

# Drawings and Scale Models Used in Building the Spanish Royal Sites

Pilar Chías, Tomás Abad

## Abstract

*In 1545 Emperor Charles V created the Board of Works and Forests to define and control all the building projects promoted by the Crown. As a result, the administration of the royal estates was updated and modernised due to its pyramidal structure. The building works were supervised by architects or draftsmen, who were responsible for the project's definition and construction respectively. The latter should also define the building contracts and build the models to be used by craftsmen. Following completion of the construction work, the administration of the royal site was entrusted to a governor or alcaide, so that the building process and management were distinctly separated. King Philip II transformed the previous practices into a strict regulatory framework affecting every craftwork, and defining in detail each piece of work in the building contracts. They included frequent references to moulds and models, and even sketches. Accordingly, the main targets and original contributions of our research are: 1/ to link the graphic documents to the written building contracts in order to make evident their complementary role, what will permit to know under which circumstances they were produced; 2/ to extend the research subject to every craftwork in the palace's construction, and not just to the stonework; 3/ to diffuse such an interesting set of documents that is essential to the history of construction in the 16th century, and particularly to the history of the royal works. For this purpose we publish for the first time some of these documents and drawings.*

*Palabras clave: Drawings, Models, Royal Sites, History of Construction, 16th Century.*

## Introduction

The construction of the royal works in Spain was regulated since 1545, when Emperor Charles created the Junta de Obras y Bosques (Board of Works and Forests). "The reason why it was created was to conserve the royal palaces, houses, sites and forests, to look after them and increase their number, and to repair their masonry." [Garma y Durán 1571, IV, 513]. The Junta remained active until the 18th century, when the powers and activities of the House of Bourbon [1] were being curtailed by a series of reforms and the decline of the institutions founded by the Habsburg dynasty [Díaz González 2006] [2].

The Junta had a strict pyramidal structure, being the supreme legal authority in regard of all royal sites, and having

power to act in cases of game and fish poaching, but also in all business dealings or legal suits arising in them.

As far as building was concerned, since the Board's mission was to protect the monarch's interests, its functions consisted in defining and supervising all work carried out in palaces and estates belonging to the crown. And to assist it in its labours, some relevant rules were drawn up governing the contracting, supervision, building, valuation and settlement of projects.

On the other hand, some powerful aristocratic families as the Mendoza, Medinaceli or Alba built remarkable buildings and gardens in Renaissance style. But the most ambitious ensemble of constructions was undertaken by the

Fig. 1. Scale model of the wooden framed structure of one of the 'chapiteles' (spires) over the towers in the Monastery. Patrimonio Nacional.



Crown under the control of the Junta, with great expense to the royal treasury [Checa 1992, pp. 34, 35]. Among the famous Spanish architects that worked in the construction of the royal sites, Covarrubias, Machuca, Egas, Luis and Gaspar de Vega, and Villalpando must be stressed.

Despite the importance of the investments made by the Crown, until now no systematic study has been made on the procedures and regulations that governed the management and control of the royal works. They are all still available in the numerous documents preserved in the Spanish archives [3].

To date, these aspects have only been studied in relation to very particular details of a building project [Bustamante 1994, pp. 36-52, pp. 128, 129] such as roofing, fluvial flood contention, the quarries in a region, and so forth; there has been no comprehensive treatment of the crafts involved or of the building process as a whole. With only few exceptions, neither has any research been conducted to date into the important role of sketches, full-scale drawings and models in royal building projects, nor to how they related to building processes [Chías, Abad 2017; Chías, Abad 2018].

### From drawings to construction

Building projects on the royal sites answered needs as varied as the refurbishment of an old building, the extension of an existing one, or the construction of a completely new palace.

The involvement of the monarchs in the building processes varied considerably, but none of them equaled King Philip II's attempts to control both the evolution of the works and the results. This trait of his character was highlighted by the Flemish gentlemen Jehan Lhermite [Lhermite, 1602 (1890-1896), p. 245]: "The natural inclination of the Monarch for every subject related with construction, and particularly with good layouts and finishes of his houses"; and also by the chronicler Luis Cabrera de Córdoba [Cabrera de Córdoba 1619 (1876-1877), p. 786]: "He was inclined naturally to build, enjoying the transit of things from their absence to their existence".

Once the general layout was drawn up by the royal draftsmen or architects according to the king's purposes, the

contracting process commenced following rigorous procedures that were only altered in case of singular or fine works.

Labour was paid at a daily rate or was contracted as piecework [4]. The pieces were assigned according to terms and conditions that had been published beforehand.

Although assignment was sometimes made directly, generally because of the degree of specialisation called for it, it was the custom for a public announcement to be made throughout the county –and sometimes beyond– which permitted pieceworkers in different crafts to apply for one assignment or another.

Before adjudicating the pieces, the king himself issued a word of warning to the piece workers, recommending that “they should give careful consideration and thought to the terms and conditions and the work to be done [...] and that no piece shall be assigned without having first complied with this requirement, and that once that is done and the samples of stonemasonry or carpentry have been prepared for the pieceworkers to follow, the assignment of pieces among expert and well-known workers should be decided, and contracting them at an agreed price, the pieces should be thus assigned, not by means of the usual auction, because if good workmen are given the jobs at fair prices, the work will be done well and in line with the samples and layout” [5]. As the text shows, the King mentioned clearly the use of moulds, samples and sketches.

The pieceworkers had first to prove their solvency and then to deposit an execution surety before being finally adjudicated the work.

Work on each piece was done in accordance with a detailed description of the tasks to be performed. This included the materials to be used and their characteristics, the dimensions of each of the elements to be built, how to set them in place, and the cost and period of execution.

Details were also given of the auxiliary means to be used, such as shoring, cranes and tools –often at the king’s expense– as well as of the materials and bonding agents to be employed, and of where to find them on the site, which was usually a point accessible to carts.

In line with its specification, each piece was given a detailed evaluation taking into account not only the materials but also the qualifications of expert workers and hired

Fig. 2. Conditions for sinking and fitting the cellar duct, with signatures. Real Biblioteca del Monasterio del Escorial, Doc. I-64.

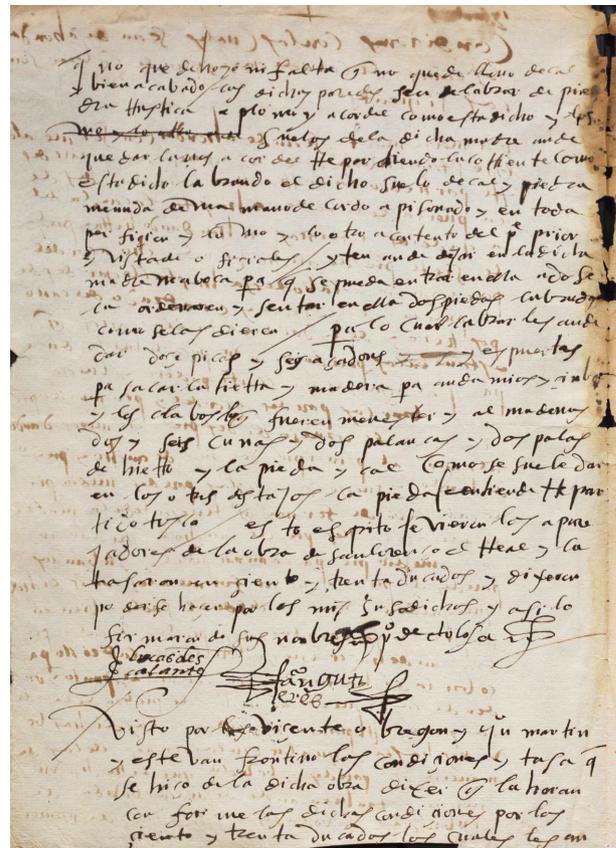
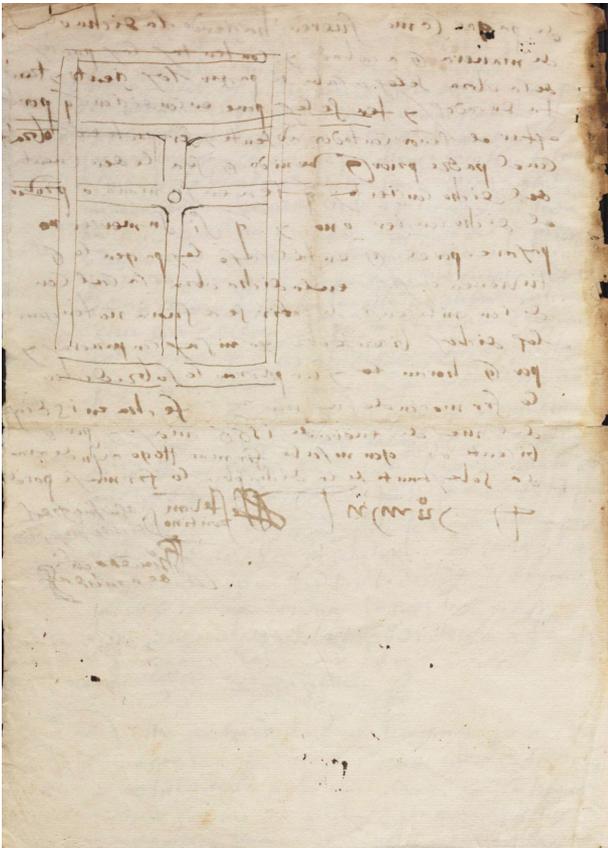


Fig. 3. Conditions for sinking and fitting the cellar duct, with signatures. Sketch. Real Biblioteca del Monasterio del Escorial, Doc. I-64.



hands, and the time employed. If the work was attractive, the hands “made their bids” at the corresponding auction like tenderers.

### Documents related to the works in the Royal Monastery of El Escorial

The works in the Monastery of El Escorial are particularly interesting. Despite its importance and the volume of work that was carried out, it was built in record time thanks to a well structured hierarchical organisation supported by successive *Instrucciones* (*Instructions*) –issued by King Philip II between 1562 y 1572– and by several *Órdenes* (*Orders*) dealing with some particular crafts.

An outstanding set of original handwritten documents relating to the works in the Monastery is preserved. It contains essential information about all project phases between 1563 y 1586. Building contracts and private correspondence between the king and the Hieronymite prior show the stage-by-stage planning and development of the work.

The documents also reveal the hierarchical nature of the project. While the architects were basically the draftsmen and site supervisors, it was the king and trusted courtiers – the Architecture Council or Consejo de arquitectura– and the monastery’s resident Congregation of Hieronymite Friars who discussed and decided issues related to design after viewing the corresponding models (fig. 1).

Below those were the master builders (stonemasons, masons and carpenters). These took charge of setting out, moulding and templates, as well as supervising the work on the different pieces. They were also responsible for taking measurements, surveying the works, and valuing them. Work on each specific section of the building and particular tasks was done in accordance with a detailed description of the tasks to be performed. This included the materials to be used and their characteristics, the dimensions of each of the elements to be built, how to set them in place, and the cost and period of execution. A case in point at the El Escorial site was the manuscript, dated 1564, setting out the “Conditions for sinking and fitting the cellar duct” [6].

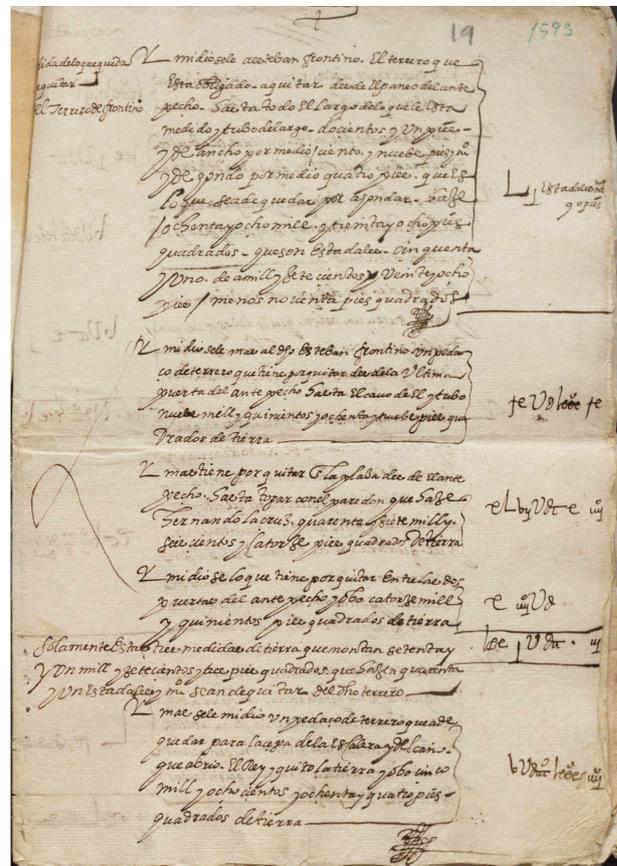
As an essential piece of work of the plumbing system, it

was put out to tender once the foundations were laid and the load-bearing walls arose from the cellar level. The contract specified that the work had to be done as follows: “using a string, make a straight trench in the earth and stone, seven feet in width, along the centre of the cellar to the door on the right and the square of the final duct [...] then use a plumb-line to build the walls with stone and lime mortar at least two feet thick, giving the start of the duct a width of two feet and a depth of one and a half feet [...] then build the vaults of brick to cover said main drain [...] also, remove shoring from the vaults, which shall be sail vaults, and plaster them [...] and use a string to ensure the floors of the main drain are flat, covering the floor with stone and lime mortar [...] to this end they have to be given twelve picks and six hoes, as well as baskets to remove the earth and wood for scaffolding and shoring; nails as required, two sledgehammers, six wooden shims, two levers and two iron shovels, and the stone and lime mortar as is usual in such pieces [...] and this document was read by the master-builders of the San Lorenzo el Real site, who valued it at one hundred and thirty ducats and said it could be done by the aforementioned, and signed it with their names”. This was followed by the signatures of all the pieceworkers and the king’s master-builders, the former undertaking to work “in compliance of the terms and conditions” and at the agreed price (fig. 2).

The written specifications were often accompanied by sketches and drawings; they even referred expressly to the use on site of templates and models by means of the formula “as per the corresponding plan and full-scale drawings” (fig. 3).

Below the architects were the master builders (stonemasons, masons and carpenters). These took charge of setting out, moulding and templates, as well as supervising the work on the different pieces. They were also responsible for taking measurements, surveying the works, and valuing them. To that end, they decided how the measurements were to be made. One example of this relates to the monastery’s main sacristy, that is located at the main cloister or Claustro de los Evangelistas. The works began in 1568, one year after Juan Bautista de Toledo’s decease, but yet according to his traces: “This wall must be measured from the corners of the columns inwards, without including the

Fig. 4. Measurements taken during earthwork in the Lonja. Real Biblioteca del Monasterio del Escorial, Doc. XII-24.



protuding parts of base, capital or cornice mouldings, to the top of the cornice, and from there to whatever there is of a certain thickness" [7].

This procedure was repeated several times during the development of the works, but always before signing the settlement. And if necessary, drawings were added in order to facilitate the identification of each measure (figs. 4, 5).

### Drawings, sketches, full-scale drawings and moulds

An interesting set of original drawings survives, still within the corresponding contract and complementing to perfection the written details.

Some of these drawings were intended for the foreman, while other were the result of architects' design solutions or just working drawings for consultation by workman on site. To the first category belong "carefully drawn, large-scale plans and elevations for presentational purposes", being the second group just schematic plans done rapidly to see what something might look like. The third category corresponds to the 'master plan', which is on the basis of the assembly of all parts into more complex structures. [Kostof 1984, p. 15].

The series of Estampas representing the Monastery by Herrera and Perret –engraved between 1583 and 1598– can be assigned to the first category, together with the set of drawings in the Library of the Palacio Real in Madrid (fig. 6).

Sketches produced to define significant architectural details within the building contracts belong to the second category. They represent the formal and metric aspects of the architectural elements and their pieces, that were essential to make the moulds and other necessary tools.

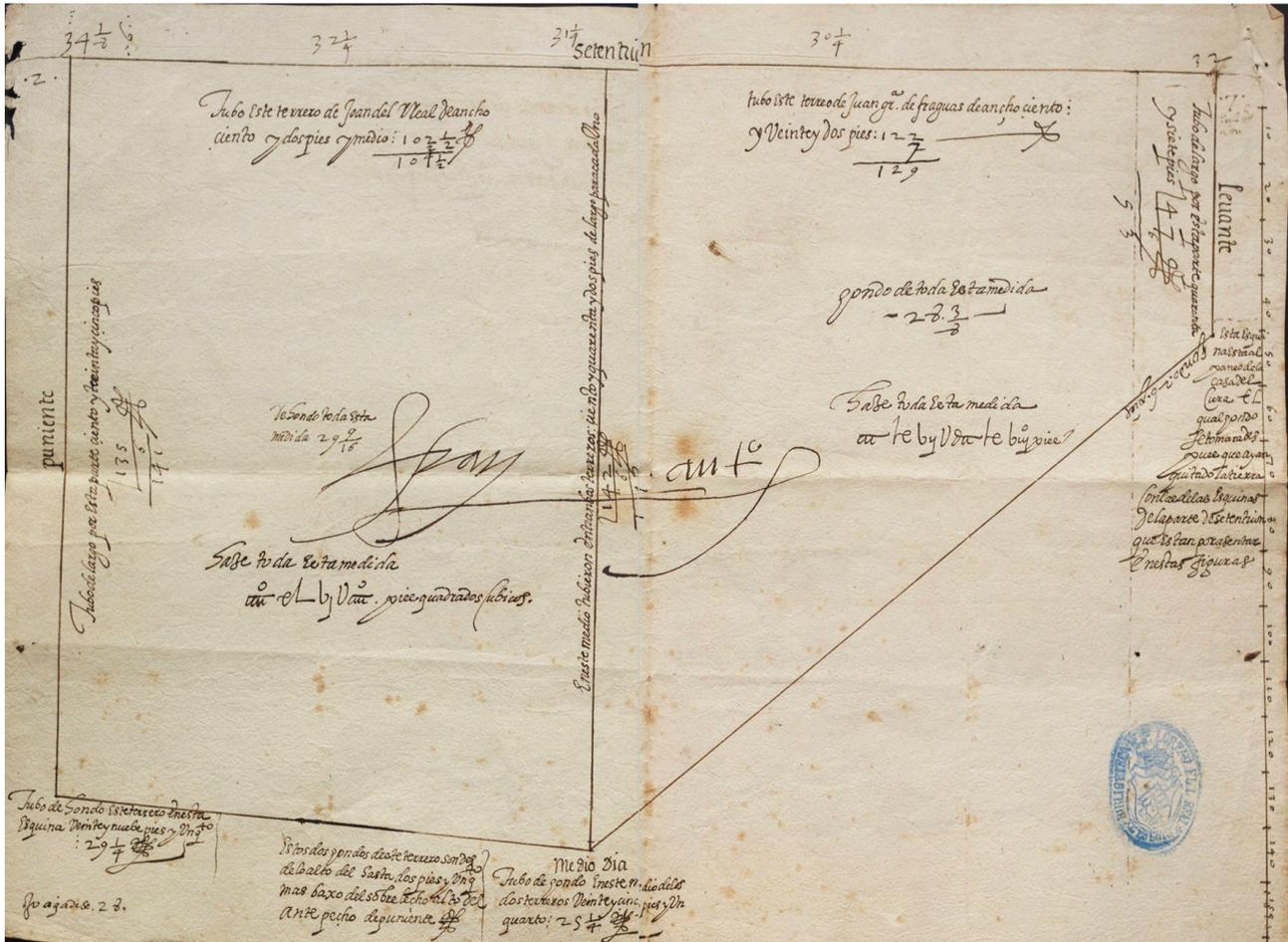
In contrast, the *monteas* or full-scale drawings were done of floors or walls in the latter stages of the building process. Showing with great precision the pieces making up each element and their distribution, they enabled tighter control of the work, thereby avoiding errors due to changes in scale [Calvo 2016] and proving at the same time the usefulness of geometry and drawing procedures. The term *montea* is used elsewhere in the documents to mean elevation or side. The joint use of full-scale drawings and

sketches is very common in the terms and conditions given to the bricklayers for the chapter house vault: "the chapels have to be done in brick and plaster as per a plan and full-scale drawing given" by the master-builder Pedro de Tolosa; in addition, "the centre-points of the vault and the windows must coincide with the marks on the floor, and said builder will make the bracing and shoring at his own cost but from material given to him as stated" [8]. It is worth pointing out that the use of sketches was not limited to stonemasonry but extended across all the crafts. A letter sent by the secretary to the king in August 1565 mentions the drawing for the model of grilles for the lesser cloisters: "Juan Bautista [de Toledo] made the sketch for the remaining grilles of these two cloisters, and after discussion with the fathers and others, he agreed how they all had to be and set to making a wooden model. He will come here to make it in iron and, once finished, will send it to Pero González de Escalante, for them to be made in Vizcaya". The king added in a note: for this, make haste on the iron model" [9].

As for the use of full-scale drawings, only some remain of the monastery's southern or '*Platerías*' basement walls and of the Prior's Tower staircase [López Mozo 2008]. We have dated the former to late November 1564 [Chías, Abad 2017] on the strength of architect Juan Bautista de Toledo's Memoria: "I proceeded to revise all the measurements and have them marked with chisels and nails, with numbers and red ochre above them, because the rainwater of the last few days had washed them away" [10] (fig. 7). The second group of full-scale drawings is of the Prior's truncated staircase, the construction of which was completed in 1574.

Unfortunately, no moulds or original models survive due to their fragile materials –brass and wood–, on-site wear and tear, and the succession of fires that afflicted the palaces from the 16th century onwards. Nonetheless, the complementary function of sketches, moulds and models was a constant at both the design and the construction phases. In so far as the models helped understand solutions adopted for particular parts or the whole, they were essential to decision-making during the building process. The sketches were always done beforehand; taken as a whole, they provide a glimpse of how the work on site was done. A royal

Fig. 5. Sketch defining the measurements of the earthwork in the Lonja. Real Biblioteca del Monasterio del Escorial, Doc. XII-24.

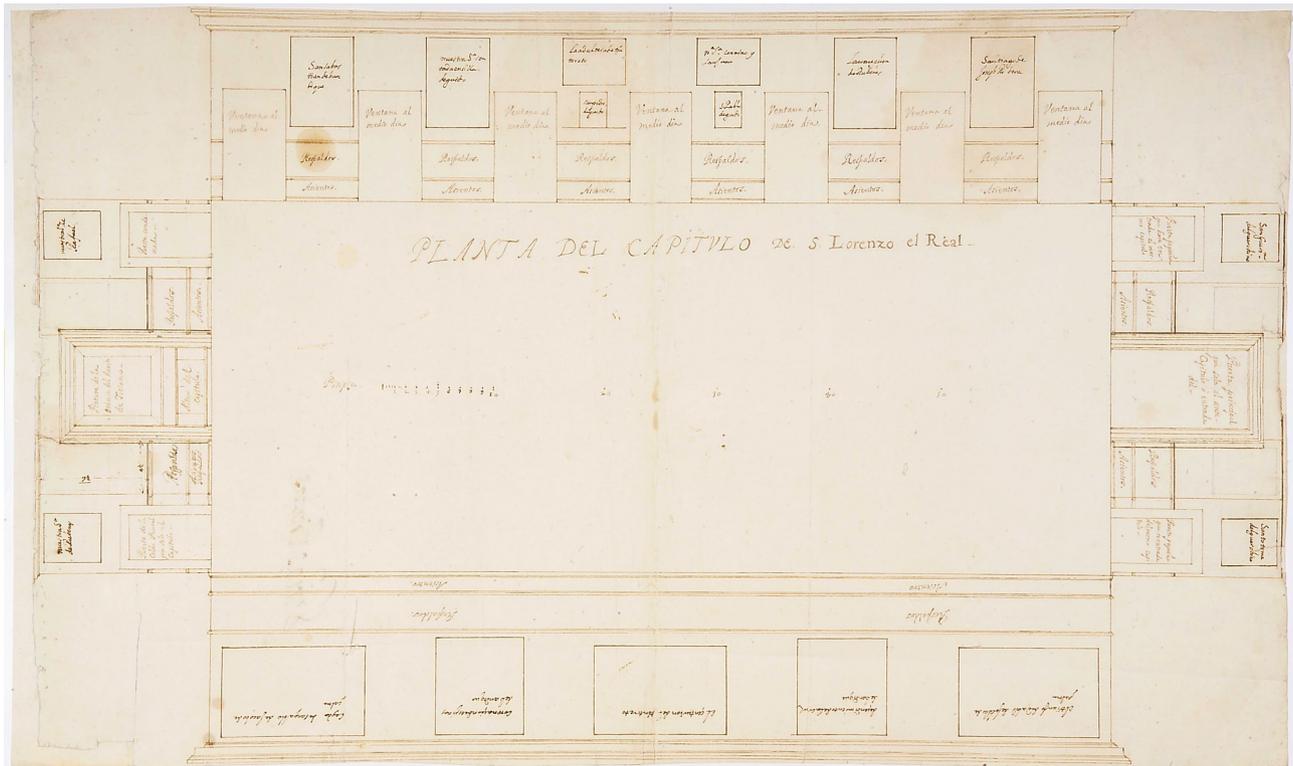


writ of 2 February 1562 already mentioned “the sketch and model being made” [Llaguno y Amírola 1829, II, pp. 227, 228]. In April, the secretary, Hoyo, informed the king that “in response to what your Majesty instructed, Juan Bautista [de Toledo] told me that he would finish shading either by yesterday afternoon or this morning, and would then set about raising the funds required for work on the model to commence, and I offered to make available to him whatever timber was necessary” [11].

It was common to refer to the model in order to determine building solutions. That was the case with the main stairwell and the ledges of the stairs down to the orchard,

it being specified that “all these stones for the ledges have to be stapled together and arranged as can be seen in the model made for the purpose; the stapling has to be done with the same stones to avoid any ugly effect, as can be seen in the model, making sure the ties are always neat and tidy as stated for everything else [...] at his Majesty’s expense, for all this work a mould for each difference, a bevel and trusses will be made available, and should more be needed, they will be made at his expense too, and the wood and tin plate to make them provided too” [12]. The documents also show how partial models by different hands were used persistently throughout the building

Fig. 6. Ground plan of the Chapter in San Lorenzo el Real. Real Biblioteca, Palacio Real de Madrid, Sign. IX\_M\_242\_I (33).





project to help decide on solutions. Thus, a letter sent by Juan Bautista de Toledo to Hoyo reads: "I herewith send to Jerónimo Gili, my former disciple, who is in charge of the model of the corners, which is done in two ways: one as if the corridors had to be vaulted, and the other as if done in wood" [13].

Apart from the model of the whole complex, the next in importance was the model of the church. The skilled carpenter Martín de Alciaga started work on it in 1573 using earlier versions based on sketches Diego de Alcántara—who was one of the stone-masons master builders. It took him two years to carve [Lasso de la Vega 1945].

Still extant are those corresponding to the lesser cloisters, the main cloister, the wall of the niches, the main staircase—for which architect Juan Bautista Castello Bergamasco also made a model—the church, the palace, the roofs and steeples, the college and the "offices and everything else that fits inside the picture".

On a smaller scale, 'little models' were also made, such as those for the door to the kitchens, for the plaster strips around the windows, for window ledges, for the cell locks, and even for the grilles.

## Conclusions

The procedure followed for contracting, executing and settling royal building projects in the 16th century was extraordinarily modern and well-defined. It continued into the 19th century in crown building contracts and still persists as the essence of Spanish legislation concerning state contracts.

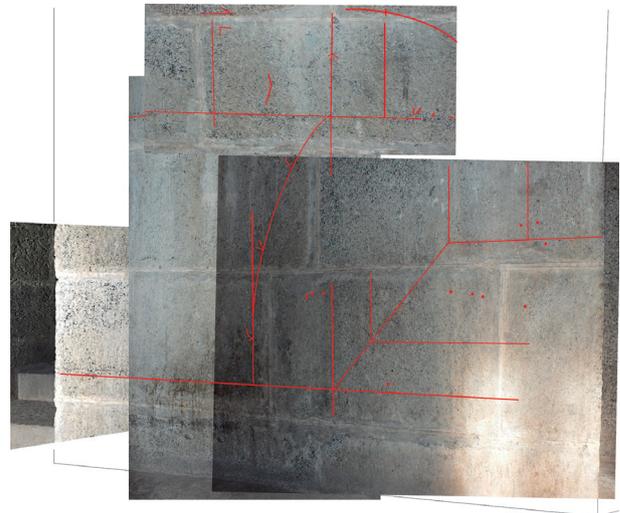
The use of different types of drawings, models and moulds was common practice at every stage of the project.

The sequential use of sketches, models and full-scale drawings, in close combination with written documents, is evidence of how the work was executed and, as has been demonstrated, was the norm for all crafts involved in the project.

The way these complemented each other is clear from Cabrera de Córdoba's [Cabrera de Córdoba 1619 (1876-1877), VI, p. XI] remarks on the El Escorial Monastery project in which, he claims, everything was done "on paper,

whether the whole, sections or parts, and then on a wooden model of the whole project because by taking them together, a better overview could be obtained, and so that whatever modification were required, whether in overall form or particular part, could be made, always with a view to improvement, since it was difficult to be right first time when planning and installing so many different things".

Fig. 7. P. Chías and T. Abad, 2017: Photomontage of the full-scale drawings in the basement of Platerías in the Monastery.



## Notes

[1] Particularly the palaces of La Granja de San Ildefonso and Riofrío, both located in the province of Segovia.

[2] The Habsburg dynasty started with the reign of King Philip I in 1504, and ended in 1700 when King Charles II died without descent. Followed King Philip V, who was the first king of the Bourbon dynasty.

[3] These are mainly the Archive and Library in the Palacio Real in Madrid, The Library of the Real Monasterio de San Lorenzo del Escorial, the Archivo General de Simancas in Valladolid, and the Instituto Valencia de Don Juan, also in Madrid.

[4] Destajo: work assigned to be done and paid according to a fixed price.

[5] Instituto de Valencia de Don Juan, Envío 61 (1), ff. 1r-2v.

[6] Real Biblioteca del Monasterio de San Lorenzo del Escorial, Doc. I-64.

[7] Real Biblioteca del Monasterio de San Lorenzo del Escorial, Doc. III-5.

[8] Real Biblioteca del Monasterio de San Lorenzo del Escorial, Doc. II-94.

[9] Instituto de Valencia de Don Juan, Envío 61 (1), ff. 327-330.

[10] Instituto de Valencia de Don Juan, Envío 61 (1), ff. 31-32.

[11] Instituto de Valencia de Don Juan, Envío 61 (1), ff. 327-330.

[12] Real Biblioteca del Monasterio de San Lorenzo del Escorial, Docs. I-90 y II-177.

[13] Archivo General de Simancas, Obras y Bosques, Escorial, leg. 3.

## Authors

Pilar Chías, School of Architecture, University of Alcalá, pilar.chias@uah.es  
Tomás Abad, School of Architecture, University of Alcalá, tomas.abad@uah.es

## Reference List

Bustamante, A. (1994). *La Octava Maravilla del Mundo*. Madrid: Ed. Alpuerto.

Cabrera de Córdoba, L. (1619). *Filipe Segundo Rey de España*. Madrid: Imp. Luis Sánchez. (quoted ed. 1876-1877: *Historia de Felipe II Rey de España*. Madrid: Imprenta de Aribau).

Calvo, J. (2016). De la traza de monte a la geometría descriptiva. La doble proyección ortogonal en la ingeniería militar, de la Edad Media a la Ilustración. In *El dibujante ingeniero al servicio de la monarquía hispánica. Siglos XVI al XVIII*, A. Cámara (ed.), pp. 45-67. Madrid: Fundación Juanelo Turriano.

Checa, F. (1992). *Felipe II, Mecenas de las artes*. Madrid: Ed. Nerea.

Chías, P., Abad, T. (2017). Scale models, templates, drawings and full-scale tracings in the construction of the Monastery of San Lorenzo del Escorial. In *Informes de la Construcción*, 69 (547). DOI: 10.3989/id55077.

Chías, P., Abad, T. (2018). The Botica or Apothecary in the Monastery of San Lorenzo el Real de El Escorial (Madrid, Spain): Written Sources, Historic Drawings, and New Surveys Applied to Architectural Analysis. In *Buildings*, 8(1), 4. DOI: 10.3390/buildings8010004.

Díaz González, F.J. (2006). La disolución de la Real Junta de Obras y

Bosques en el siglo XVIII. In *Anuario de la Facultad de Derecho de la Universidad de Alcalá 2006*, pp. 69-82.

Garma y Durán, F.J. (1738-1751). *Theatro universal de España*, 4 vols. Madrid y Barcelona: Imprenta de Mauro Martí.

Kostof, S. (1984) El ejercicio de la arquitectura en el mundo antiguo: Egipto y Grecia. In Kostof, S. (ed.). *El arquitecto: historia de una profesión*. Madrid: Eds. Cátedra, pp. 13-33.

Lasso de la Vega, M. (1945). El Rey Don Felipe II, Juan de Herrera y otros artífices del Escorial. In *Revista Escorial*, 53. Madrid: Eds. Emblema.

Lhermite, J. (1602). *Le Passetemps*. Bibliothèque royale de Belgique, Bruxelles, Manuscripti historici n. 17. (quoted ed. 1890-1896: C. Ruelens, E. Ouverleaux y J. Petit. Antwerpen: J.-E. Buschmann).

Llaguno y Amírola, E. (1829). *Noticias de los arquitectos y la arquitectura desde su restauración ... ilustradas y acrecentadas con notas, adiciones y documentos por D. Agustín Ceán Bermúdez*, 4 vols. Madrid: Imprenta Real.

López Mozo, A. (2008). Tres monteas escorialenses. In *EGA Expresión Gráfica Arquitectónica*, n. 13, pp. 190-197.