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The spiral staircase attached to the so-called Gothic Wall of the Cathedral of Jaen (Andalusia, Spain) and its relationship with Mediterranean cases

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Abstract: On the eastern façade of the cathedral of Jaen, attached to the so-called Gothic wall, there is an open-well stone spiral staircase, probably built in the early years of the 16th century. In the northern area of the tower, we also find another spiral staircase, built in the first third of the 18th century, with very similar characteristics. The originality of both staircases lies in their intrados surface that presents some helicoidal grooves. There are very few built examples of this type of spiral staircase and those known so far have been linked to Mediterranean Gothic architecture.
In this work we have analyzed from a geometric and constructive point of view the Gothic staircase of Jaen, as well as similar examples, especially the one located in the *Lonja de la Seda* of Valencia. This study of stereotomic analysis has allowed us to deepen our knowledge of the construction process of the cathedral of Jaen, establishing two clear stages in the construction of the Gothic wall and the spiral staircase. We have confirmed the direct relationship between the Valencian example and that of Jaen, confirming the theories of a transfer of knowledge between the Mediterranean area and Andalusia in the last years of the 15th century and the beginning of the 16th century.

Introduction

The cathedral of Jaen is one of the main examples of Renaissance architecture in Andalusia. Its construction process was, as in most of the great Spanish cathedrals, complex and lengthy.

Its present location coincides with the site of the Great Mosque built during the period of Muslim domination in this region. In the last quarter of the 14th century, after its demolition, a first Mudejar Gothic cathedral was built on the same site. Of this Gothic-Mudejar cathedral, known as the Antigua, no building remains.

In the last years of the 15th century, the chapter decided to build a new cathedral, known as the Gothic cathedral. Construction began by the eastern wall whilst preserving the Old Cathedral. But later, in the middle of the 16th century, the decision was made to commission the well-known architect Andrés de Vandelvira, to transform the new cathedral into a great Renaissance temple. (Fig. 1)

The list of master builders who worked on the Jaen Cathedral over the centuries includes other prestigious figures such as Juan de Aranda y Salazar, Eufrasio López de Rojas, Blas Antonio Delgado, José Gallego y Oviedo del Portal and Ventura Rodríguez (Ortega 1991).

With the passing of the centuries, the only vestige that remains of that Gothic cathedral begun at the beginning of the 16th century is the chevet wall and a spiral staircase attached to it.

While several authors have drawn attention to this singular staircase, for being located attached to the Gothic wall of the cathedral, until now, its special grooved intrados surface has

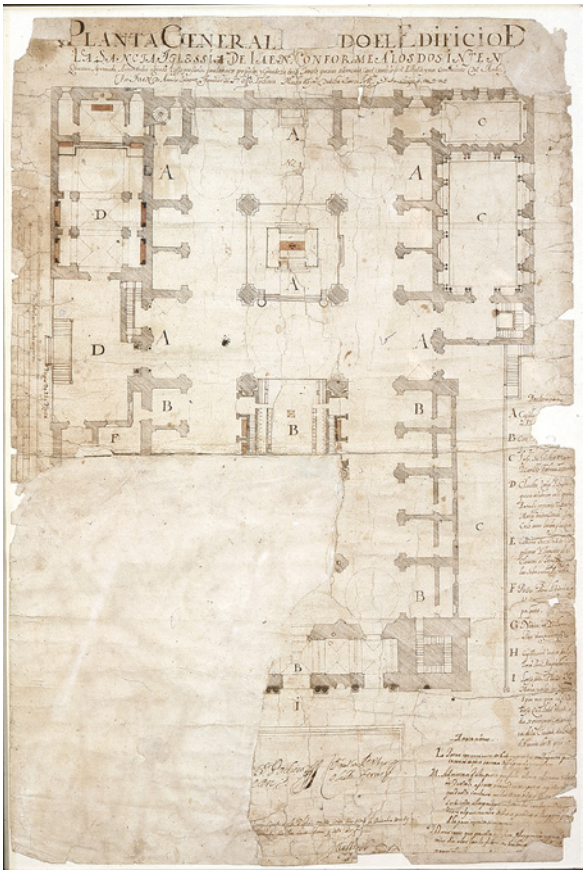

Figure 1. Plan of the Cathedral of Jaen by Juan de Aranda Salazar. 1634. Instituto Andaluz del Patrimonio Histórico. Centro de Intervención en el Patrimonio Histórico. Junta de Andalucía. 2003. Archivos digitales IAPH.

Figure 2. Cathedral of Jaen. Gothic spiral staircase. Left: Intrados surface (Image by the authors).

Figure 3. Cathedral of Jaen. Tower spiral staircase. Intrados surface (Image by the authors).

not been studied from a geometric and constructive point of view (Ortega 1991, 70; Alonso 2014, 64).

In this work we have analyzed the Gothic spiral of the Cathedral of Jaen, its stereotomic quartering, its constructive connection with the Gothic wall to determine its possible dating and the different stages in the constructive process of the chevet wall and the possible Mediterranean influence, where the few built examples of this type of spiral staircase are found. (Fig. 2)

There is another spiral staircase similar to the Gothic one in the north zone of the tower. Its first flights were built in 1717 and its last 1718. A date located on the lintel of the access room from the stairway allows us to confirm this dating. (Fig. 3)

Due to the date of construction of this second staircase in the 18th century and the resemblance between the two, we proposed as first objective to confirm the date of construction of the so-called Gothic staircase, since its similarity with the one built in the 18th century is remarkable.

Methodology

The methodology we have followed to carry out this work has been based on the rigorous analysis of the primary sources available: the Spanish manuscripts and printed texts of stereotomy and the constructed examples.

Firstly, in the stonemasonry manuscripts made in the Hispanic area between the 16th and 17th centuries, which have reached our days, reference to the so-called *Caracol de Mallorca* is frequent. It is an open-well spiral staircase with the intrados forming a right or cylindrical helicoid with a director plane. In no case do we find any model with the characteristic grooves in the intrados of this reduced group of spiral staircases (Vandelvira c.1580; Martínez de Aranda c.1600; Alonso de Guardia BNE ER 4196; Gelabert c. 1653).

Secondly, after the study of the works on stone spiral staircases carried out in recent years (Calvo López 2020; Calvo López and Nichilo 2005; Palacios 1990; Sanjurjo 2007; Sanjurjo 2017), we visited the spiral staircases that may have a greater stylistic relationship with those of the Cathedral of Jaen. We have focused on open-well spiral staircases that present striated intrados, as is the case in the two in Jaen. In this way, we have visited, photographed and measured the stair of the *Lonja de la Seda* in Valencia, work of Pere Compte around 1483, the stair of the Velez Chapel of the Cathedral of Murcia built around 1491 and that of the one of the Cathedral of Cuenca, which serves to climb to the roofs from the ambulatory.

We have also visited the precedent of all these cases in the *Castelnuovo* of Naples, the work of Guillem Sagrera during the middle of the 15th century. This is where we find the great staircase of honor and two small staircases of ascent to the gallery of the musicians in the *Sala dei Baroni*.

After this preliminary analysis, we decided to focus on the two staircases, the first, in the Jaen and the other, in the *Lonja de la Seda* in Valencia, since their similarities are remarkable. To do so, we obtained a point cloud and a textured mesh of each staircase with a Leica BLK 360 Scanner, using automated photogrammetry with the Metashape program. This rigorous survey of the three staircases has been the basis of our study from a geometric and constructive point of view.

The Gothic staircase and wall

Through a visual inspection and the set of photographs taken with a Leica Q full-frame camera, we have been able to determine some important points about the Gothic staircase in Jaen and its relationship with the chevet wall. Firstly, the starting level of the Gothic staircase gives us the information of the finished floor level of the Gothic Cathedral that begins in the earl 16th century, which is 59 cm lower than the current floor level of the Cathedral. It can be observed that the ashlars of the chevet wall, as well as the wall adjacent to San Fernando chapel, from a certain level, a surface finish different from the lower courses, with a more marked surface texture, as if bush-hammered. The same happens

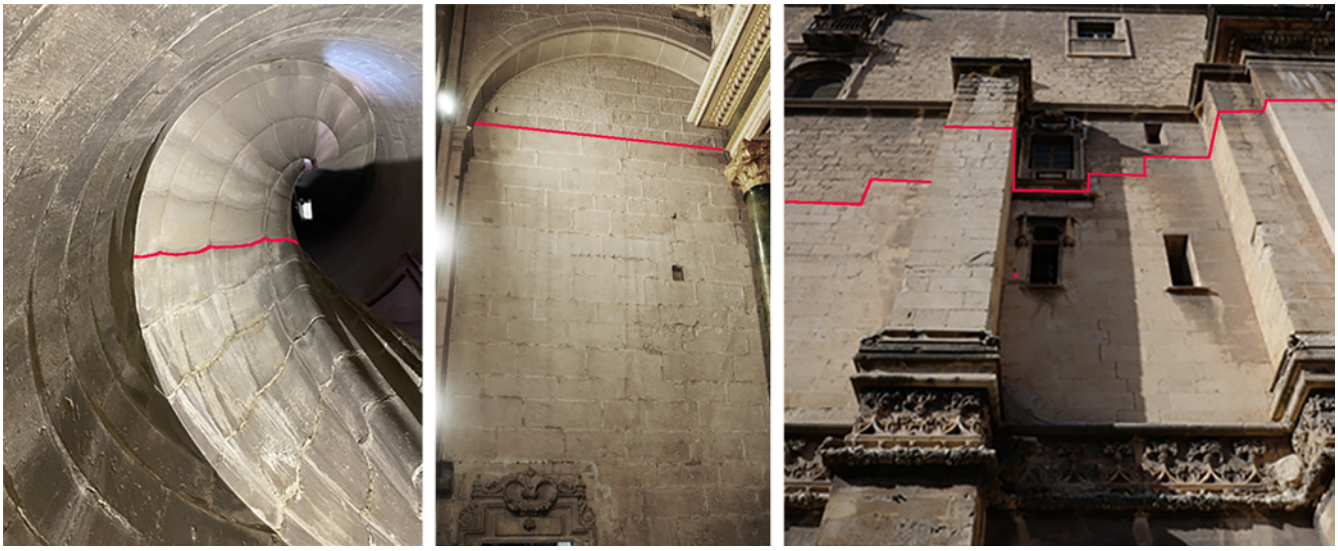

Figure 4. Cathedral of Jaen. Left. Gothic spiral staircase. Center. Wall at San Fernando Chapel. Right. Chevet wall on the east façade. Marked in red is the course of separation between the two construction stages (Image by the authors).

with the joint between ashlars, which is more noticeable in the upper courses. These aspects have led us to think about the possibility that the chevet wall had two different stages of construction. This has been confirmed by the fact that the Gothic spiral staircase clearly shows two construction stages and the course in which this change of tonality in the stone and state of conservation occurs, coincides with the level of change of texture in the aforementioned walls. In this way, we can confirm that the first courses of the Gothic wall and the first steps of the staircase attached to it were made in the same construction phase, which would have taken place in the early sixteenth century. (Fig. 4)

The *Cuaderno de Arquitectura* by Juan de Portor y Castro (BNE Ms 1914, c.1708) has also allowed us to establish the hypothesis that the rest of the construction of the Gothic wall and the spiral staircase could have been built during Juan de Aranda y Salazar's time as master builder of the Cathedral, between 1634 and 1642 (Carvajal 2011). Portor y Castro (BNE Ms 1914, c.1708, fol 8r) in his explanation of *Arco por dos rincones por plantas* says:

"Este arco puse aquí por esta diferencia que tiene y por ser el primer corte que está ejecutado en la santa Iglesia de Jaen, en el lado que mira al norte en la segunda planta en el estribo de la media columna que mira a la nave del crucero y se ejecutó año de 1643. También está ejecutado en la misma obra por el de por y esquina y rincón por plantas y viaje contra viaje por plantas, en el mismo lienzo para dar luz a un caracol de Mallorca. Y se ejecutó año de 1636."

The arches cited by Portor y Castro coincide in height with the area of wall and staircase corresponding to the second stage of construction, and in date with the years of the technical direction of the work by Juan de Aranda y Salazar.

Juan de Aranda carried out the partial demolition of the Old Cathedral in the area adjacent to the unfinished Gothic Cathedral, continuing Vandelvira's previous work on the chevet up to the transept (Ortega 1991, 92–93; Calvo et al. 2019, 162–163).

Stereotomic analysis of the Gothic spiral staircase of the Jaen Cathedral

The next step has been to design the template that allows for the construction of these three spiral staircases and the process of carving a step, since this type of spiral staircase can be manufactured in series in the masonry workshop from a container prism.

The template and, therefore, the working method differs from those found in Spanish stonemasonry manuscripts, which, as we have indicated, explain exclusively the working process of an open-well spiral staircase and helical intrados surface of director plane.

The only clue we have for the tracing of the edges of the intrados and the central molding can be found in the manuscript of Joseph Gelabert (1653) in his explanation of the *pilar entorxat*. It is a pillar with helicoidal edges similar to those of the Merchants' Hall in Palma de Mallorca and the *Lonja de la Seda* in Valencia. These pillars are typical of the Mediterranean Gothic style.

This template of a step can be divided into three clearly defined parts: the central molding, the intrados surface and the support surface of a step on the one immediately above it. The central molding is constituted on plan by three edges formed by the intersection of circumferential arches, a *baquetón* or circular section rib, two edges more and a transition curve with the intrados surface. The intrados surface is a helicoidal surface that is formed by rotating about a vertical axis and resting on a cylindrical helix, a succession of circumferential arcs that intersect each other, forming their characteristic grooves. The surface generated in this way has, in this case, three concave helical surfaces and the intersection between them are the aforementioned grooves. The radial space of the offset or connection with the next step is used for the support of the next step. It is called *ligazón* in Spanish stonemasonry manuscripts (Vandelvira c. 1580, fol 49v).

From these three elements, we will be able to draw the template of a step. The great advantage in the process of carving a step for a spiral staircase is that both the lower bed and the upper bed are flat and parallel.

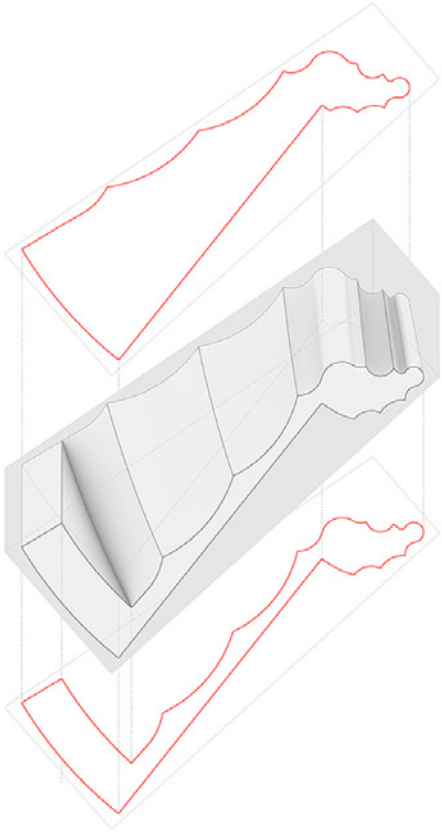

Figure 5. Plan oblique drawing showing the application of the templates on the stone block to carve a stair step (Image by the authors).

Therefore, a mixtilinear prism will be carved, which has as its base the plan of a step with its corresponding proportional part of the molding, plus the ligature, which in this case is radial and the offset that is produced in the molding. The height of this prism will coincide with the riser dimension of the step. (Fig. 5)

The next step will be to rotate the template the angle formed by the steps on the top face of the stone block. In the case of the Gothic staircase of Jaen, the angle corresponds to 21 steps per turn, a little more than 17º, which marks the place where the next step will rest.

The process of carving the central molding is similar to that found in some manuscripts, such as that of Alonso de Vandelvira (c.1580, fol 51r). Once the template is placed on both the lower and upper beds—the upper one should be turned to coincide with the ligature—the intrados surface is carved. It is at this step where we find the fundamental difference with the conventional *Caracol de Mallorca*. While in the former, the intrados surface can be carved with a ruler, since it is a ruled surface with a director plane, in our case, the intrados surface at the Jaen Cathedral, as well as the central molding, will be carved with the help of a *cerce*, or curved ruler, which makes this carving process enormously difficult.

Mediterranean origin of spiral staircases with grooved intradoses

There seems to be no doubt that if we consider this group of open-well spiral staircases as a typology, the origin of this one would be in the Mediterranean area.

The oldest stairs with striated intradoses are found in the *Castelnuovo* of Naples which was reconstructed by Guillem Sagrera between 1452 and 1454 (Zaragozá 2003, vol 1, 153).

In both cases they are linked to the *Sala dei Baroni*. The staircase of Honor, which connects this Hall with the Palatine Chapel, cannot be considered strictly as a *Caracol de Mallorca*, since its box diameter, around 369 cm, and its well, 127 cm, make it more similar to the English geometrical staircases or the *French vis d'honneur*. Although it has five grooves in its intrados, we cannot consider it as an example of direct influence on the staircases of the Cathedral of Jaen, since the stylistic and constructive differences are notable.

The other spiral staircases with grooves can be found in the *Castelnuovo*, which has tiny staircases of only 135 cm in diameter, used to go up to the musicians' tribune in the *Sala dei Baroni*. One of the two is practically destroyed and the other is in a lamentable state of preservation. With a step width of 61 cm, they have a striated central newel, 13 cm in diameter, which unfolds in the intrados forming a helicoidal surface riddled with a large number of grooves of great beauty. They constitute a unique exercise and are directly linked to one of the spiral staircases of the Merchant Hall in Palma de Mallorca, work of the same author, Guillem Sagrera, which also presents a fluted central newel.

In the chapel of the Marquis of Vélez in the Cathedral of Murcia we can also find two stairs with four grooves in their intradoses. In this case the model is more similar to the staircases of Jaen, since they are conventional open-well spiral staircases. Calvo et al. (2005, 253–255) have highlighted the influence of Mallorcan and Valencian stone masonry in Murcian works in the transition period between Late Gothic architecture and the Renaissance, which is evident in examples such as the staircase in the Cathedral of Murcia. A little further away from the Mediterranean, already in the interior of Castile, is the Cathedral of Cuenca where we can find a new example of an open-well spiral staircase with striated intrados located in the ambulatory with the aim of giving access to the roofs of the Cathedral. In this case it is a staircase with a diameter of 185 cm and a step width of 67 cm and a riser dimension of 24 cm. Its intrados has six helicoidal grooves and a central molding composed of a simple and powerful *baquetón* or circular molding. (Fig. 6) This powerful molding with an evident circular section and helicoidal development is clearly related to examples from the Mediterranean area, such as the archetype that possibly gave its name to the *Caracol de Mallorca* in the Merchants' Hall in Palma de Mallorca or those of the *Torres de Quart* in Valencia. The Mediterranean influence in the bordering Castile can be evidenced through numerous examples during this period, such as the *Almansa* Castle where we find ribbed vaults, keystones and a *Caracol de Mallorca* that some authors have related to the figure of Pere Compte, author of the *Lonja de la Seda* of Valencia (Sanjurjo 2007).

Figure 6. Left. Intrados surface of the staircase of Honor. Center. Intrados surface and flute newel of the staircase in the Sala de Baroni. Castenuovo, Naples. Guillem Sagrera. Right. Intrados surface of the staircase in the Cathedral of Cuenca, Located in the ambulatory with the aim of giving access to the roofs of the Cathedral (Images by the authors).

It is in Valencia, in the same building where we have found the spiral staircase that undoubtedly served as a model for our Gothic staircase in Jaen. It is the staircase of the tower, which directly communicates the hall of the *Lonja* with the upper rooms and the roofs of the building. As in the case of Jaen, it was built in two distinct construction phases.

The Gothic staircase and the tower staircase in the Cathedral of Jaen and the staircase of the Lonja de la Seda in Valencia.

After our first analysis of the group of known staircases with fluted intrados, we have confirmed that the staircase of the *Lonja de la Seda* in Valencia, built around 1483, could have been the model followed by the author of the Gothic staircase in Jaen. The chronology in the construction process of the three staircases was undoubtedly as follows: first, the Valencia staircase, built at the end of the 15th century. Then, about twenty years later on, in the early years of the 16th century, the construction of the first sections of the Gothic staircase in Jaen. This was followed by the last flights of the Gothic staircase constructed between 1634 and 1642 and, finally, the staircase near the tower in Jaen in 1717.

The three staircases, although differing in their fundamental measurements adapt to the spatial characteristics of the place where they are located, maintaining the same design in all their elements.

The staircase near the tower of the Cathedral of Jaen has a diameter of 247 cm, with a step width of 90 cm and a riser size of 17 cm., making it more comfortable to use. (Fig. 7) It is closer to the measurements of the staircase of the *Lonja de la Seda*, which has a diameter of 243 cm, a step width of 95 cm and a riser of 20 cm. (Fig. 8)

The Gothic staircase of the Cathedral of Jaen is the one with the most unusual measurements, especially in the dimension of the riser. It has a box diameter of 235 cm, with a step width of 89 cm and a riser dimension of 26.5 cm, which makes it especially uncomfortable to use. In the courses preceding the beginning of the second construction stage, the diameter of the staircase is progressively reduced by a few centimeters. (Fig. 9)

It is evident that the author of the staircase of the tower of Jaen imitated the design of the Gothic staircase located at the chevet of the cathedral, possibly already admired by the stonemasons who worked in the cathedral workshop in the early years of the eighteenth century.

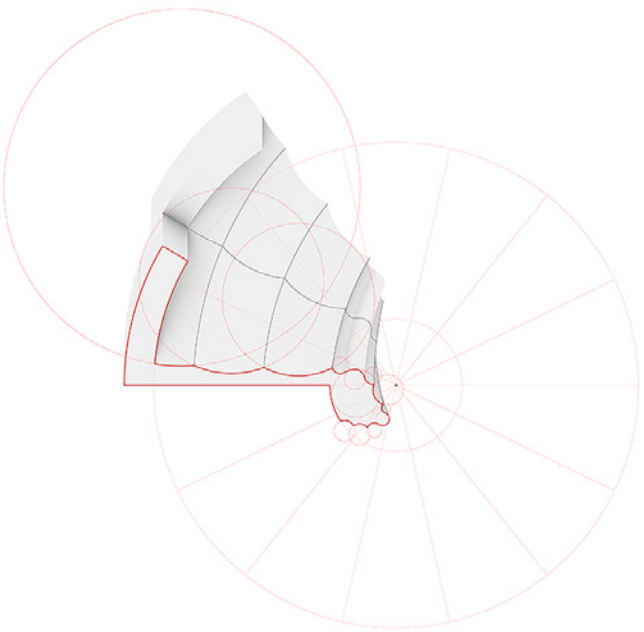

Figure 7. Staircase close to the tower in the Cathedral of Jaen. Plan oblique drawing showing the geometric layout obtained from the survey from the point cloud and textured mesh (Image by the authors).

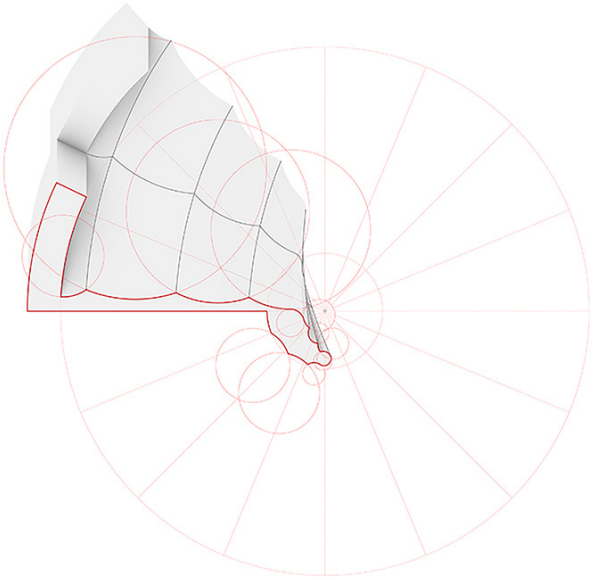

Figure 8. Staircase in the *Lonja de la Seda* in Valencia. Plan oblique drawing showing the geometric layout obtained from the survey from the point cloud and textured mesh (Image by the authors).

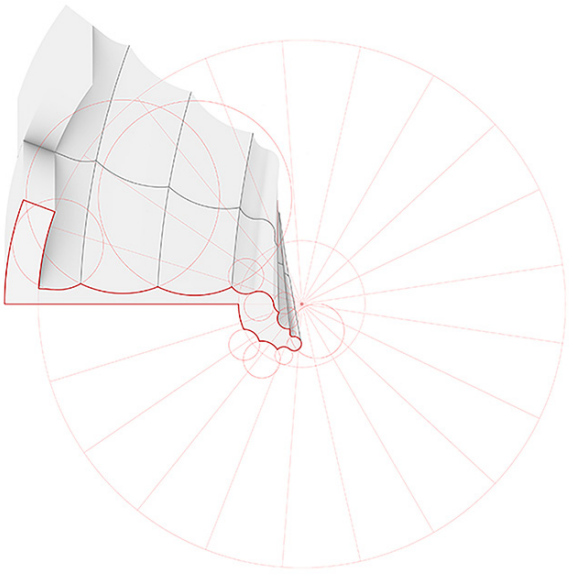

Figure 9. Gothic Staircase in the Cathedral of Jaen. Plan oblique drawing showing the geometric layout obtained from the survey from the point cloud and textured mesh (Image by the authors).

Figure 10. Left. Intrados surface of the spiral staircase in *Lonja de la Seda*. Valencia. Right. Central molding (Image by the authors).

Figure 11. Left. Intrados surface of the Gothic spiral staircase in the Cathedral of Jaen. Right. Central molding (Image by the authors).

What is most striking is the similarity in the stereotomic design between the Gothic staircase of the Cathedral of Jaen and the one located in the *Lonja de la Seda* in Valencia.

If we carefully analyze each of the elements that make up these staircases, we realize the close relationship between them. The central molding is composed of exactly the same elements: a cylindrical portion that protects the side of the step giving way to the development of the molding, composed of three helical edges, a convex circular rib, two helical edges and a new convex transition space with the intrados surface. This configuration was not the norm at the end of the 15th century in typical Mediterranean staircases where the molding was composed of a circular section with a very simple design, lacking any ornamentation.

On the contrary, this more complex model, with different variants, will be the one that will be developed in Andalusia and Castile from the 16th century onwards. Thus, we can observe *Caracoles de Mallorca* with richly ornamented moldings, including, among others, the staircase of the main sacristy of the Cathedral of Seville, the work of Diego de Riaño, or the staircase of the sacristy of the Cathedral of Plasencia, the work of Rodrigo Gil de Hontañón, both in the 16th century. However, this alternation of concave and convex helicoidal surfaces is difficult to find outside of these three staircases in Jaen and Valencia.

The starting point on the floor of the central molding and of the perimeter molding is also significantly similar in the Gothic staircase of Jaen and that of the *Lonja de la Seda* in Valencia. (Figures 10–11)

The intrados surface with the aforementioned helical grooves, giving rise to three concave helical surfaces is very similar in the three staircases, as is the link between one step and the one immediately above it.

All these common characteristics prove the affiliation of the Jaen model with the one located in the *Lonja de la Seda* in Valencia and confirm the thesis developed by various authors that the professional contact between masters and stonemasons of the Spanish Levant and Andalusia, at the dawn of the Renaissance, was constant (Calvo 2005).

Conclusion

The so-called Gothic staircase of the Cathedral of Jaen is attached to the chevet wall. In this paper we have been able to verify that the ashlar courses form a unit between both elements, which confirms that both constructive elements were built at the same time. On the other hand, the analysis of the wall linings and the steps of the staircase has allowed us to affirm that there were at least two construction stages. The first would correspond to the Gothic Cathedral at the end of the 15th century and the beginning of the 16th century. The second would have been built during the second third of the 17th century, more than a century later. This agrees with the data provided by Martínez Mazas (1794) in relation to the fact that the works were, in that area, paralyzed for a long period of years, which would justify the greater deterioration in the steps of the stairs of the first sections, which could have been outdoors for a long time.

We have not been able to find out the reason why, coinciding with these courses, the diameter of the staircase is reduced. This process is carried out in three courses, until the new diameter is reached. The adaptation to the archive rooms that were being designed at that time are a possible reason for this reduction in size.

The stairway located in the north zone, next to the tower, was built around 1717–1718, as can be seen in the lintel of two access doors to the rooms.

Although the general design of the template allows each step to be built in series is very similar, there are several differences between the two staircases. The most important one is the size of the riser, which makes the latter more comfortable to walk on. The other difference is found in the starting point or meeting point between the central molding and the pavement. In the staircase of the tower there is no finial, while in the Gothic staircase we find a typically Gothic finial, richly ornamented.

These two important differences would rule out the simultaneous or coeval execution of both staircases.

It seems to be demonstrated that the origin of these open well spiral staircases and striated intrados is in the Mediterranean area. What had not been demonstrated until now is the direct relationship between the design of the spiral staircase of the *Lonja de la Seda* in Valencia and the Gothic staircase in Jaen.

The transfer of knowledge between stonemasons and masters from different parts of the Iberian Peninsula during the last years of the 15th and 16th centuries has been studied by several authors. There is evidence of the meeting of masters that took place in 1500 to analyze the stability of the dome of the *Seo* of Zaragoza. The meeting was attended by Enrique Egas and Pere Compte, author of the staircase of the *Lonja de la Seda* in Valencia, among others. That same year there is evidence of the visit of Enrique Egas to appraise the works of the Cathedral of Jaen (Ibañez and Alonso 2016). Several authors have maintained the thesis of Enrique Egas' authorship of the Gothic Cathedral of Jaen (Alonso 2014). There is only evidence that during the last years of the 15th century the stonemason in charge of the work in Jaen was a certain Pedro López. There is evidence of the professional relationship between Enrique Egas and Pedro López, at least in the layout of the Royal Chapel of Granada and in a joint visit to the Cathedral of Seville, after the collapse of its dome (Alonso 2014).

All these crossed relationships would prove that the stonemasonry procedures and stereotypical designs were already leaving the closed medieval workshops and further that, the exchange of information was common between different workshops. With this change that took place throughout Europe at the end of the 15th century, we can find the reason for the Gothic staircase in Jaen.

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