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To cite this article: Manuel De-Miguel-Sanchez, Miguel Fernandez-Cabo & Ana Gonzalez-Uriel (2026) Main rooms and coffered ceilings as definers of a noble palace model in renaissance Spain. The case study of the palace of Peñaranda de Duero, Spain, Cogent Arts & Humanities, 13:1, 2521208, DOI: [10.1080/23311983.2025.2521208](https://doi.org/10.1080/23311983.2025.2521208)

To link to this article: <https://doi.org/10.1080/23311983.2025.2521208>



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Published online: 04 Feb 2026.



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Main rooms and coffered ceilings as definers of a noble palace model in renaissance Spain. The case study of the palace of Peñaranda de Duero, Spain

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ABSTRACT

The palace of the Counts of Miranda in Peñaranda de Duero (Burgos) is one of the main palatial works of the Spanish Renaissance of 16th century Castilian nobility. Here we find a harmonious coexistence between the Gothic and Hispano-Islamic traditions and the emerging Renaissance trends. Previous studies have highlighted that the Renaissance in the Iberian Peninsula has not been adequately valued due to its hybrid nature. Studying works such as this one aim to deepen the understanding of the evolution of this architectural model in its passage from the Middle Ages to the Renaissance. The methodology has consisted of studying the architecture and its decorations from a morphological, geometric and decorative point of view and comparing them with those of other palaces of the time. For this purpose, drawings of its characteristic elements have been made from a 3D laser scanning and automated photogrammetry survey. Among these the coffered ceilings stand out because they define the typology from its roots. The visual and spatial hybridization present in this palace is the result of the confluence of a system of organization of guilds and construction, the previous existence of a repertoire construction techniques and decorative resources and the connection with humanistic ideas.

ARTICLE HISTORY

Received 10 June 2024

Revised 30 April 2025

Accepted 13 June 2025

KEYWORDS

Spanish renaissance architecture; palatial typology; palace of the Counts of Miranda; architectural hybrids; Mendoza family; Hispano-Islamic decoration; coffered ceilings

SUBJECTS

Architecture; History; Cultural Studies

Introduction

This research addresses the question of the existence of a hybrid image in the early modern period in the Iberian Peninsula. It aims to determine whether this image arises from a mixture of Muslim and Christian craftsmen, or from a superposition of elements from different periods, or whether, on the contrary, it is the product of a full integration of forms on the same construction system, in which carpenters, stonemasons or bricklayers master both practices and apply them in an unprejudiced way.

Renaissance tendencies began to be introduced in Spain, first under the Catholic Monarchs and then during the reigns of Charles I and Philip II. Castilian noble families such as the Mirandas, and especially the Mendozas, served as spearheads in this transformation of Spanish architecture, while were reluctant to fully abandon its Hispano-Islamic traditions. This persistence led to a hybrid aesthetic that combined traditional systems developed in the Iberian Peninsula during the Middle Ages with the new tendencies aimed at reviving Roman values.

The medieval noble residences of the Iberian Peninsula were essentially castles, fortresses isolated from urban centers, adapted to the constant struggle between kingdoms, both Christian and Muslim. At the end of the 15th century, the consolidation of the catholic monarchy and the unification of Spain led to a period of greater social and political stability and made it possible to abandon defensive residences and establish new palaces in urban centers. Furthermore, there was an improvement in infrastructure, boosting trade and the economy and increasing the population of cities. The nobility played a crucial role in shaping urban centers through the construction of buildings that reflected their status and power (Violich, 1963).

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The political changes of the late 15th century transformed public space and the relationship between cities and the great centers of power. The characteristic Spanish public square, or *Plaza Mayor*, developed in the main towns and became the center of commercial, social, political, and religious activity. The church and the town lord's house, reflecting the wealth and power of the nobility, were built around the square. Municipal rulers promoted buildings to house councils and local officials, and to hold public events. This new type included public arcaded galleries on the ground floor and balconies above (Gordo Peláez, 2012). The main square of Peñaranda de Duero fulfills all the characteristics of these new Castilian Renaissance spaces, with its grand palace, church, and arcaded buildings.

The Castilian high aristocracy established a policy of alliances that consolidated its power. The different groups competed to obtain concessions from the kings in the form of titles and territories. Some of the most influential families of the time, such as the Álvarez de Toledo and the Guzmán families, were known for their military power and for accumulating enormous properties and wealth (Monsalvo Antón, 2016). Another prominent family was the Mendoza family. Cardinal Pedro González de Mendoza was an advisor to the Catholic Monarchs and had a great influence on the consolidation of the Spanish monarchy, the expansion of the Renaissance, and the political support for Columbus' voyages to America (Nader, 1986, 2004).

In addition to their political power, the Mendoza family was an important patron of the arts and education. They sponsored artists, writers, and architects. They promoted key buildings for the Spanish Renaissance. Some authors rightly point out that these buildings applied Renaissance forms to a traditional Gothic structure (Martín García, 2005). The case of the architect Lorenzo Vázquez de Segovia, who worked for Íñigo López de Mendoza, Count of Tendilla and nephew of the Cardinal, is well-known. It is believed that he traveled to Italy, where he experienced firsthand the new Renaissance architecture. Upon his return, he became the principal architect for the powerful family. An architect gifted in composition and design, who sometimes included Gothic and Andalusian motifs, because they were current languages in Castile at that time (Sobrinho González & Feito Fernández, 2024). The Cogolludo Palace, completed around 1495, is the Segovian architect's most notable work and is considered by many authors to be the first truly Renaissance building in Spain. It was promoted by Luis de la Cerda, Duke of Medinaceli and cousin of the Count of Tendilla. It is organized around a courtyard, with the main rooms opening onto the plaza. The façade is reminiscent of a spectacular Florentine palace, although the windows display Gothic decoration.

Another element that appears in this type of palace, although beyond the scope of this study, is the development of the Spanish cloister staircase. This staircase configuration emerged in the late Middle Ages, linked to both religious buildings and urban palaces. At the entrance to the palace, there was a wide vestibule from which the great courtyard could be seen. The staircase was positioned to connect to a diagonal visual axis, adapted to the aristocratic ceremonial of the time (Martínez Montero, 2014). From a closed medieval model, consisting of two flights, it evolved into a wide, open space facing the cloister, with three flights of stairs and two landings, often covered by a magnificent coffered ceiling or vault. Among many others, the works of architects such as Lorenzo Vázquez and Alonso de Covarrubias stand out. Although Renaissance inspiration is strongly present, this particular staircase model is considered to be of Spanish origin and to have influenced some later Italian works (Pevsner, 1957, Wethey, 1964).

The new palaces of the great Castilian families, Palacio del Cordón (Burgos, ca. 1476), the Ducal Palace of Cogolludo (Guadalajara, 1492), Altamira Palace in Torrijos (Toledo, late 15th century), the Palace of the Hurtado de Mendoza in Almazán (Soria, late 15th century XV), Infantado Palace in Guadalajara (late 15th century XV), the palace of the Counts of Miranda in Peñaranda de Duero (Burgos, 1536), The Ducal Palace of Pastrana (Guadalajara, 1550), etc. respond to a specialised scheme of noble palaces that began to take shape a hundred years earlier (Paulino Montero, 2013). These rural centres of power lost their medieval defensive character and were formally enriched by bringing together Gothic, Andalusian and Renaissance influences. A century later, as the nobility moved closer to the court, these palaces were left to fall into a state of abandonment. They are constructions that respond to a very specific period, lasting little more than a century, and respond to territorial power structures. This circumstance, which is negative in terms of the destruction of built heritage, nevertheless makes it possible to study these buildings since the surviving examples have preserved many of their elements in an almost original state.

This work aims to verify the validity of these buildings as a model of Iberian Renaissance. It is a group of buildings with a certain degree of homogeneity, reference for the Spanish architecture at the end of the Middle Ages. In these examples we observe a linear sequence of main rooms facing south or south-east, located on the main floor and opening onto a square (Figure 1, 2). Medieval palaces had a defensive character and used to locate the living rooms in the interior of the estate, but in the new configuration they are brought into the urban space. There is an elongated room in the centre, dedicated to representative functions, with access from the cloister, connected at the ends with private rooms, generally divided into a chamber and an antechamber.

Finally, this research proposes to assess the importance of the most peculiar elements in the configuration of the most representative spaces of the palaces of the Spanish Renaissance. Main rooms are crowned with the finest wooden ceilings, signalling the hierarchical importance of these spaces. The geometric designs of the coffered ceilings in the different palaces share similarities, although there is an enormous variety of solutions. These elements integrate structure and decoration, support only their own weight and require a roof above to protect them. They are interior structures which reach a great height



Figure 1. Palace of the Counts of Miranda in Peñaranda de Duero, Burgos. Façade opening onto the Plaza Mayor. Photograph by the authors. The raised front above the windows on the upper floor stands out. This windowless strip corresponds to the great height of the wooden ceilings.



Figure 2. Point cloud of the six main rooms on the upper floor. Image by the author. On the upper floor, facing the town square, are the main rooms. In the centre is the elongated hall, with access from the cloister. At the ends are rooms and anterooms for different uses in the palace.

in their section, forcing the walls of the façade to be raised, and thus creating a peculiar image of an elevated front.

Literature review

The framework in which this research is presented is that of the architecture of the 15th and 16th centuries in the Iberian Peninsula. Its starting point is the discussion on the hybridization that occurred at that time because of the persistence of the Gothic tradition, the influence of Al-Andalus and the arrival of Renaissance forms from Italy at the beginning of the modern period. It is perhaps this hybrid character, its amalgamated appearance, that has caused Renaissance and Baroque Iberian architecture to be relegated to second place, compared to art considered canonical. The canons of both northern and southern Europe do not fit with the peninsular diversity. For this reason, hybridization is considered by some authors to be a useful term for understanding regions that are more difficult to classify (Fernández-González & Trusted, 2020).

Most of the scientific literature dealing with Renaissance art in the Iberian Peninsula offers a simplified image of the origin of the techniques and styles that comprise it. An example is the indiscriminate use of the term *Mudejar*, a name given to the Muslims who inhabited Christian territories. This adjective is often used to refer to almost all the decorations that emerged in the 15th and 16th centuries, although its Andalusian influence is doubtful. It is known that the regulation of the built environment by the imperial administration of the Iberian territory maintained the basis established in the Middle Ages, in which the *Alarife* or master builder was the main figure (Fernández-González, 2020). The regulations imposed preserved a large part of the traditions, compiling the previous orders, although they also included important changes, following European trends. This situation produced a hybrid construction trade, made up of various influences. Among them was the circulation of collections of drawings and treatises that represented the classical language in architecture. The builders trained according to this system proliferated their works in numerous cities, both on the peninsula and in America.

These early modern Iberian architecture feature Andalusian decorations, such as plasterwork, combining both geometric lacework design and Renaissance designs. Also very common is the presence of glazed tiles, called *azulejos* on interior plinths, with both geometric Andalusian-inspired and Renaissance designs (Ventura Teixeira, 2020). And the coffered ceilings, which continue to use the medieval type of structure of *par y nudillo*, that can be translated as rafter and collar tie, to which classicist forms are imposed. The choice of these designs responds to numerous variables, taste, customs, fashions. It is often considered an added value that the same craftsman masters different techniques and patterns of diverse cultural origins.

The design of coffered ceilings stands out as an example of hybridization. The geometric knowledge required for its development makes it possible to successfully incorporate diverse shapes. The geometric base facilitates the connection of the lacework patterns with the polyhedral coffers (Redondo Buitrago, 2022). The formula is not mere imitation, but a dialectic in which the models develop alternative logics based on basic starting laws.

It is common to consider the transition to the renaissance in Castile as a superficial change (Martín García, 2005) the mere inclusion of classical ornamental elements attached to traditional structures belonging to the Hispanic repertoire (Romero Medina, 2012). These surface elements (Figure 1) were learned indirectly, through the study of treatises, and introduced into Castilian architecture by architects such as Lorenzo Vázquez de Segovia (Romero Medina, 2018) linked to the patronage of leading families such as the Mendoza family. It's understandable that these aristocrats, members of a long-established family, wanted to maintain the Gothic tradition in the overall structure of their buildings, although they were fascinated by Italian decorative elements. Vázquez participated in several projects of this type, such as the Colegio de Santa Cruz in Valladolid, the Palacio de Cogolludo in Guadalajara, the Palacio de Antonio de Mendoza, also in Guadalajara, and La Calahorra in Granada. In these examples, the Renaissance-inspired decoration is concentrated mainly on doors and windows, which are inserted into an austere Castilian façade, which does not explain its general composition, its internal structure, or the relationships between its parts.

However, unlike facades, in the case of wooden ceilings it can be said that the Spanish Renaissance goes beyond a mere superficial change to encompass the creation of a new system. Spanish carpentry emerged a few centuries earlier as a combination of medieval structures and Nasrid geometric decorations (Nuere Matauco, 2000). The traditional carpentry structure had already been used to create the polyhedral ceilings with lacework patterns. The ceilings were transformed by following this geometric and constructive knowledge and applying it to the new Renaissance tastes, first by replacing the star-shaped lacework patterns with equivalent polygons and later by creating innovative solutions, as a consequence of the adaptation of Renaissance designs to the polyhedral surface of the ceilings (González-Uriel et al., 2022). Another particular feature is the plant-inspired decoration carved into the woodwork, which adds a special sculptural vibrancy to the surfaces. From the study of the numerous contracts of the period that have been preserved, it can be deduced that the most important artisans, thanks to their technical expertise, normally managed to vary between different stylistic options (García Nistal, 2011). Numerous names of 16th century carpenters are known through building contracts, such as Andrés de Zamora, Bartolomé Aguilar, Pedro Izquierdo, Hernando de Sahagún, Hernando de la Sota, Cristóbal de Nieva, Justo de Vega, Alonso de Porquera, Pedro de Cereceda, Martín de Lombera, Guillem Doncel, Pedro de la Tijera, Juan de Villaverde, etc.

The Palacio of the Miranda in Peñaranda de Duero illustrates both trends, on the one hand, the establishment of the urban palace model and, on the other, the hybrid character of the elements of which it is comprised. The latter is confirmed both in the geometry of the structure and in the decorative aspects of the walls and ceilings. The tradition of embellishment with bas-reliefs based on Islamic plasterwork, combined with Renaissance motifs, is a constant around the door and window openings in the most representative rooms (Figure 3). According to Lampérez (1912) 'The period in which the Palace of Peñaranda was built was a time of transition in Spanish society, and in its arts the Mudejar and Gothic traditions survived and merged. And so, in the friezes, in the reliefs and in the coffered ceilings of the halls and staircase, we can see, alongside the Plateresque work, the Moorish muqarnas and lacework, with details of great purity, and at the same time, Gothic elements, such as the latticework of the tribune in the great hall'.

Methodology

This research mainly uses a qualitative methodology, focused on a case study. For this purpose, exhaustive documentation is carried out based on a data collection survey using laser scanning and automated photogrammetry. This technology is based on the use of point clouds. These are digital models formed by capturing or generating millions of points that allow the precise recreation of the shape, in this case, of an architectural element. These points can be transformed into a surface by triangulation, and by projecting the color of each point onto the surface, realistic images can be generated. This article



Figure 3. Interior photographs of the main hall and the shell room. Photograph by the authors. The plasterwork combines star-shaped decorations with Renaissance floral decoration and Gothic forms.

examines several applications of these models, especially architectural analysis drawing and two- or three-dimensional textured models, as well as a combination of both. The morphological analysis of the main case is complemented by comparisons with other cases that share its main characteristics.

The palace of the Counts of Miranda (or palace of Avellaneda), also known as the palace of Zúñiga (Lords of Miranda) is a building constructed in the first third of the 16th century, as part of a process of establishing noble houses in urban centres (Escorial Esgueva, 2019). It was built by order of Francisco de Zúñiga y Velasco, third Count of Miranda del Castañar. The work is of uncertain authorship, attributed to the school of Francisco de Colonia (Lampérez y Romea, 1912) although it is speculated that other masters may have been involved in some elements, such as Luis de Vega in the staircase (Martínez Montero, 2005). The lack of correspondence between certain notable architectural elements, such as the façade, main halls, monumental staircase, courtyard, etc., suggests that they may have been commissioned from different masters who worked without following a general design.

No documentation of the construction work at Peñaranda is preserved, but it is believed that the palace must have been finished before 1531, the year in which the Count was awarded the Golden Fleece, for if it were later, the coats of arms that decorate the walls would include this necklace, which is not present on the walls (Aguirre Rincón & López Suero, 2017). Moreover, by the death of the third count in 1536, the decoration of the halls must have been completed, as it is dedicated to him and his wife and not to his heir. We take this year as the most likely reference year for completion of the rooms in question.

Following a visit to Peñaranda de Duero in 1887, Amador de los Ríos described the enormous value and terrible state of conservation of the building (Amador de los Ríos, 1888) describing the coffered ceiling of the main hall as priceless and publishing a perspective of the ceiling of the adjacent room, formed by octagons and crowned by a muqarnas dome. It seems that by that time the ceiling of the magnificent staircase had already disappeared. Prentice (1893) in his book on Spanish Renaissance architecture, describes the building as half-ruined, and describes the coffered ceilings of the halls on the first floor as among the best in Spain. Vicente Lampérez y Romea visited the palace in 1911 and also denounced the deplorable state of conservation and the continuous plundering that the complex had suffered (Lampérez y Romea, 1912). A few years later Byne and Stapley would say of the state of the palace 'it is difficult to find a more pitiful picture even in Spain', referring to the threat posed to the ceilings of Peñaranda by the existence of a sawmill inside the building, which was ravaged by decay and neglect (Byne & Stapley, 1917). The Byne photographs show two of the ceilings of the halls, from which much of the coffered ceilings had been stripped, although the structure, decorative strips and friezes remained. They also published a complete floor plan of the upper floor of the palace.

It is reported that in 1925 the art dealer Arthur Byne offered William Randolph Hearst the chance to acquire the building in order to dismantle it and transfer it to America, (Merino de Cáceres & Martínez Ruiz, 2012) despite the fact that, at that time, it was officially protected, since, on 11 August 1923, the Spanish government had declared it a National Monument. In 1948 it was acquired by the State and various modifications and alterations to the original began. A few years later, the architect Anselmo Arenillas carried out a questionable extension and restoration of the complex. An exhibition held in 1958 mentions '...redoing all of the floors and roof, supporting the very rich series of coffered ceilings...' (Carazo Lefort, 1997, p. 523).

We will now describe other buildings linked historically and formally to Peñaranda, whose dates of construction will allow us to frame the context and value of this Palace. Construction of the Casa del Cordón began in 1476. Its initial design is attributed to Juan de Colonia. Its original state is unknown as it has been greatly transformed, although there are hypotheses about its possible configuration. It had a trapezoidal floor plan, arranged around a central courtyard with the main rooms facing the city. A longer hall in the centre and the rooms at the ends.

A building of great importance, with excellent ceilings and linked to Peñaranda is the Cárdenas Palace in Torrijos (Toledo), also promoted by the Casa de los Miranda (Dukes of Maqueda). María Enríquez de Cárdenas is the wife of Zúñiga, which links the two great families of the Hispanic nobility. Gutierre de Cárdenas began to build the palace of Altamira, in Torrijos, Toledo, in 1482.

At least four ceilings of great value were built for it, although the palace disappeared in 1904, the ceilings are still preserved in different parts of the world. The best known is the dome-shaped ceiling,

which was transferred to the National Archaeological Museum in Madrid (Nuere Matauco et al., 2020). The other three, also of great value, are octagonal chamfered ceilings, one of which is in the Château de Villandry in France, decorated with a ten-pointed star interlace pattern with gilded trumpets on the four chamfers (pendentives). Another is in the Legion of Honour Museum in San Francisco, CA, which is made up of eight-pointed stars with fan-shaped pendentives. A fourth ceiling is kept in the Victoria and Albert Museum, London, although it is not on public display. It features an eight-pointed star interlace design and has four conical pendentives. These ceilings are full of interlace patterns, they contain hardly any Renaissance polygonal coffers, pieces of wood shaped like a truncated cone or an inverted trough, and very few muqarnas, a geometric grid that connects vertical prisms, called adarajas, made of plaster or wood, carved on their underside and attached to each other. In the palace of Peñaranda, there are some lacework decorations in plaster around the doors and windows (Figure 3), but not on the ceilings, where all the decorations are floral.

The Ducal Palace of Cogolludo is a building located in the province of Guadalajara. The design of the façade is attributed to Lorenzo Vázquez de Segovia. It is believed that the works began in 1492. Although the interior has been greatly destroyed, the main rooms are still preserved and follow the layout of the new urban palace, with a long hall in the centre and secondary rooms on the sides. The façade is also in good condition and has a high front. It is known that Cogolludo housed magnificent coffered ceilings, although they have disappeared.

In the city of Guadalajara there is the Palacio del Infantado, built at the end of the 15th century. The layout of this building is slightly different from the model in Peñaranda. The great hall is located in a side body, next to a gallery that looks out onto the garden. The design of this building is maintained in a more traditional layout. Although the façade is magnificent, the layout of the rooms is more confusing than the other examples. In addition, the Infantado is known for having had extraordinary Hispano-Islamic coffered ceilings, especially the muqarnas, which disappeared in 1936.

Another important reference in this research is the Ducal Palace of Pastrana. Building promoted by Ms Ana de la Cerda, widow of Diego Hurtado de Mendoza y Lemos, first Count of Mérito, in 1542 (Alegre Carvajal et al., 2003). The palace was based on the design drafted by Covarrubias. In 1549 the carpenters Justo de Vega and Cristóbal de Nieva were commissioned to carry out the woodwork (García López, 1992, p. 66). The general layout of the coffered ceilings is so similar to that of the Burgos palace of Peñaranda that it can be assumed that the craftsmen must have been linked or shared either graphic or textual guidelines. The ceilings on the first floor facing the main façade have very similar characteristics in both buildings, both in size and design. Of the six main structures, two are flat ceilings, known as *alfarjes*, located in the front towers, while the other ceilings have sloped panel, three are square and one is elongated (González-Uriel et al., 2019).

Formal and geometrical analysis of the most notable coffered ceilings of the Peñaranda palace

This building has many interesting rooms and wooden ceilings. This research focuses on the most characteristic rooms of the palace and its ceilings, focusing on their morphological and geometrical characteristics. In view of the existing documentation, the main rooms on the first floor, those that open onto the town square, stand out. As has already been explained, this series of spaces is a characteristic feature of Castilian Renaissance urban palaces. Moreover, it is believed that these six pieces have hardly been modified from their original design and we know that recent interventions have not dealt with them, which makes their study all the more relevant (Figure 4).

For the analysis of these rooms, data was collected using a Leica BLK360 laser scanner (360,000 pts/s, and an accuracy range of 4mm/10 m) and formalised with the Cyclone Register 360 software, as a program for the construction of a point cloud (Figure 2). Automated photogrammetry of the three central polyhedral ceilings has also been used. For this, a sequence of aligned photos was created using Agisoft's Metashape software, from which a textured mesh of each of the coffered ceilings of interest was obtained. The models have been used to obtain orthoimages and measurements of the ceilings in their current state. On the basis of this data collection, detailed plans of the rooms have been drawn up.

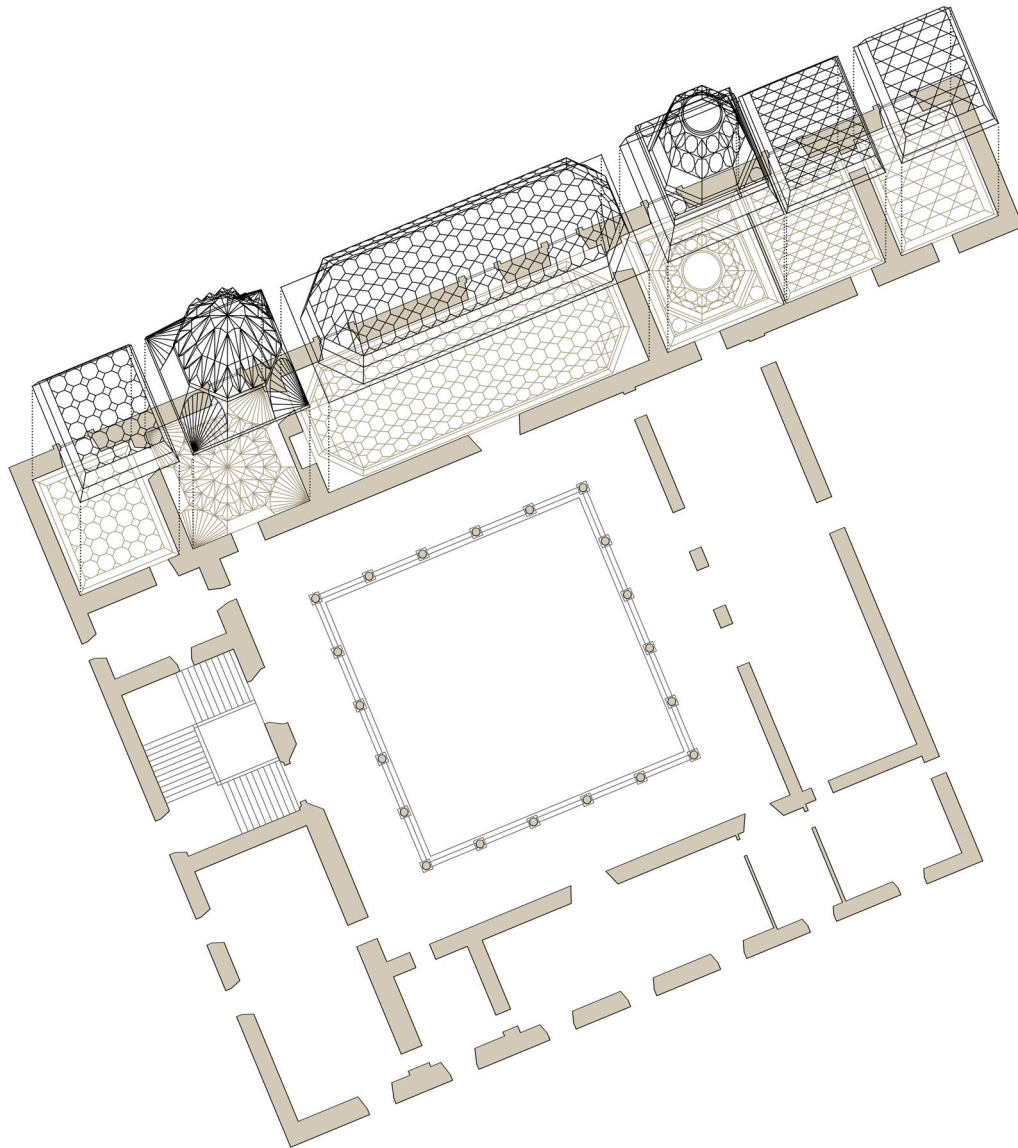


Figure 4. Axonometry of the ensemble of six main ceilings on the palace floor plan. From left to right: corner room, shell room, ambassadors' room, muqarnas room, antechamber, and library room. Drawing by the authors.

Corner room

In this room we find an *alfarje* built with beams, running across the width of the room, and rails fitted perpendicularly and diagonal pieces at the joints, forming the structure of a square grid of coffers, in tessellation 8.8.4. The room is a rectangle measuring 5.96 x 6.90 m (Ratio 1.16). The rectangle inside the frieze, occupied by the coffers, measures 4.70x5.67 m (Ratio 1.20) (Theoretical ratio $6/5=1.20$). The spacing between grid axes is 0.95 m, which is equivalent to 3 feet 5 inches (This paper refers to the Castilian foot = 0.2786 m) (Figure 5).

This pattern of octagons and squares was very common in the coffered ceilings of the time and was reported in various treatises, from the Codex Escorialensis to the writings of Serlio (1537, LXXVIII). There are several examples among Spanish coffered ceilings that feature the same pattern, such as the ceiling of the refectory of the Monastery of Uclés (De-Miguel-Sánchez et al., 2023). It contrasts the concavity of the 8-base coffered ceilings with the convexity of the pattern of squares from which inverted pyramids hang. This type of concave-convex contrast is a mannerist characteristic (Fernández-Cabo et al., 2020). The decoration of the octagonal coffered ceilings is floral, as are their covers. The crowning part of the wooden frieze has a very prominent moulded profile in a gable-shaped section. This important protrusion allows the dimensions of the room to be adjusted to a grid proportion of 5x6 modules, so that the



Figure 5. Corner room. Photograph, plan and section of the point cloud, by the authors. This room is covered by an alfarje, a horizontal ceiling. The geometric pattern is made up of octagons and squares.

tessellation fits regularly in the formation of the coffered ceilings, which will come from the workshop with the same measurements for all of them. The lower part of the frieze is decorated with *Romanesque* motifs. The plasterwork decorated with Renaissance motifs that forms the transition between the plain wall and the coffered ceiling is particularly noteworthy.

Shell room

This ensemble is a coffered octagonal vaulted ceiling with its side panels set high on a practically square room. The measurements of the room are 7.03x6.98 m, although there are some deviations in the angles of the back wall, looking from the façade. It is therefore a room of approximately 25x25 Castilian feet. The rhombus design is framed in an octagon with a width of 5.60 m, i.e. about 20 feet. The slope of the inclined planes is approximately 40° (Figure 6) and the upper area is another octagon of a similar width to the side bands in their horizontal projection, so that the rhombuses are folded in all three dimensions, but in plan both the horizontal and inclined ones appear to be the same. The lines forming the rhombuses are parallel to the diagonal edges of the octagon, forming an original network across the ensemble.

The formation of large flared fan-shaped pendentives in the corners is striking. They are wooden forms laid on an oblique cone-shaped surface, reminiscent of Gothic masonry squinches. This design was already found on three of the ceilings that belonged to the Palacio de los Cárdenas, in Torrijos and which, as has been explained, currently belong to different institutions (Legion of Honour of St Francis, the Victoria and Albert Museum in London and Château de Villandry). This form results in the development of a high, sloping frieze, which contains numerous decorative rows carved in the Romanesque manner typical of the Renaissance (Figure 6). The traditional Hispano-Islamic *arrocabe*, a wooden frieze that covers the transition from the wall to the wooden coffered ceiling, is abandoned and the joints between the sloping frieze and the arches are resolved with triangles carved with figures in relief.

From the geometric analysis of the rhomboid ceiling, it can be deduced that the design arises from the horizontal projection of the octagon. The design is found to fit the division of the polygon in three parts, both the radius of the circumscribed circle and the side (Figure 7). On these parts they are parallel to the diagonals and the rhombuses are formed. In their horizontal projection they are laid at angles of 45° and 135°. The ceiling forms a truncated pyramid whose sloping panels form an angle of 41° to the horizontal. When these trapezoids are unfolded, the inclined panels deform the lateral rhombuses (Figure 8). It is interesting to note that the size of these panels placed horizontally would fit the width of the room, i.e. the developed polyhedron could be prepared on the floor of the room itself before being folded and brought to its final position.

Ambassadors' hall

This is a large room with a rectangular base that formed the Great Hall of the Palace, also known as the Ambassadors' Hall. The ensemble is a coffered ceiling with a *three-span* section (characteristic of a rafter



Figure 6. Shell Room. Photograph and drawings by the authors. This is a square room with an octagonal ceiling over four shell-shaped pendentives. The section is raised sharply by the 40-degree slope of the panels that form the pyramid trunk of the roof.

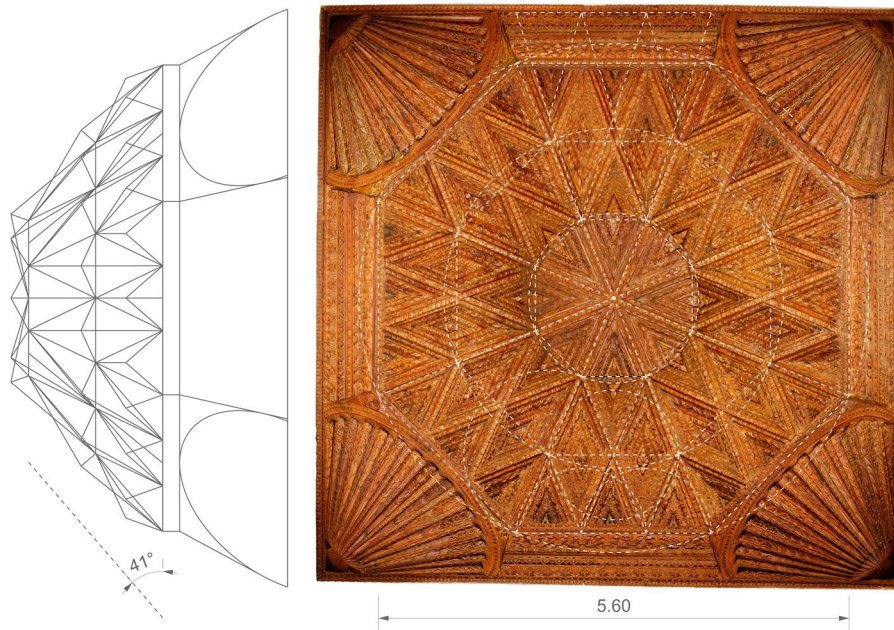


Figure 7. Shell room. Plan and elevation of the coffered ceiling. Image by the authors. The corners are resolved with shell-shaped pendentives. The rhombuses are formed by drawing parallel lines to the sides of the trapezoid on the side panel.

and collar beam truss) with a steep slope on the sides, chamfered at both ends. The dimensions in plan view are 19.28x6.98 m, i.e. 69x25 ft (Ratio = 2.76). The total of the room is close to the sum of two rectangles $\sqrt{2}$. The spacing between the axes of the beams is 0.81 m. This is slightly less than three Castilian feet (0.83). Taking this as the width of the hexagon, the diagonal of the hexagon will be 0.94 m. With this separation between axes and a tilt angle of the side panels of 35°, the general polygonal design is resolved, with the greatest difficulties concentrated in the chamfers.

The pendentives are completely covered with Andalusian muqarnas. This emphasises the link of the ceiling to the Hispano-Islamic heritage (Figure 9). Some authors point to the participation of *Mudejar* craftsmen in the work (Amador de los Ríos, 1888) although this is not confirmed. The pattern is made



Figure 8. Shell room. Axonometry of the photogrammetric model. Image by the authors.

up of hexagons in rows connected at the vertices, leaving rhombus-shaped gaps. The network is a semi-regular tessellation 6.6.4r. The hexagons are coffers with Romanesque mouldings and decorated panels. The rhombuses are decorated with hanging panels with fleurons. There are three rows of coffers on the horizontal plane and two on the side panels (Figure 10). The chamfered panels on the pendentives retain, albeit with some deformation, the hexagonal pattern. In the gable ends, there is major deformation of the border hexagons, which become seven-sided polygons. Only the central row of hexagons is preserved. The frieze is decorated with floral carvings, full-length angels in high relief and magnificent busts carved in wood. There are around ten personalised portraits, most of them women and men in Roman costume (Aguirre Rincón & López Suero, 2017).

Hall of muqarnas

This room is almost square, measuring 7.01x6.98 m. An octagonal framework is placed above it. As in the rhombuses room, the octagonal base of the gable ends is 5.60m wide, i.e. 20ft, and the central muqarnas dome has a circumference of 8ft, i.e. 2.22m. This ceiling is folded into five panels, with the base of the dome being one of them (Figure 11). The angles of the lateral planes are 65° and 28°, producing two sizes of inclined octagons, so that the polygons at the intersections appear folded but complete, although this effect is not quite achieved.

It should be noted that between the ambassadors' hall and this room there is a wall 4 feet wide, yet a half-foot partition separates it from the adjacent library (Figure 16). This may be due to the fact that the ceiling project was developed after the layout of the rooms, coordinated with those on the ground floor, and was resolved by dividing a rectangle into a square plus another rectangular space, separated by a light partition. There is a clear desire to adapt the design to the square and its central characteristics. In the centre is a magnificent muqarnas dome. There is a high degree of Renaissance-Hispanic-Islamic hybridisation in this chamfer (Figure 12).

Over a frieze of Renaissance mouldings, a muqarnas body is formed with a perfectly fitted and centred modulation, maintaining its rhythm in the changes of direction at the corners. Above the muqarnas frieze, the chamfer form flat pendentives with a centred 8-base coffer. The panels start with a double-bodied frieze reminiscent of Hispano-Islamic *arrocabes* (Figure 12). A first level with floral decoration, and a second level forming a frieze of muqarnas perfectly fitted up to the starting level of the sloped panels. These are composed of two levels of octagonal coffers connected at the apex. The octagonal grid extends through the sloped panels to the intersections or lateral edges, where it is mitred by the hinge formed by the intersections. The result is an irregular eight-sided coffer on the lower band and an irregular six-sided coffer on the upper band. The residual spaces between coffers form triangles and small four-pointed star shapes. The result is geometrically confusing, but the ensemble maintains the



Figure 9. Ambassadors' Hall. Photograph and drawings by the authors. The ambassadors' hall is the most representative space in the building. The floor plan has a proportion of 2.76, while the section is almost a square.

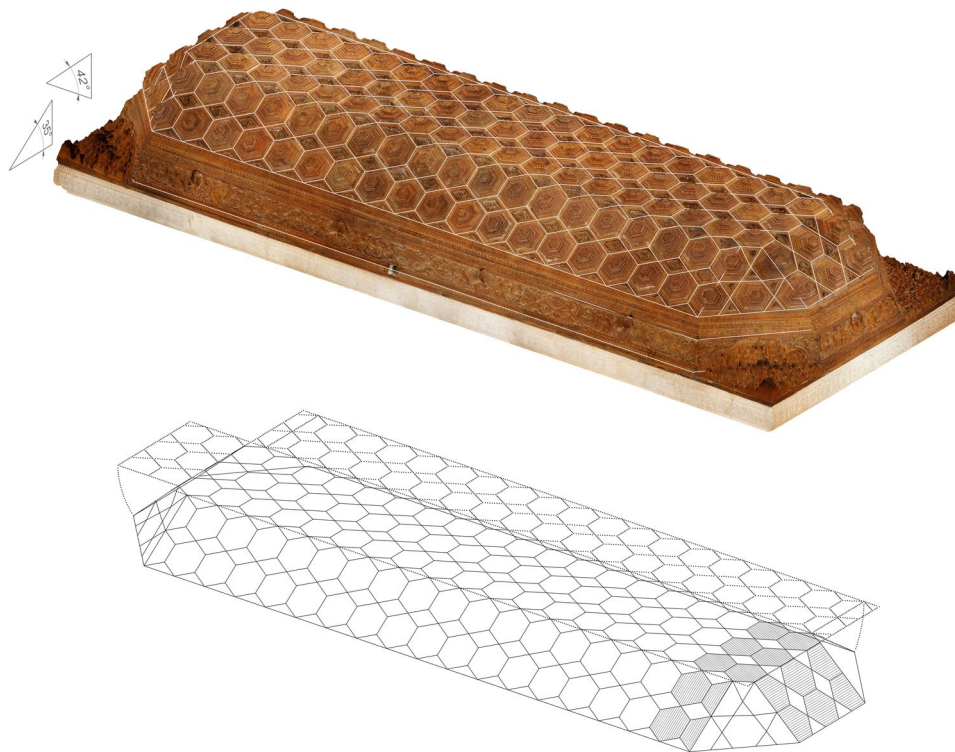


Figure 10. Ambassadors' Hall Photogrammetric model and diagram of the hexagon mosaic. Image by the authors.

appearance of continuity. This is achieved especially by the quasi-regularity of the folded octagons in the ridges of the lower band. On the flat plan, the ridge line passes through the centre of the polygon, which evens out the sides, the length of which is modified, and this modification is less than $\frac{1}{4}$ of the length. In addition, the side of these octagons in the lower band is almost the same as those inserted in the flat pendentives. In the upper band, however, the need for a lower tilt angle of the panel seems to have taken precedence over other premises, as indicated by its accuracy at 30° , corresponding to a six-point star bevel, in this case (Figure 13). The condition that the bevelled octagons kept their centre on the hip intersections would have led to an even greater reduction in their size compared to those of



Figure 11. Hall of the muqarnas. Photograph, plan and section by the authors. This ceiling shows a delicate balance between the friezes and the muqarnas dome and the panels formed by polygons.



Figure 12. Hall of muqarnas. Photogrammetric model and mosaic scheme of octagons and dome of muqarnas. Image by the authors.

the lower band, and a decrease or increase of about $\frac{1}{2}$ of the length on the unequal sides, which would have given an even more irregular appearance than the one observed in the constructed solution.

Antechamber and library room

These two coffered panelled ceilings are very similar, differing basically in the number of lanes or spacing between beams. The antechamber has twelve lanes with an interaxis of 0.49m, while the library has only eight lanes of a greater width, 0.74m. The spans of both are similar, approximately 5.90m, and the depth, like the rest of the ensemble, a little less than 7m. Intermediate panelled ceiling, measuring 5.97x6.92 (Ratio = 1.16). Panelled ceiling in the library, 5.83x 6.92m (Ratio = 1.187). The pattern is elegantly resolved based on the width of the rooms, fitting 5 and 3.5 irregular hexagons respectively and

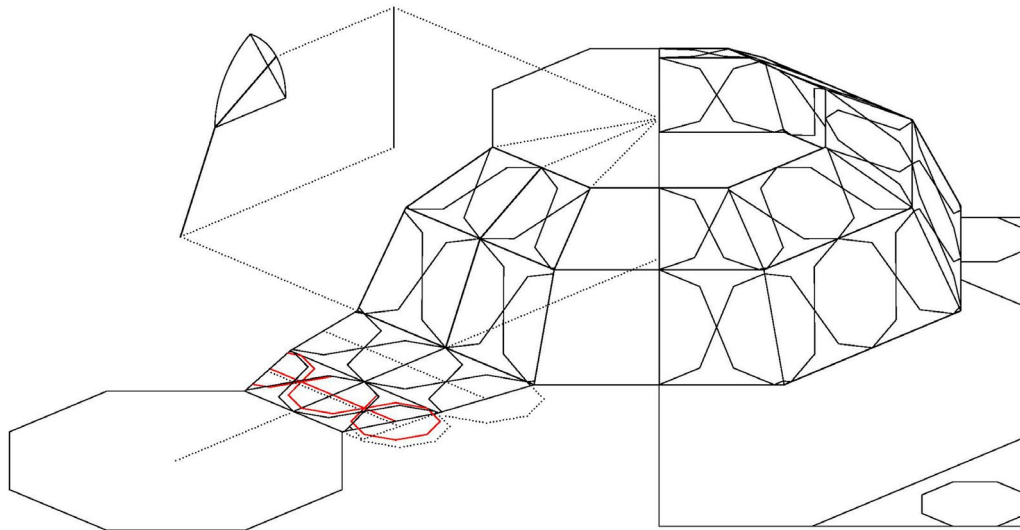


Figure 13. Hall of Muqarnas. Unfolded diagram of the mosaic of octagons. Image by the authors.

slightly skewing the diagonals, 44° degrees in the antechamber and 48° in the library, to fit the measurements of each room.

The design of the *alfarjes*, or horizontal ceilings, shows their structural configuration, showing the beams that are connected with rails, in this case placed diagonally. The result is two patterns, one with lines parallel to the front wall formed by the floor beams, and the other rotated (Figure 14) creating a set of concave coffers with an irregular hexagonal base (extended). The inclined planes of the coffers are moulded without carving, while their tops have floral decoration. The hexagons alternate with a grid of residual triangles from which pendants hang. This concave-convex combination reaffirms the mannerist character of the ceilings.

The pattern is ordered by squares rotated 45° . Irregular hexagons result from taking the rotated square and drawing parallel lines through the midpoints of its sides. It is the lateral vertices of the squares that mark the boundaries of the pattern. If we compare this pattern with another widely used at the time, such as that of regular hexagons touching at the vertices, which appear in ceilings such as those of the Paraninfo of the University of Alcalá (1520), we can see that this case gives the designer a certain flexibility, as it allows the ensemble to be adjusted to the room without the observer detecting it, just by slightly deforming the squares and turning them into rhombuses (Figure 15). This is the case in both rooms, where the diagonals deviate by a few degrees (44° and 48°) to fit the design into almost any rectangle.

Comparative analysis of the palace of peñaranda de duero (burgos) and the palace of pastrana (Guadalajara)

As already mentioned, there is a remarkable similarity between the designs of the main rooms of the palaces of Peñaranda (1536) and Pastrana (1550), which was recently restored (González-Uriel et al., 2019). These are two palaces that retain many of their original features, while the rest of the similar contemporary palaces have been modified or destroyed. Thanks to the laser scan data from the main rooms of both buildings, it is possible to make this comparison with a high degree of accuracy (Figure 16). In particular, the three central rooms are remarkably similar, built to the same dimensions, an overall width of 25 feet, identical location in the building, on the first floor of the front body, and the same number and position of doors and windows. Not least, they feature identical geometric designs in the ceilings of the long gallery and similar ones in the adjacent rooms. We hypothesised above that both works must have shared graphic and textual documentation, which is evidently reflected in a multitude of features. It is important to remember that the artistic value of the plasterwork and muqarnas that enrich all the elements in Peñaranda are not found in Pastrana, whose ornamentation is more modest. It can also be interpreted that mid-century Renaissance tastes, particularly in the area around Guadalajara, gradually diverged from Gothic-Mudejar tastes.



Figure 14. Antechamber and library room panelling. Photographs by the authors.

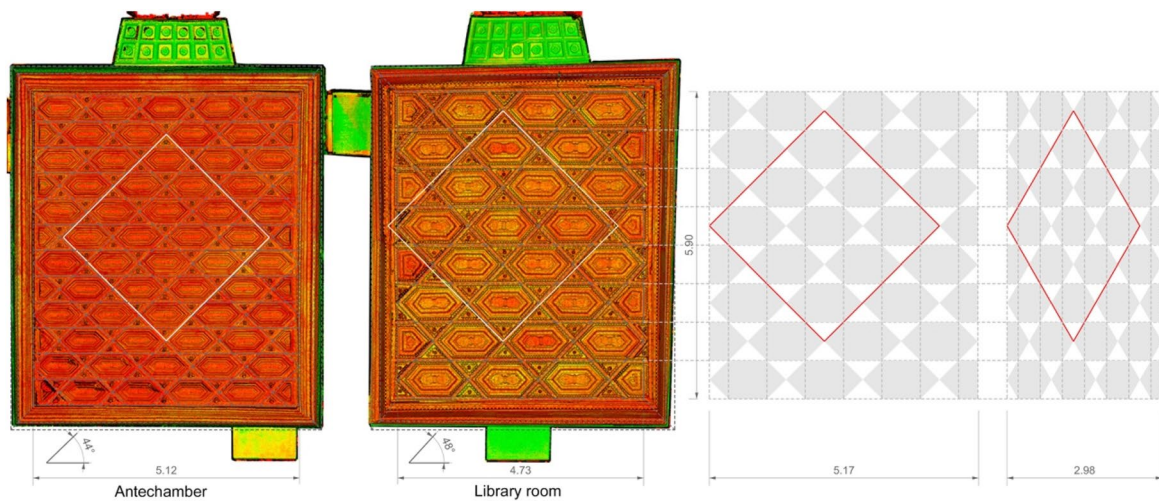


Figure 15. Mosaic scheme of irregular hexagons. Antechamber and Library room (left) and scheme of irregular hexagons (pattern rotated 45°) and regular hexagons (pattern rotated 60°) (right). Image by the authors.

As mentioned above, the long halls have a design of parallel hexagons that folds into three panels and is chamfered at the side panels. The distances between axes are 0.81 m in Peñaranda and 0.94 m in Pastrana. It should be stressed that both measurements are related because they refer to the width and the diagonal of the same hexagon. It is possible that one was taken for the other in the later work. The consequence of this difference is that the number of rows is greater in Peñaranda, with a total of 19 pieces in the upper horizontal plane, while in Pastrana there are only 17 rows. With regard to the general fit of the coffered ceiling in the hall, they differ in that the Peñaranda palace includes a very thick muqarnas frieze, while in the Pastrana palace, which is narrower, the hexagonal pattern reaches almost to the walls, although it can be deduced that the change represents a better fit and therefore a logical evolution of the initial design (Figure 17).

The starting heights of the hexagons of both ceilings are the same, 6.13 m, or 22 Castilian feet (Figure 18). The cresting heights are different, however, due to variations in the sizes of the coffers and the angles of the sloped panels. Although the shape from the soffit is so similar, the structures supporting these ceilings are different. In the case of Peñaranda, the traditional rafter and collar beam solution is maintained, with an angle of 35°, while in Pastrana a structure of horizontal beams with struts at a 45° angle is chosen. At the side panels and the chamfered corners, the solution requires some of the polygons to be folded and others completed to maintain an impression of continuity. Again, in Pastrana, the higher angle of the crossbeams makes the shape of the polygons at the intersections more equal (Figure 19).

The square rooms on either side of the Ambassadors' Hall also have their corresponding equivalents in Pastrana. These are two square rooms measuring 25x25 feet, which respectively feature a rhomboid



Figure 16. Comparison of the plans and sections of the palaces of Peñaranda de Duero (above) and Pastrana (below). Image by the authors. The similarities between the two buildings lead us to believe that there were connections between their craftsmen, who probably shared ideas or drawings.

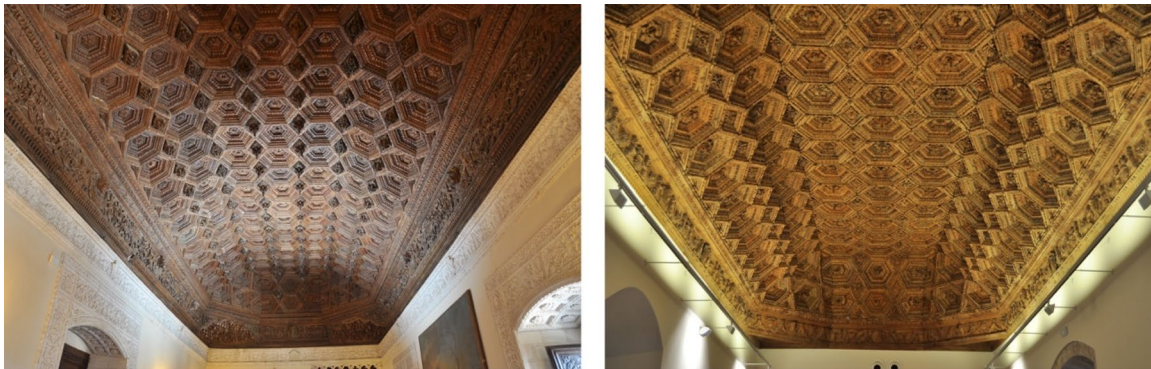


Figure 17. Comparison of the main hall of the palaces of Peñaranda (left) and Pastrana (right). Photographs by the authors.

and an octagonal ceiling. However, their positions have been switched around. The geometric patterns are similar, but the carpentry structures, again, are totally different. The Peñaranda chamfers follow the collar-tie method, while the Pastrana structures are supported by an upper beam to which the struts are attached (Figure 20). The abutments of the chamfers, to which the pendentives or the coffers at the corners are adjusted underneath, are also altered in this evolution, losing part of their complexity, since in Pastrana the structure is fixed to the walls and stability does not depend on the perimeter ties, which serve more of a formal function.

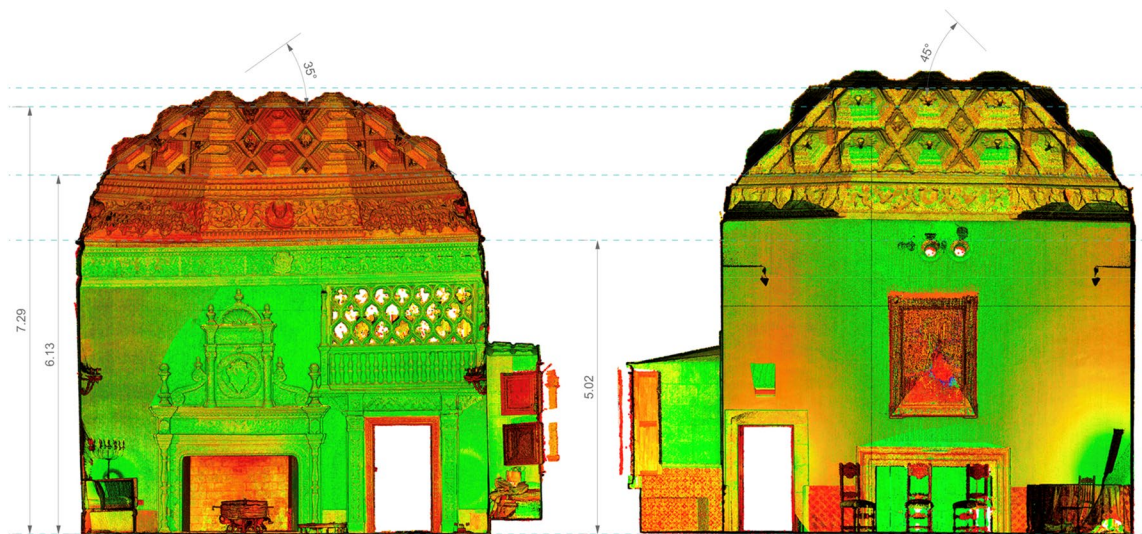


Figure 18. Comparison of the cross-sections of the central halls of the palaces of Peñaranda and Pastrana. Image taken from point cloud in intensity map display. By the authors.



Figure 19. Comparison of the coffered ceilings of Peñaranda (left) and Pastrana (right). Photographs by the authors.



Figure 20. Comparison of the Peñaranda (left) and Pastrana (right) extrados structures. Photographs by the authors.

It is plausible to suggest that the reinforcement structures of Ms Ana de la Cerda were conditioned by greater financial constraints than those of the Counts of Miranda. The dimensions of the rooms and the geometric themes are the same, but the constructive solutions and above all the decoration are of much higher quality in Peñaranda, which displays highly complex chamfers, full of muqarnas, the cost of

which must have been prohibitive for other works of that time. It is known that in Pastrana the cloister was never constructed. There are also no muqarnas, a carpentry theme that requires specialised knowledge, and other formal devices such as the horn-shaped or shell-shaped pendentives are also missing. On the other hand, the fit of the polygons again seems to evolve towards more austere solutions, although it can also be said that they are geometrically clearer.

From the point of view of the layout, the rooms in question, although they have so many similarities, show that in Peñaranda it seems that there were no main designs, but that based on a general Gothic-style construction, details were added to embellish each room, while in Pastrana it is known that Covarrubias was commissioned beforehand to draw up the layout. We suppose that the architect may have had knowledge of or access to the palace in Burgos, from which he took its main features, but he wanted to give it greater coherence, taking greater care with the symmetry of the whole and the regularity of the geometric designs, in accordance with the Renaissance style that was becoming more and more popular at the time.

Results

As has been explained, the long hall and the square chambers at the ends characterize the configuration of an urban Renaissance palace in Castile. This space is found in several civic and religious buildings of the period in rooms of a similar size, around 25x70ft (De-Miguel-Sánchez et al., 2023). At either end of the building are private rooms that are also notable for their lavish decoration and the quality of their ceilings. The lower height of the coffered ceilings is the same in all the rooms, around 5.02m or 18 feet. This is where the white of the plaster ends and the wood begins. Thus, the cross-section is 6.98x5.02 m (Ratio =0.72). The rectangle is very close to the ratio $\sqrt{2}$ which would be at 4.93, i.e. 9cm lower, measured from the current ground. If we consider the upper plane of the ceilings, the height of the room varies between 7.29, 8.37 and 8.66 metres, (Ratios = 1.04, 1.19 and 1.24). The folded polygonal pattern in the form of a truncated pyramid enhances the effect of perspective, reinforcing the sensation of verticality.

It is evident that there are a significant number of coffered ceilings moulded in plaster based on the original wooden ones, probably made during the Arenillas restoration. By simply being dyed, the material influences the reflectivity of the laser scanner. To estimate the differences, we have used this property registered by the scanner by capturing the reflection of the light pulse. Thanks to the point cloud intensity display mode (Figure 16) we note that the colour of the coffered ceilings, which at first glance appear to be plaster, takes on a reddish hue. Those in the Corner Room stand out for their tones. According to this hypothesis, 90% of the coffers in the Sala de la Esquina [Corner Room], 40% in the Salón de Embajadores [Ambassadors' Hall], another 40% in the muqarnas room and almost all at the antechamber of the library are not made of wood, but probably of plaster. The rest of the coffers and the structure can be assumed to retain both the original design and the original materials.

The geometric patterns used on the ceilings are variations of hexagons, octagons and rhombuses. Some designs are based on transformations mainly of addition, deformation and superposition (Figure

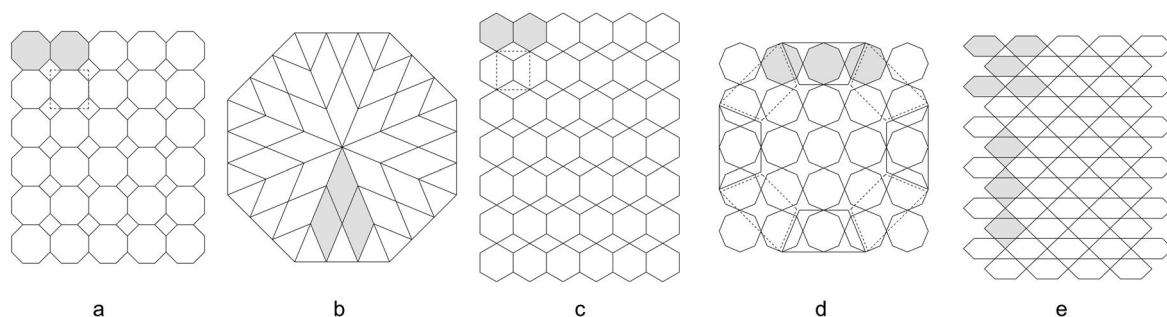


Figure 21. Polygonal patterns. Drawing by the authors. (a) Octagons joined by their sides. (b) 45° and 135° rhombuses. (c) Hexagons joined by parallel sides. (d) Octagons and four-pointed stars. (e) Hexagons deformed until two of their sides form 45 degrees and are perceived as superimposed squares.

21). The octagons in the corner room are joined by their sides forming a square grid obtained by adding pieces. The rhombuses in the Shell Room follow a logic of dividing the trapezoids of the inclined panels into parts. The 45-degree angles of the octagon are used to define the rhombuses, and the central symmetry produces a clear visual continuity between the organization lines. In the case of the Ambassadors' Room the hexagons are joined by their parallel sides forming rectangles of proportion 1.16, which produce a distortion in the edges that is possible to correct in a long room. This requires a deformation operation on the front panels. Meanwhile, the inclined ceiling of the muqarnas room uses a pattern of octagons joined by their vertices. If it were kept horizontal it would be a square grid, but it is adjusted by superimposing trapezoid-shaped panels, and this generates a distortion of the pattern. The ceilings of the library rooms are defined by a pattern of hexagons that touch at the vertices, but are deformed, superimposing squares rotated 45°, so that they have a double interpretation.

Discussion

We have seen that the urban noble palaces built at the end of the 15th century in Castile have an architectural configuration more closely linked to medieval tradition, as in the cases of the Infantado Palace in Guadalajara or the Cárdenas Palace in Torrijos (Toledo). The main rooms are distributed around the central courtyard in a random manner, without a clear hierarchy based on their relationship with the public space. Renaissance motifs began to be applied superficially to the façades and were barely used in the interior decorations.

Peñaranda is the culmination of a model in which influences from the Hispano-Islamic tradition and Renaissance forms coexist in a balanced way. The floor plan is still organized around a central courtyard, but the main rooms are moved to the front. The relationship with the public space is clearly defined. The square and the building are part of an urban project. The characteristic elements mix diverse motifs, mainly Renaissance, superimposed on traditional structures.

Pastrana, built fifteen years later, represents an intellectually perfected version, especially at the level of architectural design, not so much from a decorative point of view, but it is an unfinished work. This research has not found examples after 1555 that respond to the conditions that produced these palaces. It is a moment of evolution of ideas, political organization and the forms that make up the architecture of the Iberian Peninsula.

The structure of the medieval construction guilds in the Iberian Peninsula reflects the centuries-long coexistence of Christian and Muslim kingdoms. To this foundation of construction trades was added the introduction of Renaissance ideas from Italy at the end of the 15th century. This situation produced professional training of a transversal nature. The craftsmen knew design and construction techniques from different origins, forming a group with a certain technical and formal unity. Some authors may think that hybridization is the result of the mixture of different craftsmen or the superposition of periods with different fashions, but it has been proven that it was the same builders who combined elements from different origins in the same design.

Coffered ceilings are a characteristic feature of the Iberian Peninsula's building tradition. They are so important that the architecture is often modified to accommodate them, and they often give their names to the rooms they occupy. The evolution of Iberian Renaissance architecture cannot be understood without these elements.

While medieval coffered ceilings, formed by geometric star-shaped lacework solutions, followed rigid rules, albeit with variations, Renaissance coffered ceilings are models resulting from fusion, which gives rise to very varied, often unique solutions that do not produce transferable models. However, as we have seen, some solutions are repeated in different buildings. They can be compared thanks to the polygonal designs, the type of layout and above all by studying the mosaic solutions on the edges of the polyhedral ceilings.

Future lines of research

Spanish Renaissance palaces have other interesting features in common. One of them is the presence of muqarnas. There are friezes decorating the starting lines of the trusses, as well as large blocks forming

dense clusters on the pendentives, and the large central core of muqarnas that presides over the circular top plane of the octagonal ceiling. These pieces are so lavish and complex that we have decided they merit a study of their own, which we will carry out in a later research project.

Another aspect that requires its own study is the plasterwork. The presence of these decorative features again shows the hybrid nature of these buildings. The Peñaranda palace features an enormously diverse range of motifs with very different origins and rich links to many civic and religious buildings of the period.

Conclusions

The Peñaranda Palace is one of the examples that best illustrates the configuration of the model of Spanish Renaissance palaces. Comparison with examples built at the end of the 15th century has allowed it to be considered a Renaissance model of an urban noble palace that was developed over several decades. They all have in common that they belonged to different branches of the Mendoza family, which partly justifies these similarities. The model represented by these palaces disappeared shortly after the construction of Peñaranda. Pastrana was built fifteen years later, according to the plans of the architect Alonso de Covarrubias. Although this model reached its highest level in the mid-16th century, it did not become a reference for later projects.

The exterior is of an austere Gothic volume, on which decorative elements inspired by the Italian Renaissance are included, but without taking on the true complexity of this style. However, inside there are elements that show its Hispano-Islamic origin superimposed with Renaissance motifs. Notable among these inherited traditions is the woodwork. A system that transcends decoration and characterises the space by its value associated with the greater formal and material dignity, reserved for the most powerful families.

The hybridisation of the three stylistic trends, Gothic Castilian tradition, Christian Renaissance and Moorish art, took place with the agreement of patrons and craftsmen. The Hispano-Islamic tradition had been assumed as something unique to the Iberian Peninsula and differentiating it from other European territories where Roman-style Renaissance tendencies were already dominant. Iberian carpenters showed a good knowledge of the ornamental resources of both worlds. These differences with the European Renaissance aesthetic are clear in the geometric configuration and, above all, at the ornamental level, the widespread presence of muqarnas. However, the construction methods used in carpentry had indeed changed compared to previous centuries. And much of its most valuable knowledge was lost during the following century.

The main limitation of this research lies in the construction of a theoretical model based on hybrid case studies. These may appear more like a casual amalgamation than a coherent idea that responds to political, artistic, and technical conditions. This article argues that the guild system contributed to the development of a model that does not respond to a single project, such as the Renaissance plan, signed by a single architect, which would be established throughout the 16th century. This work frames the rich coexistence of artistic and cultural languages and forms applied to the configuration of a unique architectural type, of which we take as a reference its most outstanding example, the Peñaranda Palace. This building emerged at the height of its type's development and had few subsequent followers. Therefore, the artisan guild, specifically the carpenters, who knew how to masterfully develop their designs by integrating diverse codes, deserves special recognition. All of this was in accordance with the demands of aristocrats living in an era of economic prosperity and cultural evolution, who did not want to lose their traditional uses but rather wanted to integrate new forms into the buildings that represented their grandeur.

Acknowledgements

To the Territorial Service of Culture and Tourism of Burgos and the Department of Culture, Tourism and Sports of the Government of Castilla y León, as well as the archive staff at its headquarters in Valladolid and Gloria, from the guided tour staff of the Palace in Peñaranda de Duero.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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