach wherein the architectural project was developed from fundamental features, with details determined during the building process. These variations highlight the essence of the project: the constructed grotto is more intricate and captivating than depicted. It leaves the visitor to discover each fragment without having a vision of the whole. The alignment of the two principal façades in the original drawing, which becomes apparent when visiting the villa, creates a sense of unity. The complementarity of straight lines of the first facade, in contrast to the curved forms of the grottoes, is more relevant than the mismatch between these plans. Jujol meticulously selected stones and pieces on-site, considering their form and age, before finalizing details. This care for elements found on
the site, which were part of the same land before any construction or idea had started, is an important issue for Jujol. It is not only the will of the author, but the character of the place, the genius loci, that helps to make most of the final decisions.

Jujol’s architecture has an important dose of craftsmanship in its implementation. This work is marked by the difficulty of the orography of the plot and by the changes of direction of the commission itself. These two characteristics favor a design process in which apparent improvisation on site ends up configuring the details of the construction and even the measurements of the envelope and the top rails. Indeed, the most impressive aspect of visiting this architectural complex is the harmony among its various components, accentuated by the concept of thresholds. Each opening and each corner of this villa directs the visitor towards another place and is usually characterized by the presence of land, brick and vegetation. These gestures are precisely visible in the coincident lines between both plans.

It would be a mistake to recreate the construction as drawn in Jujol’s project, as shown by certain posthumous works by renowned architects, such as the Montferri Sanctuary by Jujol himself, the Sagrada Familia by Gaudí, or the Firmín Church by Le Corbusier. Far from this, what this paper defends and demonstrates is that between the drawings that are left and the built reality, there still exists the architect’s stroke of genius, linked to the genius loci.

In his book Mareperlers i ovaladors [5], Perejaume focuses on artistic works that create modernity anchored in tradition in Catalonia and highlights the value of those works that identify with the place in which they are located. Perejaume affirms that “between making a work in a place and making place in a work there is not much difference” and that “spaces should not be completely domestic but keep a degree of their own life”. The Sansalvador villa is a paradigm of this type of architectural work that has resisted complete domesticity and has maintained a high degree of its own life.


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