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# The graphic survey of the architectural heritage supported by the 3D laser scanner. Case study: the Castellot house


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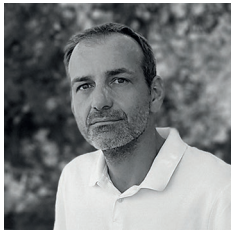

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The architectural graphic expression, with all the variants that make it up, strengthens a substantial part of the process of approaching the project, also of its resolution. When the architectural intervention corresponds to the rehabilitation of a historic building, the aforementioned link acquires greater prominence, both in the previous phases of analysis, and in the consequent decisions that will derive from them. The help of technologies in the capture of information and the possibilities of virtualization provided by computer applications, have determined both the work methodologies and the forms of graphic representation to obtain results.
This article describes the processes carried out for the graphic representation of a Renaissance palace in the province of Teruel, Casa Castellote, as a starting point to advance in its knowledge.
Every graphic survey, any virtual model analyzing an architectural object, the intangible contribution of the initial sketches, and the conclusive planimetric representation configure an essential scientific research to address a project solution.
This analytical graphic process, as well as the consequent creative graphic process, require systematization. The result is the obtaining of a digital model that will allow the study and analysis of the model through different visualizations, whether planimetry, or virtual three-dimensional models, which, in addition, enable accessibility to the documentation of the heritage asset and its dissemination to society.


Keywords:
Archaeological heritage; survey; laser scanner; Casa Castellot


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## INTRODUCTION

Traditionally, interests in documenting built architectures have been directed at obtaining complete and precise data that allows adequate graphic representations. The architectural graphic expression, with all the variants that it comprises, strengthens a substantial part of the process of approaching the project, as well as its solution.

Technologies that help to capture information and to virtualise possibilities provided by computer applications have determined both the work methodologies and the forms of graphic representation to obtain results.

When the architectural intervention concerns the rehabilitation of a historic building, the aforementioned connection takes on greater importance, both in the previous analysis phases (Fig.1) and in the consequent decisions from which these will derive.

There is a fundamental process and systematisation to acquire the necessary graphic documentation to achieve a precise analysis that will eventually influence the architectural intervention. It begins with various sketches, approach drawings made on site, complemented with photographs, limited surveys, followed by a graphic survey using a point cloud, and redrawn in 2 and 3D. Currently, the survey process is much more precise and specific with data collection systems using laser scanners and drones fixed with cameras. (Fig.2)

This article details the process carried out for the graphic representation of the Casa Castellot, an example of Aragonese Renaissance palatial architecture, as a starting point for the documentation work. This process will allow us to acquire further knowledge of the property and will facilitate its future enhancement. Likewise, due to the paradigmatic quality of the documented example, we intend to contribute to the typological knowledge of this architecture. The house, located in Mirambel, a small town in the province of Teruel in what is known as the Aragonese Maestrazgo, is a notable example of Aragonese civil architecture from the 16th century. The graphic analysis described documented geometric, constructive and spatial aspects of the building.

Located to the north of the town, it forms an interesting complex with the Casa Aliaga. (Fig. 3) Both buildings, with very similar construction, morphological and functional characteristics, dialogue with each other and make up one of the public spaces of greatest interest to the population, standing out for its scale and architectural quality compared to the rest of the buildings in the town square[1].

## CIVIL ARCHITECTURE IN THE ARAGONESE MAESTRAZGO. THE CASTELLOT HOUSE

The house is located in Mirambel, a small municipality and town in the province of Teruel, in the Maestrazgo region of the autonomous community of Aragón.

Although the population of Mirambel is settled on what was once an Iberian site, the first documented data appears from the Christian conquest by the troops of Alfonso II of Aragon, who granted it free jurisdiction in 1157. After the donation from the king to Gastón de Castellote of the six towns, including Mirambel, that would form the Bailiwick of Cantavieja attached to the Order of the Temple, a period of connection of the population to this order and its successor, the Order of Saint John of Jerusalem would begin and which would last until the middle of the 19th century.

During the 16th and 17th centuries, due to the increase in the wealth of the local nobility caused by the wool trade and consequently a period of splendour that was reflected in the rise of civil architecture. It is the time when numerous examples of ancestral architecture appear in the area, among which are Casa Castellot and Casa Aliaga.

At the beginning of the 19th century, the entire re-

Figure 1. Approach and identification drawing. 2023


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Figure 2. Aerial view of the survey site. 2022

gion would suffer the consequences of the Carlist Wars in the province of Teruel. During the Seven Years' War, the first of the Carlist wars, Mirambel became the administrative and political capital, with the Supreme Junta (Council) of Aragon, Valencia and Murcia settling there. This fact gave national renown to the town and for this reason notable Carlist figures resided there while the conflict endured.

The town centre is an interesting example of a medieval walled enclosure. (Fig.4) Built by the Templars, almost the entire wall is preserved, two of the five original towers and the four access doors. Among them, the Portal de las Monjas stands out, belonging to the Agustinas convent. The image of the interior of this portal, with the decorated plaster lattices that allowed the view of the main street from inside the convent, is one of the best-known images of the town.

Figure 3. Aliaga Palace. Espacio urban space between the houses. 2023

The exceptional nature of the complex and its good state of conservation led to it being declared Historic-Artistic Ensemble in 1980 for being a "Villa steeped in history, preserving in its entirety the walled enclosure and the notable buildings, without altering the medieval image and atmosphere." The current image of the population is the result of the urban intervention promoted by the General Directorate of Architecture and directed by the architect Francisco Pons Sorolla. This intervention was awarded the Gold medal of the Europa Nostra award for the restoration and planning tasks of the town's urban complex. The streets maintain the cobblestone pavement and the set of buildings that help to offer a unified image of the population.

Among the heritage elements of the complex, in addition to those of the fortification itself, several interesting examples of late Gothic and Renaissance Aragonese civil architecture are included; such as the Town Hall and the group of palatial houses, both of which stand out for their importance as well as for forming a complex with a powerful urban image - the aforementioned Aliaga and Castellot houses.

Both are among the best examples of noble palaces of the Teruel master class, and their characteristics make them paradigmatic. Compact buildings, without an interior patio, of three heights, with a façade of regular composition topped by a gallery of arches under a powerful eave with a profusely decorated double wooden canopy. The language of all this architecture is sober, with few decorative elements concentrated in the openings and the eaves.

The Castellot house owes its name to its first owners. The news of the family dates back to 1158, in which Español de Castellot returned the castle of the town of Castellote to King Alfonso II of Aragon, and the king granted him ownership of it. The family will maintain its power and status in the region, reflected in several palatial residences, including that of Mirambel and those of the nearby towns of La Iglesuela and Mosqueruela. The year under the eaves (1587), in stylistic and constructive agree-


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ment with the rest of building, allows us to date its construction.

The building was vacated in the first third of the 20th century, a reflection of the economic and demographic stagnation in the area that occurred from the 19th century onwards, with an essentially agrarian and livestock economy and far from the main urban and industrial centres. (fig. 5)

It was acquired in the early 70s of the 20th century by the architects Ricardo Roso Olivé and Ricard Roso i García, who meticulously restored the building. The works improved the structural behavior of the brickwork and the durability of the wooden elements and the original composition of the façade was recomposed, eliminating the opening of the balcony on the first floor. The intervention would focus on the interior and exterior carpentry elements, while recovering the quality of the interior spaces and the habitability of the property while maintaining the character of the building.

The house has the configuration of a palatial construction and occupies the west side of Aliaga Square. It is a building of notable construction quality, with facades made of powerful ashlar masonry[2], with precise carving in the significant elements, such as corner panels and the ashlars that form the gaps. Compositionally, the four interior levels read as three, due to the scarcity of openings on the ground floor. (Fig. 6)

The access door, which connects with a double-height hallway, is given shape with a semicircular arch without moulding, built with very powerful voussoirs, a classic solution in the Gothic architecture of the Crown of Aragon, and which was extended during the Renaissance. In it, as in other houses in the town, there are still remains of inscriptions from the Carlist army.

The openings of the intermediate floors, those for noble use, are configured in large lintelled windows with moulded sills. The wooden carpentry, recovered in part from the original and to which

Figure 5. Photograph of the Casa Castellot. 1st half of the 20th century. Mora Insa Juan. Historical archives of the province of Zaragoza ES/AHPZ - MF/MORA/002411

Figure 4. Areial view of Mirambel. 2023


the glass pane was added, has an intermediate lintel and upper mullion with Renaissance decoration. The lower level, not used for housing, is closed with a gallery of semicircular arches, a common solution in the palatial architecture of the area, on a continuous moulding. The façade is finished with a powerful double-bar wooden eaves, profusely decorated.

On the south façade, the powerful semicircular arch with a projecting stone balcony that allows the construction of a utility room stands out. In this case the arch has a language similar to the windows and is soberly moulded and with chamfered edges. (Fig. 7) The treatment of the brickwork of the two façades, the composition of openings, the levels and the finishing of arches with the continuous eaves, bestow uniqueness to the two façades that face the public street.

In its interior, the wall structure defines a noble corridor, facing the façades, articulated very clearly into three rooms, the central one twice the


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size of the side ones. This structure is repeated at all levels. The interior corridors, facing the north patio, for more domestic use, have a much more complex geometry, both in plan and in section. The differentiation of these areas is reflected both spatially, with more generous dimensions in plan and section, and in its construction, with more elaborate work on the structural wood.

## OBJECTIVES

Figure 6. View of the west façade of the Casa Castellot, overlooking the Plaza Aliaga. 2023

Figure 7. View of the south façade of the Casa Castellot. 2023

The first objective is to achieve a graphic representation of an architecture built in a heritage environment, with the purpose of documenting it and facilitating its registration.

This graphic documentation is essential for a prior analysis to the creative process of intervention and enhancement. To achieve this graphic representation, it is necessary to conduct an architectural survey, understanding this as the tasks that will be carried out to obtain plans and graphic documents that represent the architectural object. The results of survey will give rise to a graphic document to record and verify data, as well as an analytical tool in the study of the architecture in question. [3]

The aim is to achieve a sufficiently rigorous analysis, which, accompanied by a historical-constructive study, allows undertaking the documentation and enhancement of the property.

To do this, it is necessary to achieve a representation of a built complex for which there are no existing graphic records that provide knowledge of the built object in the face any possible intervention in the building.

Just for the conservation and enhancement process, it is essential to obtain planimetric infor-


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Figure 8. Image obtained from the point cloud of the building's façade. 2023

mation to enable the graphic analysis prior to the eventual rehabilitation, restoration or variation in use, as well as a method of historical conservation and communication.

The survey will determine the quality of the information necessary for any intervention, including all the current tools permitting rigorous and reliable information to be obtained on the built element. The resulting graphic information must achieve the three bases of architectural graphic expression: analyse, design and communicate.

## METHODOLOGY AND PROCESS

Every architectural analysis implies a search process that, through graphic representation, reflects in the set of appropriate actions that allow a constructed result. When this process focuses on the intervention on a heritage object, the rigor imposed becomes more apparent: the graphic analysis process; the meticulous identification of the piece where the intervention is going to take place; the dialogue between the representation of the project and the final solution.

It is important to emphasize that all monuments, architectural complexes and places of social interest must be documented and registered using scientific criteria. In that way, support can be provided to subsequent research carried out on them, as well as to facilitate reconstruction, replacement work or restoration without forgetting the aspects related to the dissemination of knowledge and promoting awareness about respect for our heritage. From the graphic point of view, it is essential to apply a methodology and scientific rigor when representing heritage when using graphic computer technologies.

The process begins with the search for existing bibliographic and graphic documentation about the building in order to correctly interpret the brickwork and rooms to understand the transformations and interventions previously that have occurred in the building up to the present.

Secondly, the method of collecting data in situ from photogrammetric survey field work was carried out in different stages:

_ A photographic report of the property and the surroundings.

_ A laser scanning of all the interior spaces of the building.

_ To survey the exterior using a drone equipped with a camera and photogrammetry program.

_ A Graphic restitution of all the information using the appropriate software that transforms the thousands of data obtained into a complete planimetry of the complex.

Figure 9. The eaves of the Casa Castellot. Image obtained through drone technology. 2023


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The last phase in the process is to synthesise this information (bibliography and survey in the field work, traditional and photogrammetric) to prepare the graphic documentation that allows the archive and cataloguing of the Palace, gaining special importance the drawing as a tool for the dialogue between the recognition of the constructed object and its cataloguing. (fig 8.)

To carry out this graphic survey prior to the documentation process, it is essential, in our opinion, to combine traditional methods - preliminary sketches, in-situ notes, etc. - with current graphic resources - point clouds, photogrammetric restitution, aerial images of drone flight, etc. - until reaching a reliable graphic representation of the architectural object. (Raposo Grau, 2010)

The survey will be supplemented with sketches reflecting all the details necessary to complete the documentation of the model. A complete survey of the entire building is essential since there are no existing graphic records that document the different interventions that have taken place in the house.[4]

In the survey work, direct and indirect measurements have been combined, using a Leica 3D laser scanner, model RTC 360, based on time-of-flight technology, allowing up to 2 million points per second to be measured, in a range of measure-

Figure 10. View of the roofs of the building taken in the drone flight. 2023.


Figure 11. Representation of the floor plan indicating cuts and sections 2023


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ment ranging between 0.5 m. and 130 m., and with a field of vision of 360° horizontally and 300° vertically. To capture the colour of the point, the scanner incorporates 3 36 MP cameras, which work under an advanced HDR imaging system. This scanner incorporates an inertial system based on VIS (Virtual Inertial System) technology that allows automatic registration.

Essential data was also taken using aerial photogrammetry of the most inaccessible areas, such as the roofs and the highest parts of an architectural piece. (fig 9)

This data collection from the air allows a focus on a plane parallel to the horizontal and as well as elevated areas. In our case it has been fundamental to define the roofs and eaves of the house through the flight of a UAV (Unmanned Aerial Vehicle) device DJI Mini 2 Drone, quadcopter drone, weighing 249 gr. from MTOW, with 4K Camera, and 12MP sensor.

The information has been obtained using the Cloudworks program that manages the point clouds allowing them to be easily exported to AutoCAD making it possible to draw the views that define the building. The advantages offered by new graphic survey technologies, specifically laser scanner systems, certainly include the speed in capturing three-dimensional data and "precision in their three-dimensional location." (Carazo Lefort & Martínez Gutiérrez, 2013)

Without this technology, it would have been near impossible to obtain data on elements of difficult access due to their location in height and construction complexity. (Fig. 10)

In this present study, it was necessary to combine two methods; enriching the data obtained through laser scanning with the information provided by the drawings and field sketches.

This approximation process and its analytical systematization will enable a transition that ranges from initial drawings, sketches, photographs, sketches and scales. The technology will then be incorporated to the intervention with the finality of capturing information and to virtualize the possibilities provided by the computer applications, such as: a graphic survey using a cloud of points, redrawn - 2D, 3D - currently much more precise and concrete - which allows the model to be represented using a virtual model - with data collection systems using laser scanners and drones with cameras.

Survey work is complicated in buildings of these characteristics, with intermediate levels of slabs and spatial overlaying that are difficult to graph. Therefore, laser scanning work is essential to define the different levels and sections and will complement the manual sketches describing the shooting points and the architectural details necessary for the graphic reconstruction work.

## RESULTS

The survey work will contribute to deeper knowledge about the state of the building, its dimensions and the construction characteristics that make up the model, as well as the different pathologies suffered over time. It will include three-dimensional models, plans, sections and projections that, fundamentally, must provide sufficient and rigorous information.

Figure 12. Transversal section of the building with completed scanned information. 2023

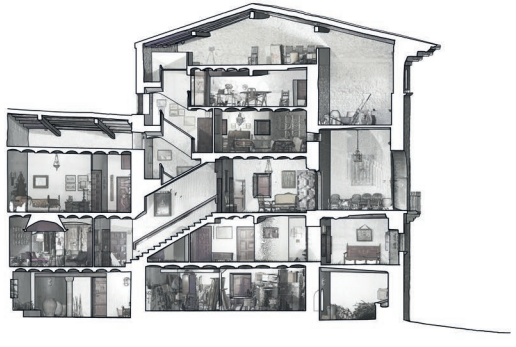
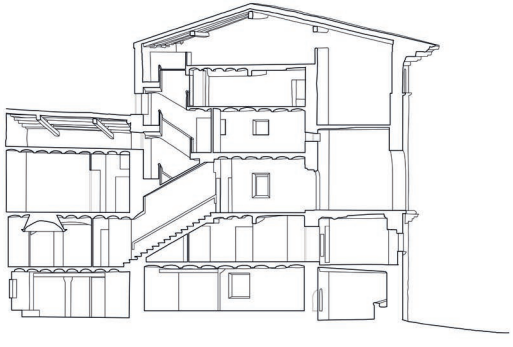


Figure 13. Phases of redrawing a section

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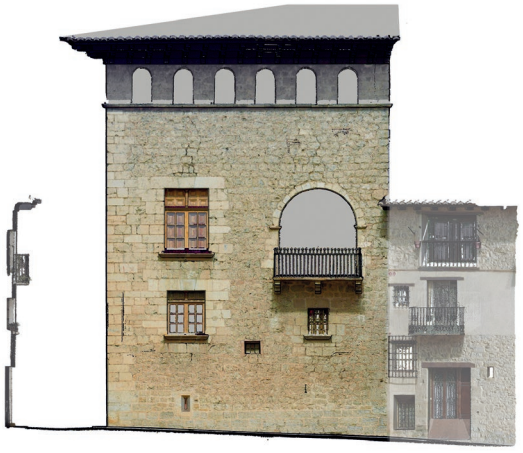

Figure 14. South elevation. Direct point cloud projection. 2023.

As a first step to obtain the graphic representation from the point cloud generated in the scanning work, both longitudinal and transversal cuts are made at the different floor levels and sections which allow establishing a clear organisation of all the essential projections described in the built complex.

We chose the floor that corresponds to the level defined by the access level to the Palace to plan the different sections and views in height. Three longitudinal sections, two transversal ones and the two projections that define the exterior elevations of the building have been selected. (Fig.11)

From working with the three-dimensional model of the point cloud, all these sections are prepared, which after a process of study, screening and cleaning allow the drawing of the projections. For the layout of the sections, extremely narrow segments have been defined, reduced sections of the point cloud depending on the area where work is going to be done, which are placed in dihedral succession until the necessary information is reached to then being able to draw the final image of the projections.

After the cut has been extracted from the cloud (Fig.12), it needs to be modified in order to achieve the final drawing. In the following image (Fig.13) corresponding to one of the cross sections, we can compare the evolution of the work required to transform the initial image with the same section represented with a line drawing.

Subsequently, post-production work on the views becomes necessary: This will give the projections a certain degree of graphic sensitivity in addition to truthful information essential to improving the drawing and at the same time transform it until a recognizable architectural language has been achieved.

Continuing the temporal discourse, in the case of flat exterior facades, the direct projection of the point cloud allows it to be used as a dihedral projection, in which in addition to providing reliable information about colour and texture, the materiality of the element can be appreciated and possible interventions, damages and information on pathological processes. (fig. 14)

As a consequence of the post-production work, we obtain projections that completely define the architectural object, and that will allow graphic analyses to be carried out to achieve a scientific cataloguing of the building.

## CONCLUSIONS

Any graphic survey of the built heritage, focused on documenting through a metric database, makes it possible to obtain a virtual model for the analysis of an architectural object. From the contribution of the initial sketches, and until the conclusive planimetric representation, the finality is a configuration of essential scientific investigation that fosters the knowledge that allows architectural intervention and conservation.

This analytical graphic process, also like the subsequent creative graphic process, requires systematization, order and rigor. The result will be the obtaining of a digital model that will permit the study and analysis of the model through different visualizations, whether 2D planimetry, or virtual three-dimensional models, which, in addition, enable accessibility to the documentation of the heritage asset and its dissemination to the public or society.

Drawing existing architecture involves scientific research supported by drawing as a generating order. All these graphic processes, from initial sketches to computerised drawings, represent the method of collecting information. The rigor with which we face each of them will govern the quality of the intervention, aware that the integration of all actions expands the possibilities. The point cloud obtained by the different scans provides raw information, a database that will require rigorous analysis work to achieve an adequate graphic representation. By undertaking a detailed survey work, combining all the telematic data collection tools, the process of graphic documentation of the built object is more measured and coherent. Drawing is thus understood as a process of mediation between thought and action to graphically arrive at the representation of the architectural object analysed. The post-production work of the different projections obtained by scanning, supported by the approximation drawings and detailed sketches, is what will provide the expressive quality that must be required from the graphic documentation of a building. (fig. 15

It is clear that computerised graphic representation systems complement traditional tools, and with their integration they help to understand ar-


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chitecture and explain its genesis and constructive development. It is important to reflect on the moderation of the method used, on whether the data obtained through scanning is sufficient, or what the degree of precision necessary to obtain the data would be. You have to measure and decide based on the ultimate objective to which the data collection is going to be used. Nowadays, the advancement and precision of cameras allows us to achieve millimetre definition of objects, which would seem appropriate for the restoration of elements reaching maximum detail. In the case at hand, the technology used has been sufficient to document the object studied, thus leaving the information in the point cloud for archiving and complete architectural documentation, that is, adequately responding to the required needs. [5]

This article thus presents the result of part of the research carried out for the R&D&i project PID2020-119469RB-I00 entitled "comprehensive 3D graphic survey of heritage. Optimisation of workflows and proposal of standards. 3DHERITATGE", funded by the Ministry of Science and Innovation/State Research Agency/ 10.13039/501100011033 as a specific case study of the needs and advantages of using computer tools to establish standards for photogrammetric documentation.

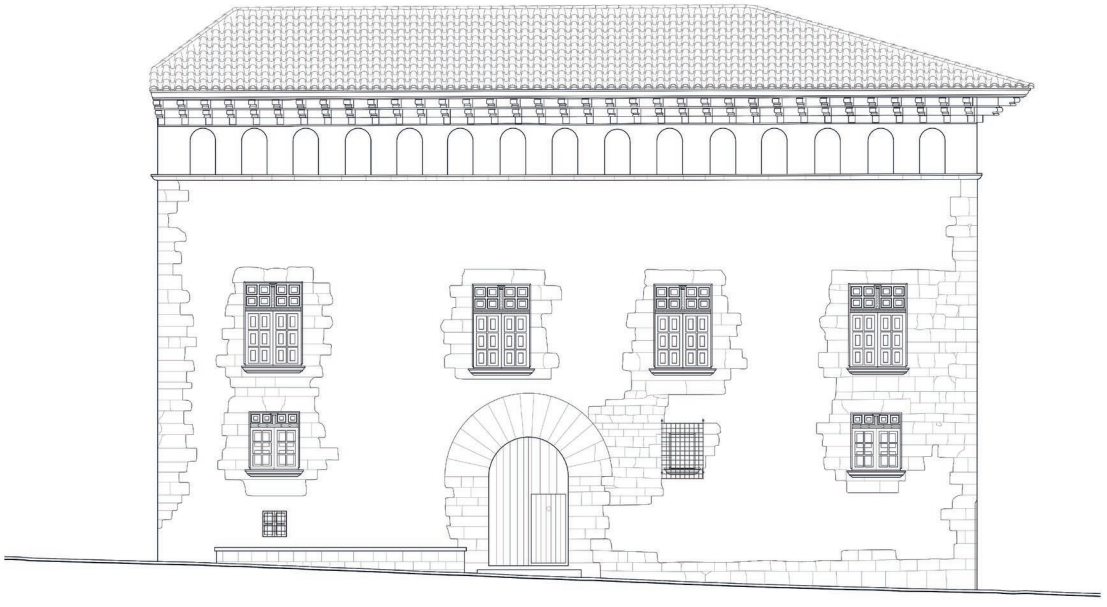

Figure 15. Main elevation of the Casa Castellot. Result of the post-production process. 2023.


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NOTES

1 " In the middle of the village there is a large square, the Plaza Mayor or Plaza de Aliaga. Two large mansions stand there, made of yellowish, blackish stone, with projecting eaves and, below it, a gallery with arches, most of them closed with stone walls."
These two large houses, due to their layout, seem to date from the end of the 16th century or the beginning of the 17th century; They do not have balconies, but rather large windows and a raised semicircular stone arch, with its voussoirs and spacious doors with their shutters. In one of these houses there is a sundial, white-washed with lime, with the Roman numerals of the hours engraved and painted black. The two dark houses, almost identical, stand in the square, facing each other, as if challenging each other. Perhaps they were built by rival families. During the first Carlist war they served as offices for employees and important people stayed there. Two sombre, sinister houses. Quite possibly haunted by goblins, souls in pain and the rattling of chains. If there had not been any, it is more than their fault due to the lack of imagination of the Mirambel's population. The other houses in the square are small, poor, with one or two floors, with simple windows and balconies, made of iron or wood." (Baroja and Nessi, 1931)

2 Aragonese Late Gothic and Renaissance architecture has traditionally been associated with the use of brick and plaster. These materials were widely used in the middle Ebro valley due to the scarcity of stone. The use of this "became more frequent the further one advanced towards the confines - both northern and southern - of the kingdom. In any case, it should be noted that if stone was available, and there were professionals capable of working with it in a convenient manner, it was almost always chosen" (Ibáñez Fernández, 2008)

3 "The term survey is understood as the set of investigations and operations aimed at determining the significant characteristics - under the morphological, dimensional, figurative and technological aspects - of a built organism or an urban complex, to evaluate and investigate it, with the purpose of constructing "a simplified three-dimensional model, through which the work can be analysed, thus facilitating the interpretation of its transformation phases and the various aspects referring to the most representative themes." Statement on the architectural survey, extracted from (Almagro Orbea, 2004)

4 "New technological resources involve increasingly complex documentation; it is not only about the drafting of more or less complete and detailed plans, but the creation of virtual 3D graphic drafts that analyse the architecture for study and to transmit their knowledge. (San José Alonso, 2018)

5 "Thus, in many cases the technological capacity exceeds the capabilities of the work teams, and this does not mean that the product obtained is of the expected quality. That is, the technological paradigm is resolved, but the processes and quality parameters required at each stage are not." (San José, 2018)

REFERENCES

Almagro Orbea, A. (2004). Levantamiento arquitectónico. Retrieved from https://digital.csic.es/handle/10261/19802
Baroja y Nessi, P. (1931). Memorias de un hombre de accion (XX). La venta de Mirambel (Caro Raggi). Retrieved from https://www.mirambel.es/wp-content/uploads/sites/79/2016/01/78318371-Baroja-Pio-MHA-20-La-venta-de-Mirambel.pdf

Cabezos Bernal, P. M., & Cisneros Vivó, J. J. (2012). FOTOGRAMETRÍA CON CÁMARAS DIGITALES CONVENCIONALES Y SOFTWARE LIBRE. EGA. Revista de Expresión Gráfica Arquitectónica, 17(20). https://doi.org/10.4995/ega.2012.1407

Carazo Lefort, E., & Martínez Gutiérrez, S. (2013). La generación digital. Más notas para el debate sobre una cibernética de la arquitectura. EGA. Revista de Expresión Gráfica Arquitectónica, 18(22). https://doi.org/10.4995/ega.2013.1680

Chías Navarro, P., & Abad Balboa, T. (2020). Levantamiento y utilitas: Las funciones de los edificios históricos. La Botica del Monasterio de El Escorial. EGA Revista de Expresión Gráfica Arquitectónica, 25(38), 32. https://doi.org/10.4995/ega.2020.12268

Ibáñez Fernández, J. (2008). La arquitectura en el reino de Aragón entre el Gótico y el Renacimiento: inercias, novedades y soluciones propias. Artigrama, (23), 39–95. https://doi.org/10.26754/ojs_artigrama/artigrama.2008237794

Raposo Grau, J. F. (2010). IDENTIFICACIÓN DE LOS PROCESOS GRÁFICOS DEL "DIBUJAR" Y DEL "PROYECTAR" ARQUITECTÓNICO, COMO "PROCESOS METODOLÓGICOS DE INVESTIGACIÓN CIENTÍFICA ARQUITECTÓNICA." EGA. Revista de Expresión Gráfica Arquitectónica, 15(15). https://doi.org/10.4995/ega.2010.997

Rodríguez Navarro, P. (2012). LA FOTOGRAMETRÍA DIGITAL AUTOMATIZADA FRENTE A LOS SISTEMAS BASADOS EN SENSORES 3D ACTIVOS. EGA. Revista de Expresión Gráfica Arquitectónica, 17(20). https://doi.org/10.4995/ega.2012.1408

San José Alonso, J. I. (2018). Levantamiento, tecnología y documentación de la arquitectura. EGA Revista de Expresion Grafica Arquitectonica, 23(34), 240–251. https://doi.org/10.4995/ega.2018.10937


DOI: https://doi.org/10.20365/disegnarecon.30.2023.9