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Nicolás Gutiérrez-Pérez
Architect, Extraordinary Prize in the Master in Advanced Architecture Project and PhD in Architecture (Heritage Intervention specialty) developed thanks to an FPU grant. His research focuses on the analysis, surveying, reconstruction and dissemination of the architectural heritage through the application of new graphic methods. Currently, holds a Margarita Salas postdoctoral grant of the UAH.

Manuel de-Miguel-Sánchez
Professor of Architectural Graphic Expression at the Department of Architecture of the University of Alcalá since 2004. He has taught at several universities and hold research stays at foreign centers such as the University of California Berkeley (CA, USA) the Institute of Urbanism of Paris (France), the Polytechnic of Turin (Italy) or the University of Novi Sad (Serbia).

A scalar approximation to the survey of the architectural, artistic and cultural heritage of the University of Alcalá (Madrid, Spain)

This work presents part of the experience accumulated by the research team of which the authors are members in data collection and information management for the representation of architectural and artistic heritage. To do so, we will analyze the results according to the characteristics of the elements to be studied, which we shall classify according to their scale, location, and nature. In this sense, we propose three working approaches: the L scale, linked to exterior urban spaces, the M scale, for buildings and their interiors, and the S scale, for movable objects and sculptures. Likewise, we address an aspect that is not often dealt with in scientific publications, such as the importance of the graphic planning of tasks and timings in order to make campaigns more efficient. In addition, we performed a critical analysis of the workflows prioritizing the characteristics of the object and the physical constraints that researchers in this field must overcome.
As a case study, we shall use the Chapel of San Ildefonso, the foundational space of the University of Alcalá (Madrid), declared a World Heritage Site by UNESCO. The heritage qualities of this space allow us to test and exemplify the work process according to the aforementioned scales of approximation. That is to say, the facade as an example of urban scale (L), the wooden coffered ceiling as the main element of the building´s interior (M) and the tomb of Cardinal Cisneros and the adjacent altarpiece as an example of movable scale (S). In short, the contribution is a reference for the effective planning and execution of the survey process, as well as for the processing of the models discussed.

Keywords:
Spanish renaissance; high-definition survey; façade; coffered ceiling; sculpture

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1. INTRODUCTION

The survey techniques applied to the representation of cultural heritage have evolved during the last years due to the significant progress in the appearance and development of new technological and methodological systems of digitization (Trizio et al., 2020). The experiences carried out in this field have enabled us to improve and implement the methods and results of the study, and to this end it is particularly important to disseminate them through scientific publications (Barazzetti et al., 2010). Among them, we can highlight recent research that, with different objectives, conservation, restoration, registration, etc. and techniques, laser scanning, terrestrial or aerial photogrammetry, etc. have advanced in this direction, taking into account the scale of the representation and the heritage theme (Remondino, 2011).
Digitization technologies applied to urban landscape and architecture have made it possible to record in millimetric form those spaces and constructions that stand out for their formal complexity (Luhmann et al., 2019) (Fig.1), their large dimensions (Aita et al., 2017) or their inaccessibility (Molina, Vidal, Cipriani & Denia, 2021), allowing a reduction in survey campaigns and a substantial improvement in the quality of these records (Fiorillo et al., 2013). In addition, these have made it possible to expand the paradigm and connect it with other objectives to understand those indirect aspects that require deeper reflection and are facilitated by 3D models. Such as, for example, the study of the internal logic of buildings (Martínez, Fernández & San José, 2018). With all this, we find recent studies that start from the digital survey for the study of the structural behavior of historic buildings (Onecha & Dotor, 2022), for structural and formal understanding (Alonso & Aliberti, 2019), for virtual reconstruction (Cianci & Colaceci, 2022), for the dissemination of the heritage. (Sánchez, Pàmies & Navarro, 2022), etc.
Likewise, the use of digital surveys applied to the recording of artistic heritage has experienced a remarkable expansion due to the applications and facilities that these media produce for the conservation and restoration of such objects (Bernardini et al., 2002). The use of point cloud generated with laser scanning and digitized photogrammetry allows us to digitally reconstruct hypotheses in case of missing small elements (Di Paola et al., 2021), as well as serving for the development of different three-dimensional models to determine the possible primitive configuration of an artistic object, particularly in the case of ancient sculptures that have lost important elements that comprised them (Fontana et al., 2022) and even the reconstruction of their original polychromy (Østergaard, 2019).

2. OBJECTIVES

The aim of the article is to disseminate the methods used by our research team to survey the architectural and artistic heritage at different scales: from the largest buildings to the smallest sculptures. Through this exhibition, we will share our vast experience in graphic data acquisition, showing the most efficient means and tools for the surveying of each object, as well as the efficient management of the time used in the data acquisition of the information obtained and the different uses of the models resulting from the applied software. We use these survey studies for the registration of the architectural heritage, as a basis for its correct conservation, as well as to discover the state prior to its intervention. In this sense, an effective and

Fig. 1 - Photogrammetric model of the tomb of cardinal Cisneros. By the authors.

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Fig.2. Volumetric analysis process from photogrammetric survey. By the authors.

in-depth survey allows us to know and understand the constructive and structural logic of the objects to be intervened or investigated, as well as to analyze the morphology of the systems with which they were executed according to the complexity of their conception (Fig.2). We also use these surveys to construct different hypotheses of graphic and virtual reconstruction of the lost or altered heritage, in order to understand its initial image and its evolution over time (Gutiérrez Pérez, 2023a).

3. TOOLS AND METHODS

Since its founding, this research group has sought to adapt the means to the objectives of each campaign, as well as to the scale of the future representation. We differentiate between two types of studies, a more abstract one, in which 2D or 3D drawings are made on the digital models, to develop architectural, constructive, structural analysis, reconstructions, 3D prints, etc., and another created with the purpose of recording the state of conservation in a digital file and which is repeated from time to time (5-10 years). The latter case requires greater precision and therefore a more exhaustive campaign. However, this difference is diluted at the time of data capture, since the average quality of the information obtained by default already serves both purposes. This is why we focus our efforts on defining an effective system based on the characteristics of the object rather than the ultimate purpose of the study.

For the development of these tasks, the team has three laser scanner models: a Leica RTC360 (2,000,000pts/s. and 1mm/10m accuracy), Leica BLK360 (360,000pts/s. and 4mm/10m accuracy) and Leica BLK2GO handheld for motion capture (420,000pts/s., and 10mm/10m accuracy). For automated photogrammetry, a DJI Mini 3 Pro drone is available, equipped with a 48 MP camera and a 1/1.3-inch sensor. For models that require a higher definition of textures and colors, photographs are taken with a high-resolution Sony Alpha 7 IV camera (up to 65 MP) and Zeiss Loxia 21 and 85mm fixed lenses. We also use different tools to facilitate the carrying out of the tasks (poles, photometers, spotlights, etc.). The data processing software used are CycloneRegister 360 for point cloud recording, Cyclone 3DR, also from Leica, for mesh processing, and Metashape, from Agisoft for 3D photogrammetry (Structure from motion). In addition, we use editing programs such as Rhinoceros, for 3D modeling. For the retopology and repair of meshes, Meshmixer and Instant Meshes. Finally, Photoshop and Cad are used to produce drawings and plans in the dihedral system (Fig.3).

4. CAMPAIGN SCHEDULING

As a first step in planning the survey campaign, it is advisable to have some graphic information available. In the case of outdoor spaces, maps available on the web (cadastre, geographic institutes, etc.) can be used to take measurements, calculate surface areas and determine orientations and number of obstacles. In the case of interiors, and in the event that documentation is not

Fig.3. Study of geometry and proportions as an application of the survey. Elevation based on the golden ratio. By the authors.

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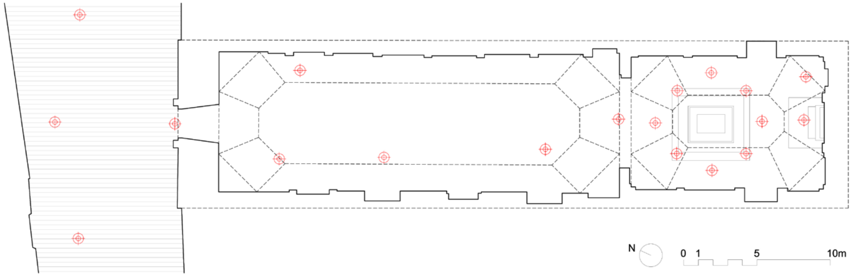

Fig.4. Work plan carried out for the preparation of the survey campaign with laser scanner positions in the chapel of San Ildefonso. By the authors.

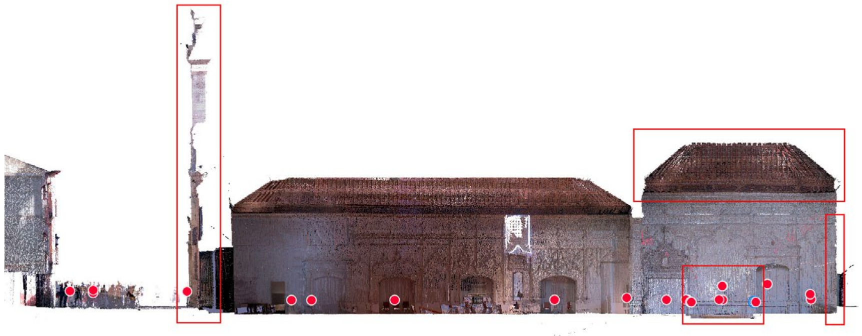
Fig.5. Section of the point cloud model, indicating the effective location of the scans in the chapel of San Ildefonso. By the authors.

available, it will be necessary to resort to historical archives, town halls or publications; or, even, it can be generated by the team itself (Fig.4).
With respect to the scanner, and based on this information, different sketches are made to determine the positions of the stations, the number of which will depend on the complexity and size of the building and its rooms. As a general rule and in order to obtain an acceptable working resolution, it is appropriate to make four starting stations outdoors: one facing and separated from the front cover, two on each side, and one under the door threshold. If the facade is very long, the number of scans will be extended until the facade is completely covered. Indoors, it seems appropriate to perform a scan per room if it is less than 100m² of surface and is square. If it is elongated and has barrier elements, this number must be extended the entire room is captured. In any case, it is necessary to scan under the thresholds of the openings that connect the rooms to improve the connection of the stations in the software. By means of this forecast, it will be possible to establish an approximate survey time according to the resolution at which the recording is needed. As a general rule, we use an estimate of 6 minutes per scan (including travel and positioning). This preliminary work also allows us to calculate the number of batteries needed in case there is no power outlet for recharging (approximately 12 scans per battery). Regarding the office processing work, we estimate 30 minutes before and between 2 and 4 hours after the field work to complete the model and obtain the orthophotos of plans and sections, depending on their size and the complexity of the model (Fig.6).
The resolution of the scans is variable depending on the work scale. The campaign has two types of captures. The medium resolution ones provide scans of 10 million points and high resolution scans that capture 50 million points. The support points taken from the scanner to orient and scale the photogrammetric model have the precision of the ensemble model. This is made up of 23 scans, has half a million points and has an average cloud-to-cloud error of 6 millimeters.
Regarding the photogrammetry campaign, we took as an example the survey of a facade. To calculate the number of photographs, we usually work with the percentage of overlapping of one image with the contiguous (Sánchez, Melendreras & Marín, 2020). We translate this concept into a graphical layout. On an elevation, we draw what we call key points, which are the ones the camera looks at. To estimate the distance between them, the photographic lens used must be taken into account. In our case, a 21mm fixed wide-angle lens is the most commonly used for all three scales. Occasionally we use another 85 mm for medium-distance details, such as a keystone in a vault or similar. Although the lens allows a visual cone to be captured, the cropped format of the photo-


Fig.6. Laser scanning of the chapel of San Ildefonso showing the complete architectural organism treated. By the authors.

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graph is limited by a rectangular pyramid with a smaller aperture. It is the angles of the latter that we are interested in to determine the distance between what we call key points.
The 21mm lens with 3:4 format forms a rectangular pyramid limited by angles of 53º and 74º in the height and width of the photograph respectively. Accordingly, for each point to appear in at least four images (recommended) the shots should be spaced at a distance equal to the separation of the camera from the object. This rule is not precise, but it is very easy to remember. If we take pictures 4 meters away from a facade, the key points should be separated by at most the same distance in the short direction of the frame. In the case of

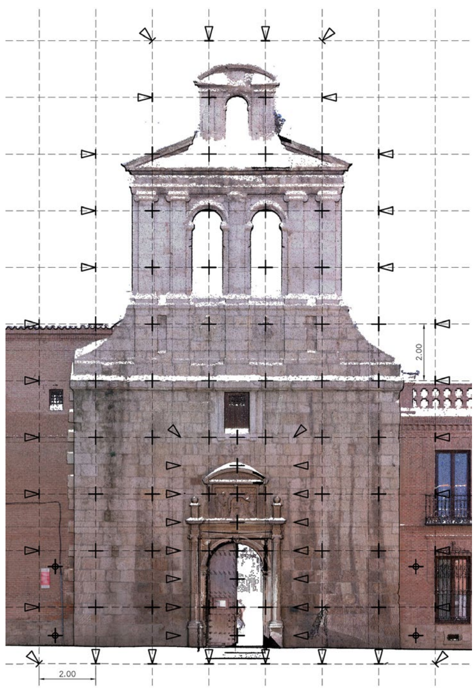

Fig.7. Elevation of the chapel indicating the key points and targets. By the authors.

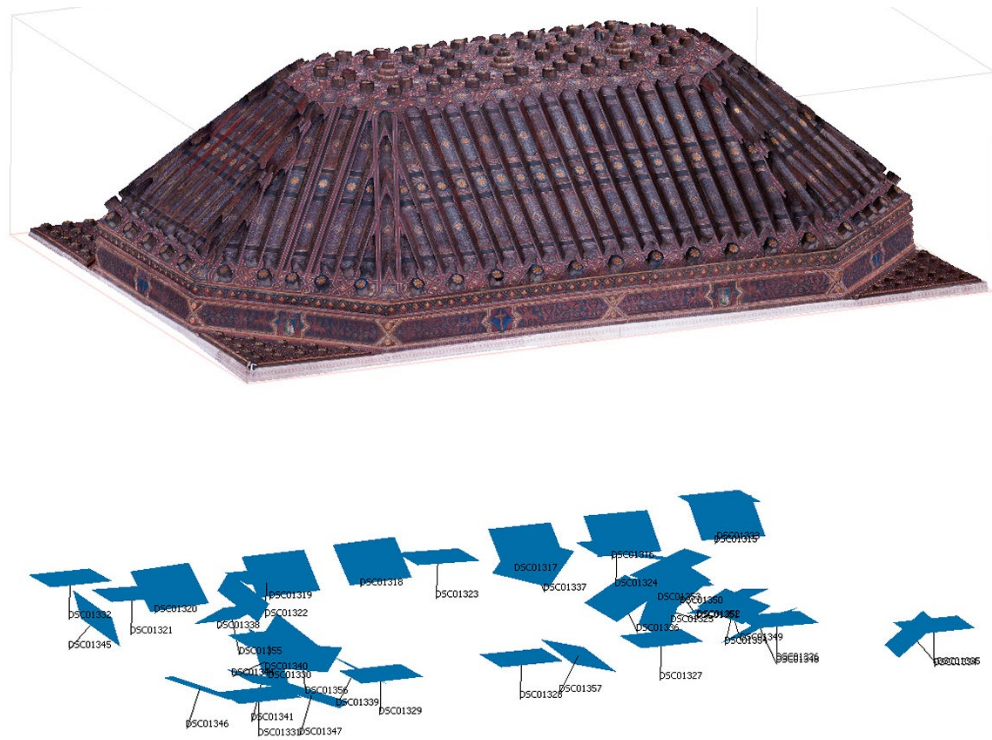

Fig.8. Photogrammetric model of the Coffered ceiling indicating the camera positions. By the authors.

the drone camera, the default visual pyramid angles are 52º and 66º (although it has a zoom, it is not advisable to use it for photogrammetry).
As a general rule and to simplify the rules to be used, we decided to apply the same criteria for the two cameras, the handheld camera with a 21 mm lens and the drone camera. On the other hand, our experience tells us that it is better to have more shots than necessary, so whenever possible we divide the distance between key points by two, increasing the recommended minimum number of shots per point by up to three times. In short, we set the limit of separating the key points by half the distance from the camera to the element. For example, on a facade, we take photos from 4 meters away and separate the key points 2 meters from each other. This rule is complemented by the reduction to an even smaller fraction (1/4) in the case of decorated areas, usually with forms of greater relief and separated from the facade plane.
Outdoor photographs can be taken about 5 per minute, including shooting time plus camera movements, both with a handheld camera and drone. However, indoor series can multiply the times by five and reduce the number of photographs to 2 per minute. For the photographing of an element that requires 100 photographs, it can

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be estimated that if the lighting is that of an exterior it will take about twenty minutes, while for interior or low light spaces we will have to reserve almost an hour of the work plan.
Photogrammetry office working times are generally more variable than those of laser scanning. The preliminary work requires about half an hour for each item to be studied and the subsequent processing about two hours. This means that, in the Chapel, the complete data collection work -office plus fieldwork- of the laser scanner is 6 hours and the photogrammetry work, taking into account that four elements will be modeled and once we know the number of photographs to be taken and the type of element to be studied, we estimate that approximately 14 hours will be invested.

5. CASE STUDY

The University of Alcalá was the great intellectual and urban planning project promoted by Cardinal Cisneros in 1499 in the Castilian town of Alcalá de Henares (in the present-day region of Madrid). The construction of its first buildings was the seed for the expansion of this university city during the sixteenth and seventeenth centuries, consolidating an urban center of extraordinary architectural and cultural richness, as was recognized by UNESCO in its declaration as a World Heritage City in 1998 (Echeverría, 2005). Unfortunately, the transfer of the university to Madrid at the beginning of the 19th century led to the abandonment of numerous buildings, and it was civil society itself that came to the rescue of its heritage in the middle of the same century (García Gutiérrez, 1986). Thanks to this work, it was possible to re-found the University of Alcalá in 1977 and establish it in the surviving historic buildings, receiving an enormous patrimonial legacy to promote, conserve and recover (Rivera, 1995). For all these reasons, this university offers an incomparable setting for the practice of lifting due to the great typological diversity of its heritage: monumental facades, portals and belfries, cloisters, coffered ceilings, vaults, staircases, sculptures, and altarpieces.
Specifically, to exemplify our experience in the survey work we will focus on the study of the chapel of San Ildefonso, which is part of the foundational complex of the University of Alcalá together with the College of San Ildefonso, the Paraninfo, and the rest of the spaces that constituted the primitive academic program, forming the so-called "Cisnerian block" (Castro & Olmo, 2013) (De Miguel Sánchez et al., 2023). This building brings together the three types of elements through which we can exemplify our practice and experience in the survey: firstly, the main façade, secondly, an interior architectural space of great spatial and material richness (with a wooden ceiling of great formal complexity) and, thirdly, some smaller artistic elements that complete the scene (an altarpiece and specifically the large tomb of Cardinal Cisneros) (Fig.9 and Fig.10).

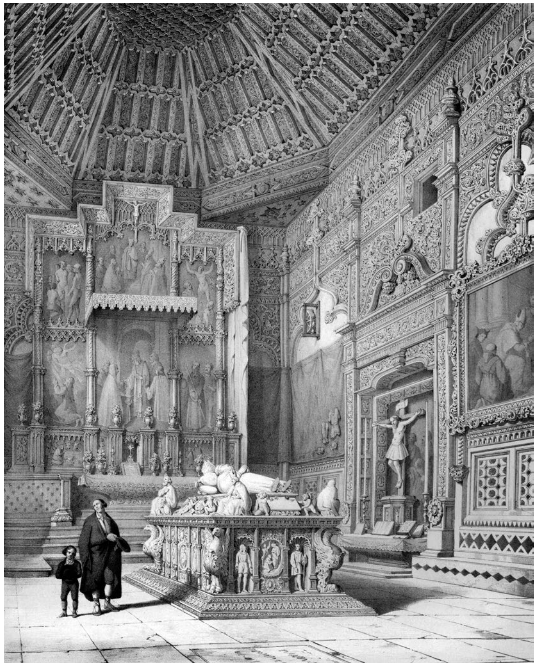

Fig.9. Old drawing of the chapel of San Ildefonso by Jenaro Pérez Villaamil (1842)

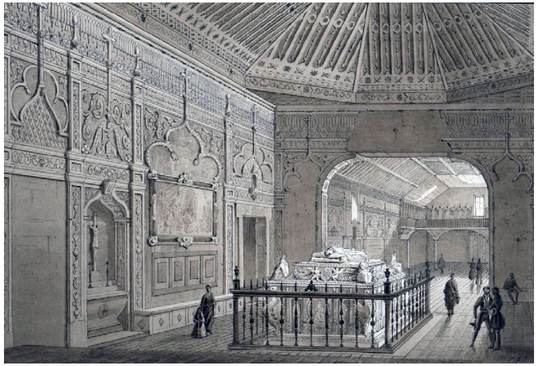

Fig.10. Old drawing of the chapel and nave of San Ildefonso by José María Avrial y Flores (1839).

The chapel of San Ildefonso was built between 1498 and 1510 by Pedro Gumiel at the expense of Cardinal Cisneros. It was built with modest materials, in order to speed up the construction process due to the advanced age of the client, who wanted to see his work completed (Quintana & Rivera, 2014). The building is organized on a longitudinal axis in which there is a single nave topped by the main chapel of the temple (Muñoz, 2013). Following the Spanish building tradition, the simple architecture with which this chapel was executed is overshadowed by the richness of the decorative elements that make up its interior and that were commissioned to the best artists of the time. Among others, the plasterwork, the wooden coffered ceilings that cover the naves (Nuere, 2013) (González Uriel et al., 2019), the work of Alonso de Quevedo, the altarpiece (now disappeared) commissioned to Juan de Borgoña, and, highlighting in this set, the important tomb of the Cardinal, work in Carrara marble by Domenico Fancelli (Migliaccio, 1992), Italian sculptor who also made the tombs of the Catholic Monarchs in the cathedral of Granada. This work, one of the finest examples of Spanish Renaissance sculpture, was installed in the center of the chapel in 1521 (González Ramos, 2018). Unfortunately, many of the elements that

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Fig.11. Current state of the head of the chapel. By the authors.

made up the original scene seen in Figures 9 and 10, are now missing and many others have deteriorated significantly (Fig.11).

5.1 SCALE L - URBAN/OUTDOOR: FACADE OF THE CHAPEL

The characteristics of the facade make it advisable to carry out a main photogrammetric model with the support of the scanner's point cloud. To make this cloud, 360º scans are taken in four positions. Three of them are on the street, distributed at angles of 45 and 90 degrees with respect to the facade plane, at a distance of approximately 6 meters. The fourth scan is performed at the threshold of the entrance door.
For the photogrammetric model, an estimated 106 photographs are needed (Fig.12). In this case, the austerity of Castilian architecture, with sober general lines and decoration concentrated on certain elements, indicates that the camera is located about 4 meters away and the key points every 2 meters. For the most decorated part, key points will be marked every meter and the camera will be two meters away from them. Targets attached to the side walls are placed in the accessible areas (Fig.7). The orientation of the facade is north, so the most suitable natural light is that of a slightly cloudy day. This circumstance entails certain difficulties in terms of equipment organization and permit management.
Finally, 110 photographs are taken in approximately 30 minutes. With these images, a photogrammetry cloud is generated, in which 6 markers are inserted with their coordinates, taken from the point cloud of the laser scanner. The model is thus scaled and oriented. Then, the required graphic outputs are chosen according to the work to be performed. The result is an elevation of great geometric and textural quality, which allows us to study the proportions of the project and to document the state of conservation of the stone. The textured mesh has more than four million faces and the facade orthomosaic has a resolution of 2.37 mm/pix.

5.2 SCALE M - BUILDING/INTERIOR: COFFERED CEILING

The ceilings of the Chapel are wooden ceilings of varying complexity. On the one hand, the ceiling of the long nave is a ceiling called "ataujerado", that is to say, it is formed by a wooden board to which thin slats are attached to form the decoration. On the other hand, the ceiling of the chapel is

Fig.12. Survey of the façade by photogrammetric model (left) and of the interior by means of a laser scanner point cloud (right) of the chapel. By the authors.

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Fig.13. Geometric analysis of the plasterwork of the chapel of San Ildenfonso through the point cloud model. By the authors.

"apeinazado", formed by rafters and short wooden pieces intertwined forming eight-pointed stars, making the structure and decoration a unit and therefore a work of architecture of greater value. The scanner positions are chosen to ensure that all chapel and window openings around the rooms are recorded and that the wall and ceiling decorations are well documented. This makes it possible to obtain highly accurate planimetry and ortho-images in the form of plans and sections (Fig.13). In the nave 5 scans are taken and in the chapel 10, which added to the 4 scans of the exterior add up to 19 in total. This field work lasted approximately two hours.

Fig.15. Photogrammetric model of the Coffered ceiling of the head of the chapel of San Ildefonso. By the authors.

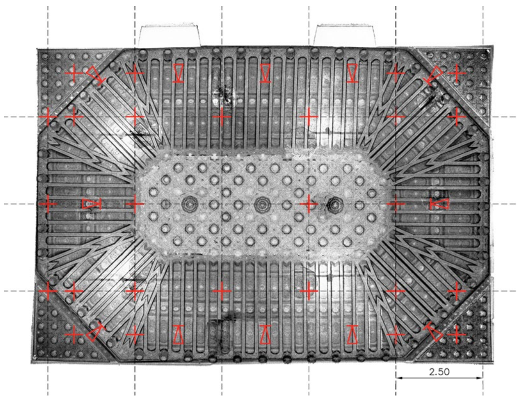

Fig.14. Plan of the coffered ceiling of the apse of the chapel of San Ildefonso indicating key points. By the authors.

For the ceiling photogrammetry model, the highest area of the roof, 11.6 meters from the ground, is measured and the height of the camera tripod is subtracted. The difference is approximately 10 meters. The main key points are located every 5 meters (Fig. 14). These are complemented by oblique shots at the middle distance. It is estimated that about 38 photographs are necessary, making sure that all planes are visible, which is achieved by controlling the angle of inclination of the camera with respect to the ceiling plane. Several shots are taken with the nadir point of view (vertical from below) and other oblique shots. It is necessary to use portable lighting, without screen, which improve the illumination of the wooden structure.

During the work session, 41 photographs are taken. For orientation and scaling, 6 markers from the scanner cloud are used, after selecting the vertices of the ceiling itself, since it is not possible to place targets at the height at which they are located. All ceiling surfaces are visible to the camera and this produces a homogeneous model of optimum quality (Fig.15). The mesh is almost two million faces and the orthomosaic is 2.76 mm/pix.

5.3 SCALE S - FURNITURE/SCULPTURE: TOMB AND ALTARPIECE

The chapel of San Ildefonso is a space whose natural light invites meditation, but it is very scarce for photography. The lighting of the tomb is done with the assistance of portable spotlights, which move with the camera. Diffuser screens are placed to

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shade the light and avoid the appearance of hard shadows, which could hinder the definition of the digital model. In terms of the number of images required, the camera is placed at a distance of one meter, so the key points are approximately half a meter apart. It is estimated that each of the five faces of the monument requires the taking of at least 20 photographs, since the volumes of the figures require several oblique shots. In addition to another 10 for each sculpture located at the vertices (Fig.16). This involves taking 140 photographs. Taking into account that the camera is in Aperture mode and that it automatically regulates the exposure time, each shot takes about 12 seconds, plus another 12 seconds to move the equipment, which means that an hour and a half of work is necessary, to which must be added the preparation and collection of the equipment, in total two hours of field work.
The study of the tomb is focused on the documentation of the state of the sculpture, so it is very important that the qualities of the shape and texture of the photogrammetric model are maximized. For this purpose, 8 targets are fixed in the vicinity of the sculpture, which are captured by both the photographs and the laser scanner. The photogrammetric model is made by aligning 147 pho-

Fig.17. Detail of the photogrammetric model of the tomb of Cardinal Cisneros, in which the definition of the mesh can be observed. By the authors.

Fig.16. Photogrammetric model of the tomb of cardinal Cisneros indicating the camera position. By the authors.

tographs. It is verified that the quality is optimal, both in geometry and lighting. The point cloud is then oriented and scaled using the positions of the 8 targets as markers. The graphic outputs are high-resolution plans and elevations, as well as axonometric perspectives and detail videos, which allow the current state of the sculpture and its material to be documented and visually verified (Fig.17). The mesh has 33 million faces and the orthomosaics are 0.54 mm/pix.
We also took data from the Altarpiece. The objective in relation to this element is to obtain a faithful model of the sculptures and reliefs that will allow a detailed iconographic study. A photogrammetric model is also proposed, scaled and oriented, following a process similar to that of the Sepulcher. It is estimated that about 15 photographs are necessary to record the altarpiece from its front, but the separation of the columns from the main body requires additional side shots. It is decided to take 30 photographs. Finally, 39 are made and with them the point cloud and a textured mesh are generated. The mesh has 7 million faces and the orthomosaic 1.3 mm/pix (Fig.18).

6. DISCUSSION

The different captures of the laser scanner and their connection allow the study of relationships between the different parts of the building and its

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elements, thickness of walls separating rooms from the street and from each other, thickness of vaults and roof structure, or position of ducts or basements in their position relative to the main plane of the building, etc. The scanner captures the complete building, generating a base model that we call architectural organism in which the different elements are integrated. This technique is fundamental for the realization of plans and general sections of the architecture and the fundamental knowledge that derives from them.
Photogrammetry is reserved for the most representative elements, those that can be susceptible to restoration and maintenance work and that can benefit from the details of visual quality (Fig.18).
As a graphic output, the photogrammetric model is usually exported to a CAD program such as Rhinoceros that allows projecting curves directly on the textured mesh surfaces. These are mainly used to analyze morphology and make 3D models (Figs. 2, 3 and 19).
It should be borne in mind that when surfaces show materials such as wood, brick or stone, which are frequent in heritage buildings, the quality of the results is higher. Structure From motion software identifies singularities as homologous points. Therefore, when the texture is smooth and the color is uniform, the algorithm has more difficulty in extracting the information. Regarding the material of the objects to be documented, the most difficult case is the presence of reflective or polished objects. Special cases to be treated are mirrors. Both laser scanners and photographs capture the reflection points and place them on the other side of the mirror. The point cloud must be corrected, eliminating these reflections before they are confused with those that make up the real space that is the object of the campaign.
The use of drone with camera is very interesting, because the high areas of the buildings are difficult to access from the street level. The upper faces of overhanging elements such as cornices or eaves are best recorded from the elevated position of the drone. The drone is also particularly efficient for photographic scanning, as it moves millimetrically on the vertical and horizontal axis.

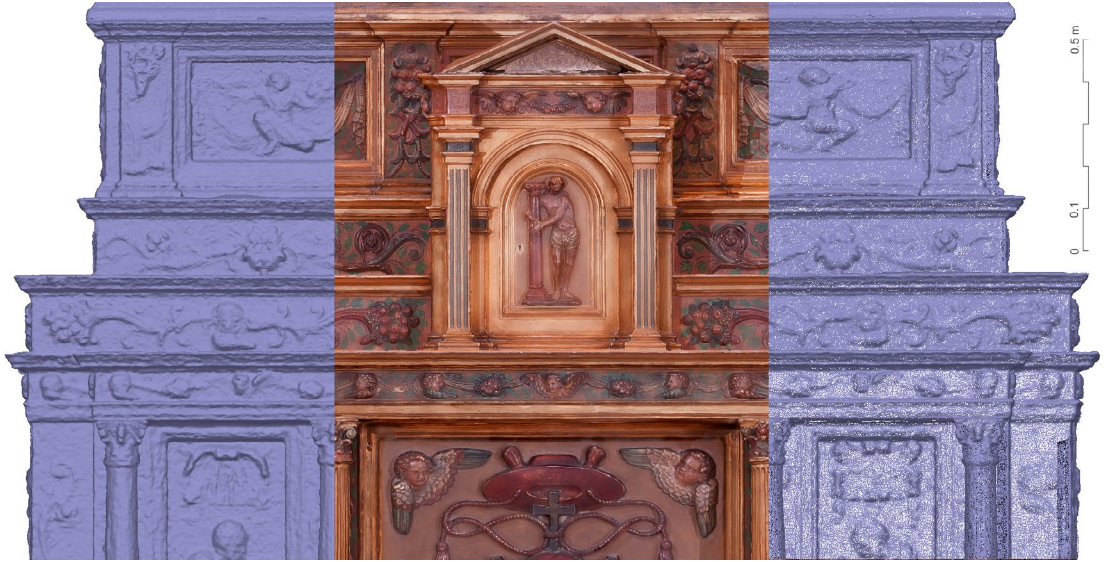

Fig.18. Detail of the photogrammetric model of the altarpiece, combining three visual styles. By the authors.

Two photogrammetric models are usually made with the images, one with those taken with a handheld camera from the street plane on one side and the other with those from the drone camera on the other, to later merge them into one.
In outdoor campaigns, it is necessary to determine the best possible lighting. Therefore, it is necessary to monitor the weather. A cloudy day is preferred. Backlighting and direct solar radiation against the facing to be scanned shall be avoided.
For indoor shooting of sculptural objects, lighting is especially important and we resorted to the use of spotlights, which move around to support the camera. Diffusers and reflective screens are used to obtain a more homogeneous illumination and to avoid possible variations in shadows that would make it difficult to align the photographs.
The presence of obstacles is one of the most difficult problems to solve when taking data of an architectural object. Outside, we often encounter the presence of vehicles on the streets, near the facade to be studied, or street furniture, construction site huts, flags, trees, etc. It is common to take data on different days, with different environmental circumstances and to complete the models by means of partial modifications.
Indoors there are also a large number of obstacles, usually furniture, which prevent the space and objects from being captured at once, and complex office modification processes have to be resorted to once again. New laser scanner point cloud capture and registration programs now allow moving objects to be removed automatically, assisting the operator's work, but stationary obstacles still require cleanup.
The combination of point clouds from different sources is useful when one of the models produces an erroneous or poorly defined area. In general, the studies presented here have not required the actual fusion of point clouds from different

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origins, except for the scanner support points already mentioned.
The following table summarizes the work and survey process according to the heritage elements discussed in the article.

7. CONCLUSIONS

When it comes to data collection campaigns for heritage objects, in addition to the type of study to which the information is to be dedicated, the characteristics of the element must be taken into account. A brief and practical classification helps to determine the limits of the result, since not all techniques are applicable to every object, and to schedule tasks as efficiently as possible. In this

		SCANNER		PHOTOGRAMMETRY			
SCALE		NUMBER OF SCANNER SOCKETS	USE OF TARGETS	AVERAGE CAMERA-TO-ITEM DISTANCE	DISTANCE BETWEEN KEY PTS	CAMERA TYPE	ILLUMINATION
L	FACADE	3+1 DOOR	YES	4 M	1 EVERY 2M +1 EVERY 1M (DETAIL)	DRON + HAND-HELD CAMERA	CLOUDY DAY WITHOUT RAIN OR WIND
M	CEILING OR VAULT	8-12	NO	10 M	1/5 M+1/2.5 (DETAILS)	HANDHELD CAMERA	POWERFUL SPOTLIGHTS WITHOUT SCREEN
S	SCULPTURE OR FURNITURE	4	YES	1 M	1/0.5 M	HANDHELD CAMERA	SPOTLIGHTS WITH SCREEN

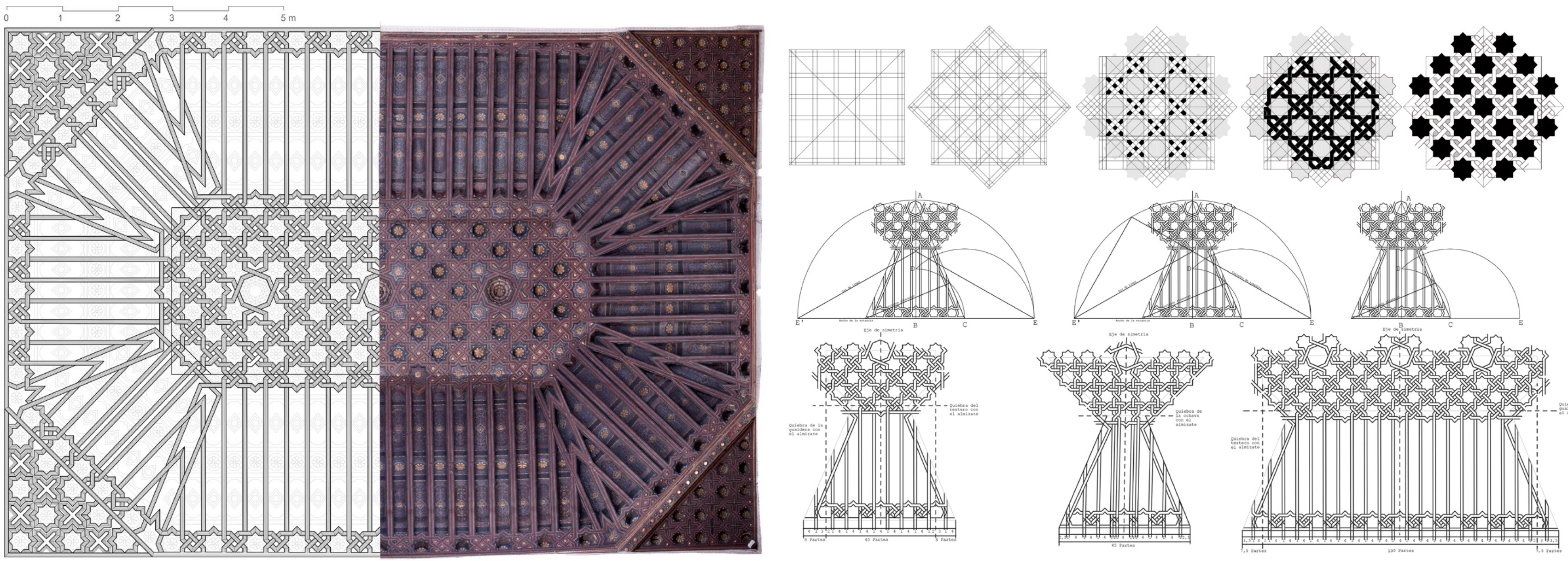

Fig.19. Practical application of the survey to make drawings, diagrams and photogrammetric survey of the coffered ceiling. By Miriam Fernández and the authors.

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case, the classification into three scales has been a useful tool for this team of researchers, since most of the particularities that have been alluded to are adequately identified in these three sections.
In the case of this data collection campaign on the Chapel of San Ildefonso, the characteristics of each element have become more decisive than the type of study to which the information is to be dedicated. This research has defined the optimal quality limits of digital capture and has proven that the levels of definition obtained are useful for both conservation status studies and morphological analysis.
In short, and in accordance with the objectives of our work, registration prior to the intervention, conservation work, constructive, geometric, and formal study, etc., we can affirm that the methodology described above is very effective in achieving them in the shortest possible time and that the management of the archives obtained is efficient and coherent for our practical work.

Fig.20. Photogrammetric model elevation of the tomb of Cardinal Cisneros. By the authors.

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