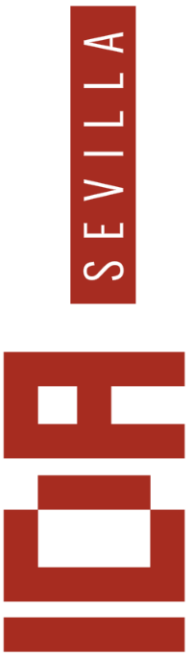

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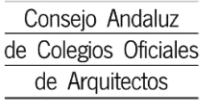

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LT 3

PATRIMONIO Y REHABILITACIÓN

HERITAGE AND REHABILITATION / PATRIMONIO Y REHABILITACIÓN

GEOMETRY AND CONSTRUCTION THROUGH THE SACRED SPACE OF ANDRÉS DE VANDELVIRA

GEOMETRÍA Y CONSTRUCCIÓN A TRAVÉS DEL ESPACIO SACRO DE ANDRÉS DE VANDELVIRA

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Abstract: Mainly we value this work as a review on the importance of the contributions of the architect Andrés de Vandelvira in the configuration of the new scenario on which the Architecture of the southern was defined in the XVI; For this, we develop our work through the formal analysis of its main sacred works, acting both from project approaches and others substantially executive.
In order to shape the research, we have taken some distance from the achievements we have worked on, in order to rigorously evaluate, through graphic reconstructions, the main innovations developed by the master.
We have approached a new interpretation on the project genesis with which Andrés de Vandelvira operates, based on the knowledge of the trades and the control of the processes, rather than on the application of specific theoretical methods. This means that in their production we can discover constant interrelationships between geometry and stonework (design and construction), which result in formal and stereotomic solutions only comprehensible from experimentation.

Key words: Vandelvira, Geometry, Stereotomy, Stonework, Construction.

1. Conceptual approach

Before the exposition, it could be said that the reflections on which research is supported are limited to the analysis and study of models belonging to sacred functional programs (Lázaro Damas 2005). This consideration allows us to understand some issues, while justifying the emergence of certain solutions or, in parallel, disables other approaches.
From this position it is accepted that a good part of the conclusions that are going to be presented are based on graphical reviews[1], focused to a greater or lesser extent, or in one direction or another, on the subject studied.
This exercise approximates the evaluation of the vandelviria's architectural language from the formal analysis of its sacred space[2]; however, this does not mean that the conclusions reached can not, or even must be, applied to the full extent of his work; we only indicate that his sacred production is an independent catalog to understand the greatness of his propositions and the investigative capacity with which he worked.
According to the scale, the complexity of the program, the capacity of budgets, either by the formulas deployed, the techniques, the singularity of the essays, or by the urban design, by the relationship with power, or whatever, it is unquestionable that the particularization of this kind of solutions serves well enough to support the objectives developed by this study.
When we compare Vandelvira's work with the projects of other masters, such as Ginés Martínez de Aranda (Clavo López 1999), or even with some less relevant, such as Joseph Gelabert, we understand that the work supported by José Carlos Palacios Gonzalo (Palacios Gonzalo 1990) and Barbé Coquelin De Lisle (Barbé Coquelin De Lisle 1977), can be expanded and promulgated beyond the reworking of existing drawings in the treaty his son Alonso.

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[1] For this reason, the exposition of arguments that has been developed is accompanied by a set of drawings, perspectives, explanations or developments, without whose presence the wording would be sterile and that, for a logical matter of space, it is impossible to collect integrally in this paper.

[2] It is clear that the research work presented, even though it seems to be homogeneous, results from the sedimentation and accumulation of knowledge that has been acquired on the topic over time. In practice, this means that the relationships worked through the different sections do not necessarily have the same starting point, nor an equal working formula, nor the same logic of extraction of results.

2. Form and construction in the sacred work of Vandelvira

Starting from a fundamental historiographical revision, we see that different hypotheses emerge about the imprint and importance (Chueca Goitia 1995), at the level of work and project, of the figure of Vandelvira.

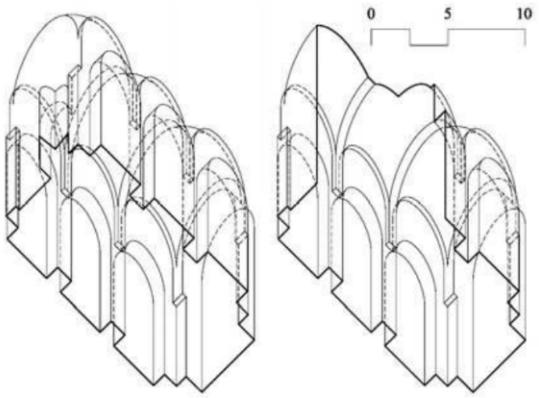

Fig. 1 Egyptian axonometries of the Sacristy of the Sacred Chapel of El Salvador in Úbeda. Drawings of the autor.

2.1. *Production system*

In order to understand Vandelvira, it would be justified to make a parallel review with the contributions of other architects, such as Martínez de Aranda or Hernán Ruiz, whose works would support a critical revision through the linear concatenation *creation / ideation / planning / organization*[3]. It is precisely thanks to this succession of hierarchies by which their contributions manage to overcome the barrier of time, even beyond their own existence; as for example would occur with the Cathedral of Jaén, because in other way, those who came behind (Alonso Barba or Juan de Aranda Salazar) would probably have distorted the global idea of Andres de Vandelvira, perhaps in a way as abrupt as the intrusion of the baroque choir wall projected by Gallego and Portal (Galera Andreu 2000).

Needless to say, the idea to be able to control the project from its earliest stage to its final result, it was necessary a very thorough training which, as it could not be otherwise, was closely linked with the stonework. In addition, it is well known that for working in this field is required an enormous capacity for resolution "in an abstract way" (at any scale and in any place), in addition to an important specialization on graphic communication techniques.

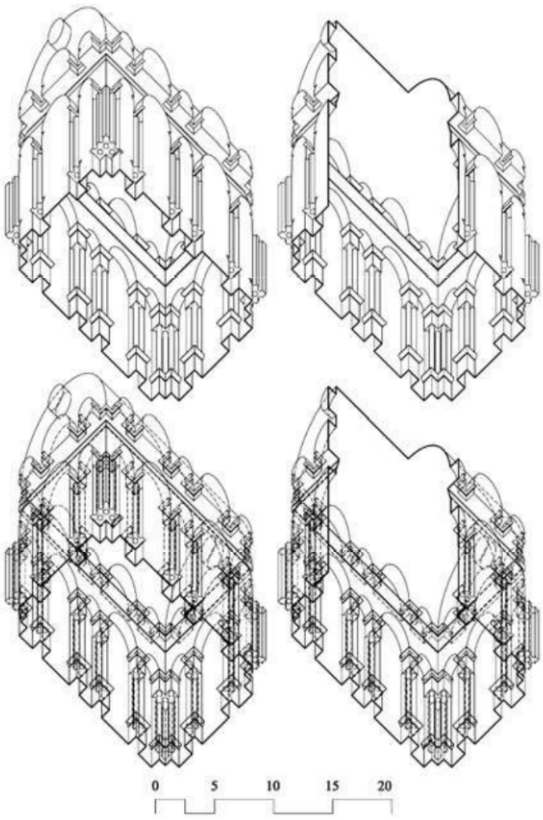

Fig. 2 Egyptian axonometries of the Sacristy of the Cathedral of Jaén. Drawings of the author.

We argue that there was a *propositional reformulation* that was no longer supported only by perspective design (as it had been inherited from Italy), but was now based on a logic of *design of an executive nature*. What we have come to defend is that in the work of Vandelvira, as in the proposals of others of this time, there is a deep concern to sponsor the achievement of certain spatial intentions according to the use of the most correct and coherent executive solution for each case; or what comes to be the same, because in the projects of Vandelvira does not fit the separation between ideation and execution. A magnificent example[4] that shows what has been said would be the sacristy of the *Sacred Chapel of El Salvador in Úbeda*.

[3] In order to make sense of this discourse, we explored the way in which Vandelvira produced, or what came to be the same thing, we inquired about *what were his main tools of projection*, for trying to attack and to know those procedures of articulation used of according to the guidelines of this new productive language of the XVI (spatial and executive). It is here that the constant and intrinsic reference is predicted in all his work with respect to the close and inseparable communion between *geometry and stonework*; for although it is evident that the very presence of the manuscript of his son Alonso records this, we can only understand the depth of these roots when we begin to crumble, to "re-project" some of their solutions in work.

[4] We can detect how a silent battle is fought against the impregnable laws of the mechanics of the rigid solid and against the aptitudes of the material used for the construction, that is, the stone.

There is no doubt that Vandelvira is interested in the perspective construction of the space, otherwise it would not have projected the Sacristy of the Cathedral of Jaén, according to a so marked system of organization for the mural planes; although its intention is also crystalline when it bets to promulgate an action that is justified in the construction, that is, the layout, the rethinking, the cutting or the assembly, as it happens with its unique contributions for the *Chapel of the Convent of San Francisco in Baeza*, *Chapel of the Hospital of Santiago in Úbeda*, *the ochavo of the Church of the Convent of Santo Domingo in La Guardia*, or the *Baptistry of the church of San Nicolás de Bari in Úbeda*, among others.

2.2. *Technical and geometric invariants*

The relations, direct or indirect (Gómez Moreno 1988), with the proposals of Jerónimo Quijano, Diego de Siloé, Hernán Ruiz, Juan de Herrera, Rodrigo Gil de Hontañón, Juan de Portor y Castro, Ginés Martínez de Aranda, Francisco del Castillo, Juan de Aranda Salazar, Alonso Barba, or Juan Bautista Villalpando, present proof that show the previous hypothesis about the existence of means of exchange that made feasible the construction of solutions previously tested.

Within this catalog vertebrate by Alonso de Vandelvira, not infrequently based on the concrete work of his father, we could distinguish a couple of general considerations that would help us *to understand the manuscript as a set of solutions and invariants of a technical and geometric character*.

The first of these considerations is based on the search for answers to the vertical stabilization of constructions, resulting in solutions such as pendants, tubs, hoops, arches, corner and corner openings, stairs, ramps and spiral starecases (Natividad Vivó 2012).

As might be expected, the second of our considerations is based on focusing on the ingenuity with which Vandelvira responds to the demands for horizontal stabilization, from which will appear all kinds of vaults, more or less complex, where it seems to occur for good use of the sphere as an ideal geometric solution; here we could refer to *the oven vaults*, *square vaults*, *diagonals* and *oblique*, *vaults of cruises* and, of course, *the murcian cover* or *the cross chapels* and *the chapel of the jarjas*.

One of the most relevant contributions that we have reached throughout the study has been the assessment of *the transcendence of the graphic planning mechanisms that Andrés de Vandelvira uses to design the interior of the spaces*. Although for this part of the discourse we have to make use of the justification about the develop of a *control system based on the way in which interior space is understood* (Lotz 1985).

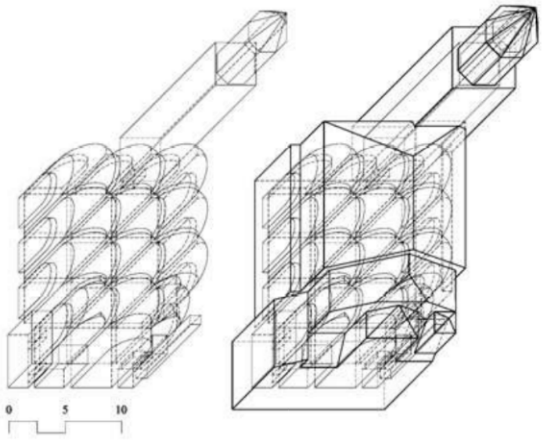

Fig. 3 Military axonometries of the interior empty space of the Church of the Immaculate Conception in Huelma. Drawings of the author.

To justify this idea we rely on the internal volumetric cavity of the *Church of the Immaculate Conception in Huelma*. Here there are multiple answers about the orthodox concerns of his time (Lotz 1985) and, in that sense it should be said that, for example, the phenomenological constitution of the interior space[5], despite being worked from perspective visualization, is solved for its appreciation from the detail and the closeness.

[5] In the case of Huelma, the architect had to negotiate with the preexistence of an anterior body that responds to a gothic language, whose after its insertion within the arranged grid, it achieves an absolute integration with the rest of the fluid space of a new plant.

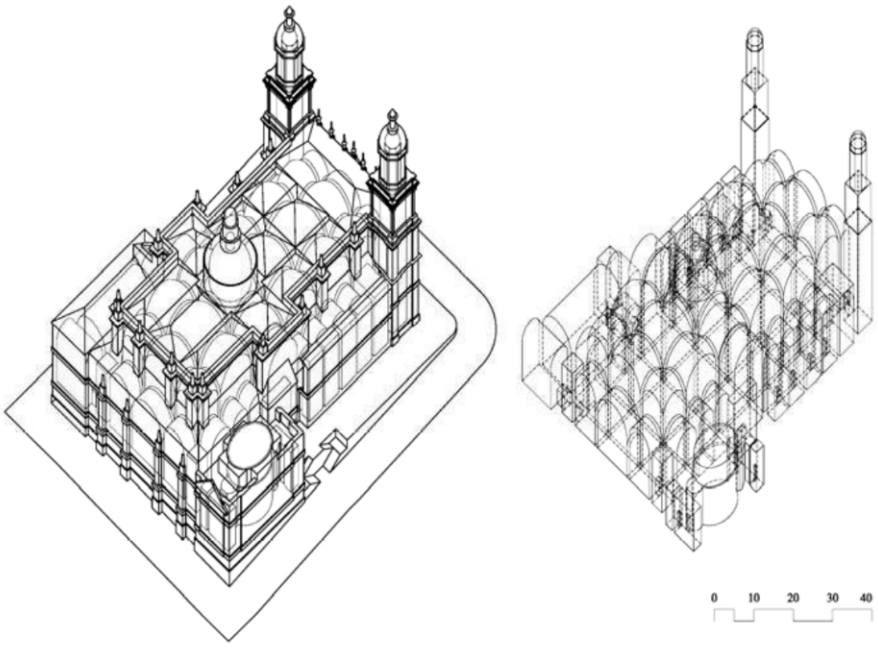

Fig. 4 Military axonometries of the interior empty space of the Cathedral of Jaén. Drawings of the author.

2.3. *Executive desing didactics*

Another aspect has been the *didactic evaluation of his sacred work* from the construction. We understand that in his work there is a discursive development based on the graphic essay, on which can be explained which were the itineraries that originated certain formal, spatial and constructive solutions.

The drawing was the fundamental tool for the simulation of the architectural space at that time, sometimes complemented with the sporadic appearance of models. Although we don't have original documents that can illuminate the activity of the master in this sense, it is evident that from the study of the manuscript of his son it is possible to elucidate on the necessity that those laborious stereotomic tracings had been tried, time and again, to promote the decanting of the magnificent solutions that are reached.

The constant graphics, which for Vandelvira's case was redefined in Alonso's court treatise, allows us to talk about the *pre-temporalization of the executive processes*, or what is the same, talk about of the previous planning of the task to develop in the plot. In the work of those great planners of the XVI, we can see a quantitative and qualitative advance on the previous control that existed for their realizations, surpassing the practice, common at the moment, to raise the buildings according to the tests on-site solved.

It would not be strange to catalog the work of Andres de Vandelvira as a production with doses of abstraction; because in otherwise it would be difficult to understand, for example, why there is a recognizable and comparable spatial model for the cases of the *Chapel of the Convent of San Francisco in Baeza*, the *Chapel of the Hospital of Santiago in Ubeda*, or the *Church of the Convent of Santo Domingo in La Guardia*, where the spatial organization is obtained from the central liberation of the space through the use of a thick folded wall;

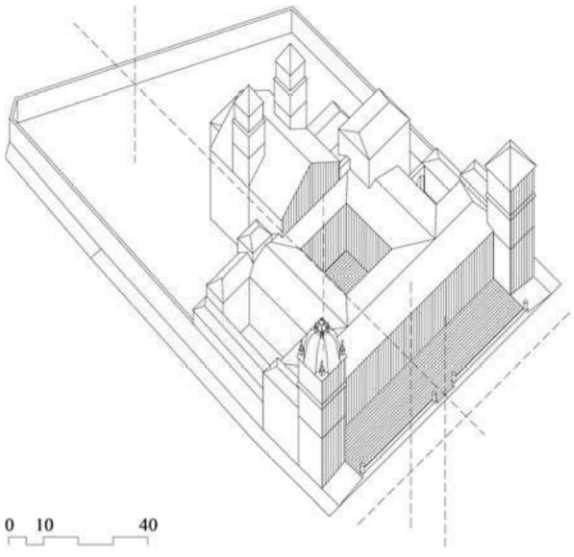

Fig. 5 Military axonometry of the external volumetric organization of the Hospital de Santiago in Úbeda. Drawing of the author.

or on the other hand, why there is a same perspective atmosphere in the *Church of the Immaculate Conception in Huelma*, in the *Church of the Assumption in Villacarrillo*, or in the *Cathedral of Jaén*, where the spatial sequence is obtained from the categorization of a system of supports ordered in a grid that gives meaning to the communication of the galleries, in addition being organized thanks to the elevation of elegant handkerchief vaults.

3. Contributions and findings

From the present study it is also possible to conclude that through the work of Vandelvira, it is proclaimed *the constitution of novel principles to be included into the rules of stereotomy*, because his work is full of solutions little used at this moment, some of these directly resolved by him, and others executed by his predecessors. The aforementioned principles can be summarized in a clear manner by the following ideas:

· *The connection between the design process and the construction process*, because the application of the geometric methods forced to draw in detail each one of the pieces that would be used.

· *The general simplification of forms towards simple geometrical figures*, or parts of them, which facilitate the complex definition of their spatial compositions.

· *Equivalent use of circular-cut exploded models and straight-line exploded models* (Gentil Baldrich 1996), irrespective of the surface on which it is used, which implies the same geometric cutting method, either in a vertical or horizontal position, and which responds to the way in which it applies the graphic theorems used.

We can also point out that the overall proportionality used by Vandelvira in his works (Ortega Suca 2012 and 1991), and in particular the proportionality of the *Cathedral of Jaén*, derives from certain spatial solutions tested, as evidenced by *the Church of the Convent of Santo Domingo in La Guardia*, or *the ruins of the Church of Santa Maria in Cazorla*.

3.1. *Spacial idealisation*

The specific way of proceeding of the masters was based on the idea that *all construction, regardless of its morphology, can be reduced to partial fragments of primitive geometric natures*, that by manipulation will generate more complex groupings. The stereotomy of the Renaissance is basically articulated around a single geometric process, and that is, the ability to develop surfaces on a horizontal plane.

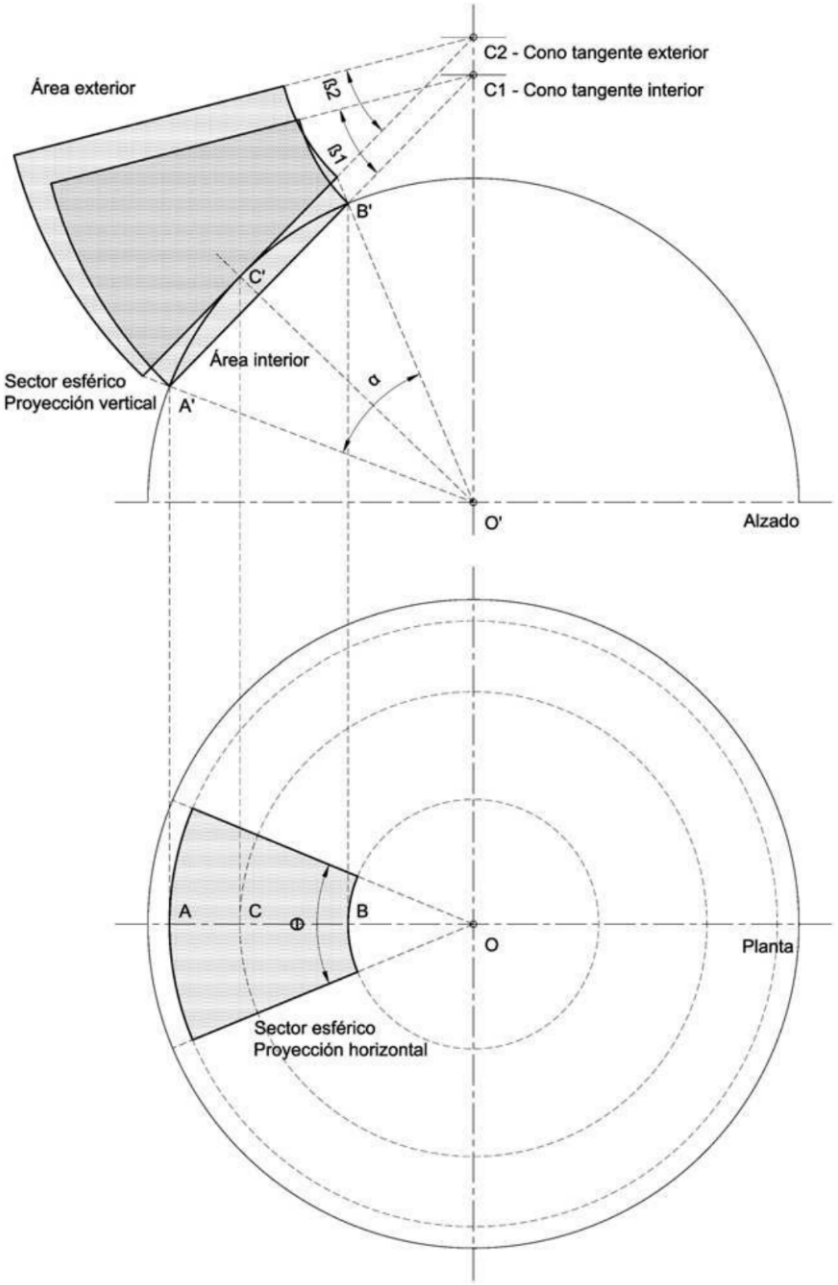

Fig. 6 Stereotomic development of the sphere according to the method of cones. Drawings of the author.

For practical purposes, the way of reducing surfaces to flat fragments that could be brought to the work in the form of stonework insoles (Natividad Vivó and Calvo López 2012) is supported in two graphic methods used by Vandelvira in an indistinct way, and sometimes at the same time. These are:

· *Method of cones*: based on inscribing a cone in each course, so that the inner faces of the veils can be understood as part of this new surface that, unlike the sphere, does allow to be developed in a plane.

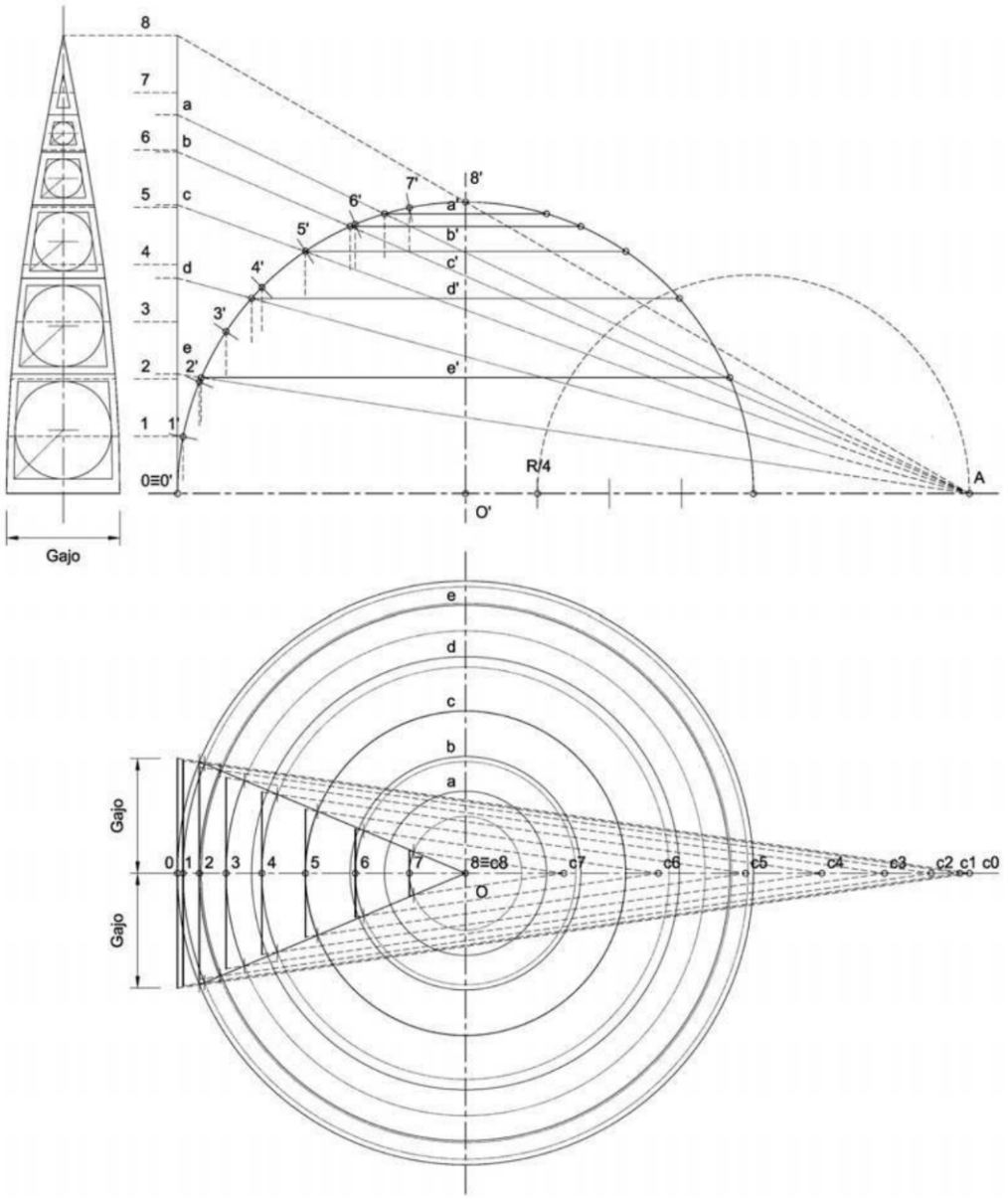

Fig. 7 Stereotomic development of the sphere according to the method of slices. Drawings of the author.

· *Method of slices*: it is based on the theory of dividing the sphere in parts bounded by sections of vertical planes that pass through the axis of the surface and that, from the theory of the development of the circumferences, allows to proceed to its reconstruction on a plane.

There is a constant negotiation[6] between the graphic and plastic processes used to control the perspective perception, whose results poses modifications in the cutting system to link the visual perception with the stonework logic.

[6] This research also makes explicit *the use of geometric methods of intersection of quadratic surfaces*, especially for the treatment of large space spaces, always using large format pieces; and is studied the application of these geometrical methods on the constructive protocols of material execution and on the procedures of cutting of stonework, which undoubtedly is one of the fundamental characteristics of the new language of the andalusian Renaissance.

With this work we also provide *a graphic synthesis of the empty spaces of the volumes constructed in the work of Vandelvira*, through the modeling in military perspective of some of the most interesting space sets of his work, where we can appreciate the spatial singularity of its realizations, and where it is demonstrated the capacity of experimentation of this architect.

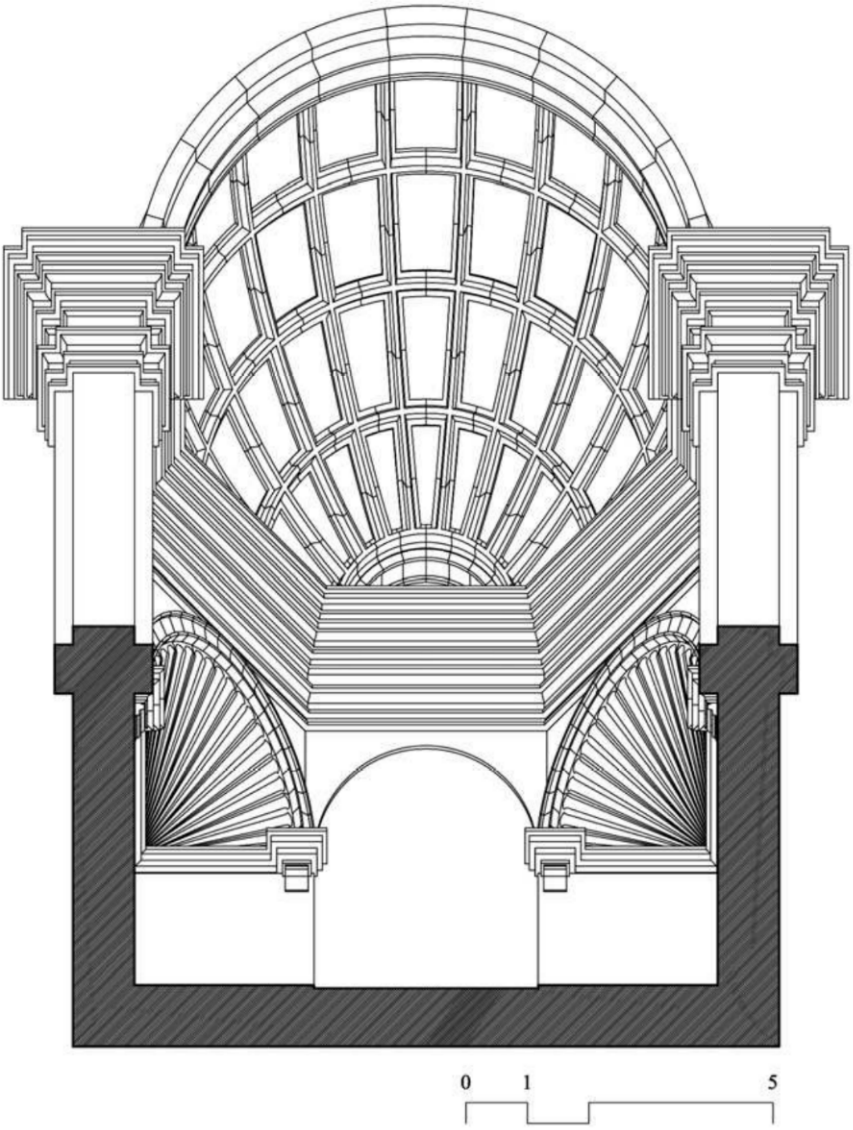

Fig. 8 Egyptian Axonometría of the ochavo of La Guardia (closing with a vault of Murcia). Drawing of the author.

3.2. *Experimentation and theatricality*

In this study also have worked questions that inquire about *the experimental vision that seems to pursue Vandelvira throughout his professional career*. Therefore, if we understand in depth some details of his work, we shed light on his work of innovation; because the solved cases for the *Mallorca staircase*, the *vía de San Gil*, the *emperors staircase*, the *vault of Murcia* or the *ochavo of La Guardia*, were tests that explain what previously mentioned (Zaragozá Catalán 2007 and Rabasa Diaz 2013).

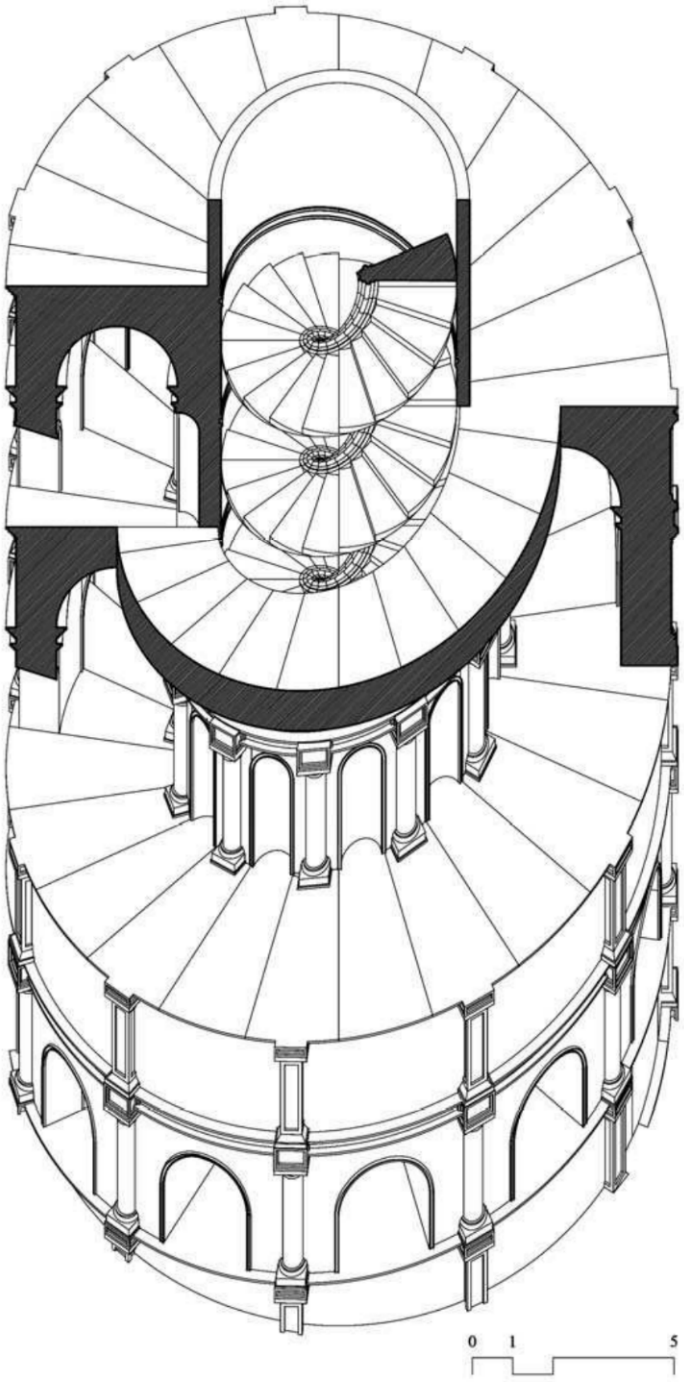

Fig. 9 Egyptian axonometry of the emperors staircase (sum of the vía de San Gil and the Mallorca staircase). Drawing of the author.

The first of the entries presents *global reflections on the formal and executive design of stairs, helix staircases and ramps*; that is, it reflect the importance that the architect gives to these space systems, not only for the ability to increase the density of use on the plot, but also because it gives him a fertile place to prove his particular interest in complex geometric models.

In the sacred spaces of the sixteenth century, we find traces that were the germ of major findings; The development of stairs designed from helical surfaces made it possible to test, in addition to new space formulas, interesting cutting systems. The helicoid coverings solved by rule, that is, solved from helicoids engendered by parallel lines that rotate around the same axis, give way to other more complex solutions that, for example, for the case of the *vía de San Gil*, arise from the movement of a semicircle contained in a vertical plane through two lanes, an helix and a vertical line.

The Mallorca staircase satisfies constructive questions also certainly interesting, as we can say that this type of stair was an early solution based on prefabrication and its self-supporting capacity. There is no doubt that its formalization is obtained through the overlapping of a single piece that had to be previously formed, because if we review the manuscript of Alonso de Vandelvira, we see how

precisely the definition is precisely of the rung which allows vertebrate the stair along its path. It is crucial to understand how the design of a false support is dimensioned to stabilize all the steps, achieving a structural effect equivalent to a *husillo staircase* but now allowing the passage of light through a hollow with an helix form.
But among the solutions studied, the best to understand the genius of Vandelvira is the *ochavo of La Guardia*. He uses here the solution of the model of Murcia, that is to say, a surface of translation that derives from the sweep of a curve around a axis of rotation. As for its carrying capacity, he makes use of the static mechanisms arranged for the *round chapel by cruisers*, whose rigidity emerges from the monolithism achieved at the points where the transverse and longitudinal ribs intersect.
In addition, in the *ochavo of La Guardia* we also discovered an obvious attempt to dissociate between the geometric configuration of the contour of the plant respect to the covering of the space, for which he designs a pair of *trompas aveneradas* that allow the effort transmissions in a easy way.

4. Corollary

As a final closing of this paper, we have to mention the importance of the contribution of Vandelvira as one of the main actors in the change of direction of the architecture of his time (Ampliato Briones 1996).
His extensive work, which we have limited to sacred programs, stands out for solving a catalog of scales, detailed designs, formal, structural and constructive solutions that have left an indelible record of the intelligence with which he was able to solve his projects.

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