GENERAL ARTICLE

The Sacred Geometry of Velázquez's *Las Meninas*

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ABSTRACT

This study reveals the crucial role played by sacred geometry in the spatial structure of Velázquez's *Las Meninas*. It further explains how Velázquez, by means of geometric composition, achieved double centrality and why nearly half of those who look at his masterpiece perceive that the point of view is opposite the mirror. The spatial analysis of the floor plan confirms that, according to the law of reflection, the image in the mirror is coming from the large canvas. The correct floor plan follows from the Renaissance perspective system, and its understanding leads to further revelation of its universal use.

"*Las Meninas* is, without a doubt, a masterpiece. Its complex and enigmatic composition raises questions about reality and illusion, about reflection and representation" [1].

The painting was originally called *La Familia* but in the latter nineteenth century was incorrectly renamed to its now-popular title, *Las Meninas* [2]. The change in title shifted the focus from the royal family to the young female attendants. Nevertheless, the painting is undoubtedly a collective portrait of the royal family and their closest court members.

In the scene, the royal daughter, the five-year-old Infanta Margarita Teresa, stands in the middle with her *meninas* (maids of honor). Behind them are a pair of chaperones. Framed by the doorway at the back of the picture can be seen the queen's chamberlain, José Nieto. Velázquez, chamberlain of the royal palace, is standing in front of a large frame as he paints the royal couple, whose images we can see reflected in the mirror on the back wall. There are also two dwarfs, Maribárbola and Nicolasito—the latter is caught in the act of teasing a sleepy dog. The main members of the family, the king and the queen, while not seen directly, encompass the group from three sides: as their "real" selves, facing Velázquez and the others; reflected in the mirror behind the group; and on Velázquez's canvas. Their presence is tangible.

Its complex and puzzling arrangement creates an ambivalent relationship between the viewer and the portrayed figures. Given the challenge presented by these complexities, this painting has been scrutinized from all possible angles. Yet a couple of pieces of the puzzle remain missing. This narrative picture presents a difficult interpretative challenge, not only because the architecture disappears into the shadows, but because of its advanced spatial design. This amazing work relies on the magical effect of perspective projection and is the only one in which Velázquez used the Renaissance perspective system.

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THE REFLECTION

Doubts exist whether the reflection in the mirror is of a royal couple on the canvas or of the couple standing in front of the group. Many convincing hypotheses have been proposed. Leo Steinberg asserts that the king and queen are to the left of the viewer, at the picture's dramatic focus [3]. The same opinion that the royal family is to the left of the viewer and that the reflection in the mirror is coming from the canvas was previously proposed by Bartolome Mestre Fiol [4].

To find an answer to this question is not as difficult as it may seem. To support Steinberg and Mestre Fiol's theory, we do not even need the perspective system. We only need to measure the figures in the mirror (including the estimated length of their legs) and compare their measurements with those of José Nieto, who stands slightly further back. By doing so, we can estimate the height of the king and queen in the mirror at about 150 cm. We can also use a quadrature grid for precise measurement, but let us leave this method aside for now. If we follow the law of optics, the size of the mirror's image is equal to one half the real object size, then the royal couple would have to be almost 3 meters tall in reality. That means the reflected image must be coming from the large canvas.

In this particular case, however, we must consider that the distance is not precisely halved, since the viewing point is further from the mirror than the canvas is. To find the correct distance and adjust the measurements, we need to know the viewer's position and the correct floor plan of the rooms depicted. The ratio of the viewer–mirror distance to

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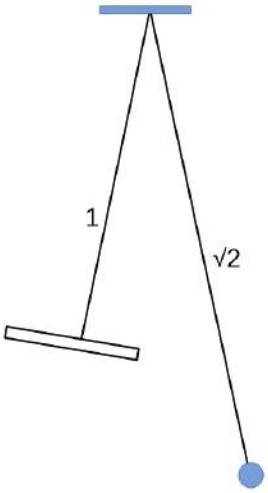

Fig. 1. Viewer-mirror-canvas ratio, Velázquez's *Las Meninas*. (© Petr Bouc)

the mirror–canvas distance is 1.414 to 1 (Fig. 1). The value 1.414—or the square root of 2 (√2)—is generated from the perfect square and is one of the building blocks of sacred geometry.

The ratio √2:1 or 1.4:1 diminishes the object in the mirror not by half (as it would happen at the equal legs distance or at a 1:1 ratio), since the second (reflected) leg is shorter, the image on the canvas is not 2 times bigger but only 1.7 times. This is an empirical estimate, which I calculated by standing in front of a mirror. If we use this estimate and multiply the mirrored royal pair size of 150 cm by 1.7 we arrive at an estimated original height of 255 cm, indicating ca.-255-cm-tall figures on an almost 3-meter-high canvas. This leads to only one conclusion: The reflected image in the mirror is coming from the large canvas, and Velázquez is working on the full-size portrait of the royal couple.

Another optical law only confirms the above assertion. The law of reflection states that when a ray of light reflects off a surface, the angle of incidence is equal to the angle of reflection [5]. On the floor plan in Fig. 2, the line of vision reflects from the mirror and comes across the large canvas. In optical terms, the light from the canvas reflects from the mirror into the viewer's eye.

VANISHING/VIEWING POINT

A simple method for locating the vanishing point is to extend all parallel lines perpendicular to the picture plane to the point at which they intersect. In any coherent perspectival painting, the vanishing point defines itself as the point directly opposite the viewer's eye or, more precisely, opposite the eye that established the projection. Many misinterpretations originate with an inability to find the vanishing point and, consequently, the location of the viewing point. The viewing point is the point from which a picture is projected. Michel Foucault and many others have ignored this basic axiom and fallen into a trap set by Velázquez [6]. Joel Snyder and Ted Cohen, in their excellent critical response to John R. Searle, write, "At the level of its geometry, *Las Meninas* is not paradoxical. On the contrary, it is thoroughly and ingeniously orthodox" [7]. This is true; however, Velázquez, in contrast with his Dutch contemporaries, provides us only a few perspectival paths. Yet the black contours on the right wall, and the line through the ceiling hooks, unmistakably lead the viewer's eye toward the elbow of José Nieto, toward the vanishing point (Fig. 3).

While scholars disagree about what is being reflected in the mirror, there is more or less accordance among them that the royal couple is standing at the viewing point. But if this were the case, then Velázquez would be 7.5 meters (25 imperial feet, 27 Castilian *pies*) away from the royal couple (Fig. 2). (The unit of measurement in use at the time was the *pie castellano*—Castilian foot—which is equivalent to 27.8 cm [8].) Twenty-seven Castilian *pies* is just a bit too far away for painting a portrait, even for a master of Velázquez's caliber. The distance between the pillars, according to the period

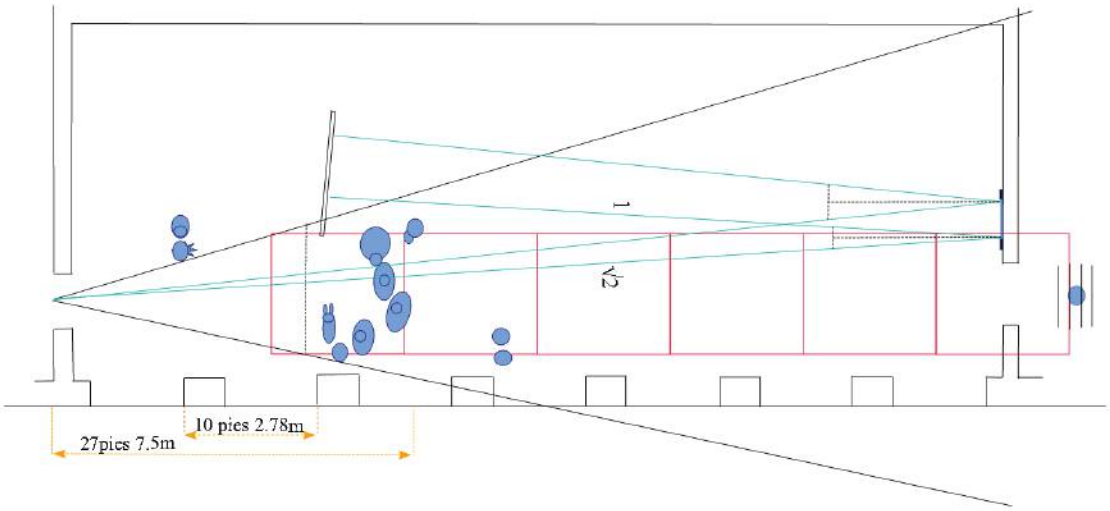

Fig. 2. Floor plan of the room in the Alcázar Palace, mirror reflection in Velázquez's *Las Meninas*. (© Petr Bouc)

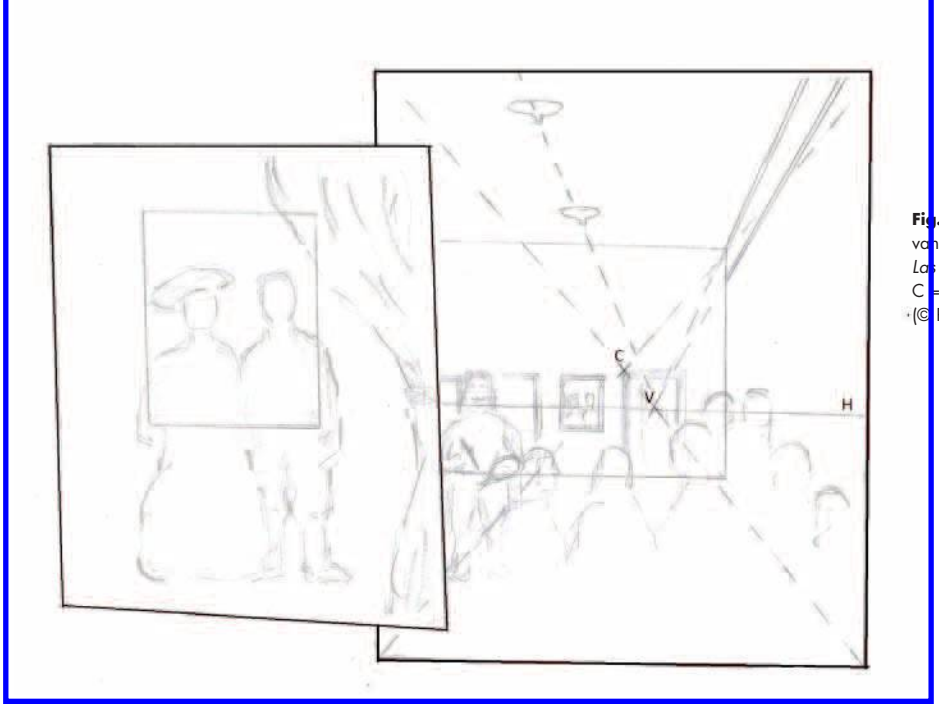

Fig. 3. Location of the central and vanishing points in Velázquez's *Las Meninas* (V = vanishing point, C = central point, H = horizon). (© Petr Bouc)

records, was 10 Castilian *pies*, and there were seven windows in the room 72 *pies* long [9].

Furthermore, the vanishing point is about 140 cm above floor level. This is certainly not the height of the standing king or queen, and it is unlikely that they were sitting in the doorway. To determine the height of a vanishing point, we must use a real person or real object of a size we can estimate—once again, in this case, José Nieto. Nieto stands on the second step, and the vanishing point is approximately 5 cm beneath his elbow. The distance from the floor to the elbow of a man of average height of that time (170 cm) would have been around 110 cm. If we subtract 5 cm and add the height of the two steps (each around 17 cm), then we arrive at a height of around 140 cm for the vanishing point. Or if we use the exact method, the quadrature's base square confirms our estimate. If side *a* of the base square measures 10 Castilian *pies*, then the vanishing point is at *a*/2. Velázquez located the vanishing point at exactly 5 Castilian *pies*, or 139 cm or 4.56 imperial feet, high.

DOUBLE CENTRALITY AND VISUAL AXIS

Steinberg flawlessly captures Velázquez's intention to conceive these characters as subordinated to yet another centrality. "For he located the picture's dramatic and psychological focus outside itself, displaced from what the picture actually shows to what it beholds. That center, of course, is on our left. It resides in the royal pair bestriding the room's central axis" [10]. The king and the queen pose for their own portrait, and their daughter with her entourage keeps them company. The royal presence can indeed be sensed, though much closer than at the viewing point.

Spatial analysis of the setting implies that Velázquez achieved the effect of another centrality through precise geometrical planning. The physical central point of the picture can be found by diagonal crossing and is located in the left corner of the doorframe (Fig. 3). The central point determines the path of the visual field axis. As we can see in the floor plan (Fig. 4), the visual axis (dashed line) of the viewing angle passes through the princess, the center of our attention,

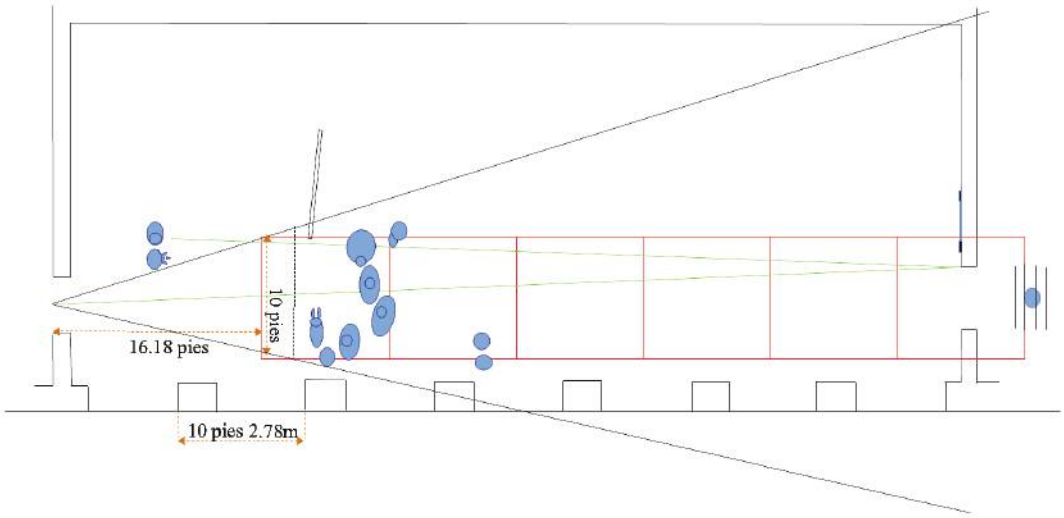

Fig. 4. Floor plan of the room in the Alcázar Palace, visual axis in Velázquez's *Las Meninas*. (© Petr Bouc)

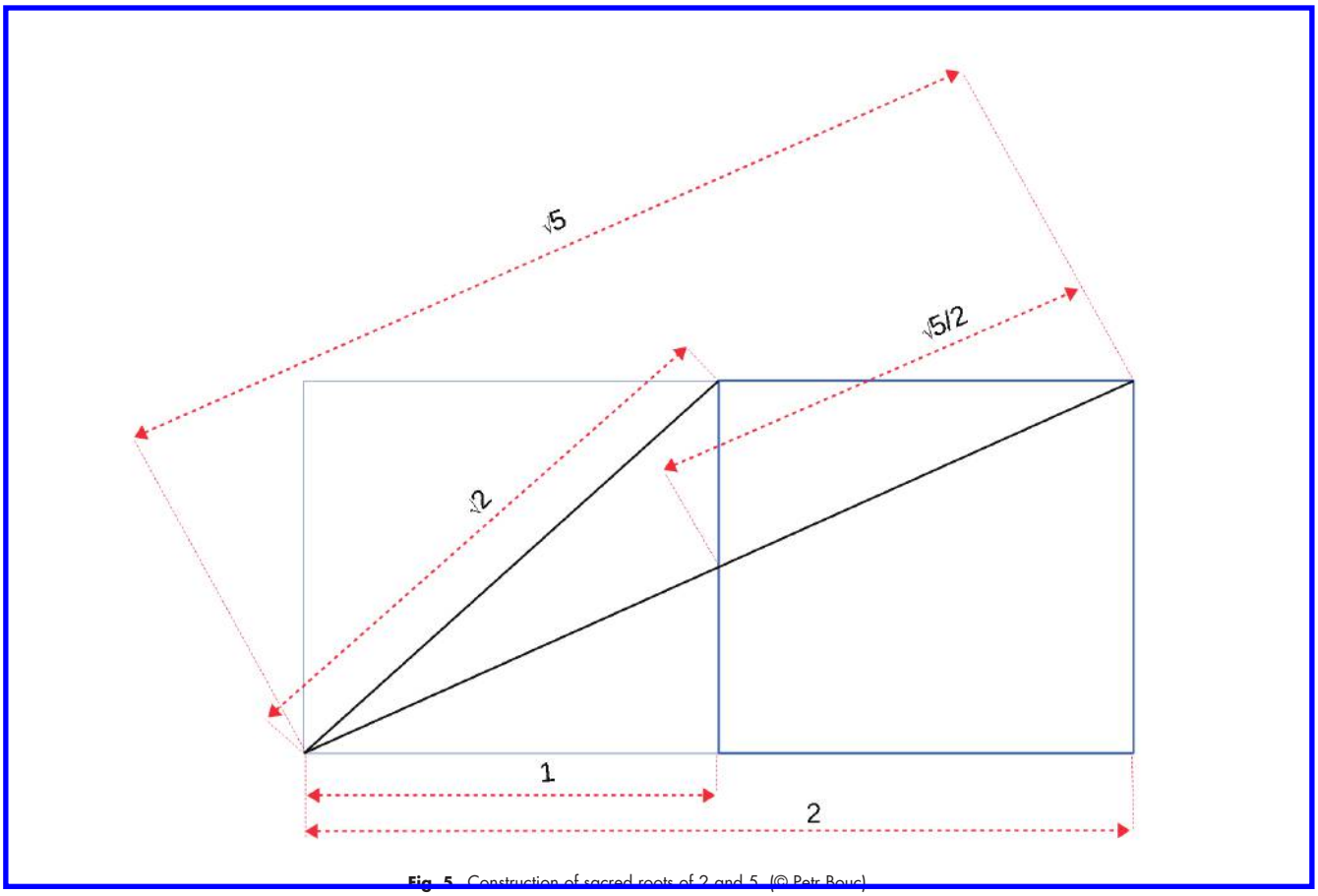

Fig. 5. Construction of sacred roots of 2 and 5. (© Petr Bouc)

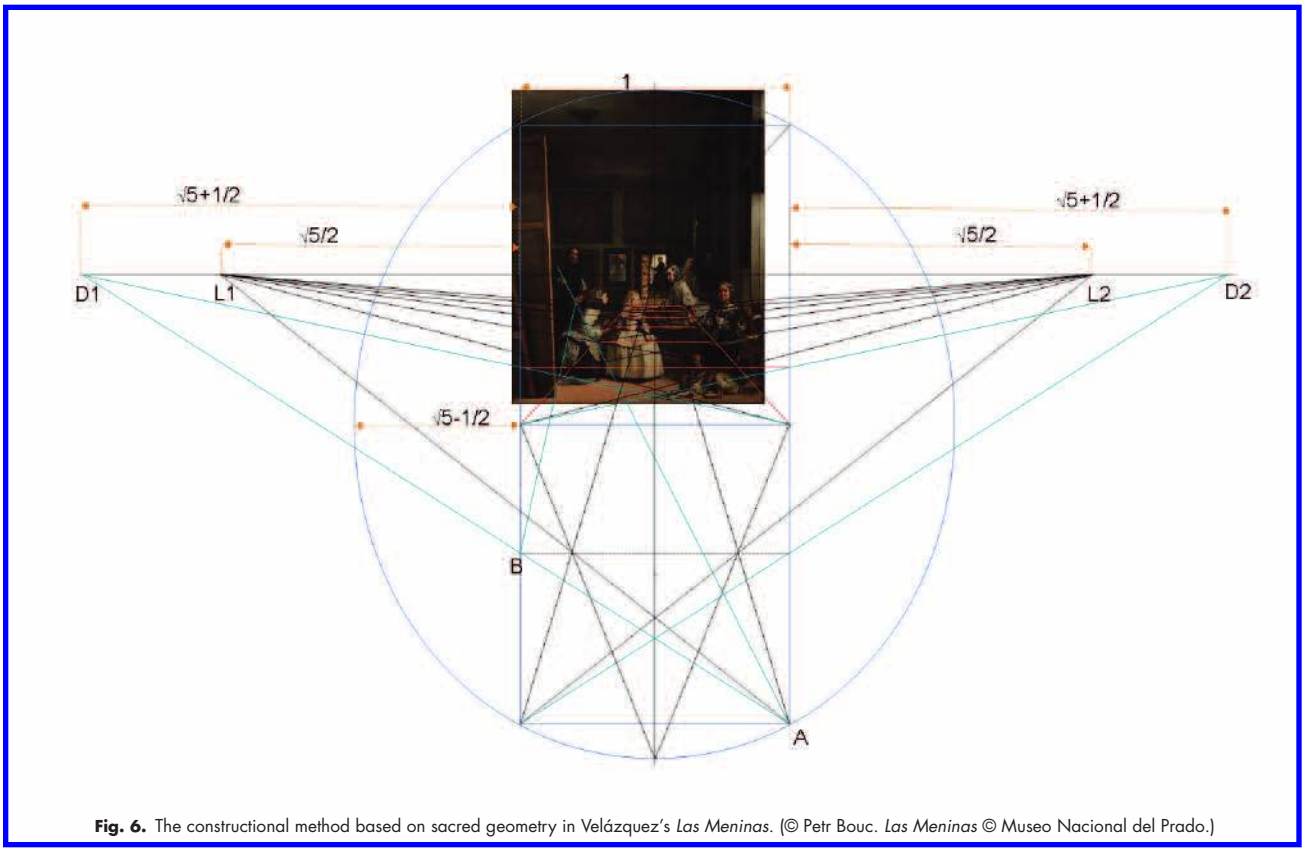

Fig. 6. The constructional method based on sacred geometry in Velázquez's *Las Meninas*. (© Petr Bouc. *Las Meninas* © Museo Nacional del Prado.)

and then runs asymmetrically down the room and reaches the back wall at the central point. If we then reflect its path back at the same angle, the imaginary (this is not the mirror reflection) line passes alongside the painter and continues to the royal pair, who are standing right beside the edge of the viewing angle.

Velázquez skillfully used the geometry to suggest something occurring outside the painting's pictorial frame. According to informal research by Snyder and Cohen, nearly half of those who look at *Las Meninas* perceive the point of view as directly opposite some point in the mirror [11]. Indeed, the royal couple's position *is* just about opposite the mirror. It is apparent that nothing in Velázquez's composition has been left to chance.

QUADRATURE

Quadrature refers to illusionistic ceiling or fresco painting, after a Latin word for making something square or dividing something into squares. It can also refer to the "opening up" of walls through architectural illusion and Velazquez had the opportunity to study the works of Agostino Mitelli and Angelo Michele Colonna, Italian quadraturisti, who had been employed to decorate the Alcázar [12].

Let us see how Velázquez created his only work of art that appears to share the physical space with the viewer. The Renaissance perspective was invented at the end of the fifteenth century in Italy. Knowledge of the perspective system was valuable (or "sacred") know-how, which was kept secret, and those artists who had access to this knowledge were often employed by kings or popes.

Figure 5 illustrates the geometrical construction of the sacred roots of 2 and 5.

The magic of *Las Meninas* is hidden behind the sacred proportions and constructional method of the Renaissance perspective system. Velázquez here used the span of 10 Castilian *pies* between the pillars as the unit of measure for his base square. The diagonal of this square is 14.14 *pies* or the ratio of the square root of 2.

Although Velázquez is quite parsimonious with hints—there are no tiles or any other clues to help us determine the lateral points—he yet provides one (Fig. 6): His brush points to the corner of the bottom square, to point A, and his mahl stick points to point B. If we connect points A and B, we get distance point D1 on the horizon.

The distance point is the most crucial aspect of the perspectival painting; it determines the position of the viewer. If this point is correctly placed, the entire space construction unfolds in visual harmony. In Las Meninas, the position of the viewer, from whose eye the picture is taken, is distant from the base in the ratio of 1.618 to 1, where 1 is of the base square or expressed by a formula $\frac{\sqrt{5}+1}{2}$ to 1 (Fig. 4).

On the edge of the last square rests José Nieto, holding the back door open, as a symbolic guardian of the systematically organized space inside a frame.

THE RENAISSANCE PERSPECTIVE

The distance points are of substantial importance and are closely related to the floor plan.

We no longer have to estimate, and if we set the lateral points according to the principles of sacred geometry, then the distance point is L1 + *a*/2.

Again, the lateral points define the back wall of the cube (E, F, G and H in Fig. 7) and the following cubes, thus yielding an exact measurement to work with within the three-dimensional space of the picture.

Yet there are a couple of variables in the picture alone, which generate the lateral points. The difference between the linear perspective and the Renaissance perspective is that the latter knows exactly where and how to locate the lateral points. The painter no longer estimates; he achieves the results geometrically [13].

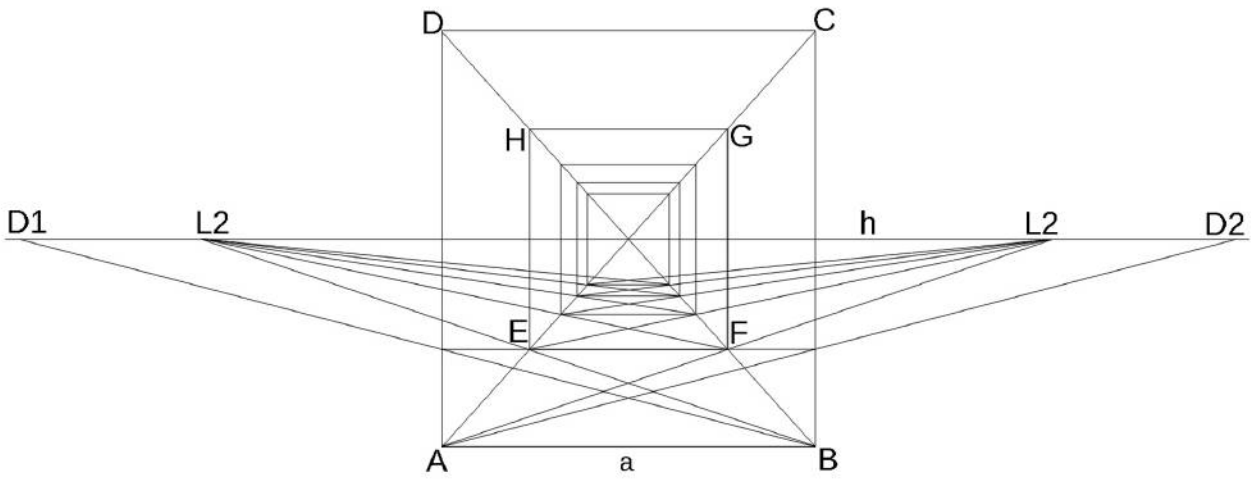

Fig. 7. The constructional method of distance points. (© Petr Bouc)

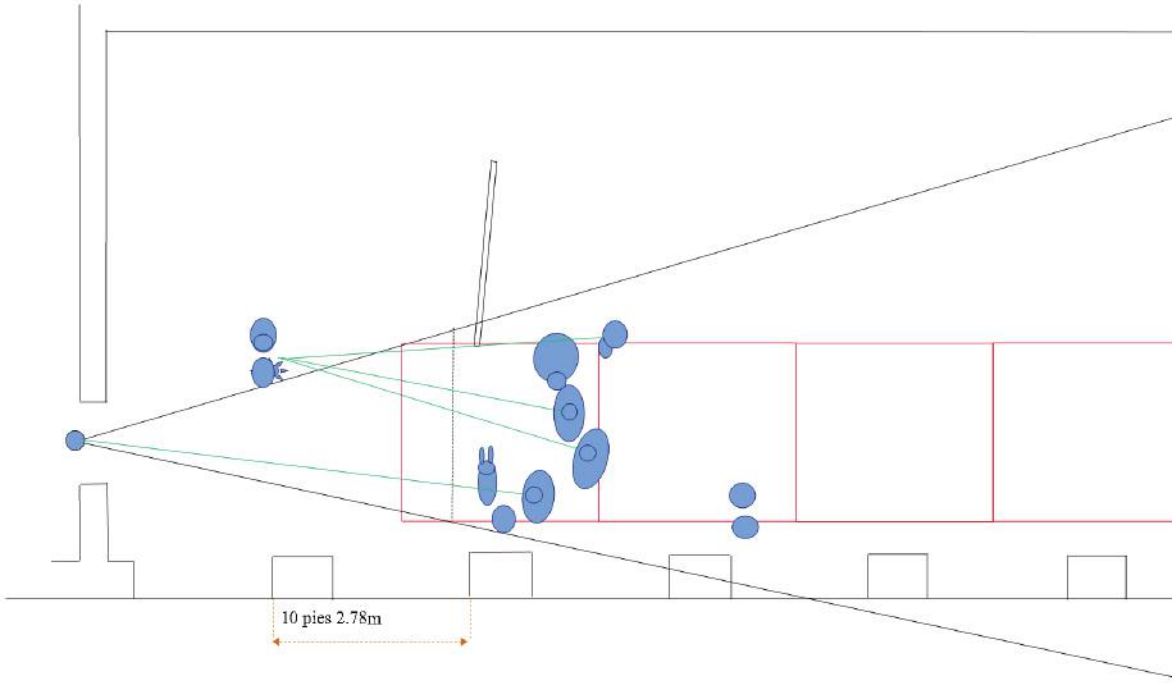

Fig. 8. Floor plan of the room in the Alcazár Palace, individual views in Velázquez's *Las Meninas*. (© Petr Bouc)

VIEWS

Velázquez's relationship with the king was based on mutual respect; perhaps he tried to intimate a contrast between the various aspects and what the duty to rule entails. There are actually three frames, three states of reality, we are looking into.

In the first frame, the frame holding the canvas Velázquez is working on (furthest on our visual path) expresses royal nobility and grandeur in the larger-than-life-size image.

The second frame confines the reflected image within the mirror. The image, opposite from the first one, is smaller than life size. The image is distant and blurred, as the royal couple might have been perceived by the tributary—too remote to understand our problems.

The third frame encloses the picture itself. In this case the royal couple, although not visible, is in the immediate vicinity, as parents, as members of the family. Here they are neither smaller nor larger but as they really are, respectable and caring persons surrounded by family and loved ones, invisible to the scrutinizing public eye.

Yet the glances of our protagonists suggest where to look. Their eyes are fixed into our space, but not all of them are looking to the same spot. It is noticeable that Maribárbola is looking in a different direction than the rest of the group. She is the only one whose eyes linger on the one from whose point of view the picture is projected—on us. Others are looking to the left, and the focus of their attention is the king and queen. Although the princess's head remains turned in the direction of the door, her eyes aim back to the left, toward her parents (Fig. 8).

MIMESIS

Velázquez intentionally challenges our understanding of representation as a reflection of reality. The Greek term *mimesis*—which means "imitation" or "representation"—has been used to explore the relationship between an original object and a representation that attempts to imitate that original. Plato and Aristotle, the leading philosophers of their time, arrived at relatively different conclusions about the relationship between fine arts and reality. Their debates revolved around the issue of whether the systems of representation reflect the world as it is, such that they mirror it back to us as a form of mimesis or imitation, or whether we actually construct the world through the mechanism of our visual perception [14].

Velázquez's private library included titles such as *Política de Aristoteles Italiano* and *Philosophia antiqua* [15]. *Las Meninas* is Velázquez's answer to Plato's question, *why imitate at all—can we obtain knowledge or pleasure through it?* Through *Las Meninas*, Velázquez conveys his opinion that representation is not just a matter of reflection, and he leans toward Aristotle's view. Aristotle does not limit mimesis to artistic reproduction; he argues that mimesis is an imaginative act, not mere representation [16].

Velázquez creatively arranges the scene within the two-dimensional space of the canvas, and he intentionally positions the mirror in such a way that it fools so many people.

The mirror, a crucial aspect of the composition, holds the reflection of representation; it reflects the image of the canvas. Velázquez thus declares that he is the creator (not a copier) of the scene, that this work is the product of his mind,

imagination and construction skills. He invents the narrative to fit his own objective. Although his perspectival space is faithful to reality, his goal was not to faithfully depict an individual event, but to improve it, that is, to indicate what could happen and turn it into a work capable of universal truth.

Velázquez wanted to ennoble his craft; he wanted to elevate the art of painting to the status of a liberal art. Given our knowledge of the setting, he justifiably deserved to be honored by the Cross of Saint James of the Order of Santiago, because *Las Meninas* is the product of a powerful intellect.

CONCLUSION

And from whose point of view is the picture constructed? Who is the subject of Maribárbola's inquisitive observation? Could it be a *señor* entering the room? Does he see the royal family and take off his hat and bow? But wouldn't all eyes turn in his direction? It seems more likely that another dwarf or a jester is standing in the doorway. Only Maribárbola is looking directly to someone holding a similar role as José Nieto on the other end of the room. His task was to prevent distractions while the royal couple was being portrayed, and we witness the scene from his point of view. It was someone of her own height, and the hand on her heart even indicates a romantic interest.

Velázquez visited Italy twice and, although he expressed distaste for Raphael's work, he used the same geometrical system that the Renaissance master had used more than a century before him. He was seriously interested in the principles of composition and perspective. At the time of his death, his private library contained what was a large collection at the time: 156 books. Most of the books in its inventory related to optics, perspective, geometry and Italian architecture. Velázquez sought throughout his life to combine theory and practice. He was searching for the elusive perspective system and it is apparent that, at the end of his fruitful and successful career, he found it. He too deciphered the secret of Renaissance perspective. And *Las Meninas* is a declaration of his geometrical skills.

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