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When Image sets Reality Perspectival alchemy in Velázquez's *Las Meninas*

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ABSTRACT

There are images in History of Art, Science, Technique, Humanities, which are milestones. *Las Meninas* is one of these. Several levels of reading and deepening have been proposed by historians and theoreticians, and many interpretations have been made. Yet the very sophisticated construction of this masterpiece seems to escape any univocal hypothesis, making it as well astonishing as enigmatic.

Our interest in this extraordinary opera stems from the fact that it belongs to that special category of paintings whose meaning is inextricably based on and linked to their projective structure; therefore, aware of the wideness of the implications, we will mainly focus on its geometric and graphic feature.

Key words: Diego Velázquez, Alcázar de Madrid, perspective, geometry and graphics, photogrammetry, projective geometry, descriptive geometry, optics, catoptrics

MSC2010: 00A05, 00A66, 01A05, 51N05, 97U99

**Kad slike postavljaju stvarnost
Perspektivna alkemija u Velázquezijevoj
*Las Meninas***

SAŽETAK

Postoje djela prekretnice u povijesti umjetnosti, znanosti, tehnici i humanistici. Takvo djelo je i slika *Las Meninas*. Povjesničari i teoretičari su predložili nekoliko razina "čitanja" i istraživanja djela te su se pojavila brojna tumačenja. Izgleda da još uvijek vrlo sofisticirana konstrukcija ovog remek djela nije pod jednoznačnom hipotezom što ga čini jednako zadivljujućim koliko i zagonetnim.

Naše zanimajne za ovo izvanredno remek djelo proizlazi iz činjenice da slika pripada posebnoj kategoriji djela čije se značenje temelji i neraskidivo je povezano s njihovom projektivnom strukturom. Stoga, svjesni opsežnosti implikacija mi ćemo se fokusirati na njezin geometrijski i grafički značaj.

Ključne riječi: Diego Velázquez, Alcázar de Madrid, perspektiva, geometrija i grafika, fotogrametrija, projektivna geometrija, deskriptivna geometrija, optika, katoptrika

1 Introduction

Painted by Diego Rodríguez de Silva y Velázquez in 1656, this imposing painting (318 x 276 cm) shows an intriguing scene taking place in a lazy afternoon in the *Galería de Mediodía of the Alcázar de Madrid*. Strangely enough we basically see the painter in person at work beyond a large canvas, the Infanta Margarita Theresa of Spain, her Maids of Honour and other members of the Royal entourage, including a dwarf, a midget and a dog. Apart from the last two, all the characters are looking fixedly at us with curiosity, while we are looking into their space, that is, quite unusually, the studio of the painter. In this dialog of glances,

looking more closely and attentively we surprisingly discover the image of the King Felipe IV and Queen Mariana de Austria, which is reflected in a small mirror hanging in the middle of the rear wall, also they looking towards us. Above, two big mythological paintings appear, showing the hard punishments that await those who dare to challenge gods.

Any attempt to undertake a philological reconstruction of the geometric space of the scene has to deal with at least two issues. On the one hand the sophisticated perspective pattern of the painting, including the representation of mirror and reflection effects, and the crucial fact that the large canvas appearing in the painting, slightly rotated and tilted,

faces the artist, therefore its figurative content remains a secret. On the other hand, the fact that the real room represented in the painting was located in the south western wing of the castle, known as Cuarto del Príncipe Major, which burned during the big fire of Christmas Eve in the year 1734. On the bases of the available information, we aim to compare the presumable shape of the painted room as it results from the perspective reconstruction based on the *depicted space*, with the presumable shape of the *real space* hypothesized on the base of some historical plans, especially that of Juan Gómez de Mora date back to 1626, and some information about other important changes supervised by the same Velázquez afterwards. In this process, the reflection in the mirror will provide a valuable aid for the geometrical reconstruction, but at the same time it will set a limit to the investigation.

2 A glance at the painting

Based on the available information, mainly coming from the book *El Museo Pictórico, y Escala Óptica* by Acisclo Antonio Palomino de Castro y Velasco, the painting has been painted in 1656. It is a big oil on canvas, 2,76 meters wide and 3,18 high, nowadays placed at the Prado Museum in Madrid [12]. At its time, it was known as *La Familia* (The Family) and hung in the Royal Alcazar de Madrid for about eighty years, until 1734 when the castle burned during Christmas Eve. Due to the fire both left and right edges were damaged and consequently these marginal areas were cut and removed, while the high temperature caused the loss of pigment in some parts, including one cheek of the Infanta Margarita, as well as some diffused alterations of the original colours. It was soon restored and cleaned by the painter Juan Garcia de Miranda and included in the royal collection in 1748. In 1772 it was in the new Royal Palace of Madrid with the title *La Familia de Felipe IV* (The Family of Philip IV). Half a century later, in 1819 it was finally included in the collection of the Prado Museum, where it received his final name, *Las Meninas*, about twenty years later, in 1843. The last restoration took place on 1984 and nowadays it is still visible at the Prado Museum (Figure 1) [13].

Curiously, the present name takes its origin from two secondary characters, namely the two young Maids of Honour, that is, *Las Meninas*, who appear in the painting at the two sides of the Infanta Margarita (1651-1673), at the time aging five, the young daughter of King Felipe IV (1605-1665) and Queen Mariana de Austria (1634-1696), who stands shiningly at the centre of the scene, blond and white dressed. Thanks to Palomino, who had the opportunity to talk with persons that had been in touch or that simply had known the members of the royal court, and based on other



Figure 1: *Las Meninas*, 1656: space and scene (source of image [12], text by author)

historical sources, we have information about all the persons portrayed in the painting, which makes understandable the situation and helps us to get the feeling of the scene. The maid on the left is María Augustina Sarmiento de Sotomayor, who is offering the Infanta a red cup on a silver plate, the one on the right is Isabel de Velasco. The two young girls are attending the young princess. Beyond them, almost in the shadow, close to the balconies, we see Marcela de Ulloa and Diego Ruiz de Ancona, enrolled as *guardadamas*, that is, in charge for the surveillance of the maids, silently discussing with each other, in a way that contributes to giving the scene the special atmosphere of a private family meeting. On the foreground we see another group composed by the German dwarf Mari Bárbola, and the Italian midget Nicolastico Pertusato, who is joking with a big indolent dozy dog. Dwarfs and midgets were very familiar at royal court at that time. They were considered as fool of God and had the task to cheer up court and guests, but they were also considered talented with a supernatural wisdom, symbols of divine mercy, then they were among the fewest allowed to tell the King truth, no matter how much unwelcome it could be, without any consequence. In the very foreground the dog, symbolizes loyalty and devotion, he is growing drowsy but he is also garrisoning the threshold of the gate to the painted space. On the left side, just beyond the kneeling maid, we see the painter, Diego Velázquez (1599-1660), standing, imperious and attentive, at work in front of the huge canvas, whose pictorial

surface we can not see directly. It shows in a key moment of pause, looking in our direction as he was taking information about his subject in order to proceed or complete his work. At that time he was *apostador major*, a kind of Marshal and Master of Ceremonies of the castle, at the service of King, the highest grade in this role. We will know a bit more about him in the following paragraph. On the opposite side, beyond the door of the rear wall, another *apostador* is on the mid steps of a short staircase. He is Don José Nieto Velázquez, who apart from the name did not have any family ties with Diego Velázquez. He was the person in charge of staying at hand of the Queen, opening and closing the doors to give her way. Since he is managing with a drapery, it has been written that he was preparing the way to the Queen, who was on the point of leaving the room, consequently what we see in the painting might be the end of the painting session. But it is also possible, on our opinion, that he was just coming to see the advancement of the session, or just leaving before the session started. These latter hypotheses seem quite convincing if we look at the sense of waiting pervading the space, emphasized by the bowing maid on the right, as well as by the attentive glances of the bystanders gazing into our space. The last two members of the group, smaller than one could expect, appear as busts in a frame located in the middle of the rear wall. They are King Felipe IV and Queen Mariana. The boundary of the rectangular area from which their profiles arise, and the less sharp outlines and colours, tell us that they appear in a mirror, which is one of the most interesting aspects and one of the most discussed points of this masterpiece, besides being one of the major focuses of our projective investigation.

3 The painter

As widely recognized, Diego Velázquez is considered as the leading artist of the Spanish “Golden Age” (Figure 2). His curriculum includes not only pictorial masterpieces but also a relevant number of public offices and appointments under the kingdom of Felipe IV. Born in Seville on June 1599, he was at the royal court since 1623, at his twenties, having a special feeling with the King since the beginning. It is told that, especially in the old age, he used to visit the painter in his studio, frequently waiting there for long hours looking at him painting. When Velázquez died at the beginning of August 1660, Felipe wrote moving words expressing his solitude and grief for the loss of the esteemed artist, adviser and confidant. Velázquez was, indeed, a deeply cultured artist, at same time very brilliant in political, administrative stuffs, and management. His library was very rich and full of international books and treatises. Thanks to his sensibility and active efforts, the royal



Figure 2: *Diego Rodríguez de Silva y Velázquez. Self portrait, about 1640 (left, source of image [13]). In Las Meninas, 1656 (right, source of image [12]) (Images cropped by author)*

collection of art masterpieces had a significant increase under his tutorship. He was in touch with great artists, especially Pieter Paul Rubens, getting from him a deep pictorial influence and important works for the archives of Spain. To further enrich the art collection Diego Velázquez also visited Italy twice, selecting and importing in Madrid important sculptures, paintings and documents. Again Palomino, the official biographer of the Spanish artist of that time, whose contribution is often compared with the one offered by Vasari for Italian Renaissance, helps us to know detailed information about him, especially in the period from 1650 and 1660. Palomino completed the biography in 1724, only six decades after the death of the artist, therefore he could get direct information about the painter from people who had the opportunity to meet him in person, including Juan de Alfaro y Gámez, one of his artistic disciples [4]. There are not so many other words to spend about Velázquez's universally recognized outstanding career as a painter. Instead, here we would look at a special part of his story as a public man, which is related to the red cross appearing on his chest in *Las Meninas*. At the time when he painted *Las Meninas*, he was at the apex of his public career, attending several royal offices. He was, indeed, *Pintor de camera*, kind of personal painter of the King, *Ayuda de camera*, that is a kind of personal counsellor and assistant of the King, *Apostador de palacio*, or the marshal of the Alcazar de Madrid, that is, the castle of the King of Spain, and from 1652 *Superintendente de obras particulares*, or superintendent to special works, like managing royal art collections and architectural works in the castle. In short, he was also a kind of artistic supervisor and managing director of the King.

Nevertheless, his biggest ambition was not yet been satisfied. At that time indeed, he was struggling in the middle of a personal fight to become a member of the *Orden de Santiago*, which was the most prestigious monastic-military order, whose reputation was echoing since its foundation in

XII century. Symbol of the members was, precisely, a red cross on the chest. Well, almost incredible the sequence of facts concerning Velázquez's admission to this Order, which also demonstrates the tenaciousness of the painter. The story starts in 1650, six years before *Las Meninas* was painted and before the birth of the Infanta Margarita, when, after the death of his first wife Isabel de Borbón (1602-1644) and of his young son Balthasar Carlos (1629-1646), Felipe IV was starting forming a new family with Mariana de Austria. In this year, Velázquez obtained the support from the Secretary of State of the Pope. From that moment, it will have taken other eight years to obtain the royal nomination, the document with which the King tried to solve the pending suit. *Las Meninas* was painted during the wait for this royal document. But once obtained the royal paper, the request was reviewed and rejected by the Council of Military Orders, after investigation about painter's genealogy and social condition. To deny the admission, they highlighted the basic contradiction between the painter's "God-given talent" and his "man-made hierarchy of court". Obstinate as never before, Diego Velázquez brought a legal action against this result, and a big trial started up involving 148 witnesses. The main point was about nobility. In order to demonstrate his noble origin, he pushed many witnesses to affirm that he had never worked for money, since he did not need it because of his aristocratic genealogy. At the end, it was not difficult to discover the falseness of these proofs, which made the situation even worse. At this point, in a short time between 1658 and 1659, a new endorsement by Pope and, to redundantly reinforce it, the ennoblement by King, removed the obstacle once and forever. In the same year of 1659, on November 28, Diego Rodríguez de Silva y Velázquez was finally admitted to the *Orden de Santiago*, eight months before he passed away [4]. Thus, what about the red cross depicted on his chest in *Las Meninas*? Legend tells that it should have added by direct hand of King Felipe IV after the death of his beloved "painter and courtier".

4 Architectural set

The room we see in the painting is no longer an existing room. It was destroyed in the fire of that fatal night during the Christmas Eve of 1734, which just started from the south-western wing of the Castle (Figure 3), where the room was located as a part of the *Cuarto Bajo del Principe*, that is, an apartment at the ground floor belonging to the *Cuarto del Rey*, the western part of the Castle in use by the King and for his private activities and public ceremonies. This room, also known as *Galería de Mediodía*, which means southern gallery, was pleasantly warm, especially during winter time, then kings since Felipe II liked to spend time there during the most freezing days of the year



Figure 3: *Alcázar de Madrid, XVII century, by anonymous (source of image [13], cropped by author)*

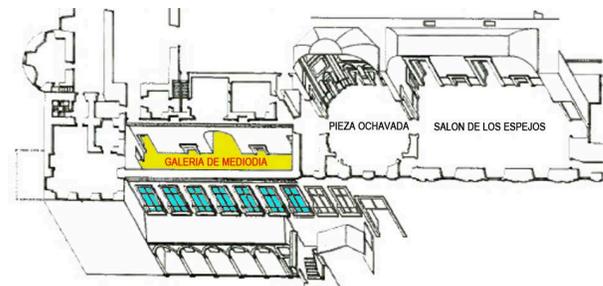


Figure 4: *Galería de Mediodía, axonometry (source of image [2], cropped and coloured by author)*

(Figure 4). Since 1646 the room was also the *atelier* of the painter, as the paintings represented in the canvas testify. The Alcázar de Madrid was founded in IX Century as a Muslim fortress and had done several significant transformations over time. One of the most impressive transformations took place between 1640 and 1650, in part under Velázquez's direction, when the great royal gallery at the first floor decorated with mirrors and named *Salón de los Espejos* was realized, together with the contiguous *Sala Ochavada*, an octagonal room adorned with precious statues, some of them coming from Italy, and directly connected by a staircase with the *Galería de Mediodía* at the lower floor [2]. There are no evidences of this staircase in the coeval maps, but only in *Las Meninas*, which shows a view of a stepped ramp beyond the rear wall, where José Nieto stands on looking at the scene and preparing the way to the Queen. The reason why *Las Meninas* is also one of the historical sources taken into account by the scholars in relation to the history of Alcazar.

The main iconographic sources basically consist of a plan by Juan Gomez de Mora, date back to 1626, thirty years

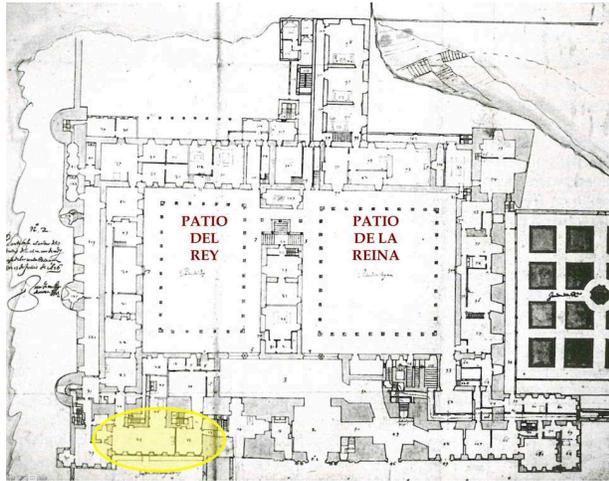


Figure 5: *Galería de Mediodía* (yellow area) in the Alcázar de Madrid, by Juan Gomez de Mora, 1626 (source of image [1], cropped by author)

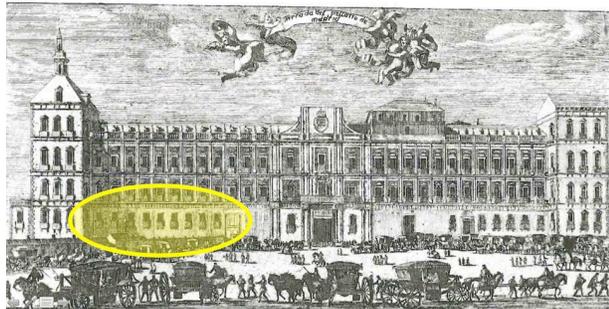
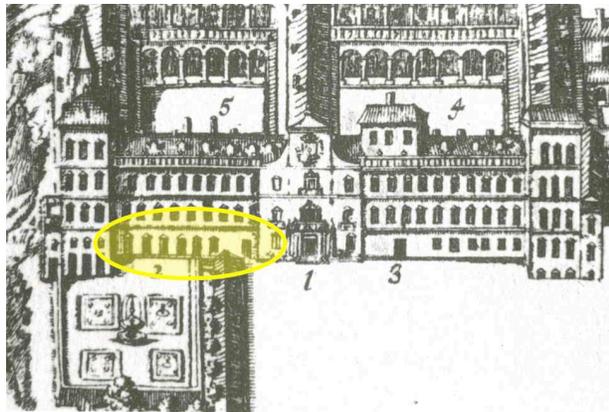


Figure 6: *Front of the Galería de Mediodía* (yellow area), southern wing of Alcázar de Madrid (source of images [1], both cropped by author). Views by Pedro Texeira Albernaz, 1656 (above), and Luis Meunier, 1666 (below)

before the painting (Figure 5), and a plan by Teodoro Ardemans, realized in 1705. They are both quite far from the time of the painting here discussed, but they are anyway helpful to understand architectural structure and proportions of the room. A view from 1656 by the cartographer

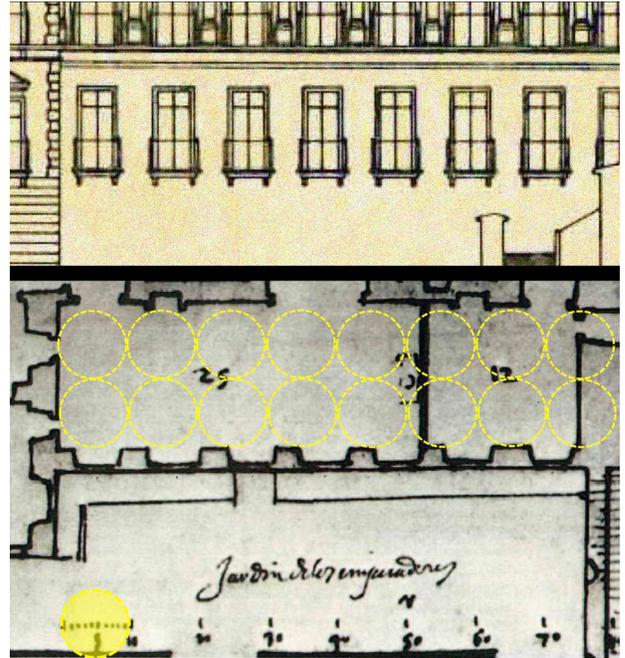


Figure 7: *Galería de Mediodía*, the geometrical set. Detail of the plan (source of image [3]) and front (source of image [1]). Unit: *pie castellano*, 1 *pie* = 27.86 cm (composition and diagram by author)

Pedro Texeira Albernaz and a view from 1666 by Luis Meunier help us to complete the picture, being useful to analyse the consistency between the faade and the interiors (Figure 6). There are also maquettes of the castle, the most well-known realized after 1630 and now at the Museo Municipal, in Madrid. A recent, complete and detailed historical reconstruction of the castle and its transformations is nowadays available, thanks to the book *Alcázar de Madrid*, by José Manuel Barbeito, published in 1992 [1].

The geometry of the room appearing in *Las Meninas* is clear from the mentioned map of Juan Gómez de Mora. It shows a long room with seven balconies along the southern wall, the one appearing on the right in the painting (Figure 7). At the time when the plan was drawn a thin partition divided the room in two parts, marked in the plan with numbers 25 and 12, the latter included in the apartment of Prince Balthasar Carlos, also said *El Cardenal Infante*. When the young Prince died, the partition was removed and the room became the studio of Diego Velázquez. The eastern wall, corresponding to the rear wall appearing in the painting, only shows one gate to a gallery in a massive wall, but not the other gate, where José Nieto appears in *Las Meninas*, neither the staircase on which he is standing (Figure 8). Gate and staircase could have been realized during the big transformation occurred between 1630 and 1650, when the *Torre del Sumiller*, that is, the huge tower connected to the room and its massive wall, were

demolished. The western wall represented in the 1626's map, shows two gates, one of them close to the wall with balconies and almost specular to the Nieto's gate visible in the painting, for this reason supposed to hold the viewpoint from which the scene was depicted. Northern wall does not appear in the painting, but it has been useful to understand the symmetry of the room, which has been helpful in reconstructing the sequence of the balconies in spite of the graphic approximations in the map.

Concerning metrics, we had to refer to the unit in use at the time, clearly indicated in the drawing, which is *pie castellano*, or the castilian foot, so that $1 \text{ pie} = 27.86 \text{ cm}$. The size of the room is $75 \times 20 \text{ pies}$, which means about $20.90 \times 5.57 \text{ mt}$. Taking advantage from the fact that width and height of one of the walls, namely the eastern wall, appear frontally in the painting, the height of the room has been deduced by a simple proportion, and then compared with the available drawings of the façade. Other important information comes from an *Inventory* of the paintings recorded in 1686 [3]. Starting from the ceiling, this list describes all the paintings hanging above and in between the balconies (Figure 9), including precise information about their sizes. All the paintings are by Juan Baptista del Mazo, the Velázquez's son in law, some original, mostly are copies of Rubens. In *Las Meninas* they appear strongly foreshortened by the effect of perspective distortion, which affects the representation of that side of the room. As the inventory includes the description of the frames, we considered the metrical information as related to the outline of the frames and not to the real dimensions of the canvases, about which there are no explicit information. New multiple units are mentioned in the inventory, namely $1 \text{ vara} = 83.5 \text{ cm}$, $1 \text{ tercia} = 27.5 \text{ cm}$, $1 \text{ quarta} = 20.5 \text{ cm}$. In total, four types of frames are mentioned. Above the balconies, seven long frames measuring $3 \text{ varas} \times 3 \text{ quartas}$, copies of Rubens, showing images of birds, animals and landscapes. In between, five small original paintings by Mazo measuring $\frac{1}{2} \text{ vara} \times 3 \text{ quartas}$, displaying wild boar, small dogs, and again animals and landscapes. Below, other six smaller copies by Rubens, measuring $\frac{1}{2} \text{ varas} \times 2 \text{ tercias}$, with the Labor of Hercules. Below these and finally, six higher copies of Rubens, measuring $2 \text{ tercias} \times 1 + \frac{1}{2} \text{ varas}$, showing the philosophers Heraclitus and Democritus, Hercules slaying the seven-headed Hydra, Mercury, Saturn, and Diana. Magnified by the frontal view, hanging up on the rear wall under the ceiling, are two big copies of Rubens realized by Mazo, telling mythological stories. The one on the left, burned during the fire, is about *Minerva Punishing Arachne*, the other is about *Apollo's victory over Marsyas*. Besides the mentioned works, the framed mirror between the two doors and the big canvas on which Velázquez is at work, complete the set. On the ceiling, two lamps appear, and some evident



Figure 8: *South eastern entrance and staircase (source of image [12], cropped by author)*

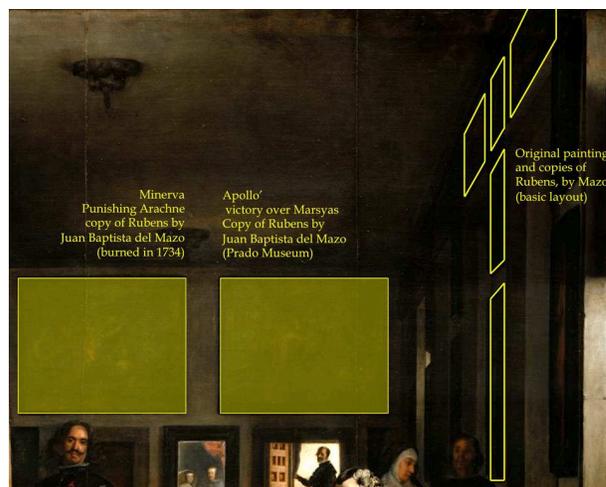


Figure 9: *Distribution of paintings on the walls (source of image [12], cuts and diagrams by author)*

humidity stains, a clear proof of one of the major persisting problems that Alcázar had to face during its existence, well documented in the archives and often cause of restoration as well as of profound architectural transformations [1]. Nowadays the Royal Palace of Madrid stands on the same place of the Alcázar de Madrid.

5 Graphics, or, “the truth of tone”

Talking about painting necessarily implies to take into account the primary role of Graphics. No matter what subject and story are, and what the organization of shapes is, at the end a painting is made of pigments on a canvas, and these pigments makes the story alive. Discussing about graphic aspects is not the main purpose of this work, anyway we could not avoid to note how much they are in a masterly manner interlinked with geometry of space, spatial perception, location of characters, and symbolism in this art masterpiece. Besides how the scene is shaped and its proportions on the canvas, the whole atmosphere of the event is here dominant, based on a refined chromatic combination of factors [7]. First of all the dimension of the room is emphasized thanks to a wide use of dim light effects, and of their contrast with brighter areas and silhouettes. The soft colour of the ground and the absence of any flooring, drive the attention on the human characters and the space around, far from the traditional iconography of tiled perspective grounds, which in this case would have interfered with the contemplation of the very points of the scene. Velázquez pushes our sight up to the space in front of us instead of on graphic nets under our feet. We can then appreciate the illuminated foreground, as if we also were invested by the light incoming through the opened shutters of the balcony on the right. The opposite happens on the left, due to the huge brown back side of the canvas where the painter's work is supposed to be in progress. Then a dark *penumbra* pervades the whole depth of the room. This area is really wide, if we consider that the entire upper half of the painting is shown as an empty space (Figure 10). It has been a really superb choice to take this risk, but in a way it seems this upper half part is the space of Art and Myth, indeed, almost the total amount of paintings lay in this superior area. It is remarkable that almost all these paintings are perfectly recognizable, being masterly reproductions of those that hung in the room. The lower half of the painting is where the scene with people takes place (Figure 11). Then, in the dark rear wall darkness is again broken, firstly by the reflected image of the royal couple in the mirror, mid of the wall, and most of all by the very bright spot of light filtering through the door where José Nieto stands, light coming from an undefined space beyond the room. These oases of light work as a tonal balance in the painting, the latter being located ex-

actly in front of the supposed designated location for the perspectival viewpoint. Great attention is paid on graphic resolution and tones according to the distances, as explicitly recommended since the Leonardo da Vinci's *perspectiva aerea*. Compared with the figures of the persons in the foreground, the silhouette of José Nieto, as well as those of King and Queen, appearing under the red drapery of a gate, are less defined. This latter could also have been a strategy, either due to a certain reluctance of the King to show in sharp portraits during his mature age, reasonable also in consideration of the very young age of his wife, or and at the same time to affirm the minor role of the attendant of Queen in comparison with the role of the painter himself as an attendant of King. Light and colours also help to recognize hierarchies among the portrayed persons (Figure 12). Fully direct light, indeed, only reaches the Infanta Margarita, at the time aging five and being the only daughter of the royal house still alive, first descendant for Felipe IV and Queen Mariana. Shining as the hope of the reign, she is blond and white dressed, while vivid red details, like the round big brown eyes, brooches in the hear and on the corset, as well as the red cup, exalt her bright figure even more. Not by chance, she is at the centre of the scene. Other characters, although showing faces, are never



Figure 10: *Las Meninas*, upper pictorial area (source [12], cropped by author)



Figure 11: *Las Meninas*, lower pictorial area (source [12], cropped by author)



Figure 12: *Las Meninas*, graphic features of characters (source [12], cropped and composed by author)

fully illuminated, like in the case of the dwarf, or in the light but only showing a profile, like in the case of the maids of honour. Very secondary characters are even more far from light, like the two tutors of the maids. The midget and the dog show detailed feature because they are in the very foreground, but not so much in the light, which comes from the upper area of the balcony. Velázquez's silhouette is definitely imposing in the composition. Not as much important as the Royal Family, the pictorial feature makes anyway impossible not to be attracted by his image. Apart from the proud and aristocratic pose, his location in a uniform *penumbra* weakens the light contrasts on his face, which is clear and defined, together with his hands. This kind of fore-ground effect achieved in a mid-ground position is also emphasized by the total black uniform he dresses, since this black area makes the image of his face and hands emerging from the shady atmosphere around. Of course much other could be told about the expressiveness of the characters, or on the chromatic techniques adopted and developed by Velázquez, including the special blue pigment used in this painting, but all this is beyond our specific task and competences. Only one thing more about light and shadows: what time is it? Although we will not go in search for the sunlight angles of incidence, considering that the balconies on the right were oriented towards South, and that light runs towards the scene, the depicted event might have taken place in an early afternoon. On our opinion the light blade casting on the floor from an apparently opposite direction through the gate in the rear room does not contradict this hypothesis, being the normal effect of light in the space beyond the wall, entering

the darkest part of the room, something we are quite familiar with in our real life. Because of all this and much other that we will not tell in this paper, this painting has been considered one of the best examples of “truth of tones”, using Kenneth Clark's words, ever realized in the history of painting [5].

6 Geometry, or, “the bones of truth”

Talking about painting also implies Geometry, at different levels of investigation. In our case, at least two levels: topology of composition, and projective structure. Concerning composition, a dynamic equilibrium emerges from position and orientation of the static images on the canvas (Figure 13). The wide empty part of the room represented in the upper half part of the canvas, where we see the gallery of paintings on the walls symbolizes, have we already mentioned, the higher level of Art, giving at the same time gravity and weight to the human characters in the lower part, pushing them firmly on the floor, balancing the absence of visual references on this horizontal plane. Primary and secondary characters can be identified, related in various ways one another. Infanta, mirrored images of King and Queen, and painter at work, define a first primary group. Without these members of the royal family the painting would not make sense, without the painter it could not have been made. Infanta and the two maids form another group, a wing dynamically growing up and bearing anti-clockwise from left to right, where genuflexion and courtesy of maids suggest a balanced rotational motion about the Infanta, and the sloping axes of their busts form an ideal protective triangular shelter above the young princess. Velázquez and José Nieto are corresponding figures garrisoning the beginning and the end of the space of the room, keeping King and Queen between them, similarly to what Maids of Honour do with the princess. Moreover, Velázquez, José Nieto, and the dog, are the endpoints of an ideal triangle around the Infanta, meaning again a sense of protection and defence. It is important to highlight the role of these three figures in emphasizing the perspective effect and in helping to appreciate the long extension of the room. Velázquez and dog's heads are also the endpoints of a line touching the Infanta's head. Two dynamic crossing curves are formed, the first including maids, princess and *guardadamas*, the second including Velázquez, the maid on the right and the group of dwarf, midget, and dog. This latter group contributes to stabilizing the lower right area of the painting, balancing the visual weight of the huge canvas on the left. The gesture of distraction played by the midget Nicolastico joking with the dog, releases a little the brake of tension, working in favour of a familiar atmosphere. The dozy dog would also tell about the serene security of the place, and by extension,

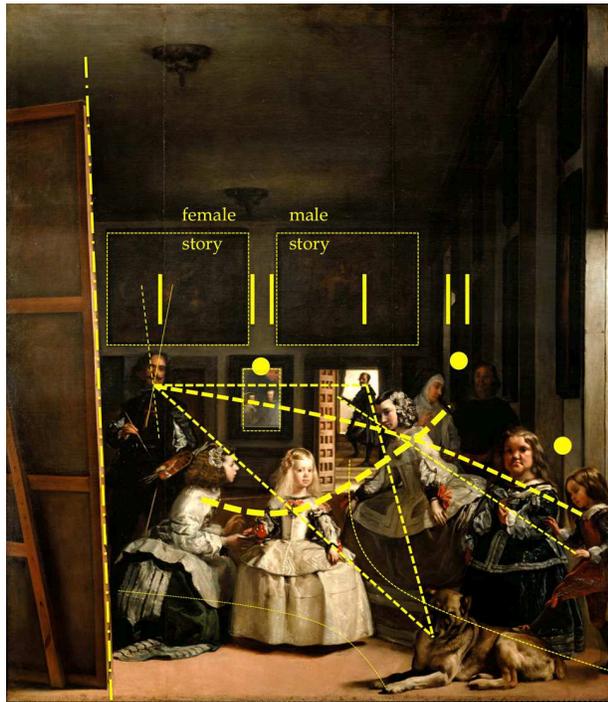


Figure 13: *Las Meninas*, rhythm and composition (source of image [12], diagrams by author)



Figure 14: *Las Meninas*, a special framing into the whole frame (source of image [12], cropped by author)

of the kingdom. Once one look at this very close zone, some details drive the sight again in opposite directions, like the position of the Nicolastico's leg towards left, and his inclined arm, aligned with and echoed by the Nieto's arm keeping the drapery at the end of the room, so recalling the main perspective direction. X-ray analysis of the painting also revealed an afterthought in the inclination of painter's head, which was leftwards in the first version. Maybe this change is also in order to keep the dynamism

of the composition, either in relation to the opposite inclined outline of the canvas in front of him, or in relation to the inclinations of the other figures. Moreover, much other could be said about the geometry of glances looking at the eyes of each member in the scene, and mainly in relation with our direction of sight. Other interesting relationship is in the alternation of single figures and couples in the sequence from left to right from Velázquez to King and Queen, Nieto, and the *guardadamas*, a kind of horizontal rhythm reducing the strong effect of perspective. Another significant fact we noticed is that Velázquez, Infanta Margarita, Royal Couple in the mirror, the Maids of Honour and Nieto, together with the two big paintings above the doors and their legendary stories, and in part the canvas on which Velázquez is at work, lay inside the boundaries of the rear wall, whose ideal frame works as a picture apart in the whole picture (Figure 14).

Concerning projective structure, the main vanishing point, and consequently the viewpoint, is eccentric and laid in the surrounding of the right arm of Nieto, emphasizing the southern area of the room, closer to the sun light. The eccentric effect is reinforced by the diagonal foreshortenings of the lamps on the ceiling. Consistently with the other aspects here discussed, this choice also contributes to giving a dynamic impact to the image. The spatial depth of the room can be subdivided in three main stages (Figure 15). The very background beyond the rear wall, or the space in which the staircase and Nieto appear, illuminated by a dazzling light. Hypotheses on this space have been formulated, supposing that a monumental staircase to the main floor upstairs [11]. In relation to our purposes, we see that this undefined space tells us that there is something else, something shining, beyond the room, therefore it either works as a perspective safety-valve avoiding claustrophobic effects, or metaphorically, suggesting the idea of the depicted room as a small space in a wider reign. A "poetic" projective licence, maybe the only deviation from the purely perspective rules in order to have a better picture, is in the upper side of door, which is not visible as it should be (Figure 16). Another stage can be recognized between the rear wall and about half of the visible part of the room, more or less until the position of the two *guardadamas*. This mid-ground is totally empty. Closer to us is the foreground, where eight out of eleven depicted people show, together with the dog. Here the big canvas introduces an oblique perspective, avoiding the risk of a motionlessness perception of the gallery. The distribution of the three couples, that is, sovereigns, *guardadamas*, dwarf and midget, also helps to visually mark the three foreshortening stages of the space, again fostering a dynamic perception. As we can see, a very sophisticated system of topologic and projective aspects has been build up in this painting, perfectly



Figure 15: *Las Meninas*, perspective stages in the pictorial space (source of image [12], diagram by author)

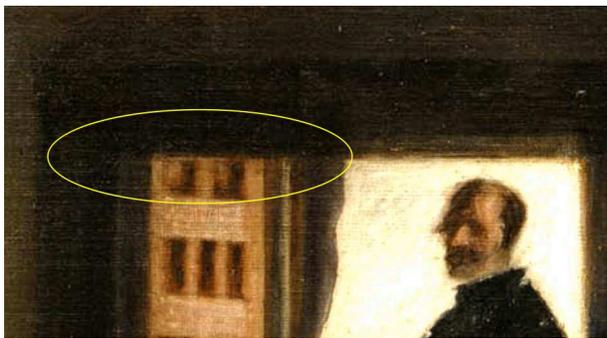


Figure 16: *Las Meninas*, a perspective “licence” (source of image [12], cropped and marked by author)

integrated with a magisterial graphic feature. But there is more in this painting making it so unique: a mirror. Reflection is then included in this perspective, that is, another perspective into the perspective representation [7, 9]. As we said, King Felipe IV and Queen Mariana de Austria appear there, smaller than Nieto despite mirror hangs on the wall at same distance from our point of sight, which is a proof that they show in a mirror. What we see on the mirror, indeed, is the projection of the virtual image of the Royal Couple, geometrically formed beyond the surface of the mirror, at the same distance of that from the mirror King and Queen were into the real room in that moment. That is supposed to be, in front of the painter who was

depicting them, while he and the other bystanders were attentively looking at them. As well as they seem looking at us. Based on this hypothesis, the sight point of *Las Meninas* should be the same viewpoint of the King. Of course, many authoritative hypotheses have been proposed, since we can not see what Velázquez is actually painting on his big canvas. Our goal will be about proving the projective consistency of what we see depicted on the canvas. Or, the consistency of Geometry, as the “bones of truth”.

7 Projective proof

Projective analysis and graphic reconstruction have been carried on a digital copy of the painting imported in a CAD system. Some tolerances have been considered, due to the incomparable major resolution of CAD visualization in relation to the real painting. We sometimes thought that pencil and strokes, ruler and compasses, might have been better tools to use. On the other hand, CAD system would have allowed us to carry on 1:1 perspective investigations, and to store all the constructions in one file, reason why we decided to stay on it, working in the consciousness of the mentioned technical gap. The perspective reconstruction is made of two parts, one of them related to the reconstruction of the *Galería de Mediodía*, the other one focusing on mirror and its reflected image.

Compared with the richness of the composition, the painting offers a limited set of perspective elements. Apart from the clear front view of the rear wall with the mirror, whose dimensions were known, together with those of the two big canvas hung on it, the only usable foreshortened geometrical element are balconies and the paintings hung on the wall on the right. The first check has been about extending the depth lines in search for the main vanishing point of the structure. Initially, we tried to assume that this point was on the finger of the left hand of Nieto, consequently implying a horizon line passing through the baseline of the mirror reflecting the royal busts as well as through Velázquez’s brush. This looked very convincing at the beginning, especially from a metaphoric point of view, as if also Nieto, the second *apostador*, was involved, together with the *apostador mayor*, in the perspective construction, by indicating that crucial vanishing point. Nevertheless, at the end of more accurate investigations, the choice of a little higher vanishing point appeared more correct (Figure 17), either because of its better connection with the whole perspective pattern, or, and most of all, because the projection of the right half of the baseline of the rear wall on the baseline of the canvas, nearly shows the corresponding real length, according to the historical map of the room (Figure 18). This means that Velázquez could use the baseline of the canvas as a perspective ground line. As we can see, the right endpoint of this segment actually lays outside

the boundary of the canvas. However, we decided to trust on this point, reasonably supposed to be part of the canvas before it was cut on the two sides after the fire, as we mentioned before. It was pivotal in this decision the recognition of a quite invisible point in the foreground, visible between Nicolastico's legs, which is the intersection point between the floor and the left jamb of the first balcony, only partially included in the image. This point, connected with the graphically reconstructed lower right corner of the rear wall, generates a line extensible to the vanishing point in question. The last issue, definitely convincing us, was the importance that the ground line would have at that time to carry on perspective constructions.

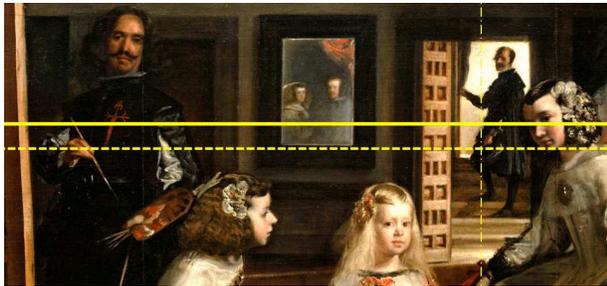


Figure 17: *Horizon line, first hypothesis (below), final hypothesis (above) (source of image [12], cuts and diagram by author)*

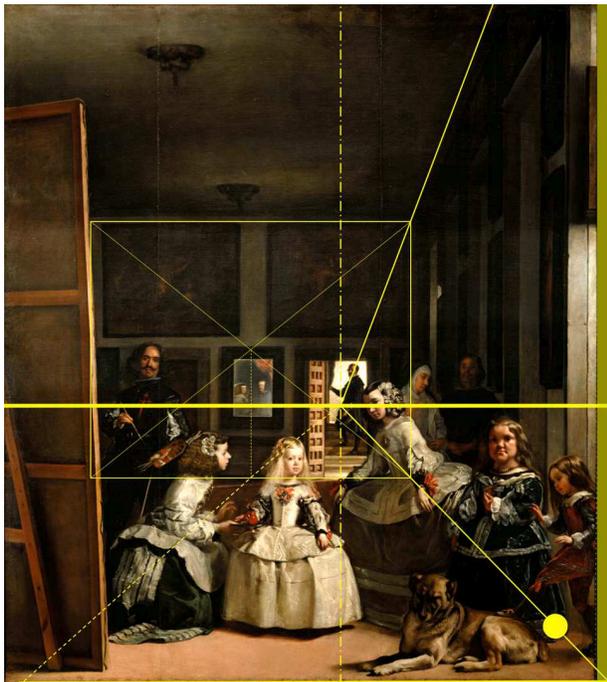


Figure 18: *The assumed basic perspective pattern (source of image [12], diagram by author)*

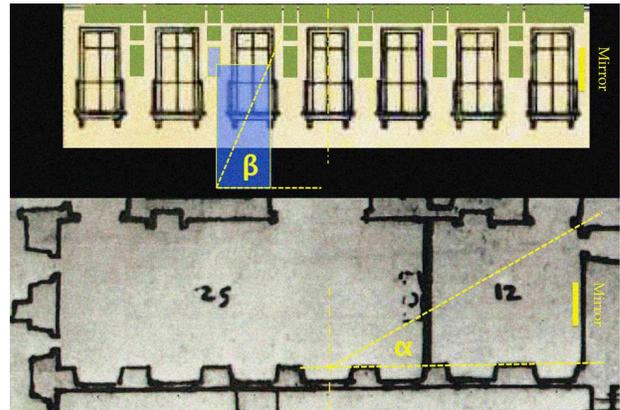


Figure 19: *Basic angles for the perspective reconstruction (source of images [1], [3], cuts and diagrams by author)*

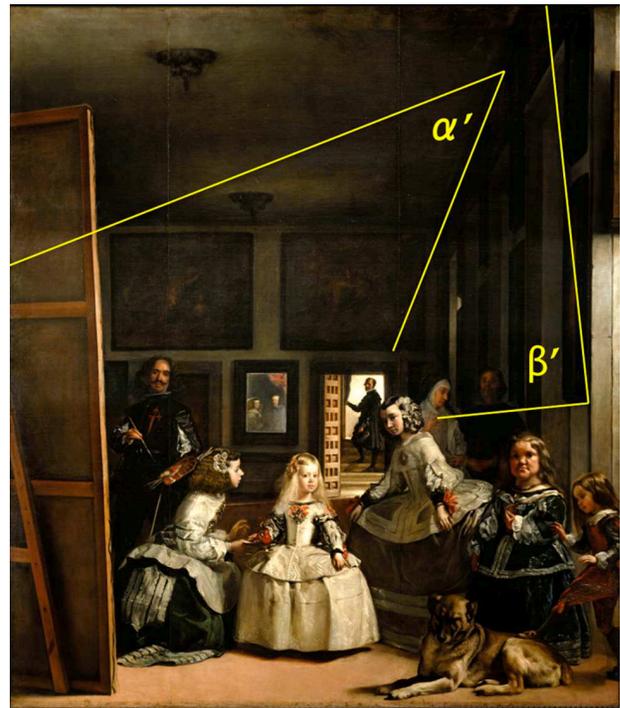


Figure 20: *Basic angles, transcription on the painting (source of images [12] diagrams by author)*

Once set the main bundle of lines, we had to work now on the foreshortenings in order to find the main distance and locate the viewpoint for the perspective reconstruction. To do this two angular data, that is, two directions were required. Since we already had the main vanishing point, related to the direction of the visual axis and orthogonal to the picture plane, we only needed another known direction recognizable in the painting. Given the absence of any geometrical reference on the floor, it was necessary to go back again to the information available from the 1626

plan by Juan Gomez de Mora [1, 3]. Whereas not the entire room is represented in the painting, whereas it was not possible to trust on the width of the windows drawn in the map because of the graphic imprecision, whereas it was not possible to estimate the width of balconies because of the unknown dimension of the chamfers in the painting, it was decided to consider an auxiliary diagonal running on an area having half the length of the room, extended from the midpoint of the medial balcony to the rear wall. Once drawn on the map, we could measure the true angle that this line formed with the southern wall (Figure 19). The same diagonal has been traced in perspective on the ceiling in the painting (Figure 20), and extended to the horizon line to find its vanishing point, which finally allowed us to draw a circle whose chord on the vertical visual axis was as long as the required main distance of the perspective construction. As a further proof, we repeated the procedure on the vertical plane of the wall, considering as a perspective reference for the metric data one of the paintings hung on between the balconies. At the end only a slight difference arose between the little shorter distance obtained with this additional construction, and the previous one, which we actually adopted (Figure 21). Now the main distance and the related distance circle allowed us to apply homological procedures for a true-to-size graphic reconstruction of the depicted elements (Figure 22). In addition, we also wanted to reconstruct the part of the room outside the pictorial space, that is, the part invading now our own space, corresponding to the area where King and Queen were during the painting session (Figure 23). Concerning metrics, we used to convert *pies* in *centimetres*, while the scale of graphic reconstruction, was 1:1, as we already said. The reconstruction confirmed the projective correspondence between the real room as it is drawn in the map and the depicted room, as well as the reliability of people, dog and furniture (Figure 24). Based on these parameters, the picture plane would be located at two thirds of the width of the first gate partially visible in the painting, measured from the painter's position, while the Royal Couple would be seated just behind the door located in front of the painter. Width and position of this door has been of course deduced only from the map that, as we saw, can be a little inaccurate in this kind of details. On our opinion, this door would be specular to the opposite one where we see Nieto, what should make the visual field more corresponding to what the painting suggests.

The pictorial set was in this way completely reconstructed (Figure 25). The last proof concerned the credibility of the reflected image of King Felipe and Queen Mariana. To make the proof it was first of all necessary to find the oblique plane to which the canvas belongs, and to determine its virtual specular outline beyond the mirror. This latter outline was determined by imposing symmetric van-

ishing elements, corresponding to those of the plane of the canvas represented in the painting, according to the distance circle. To complete the test, point of the reflected image of the King, namely a point between the eyes, was

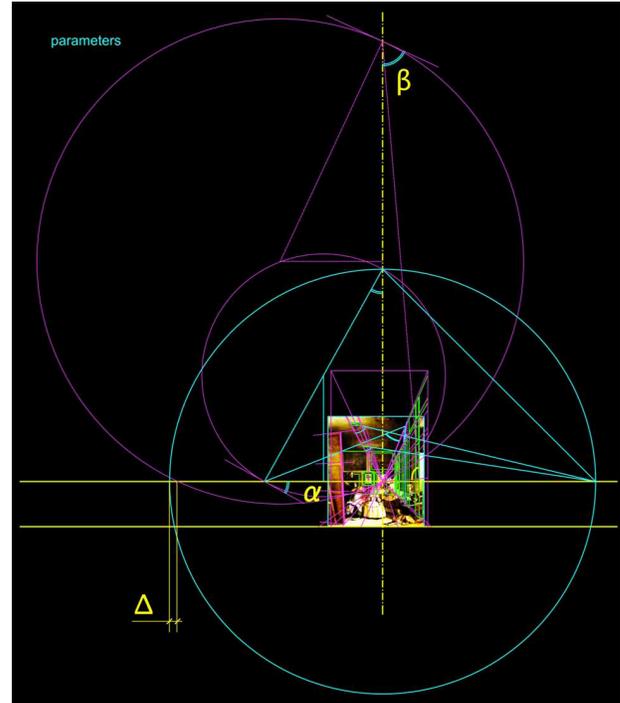


Figure 21: *In search for the perspective set: auxiliary circles and distance circle (drawn by author)*

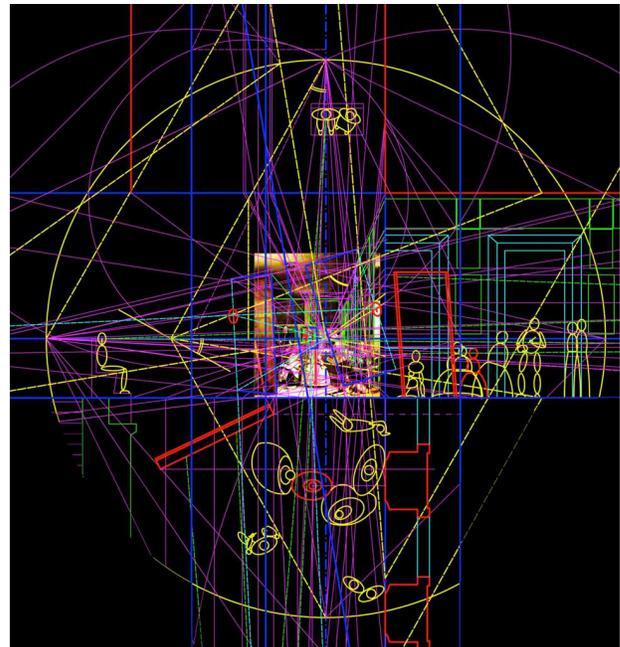


Figure 22: *Homology at work. Space and sight point: detail of the true-to-size reconstructions (drawn by author)*

translated from the virtual image of the mirrored oblique plane of the canvas, to the oblique plane of the canvas in front of Velázquez. The translation run on a depth line, belonging to a vertical plane perpendicular to the mirror in the real wall. As a final result, the point matches the canvas, meaning that the image of King and Queen we see in the mirror can really be the reflex of their portrait painted on the canvas, so that the sovereigns could see and follow the pictorial work going on in real time (Figure 26). By the way, since the portrait in the mirror seems complete, *Las Meninas* might represent the end of the pictorial session, then justifying the arrival of Nieto from the opposite side of the room. Taking advantage of homology, the graphically deduced true-to-size of the canvas shows that the hypothesized real position of the face of the King painted on the canvas, would be about one meter far from the oblique edge and about one and half meter high from the ground, which seems perfectly at hand for a painter about one meter and seventy centimetres tall portraying a man sitting at the mentioned distance from him. The perspective analysis of the painting has been also proposed to the students of my elective course *Geometrical Complements of Graphic Representation* at the School of Architettura e Società of Politecnico di Milano in the academic year 2014-2015. During the course, as double check, physical models (Figure 27) and digital animations (Figure 28), where for the sake of “projective philology” gaps in the 3D models cor-

respond to hidden areas in the painting, have confirmed this hypothesis. On the other hand, it would have been easy for Velázquez to set the elements and the chair for the royal husband and wife in the correct position in the real space beforehand as a proof, since this room was his *atelier*.

Concerning the adopted methodology, it has to be said that for the graphic reconstruction we used the modern homological method of Projective and Descriptive Geometry, which during the XVII Century was still under development. In addition, the use of *rabatment*, which we used to have the true profiles available on the same plane, requires an enormous graphic space, especially for the auxiliary constructions. For sure the method adopted by Velázquez was one allowing him to have all the basic auxiliary constructions on the canvas, maybe also together with the help of optical instruments, a matter that could be explored in new researches. Anyway, his strong background in perspective, optics and catoptrics is clear from his paintings. Moreover, it has been highlighted that he took care of his own education in these fields. At his death, indeed, 154 books were found in his library, mostly about math, geometry, optics, astronomy, including treatises and books by Luca Pacioli, Aguilonius, Dürer, Witelo, Guidobaldo Del Monte, Serlio, Benedetti, Zuccaro, Cousin, Barbaro, Tartaglia, Euclid, Alberti, Egnatio Danti, Vignola, Leonardo da Vinci, Cespedes, together with graphic instruments and a series of mirrors [7].

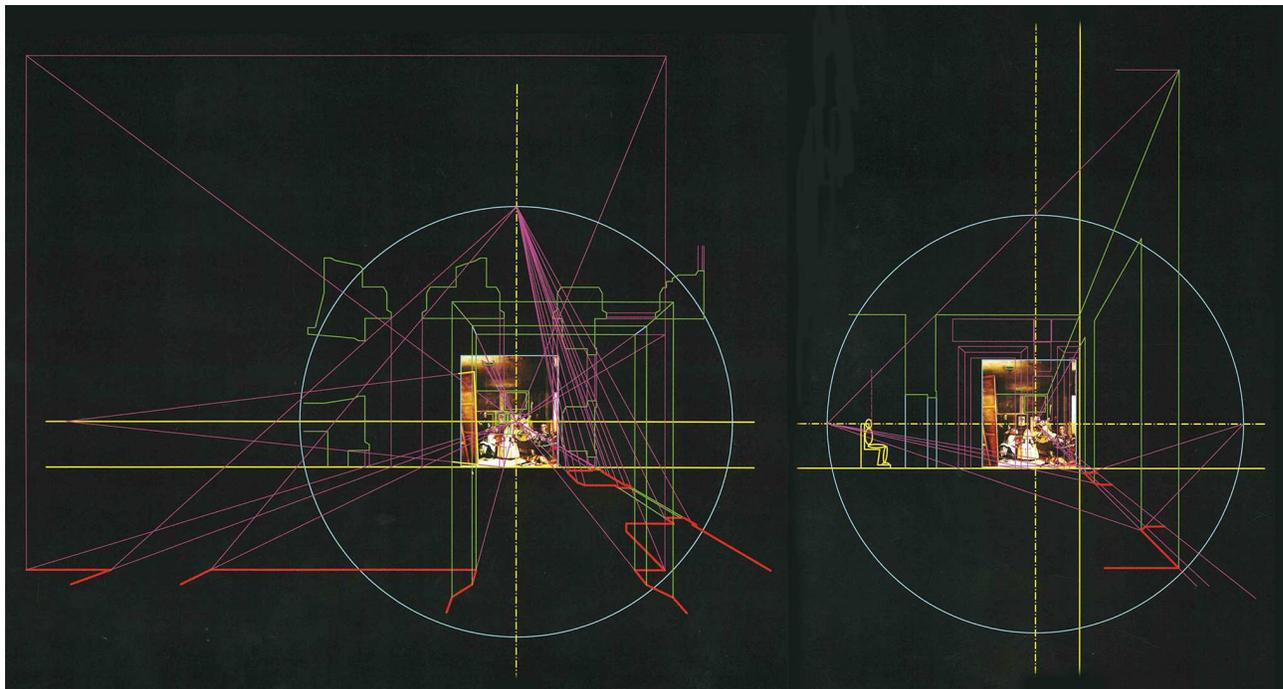


Figure 23: *Behind the canvas, inside our own space: perspective reconstructions (drawn by author)*

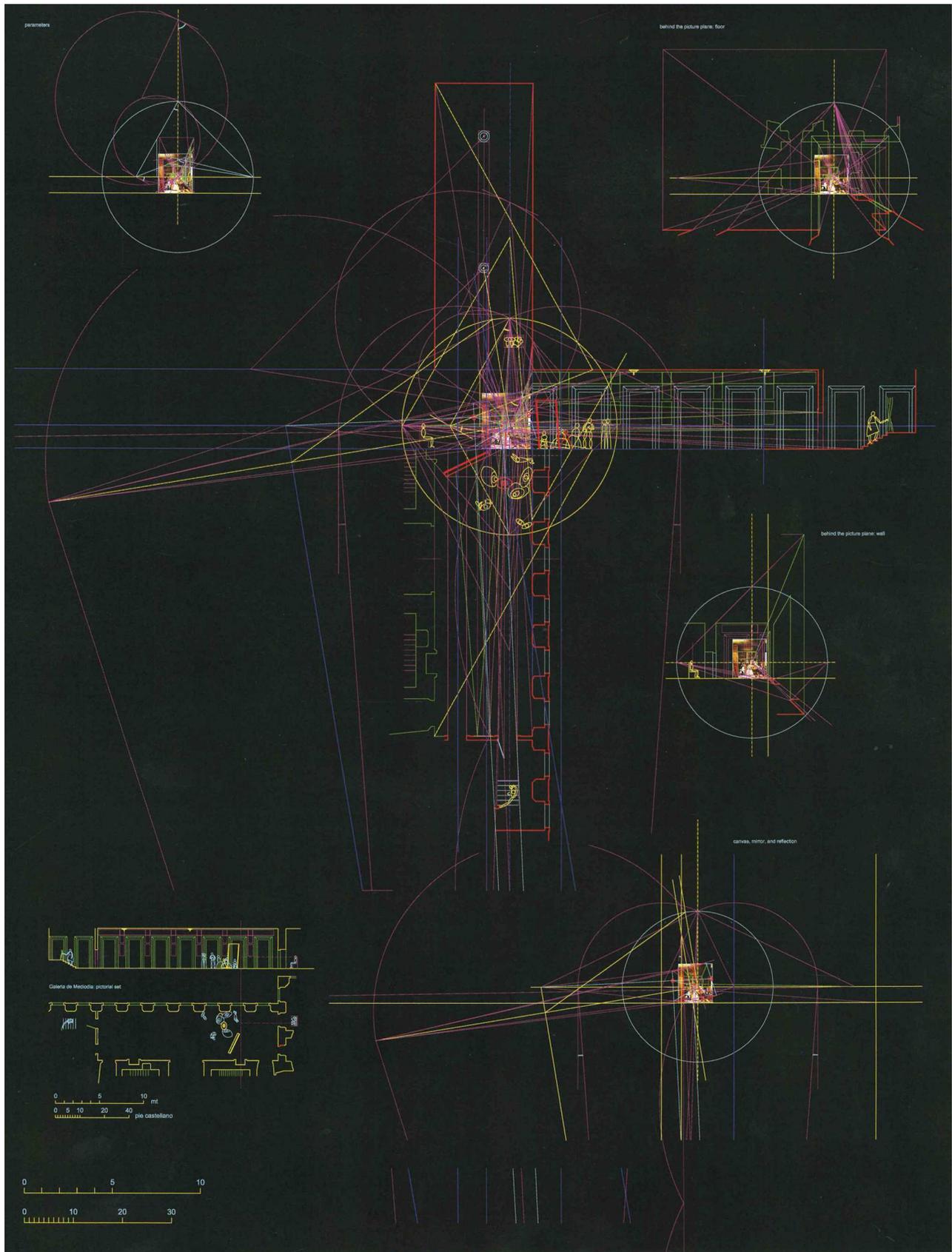


Figure 24: *Las Meninas*, the whole projective analysis (drawn by author)

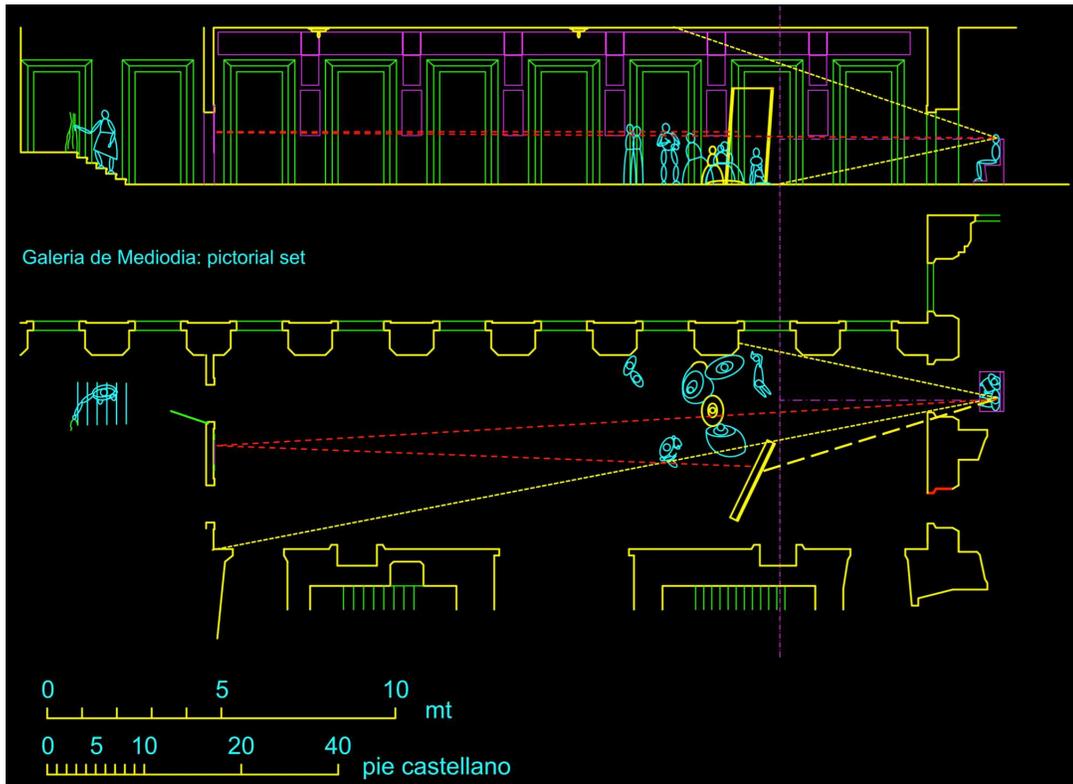


Figure 25: *Las Meninas*, reconstruction of pictorial set and visual field: plan and section (drawn by author)

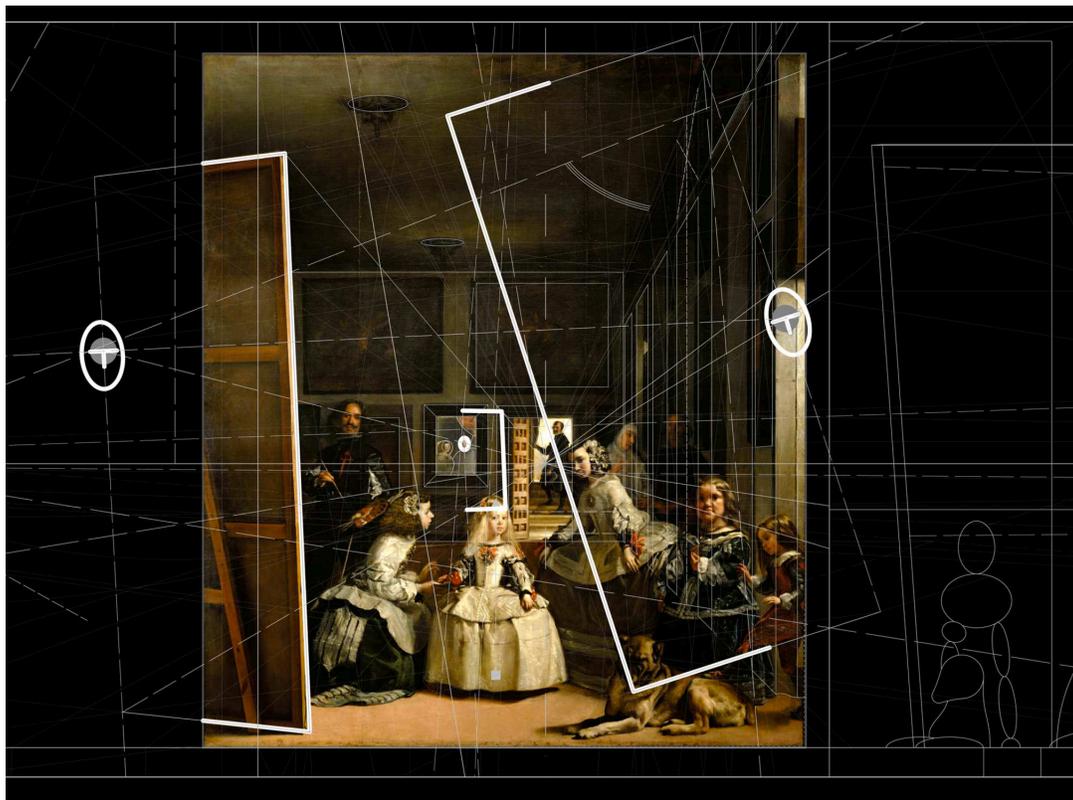


Figure 26: *Las Meninas*, into the enigma of mirror via homological investigation (drawn by author)



Figure 27: *Las Meninas*, physical replica. Photographic view from the designated sight point (model and image by Aamir Ahmed Patel and Abhay Kaushik)



Figure 28: *Las Meninas*, “philological” digital replica: gaps in the 3D model correspond to hidden part in the painting (frames from an animation by Aamir Ahmed Patel and Abhay Kaushik)

8 Conclusion

At this point, some comments about reason and meaning can be proposed. At a first glance the painting is shocking for the intriguing and flooring set as well as the pictorial virtuosity. But there is even more behind. Velázquez painted *Las Meninas* in his mature age, few years before he passed away, and thanks to his multiple offices across Art and Court he had a clear vision of the world around him [4]. He knew and showed the double side of reality, serious and mocking, light and dramatic, ironic and melancholy. *Las Meninas* is about all these. And its iconography is as precisely calibrated as a treatise, superbly integrating various aspects and levels. The representation of meaning follows a dynamic equilibrium, as well as we already saw in the pictorial composition, even more emphasized by the alternation of bright and dark areas in the pictorial space. All the basic hierarchical ranks of the Court and typologies of human beings appear on the canvas, in an interesting order, since backstage is of a dog, together with a midget and a dwarf, while King and Queen are the smallest figures, little dimed because of the reflection in the mirror. In opposite, the most shining figure is that of Infanta Margarita, at very barycentre of the scene, may be the real main subject of the painting, representing the future and the hope of the reign. This fact can not be clear without considering the heavy series of mourning afflicting the King, at his second wedding and having Margarita as his only son at that moment. On the other hand he was getting old, something consistent with his fading image in the mirror.

However, mirror is a pivotal enigmatic point in *Las Meninas*, and the duplication of the pictorial space a recurring obsession for the painting. We can mention *Christ at the house of Martha and Mary*, painted nearly four decades before, integrating two spaces in the same painting, or *Venus and Cupid*, better known as *Venus Rokeby*, painted seven years before, a nude where the face of the goddess is revealed into a small mirrored hand by Cupid. Some comparisons have been carried on with *The Arnolfini Portrait* by Jan van Eyck, realized more than two centuries before, in 1434. Anyway, considering the different typology of reflection, in van Eyck generated by a curved mirror, and apart from the superficial evidence of the presence of a mirror depicted in the scene, we do not see other significant similarities. Like in the *Venus Rokeby*, in fact, both subjects and their mirrored images appear on the canvas, while in *Las Meninas* we see only the mirrored image, but not the King and the Queen. To find the reason, it has been suggested to search into the literary genre of the *speculum principis*, or the mirror of prince, inspired by an ancient Roman tradition starting with Isocrate's *To Nicocles*, including booklets and manuals focusing on how to educate a Prince [10]. The basic idea was that mirror never fails, and that reality looked through a mirror can be dominated,

like in the case of Perseus and Medusa Gorgon. At the time this literary genre was widely diffused in the European area. In Spain, it was known as *espejo de principe*, where vices and virtues were compared and analysed by using various literary formulas and expedients. In the modern era some reference works were *Il Cortegiano* by Baldasar Castiglione in 1528, *Agudeza y arte de ingenio*, and *El criticon* by Balthasar Gracian, respectively in 1648 and 1651. About Italy we could remind *De Principatibus* by Nicolò Machiavelli, date back to 1513. But it seems that the main reference to Velázquez was the book *Idea de un principe politico Christiano*, that means the ideal Christian political prince, written in 1640 by Don Diego de Saavedra Fajardo, who was minister and ambassador, closely in touch with the King of Spain, and most of all, knight of the Order of Santiago, the Order that Velázquez was struggling to join at the time, as we saw before (Figure 29). Back to *Las Meninas*, mirror could allow king and queen to be there and not there at the same time, in the purity of a reflected image without contaminations with the real space. In other words, they could be there as a reflected image to represent the pure principle of being sovereigns, that is, as the mirror of their darling Princess (Figure 30).

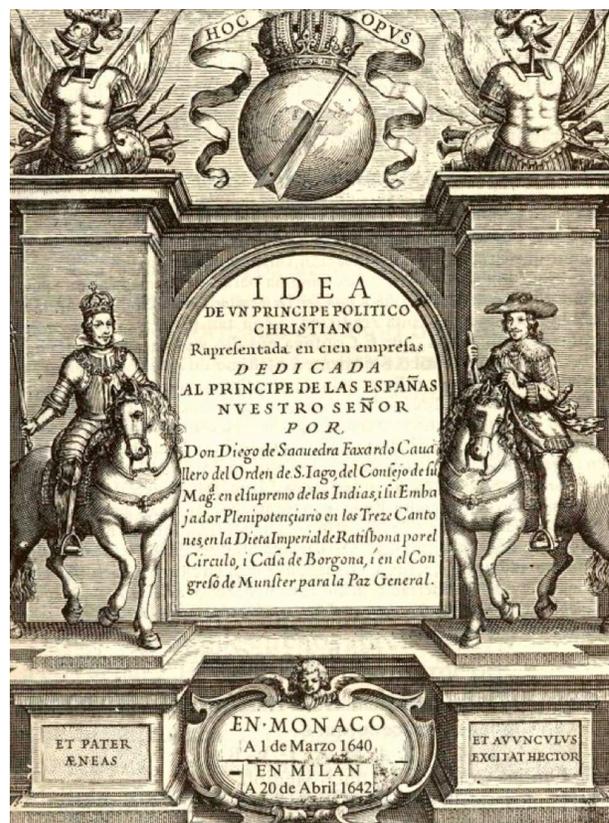


Figure 29: Frontispiece of the book “*Idea de un principe politico Christiano*”, written in 1640 by Don Diego de Saavedra Fajardo (source of image [13])



Figure 30: *The Infanta Margarita, darling daughter of Felipe IV and Mariana de Austria, seen through the pin-hole of the model (picture by Georg Glaeser)*

The mirror is also connected with the two copies of Rubens hung above, namely *Minerva Punishing Arachne*, on the left, and *Apollo's Victory over Marsyas* on the right. They tell mythological stories of the dramatic consequences on humans who dared to challenge gods. As we know Arachne was turned in a spider and Marsyas ended up being flayed. What is also interesting to see is the correspondence in genders, since the feminine story is set above Queen and the masculine above King, to remind the limited power of human beings, no matter how much is their role in this world. But since Apollo is patron of Arts and Minerva's patron of Wisdom, their presence also symbolizes a wider admonishment, involving Velázquez himself, who is just at work on a painting. At the time, indeed, painters and were considered artisans working with hands, to whom the shift to high society was impeded. Proof is the hard work Velazquez was still doing, in spite of his multiple prestigious offices at Court, to be accepted as a member by the Order of Santiago. The two mythological stories seem then to have, first of all, a double meaning, as auspices for a divine protection as well as defences from the ire of deities due to the arrogance and haughtiness of the painter. He knew there might have been reasons for that. Why?

At the end, Royal Family, officers and servants show in his *atelier*. There are similar cases of pictorial scenes located in painters' ateliers, among the most well known we could remind *The Arkidukes Albert and Isabella Visiting a Collector's Cabinet* in 1623 by Jan Brueghel the Elder and Hieronymus Francken, and *The Gallery of Cornelis van der Geest Visited by the Regents* in 1628 by William van Haecht [8]. Nevertheless, the mood in *Las Meninas* is

quite different, and definitely stronger. We see the painter himself looking into our space and our eyes, together with several other people in the painted space, in a way that his figure can not be removed without trivializing the scene. His silhouette stands out over the other characters, imperious and concentrated, despite the light *penumbra* around him. Considering the size on the canvas, it is large and detailed enough to be cut out as a self-portrait apart. Anyway, the additional and maybe most significant meaning comes from the fact that the painter in person is acting in the community of sovereigns, dignitaries, and deities. Moreover, he also involved goddesses in his work, in a way that they could see the work in progress on the canvas, as if it was something worthy of their consideration and worries. This point is related to Velázquez's main aim, that is, release and redemption of painting and painters. Challenging task, in *Las Meninas* it seems fully realized, at the point that painting itself brings together history and mythology, which is not possible to achieve outside the boundaries of Art, in this case, of Painting. Where perspectival and optical interplays are of crucial importance to achieve the goal [7-10]. In this sense, as proposed in the title of this paper, we see the alchemic contribution of perspective in making Image able to set a reality. In this case, as a kind of *augmented* reality, enriched by supernatural presences and new meanings. That is, more than what would be possible to realize in the tangible space of the every day life. From the Golden Age of the Spanish Painting, Velázquez carried on in this painting a revolutionary enhancement, for some extents comparable to the one carried on in Italy by Leon Battista Alberti during the XV Century. This makes this masterpiece relevant not only for Art, but also in a wider social, cultural, and historical sense.

Therefore, and not only for technical reasons, we believe that the scene depicted in *Las Meninas* has not been simply outlined from a whole image reflected in a big mirror put in front of the artist, which would have implied an *imitation*, given that painting would be explicitly shown here as a *creation*. An intellectual, besides manual, creation, or, re-creation. Secondarily, a specular image would have weakened that exclusive *mirror of prince* effect provided by the specular image of the royal couple. In a way, there should have not been room for mirrored image as model of virtues, apart from the sovereigns. Another point reinforcing this hypothesis comes from the observation of the canvas in front of Velázquez, whose content we can only suppose but not see directly. In our opinion, this is one of the strongest metaphors incorporated in this pictorial manifesto, telling us that art is not revealed, if not to the artist, goddess wishing. In which is also an eternal enigma of Art. One more reason to avoid mere imitations of images reflected by a mirror. Art is a fleeing construction of genius and intelligence. In conclusion we have no other chances

but agree with Jonathan Brown's opinion: "A painting as rich in ambiguity as it is in subtlety, *Las Meninas* has long been recognized as a masterpiece of Western art, a pictorial tour de force rarely equalled and never surpassed. But when we attempt to explain its greatness, we soon realize how it seems to evade the grasp both of intuitive and rational understanding". Nevertheless, the prospective meager expected results have been largely offset by the wealth of experience resulting in the geometric study and graphic analysis of this, which is not only a masterpiece of genius, but also a superb educational example of scientific

and artistic dedication as well as professional ennobling. Would we be able to achieve comparable goals in our research, educational, and professional field nowadays?

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