

## PERSPECTIVE STUDIES ON THE ADORATION OF THE MAGI BY LEONARDO DA VINCI

*Fabrizio Ivan Apollonio\*, Riccardo Foschi\**

\*Dept. of Architecture - Alma Mater Studiorum University of Bologna – Bologna, Italy.

### Abstract

This paper aims to unravel the perspective construction used by Leonardo da Vinci for his iconic and celebrated unfinished painting the Adoration of the Magi. This study is the final step of years-long research brought forward by our department focused on the study of the perspective construction used by Leonardo in the preparatory drawings of his masterpiece. The first two published studies demonstrate how Leonardo re-interpreted the Albertian rules of perspective construction and used them in a non-rigorous way to draw the architectural elements of the preparatory drawings. Starting from these discoveries, this contribution aspires to complete the analysis by investigating if the same aberrations and formal errors are also present in the final painting. By inverse construction and comparison with the preparatory drawings, we observed probable perspective aberrations analogous to those observed in Uffizi's preparatory drawing.

### Keywords

Descriptive geometry, perspective, reconstruction, 3D modelling, graphic analysis, Leonardo da Vinci, drawing

### 1. Introduction

Unfinished paintings often capture the interest of researchers and scholars because they provide the opportunity to investigate the artists' techniques by sneak peeking at the early stages of their work, such as preliminary constructions and sketches that would have been later covered and lost under layers of paint.

In these regards, Leonardo da Vinci is a perfect case study because he left to posterity innumerable unfinished works of art. In particular one of his most studied and renowned unfinished masterpieces is the "Adoration of the Magi" dated back to 1482 c. (shown in Fig. 1) today conserved at "Le Gallerie degli Uffizi" in Florence (Parenti, n.d.). One of the reasons for the fame of this artwork, other than being one of the earliest works commissioned to Leonardo, is the fact that it is unevenly refined, some parts are only sketched, while some others are already roughly painted. This offers the opportunity to investigate many different layers and operative phases in the same artwork which is a rare opportunity.

Not only that, but the importance of this painting is also, if not mainly, because we still have access to about fifteen preparatory drawings today linked to the Adoration of the Magi, such as the one housed at Louvre [Leonardo da Vinci,

Preparatory study for the Adoration of the Magi, 1481, drawing in pen and brown ink over lead-point tracing on paper, 284 × 213 mm, Musée du Louvre, Département des Arts Graphiques, n. R.F. 1978] (Fig. 2) where the artist studied the composition as a handmade sketch; and the other conserved at "Le Gallerie degli Uffizi" [Leonardo da Vinci, Study for the Background of the Adoration of the Magi, drawing in metal point, reworked with pen and iron-gall ink, diluted iron-gall ink, partially oxidized white gouache highlights (basic lead carbonate), stylus and compass, on light brown prepared paper, 164 × 290 mm, around 1481, Florence, Gabinetto di Disegni e stampe degli Uffizi, GDSU, inv. 436 E] (Fig. 3) where we can see the perspective construction and many different layers of his working phases. These drawings were specifically drawn by the artist in preparation for this painting, which is an even rarer opportunity to investigate the generative process from even earlier phases concerning the realization of the artwork itself. The other mentioned preparatory drawings refer mainly to human figures and other non-architectural details so they had marginal importance for the scope of this research.

The drawing now housed at Louvre has been recently the subject of a study (Apollonio, et al., 2021) focused on the architectonic elements

present in the scene. It highlighted how the drawing discloses three distinct vanishing points/centres of vision.

On the contrary, the “Study for the Background of the Adoration of the Magi” housed at Le Gallerie degli Uffizi (also known as “Scenario architettonico e rissa di cavalieri”) was the object of many more studies and it presents a richer bibliography. The contributions published in the book curated by Filippo Camerota in 2006 “Leonardo da Vinci Studio per l’Adorazione dei Magi” (Camerota, 2006a; Camerota, 2006b; Seracini, 2006; Dalli Regoli, 2006) are, up to now, considered some of the most comprehensive and accurate studies on the subject, together with the text by Antonio Natali “La Guerra, il tempio, il virgulto: una trama per l’Adorazione dei Magi” (2016), and the works by Chapman (2010) and Casoli (2015). This state-of-the-art was recently extended thanks to ISLe (InSight Leonardo) (Apollonio, et al., 2019). Through this project, the techniques and graphical processes adopted by Leonardo were further studied, and it unveiled that Leonardo adopted an unconventional “practical” method to represent the architectonic scene. This method produced, as a result, a stretched space with a particular perspective depth that wouldn’t have been possible with the rigorous Albertian perspective construction. It is still not known if he made this formal imprecision, consciously, for compositive\practical reasons or not.

Furthermore, thanks to the recent restoration campaigns commissioned by “Le Gallerie degli Uffizi” and carried out by the “Opificio delle Pietre Dure”, we now have available many advanced and accurate surveys of the painting which highlight details not visible before. In particular, the IR reflectography unveiled some preliminary strokes hidden by the paint and not visible to the bare eye. Some of these strokes are particularly interesting to investigate how Leonardo used perspective construction to draw the building with stairs in the background which is the focus of our study.

For those interested to study the survey campaigns further, refer to (Frosinini, et al., 2017; Bellucci, et al., 2012; ArtMediaStudio, 2021; Opificio delle Pietre Dure, n.d.; Ciatti & Frosinini, 2017)



**Fig. 1:** Leonardo da Vinci, Adoration of the Magi, around 1482, Drawing in charcoal, watercolour, gouache, ink and oil on assembled poplar wood table, 244 × 240 cm, Florence, Le Gallerie degli Uffizi—Courtesy of the “Ministero della cultura”, it is hereby prohibited any unauthorized use of the image.



**Fig. 2:** Leonardo da Vinci, Adoration of the Magi, 1481, Drawing in pen and brown ink over lead-point tracing on paper, 284 × 213 mm, “Cabinet des Dessins”, Louvre, Paris, France—Photo credits: © RMN-Grand Palais (Musée du Louvre)/Michel Urtado, it is hereby prohibited any unauthorized use of the image.



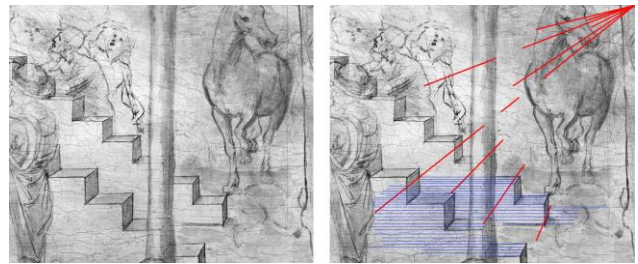
**Fig. 3:** Leonardo da Vinci, Study for the Background of the Adoration of the Magi, around 1481, Drawing in metal point, reworked with pen and iron-gall ink, diluted iron-gall ink, partially oxidized white gouache highlights (basic lead carbonate), stylus and compass, on light brown prepared paper, 164 × 290 mm, Florence, Le Gallerie degli Uffizi, GDSU, inv. 436 E—Courtesy of the “Ministero della cultura”, it is hereby prohibited any unauthorized use of the image.

Frosinini, Bellucci and Riitano (2017) observed how the reflectography and the study of the painting clarified that Leonardo drew from scratch the perspective layout without being worried about marking invasive strokes. Furthermore, Bellucci et al. (2012, pp. 53) pointed out that on the preparation layer it is possible to observe some construction lines made with a dry point, and a small hole in correspondence with the vanishing point, placed on the trunk of the central tree, that was marked by a small nail that he used as a reference to trace the obliquous lines used to draw the architectural scene.

From these pieces of evidence, it is plausible to assume that Leonardo did not use one of the known techniques to transfer the drawing from an accurate sketch to the table, such as the cardboard pouncing or square grid techniques, but he rather rebuilt the entire construction from scratch.

However, not everyone agrees with this theory. García-Salgado has conjectured that there might have been another preparatory drawing now lost (after the one now housed at Uffizi), which would have been traced on cardboard and used to apply one of the known tracing techniques abovementioned (García-Salgado, 2020). However, this supposition does not seem to be compatible with the fact that Leonardo re-drawn the vanishing lines and also some of the transversal receding lines on the ground plane of which we have clear evidence (as shown in Fig 4.).

Others (Bellucci, 2017) conjectured that Leonardo might have used a rigorous technique



**Fig. 4:** (left) close-up detail of the reflectography of the Adoration of the Magi; (right) same detail with marked most visible vanishing and receding lines.

only for the first part of the perspective construction (for the drawing of the vanishing lines), but then he approximated the disposition of the transversal receding lines because it would have been too hard to use the Albertian rule since the distance point (where 45 degrees lines converge) would have been too far away outside from the wooden table.

Bellucci explains this assumption in detail: “He traces from scratch many construction lines on the plane: in particular it can be observed that the horizontal parallel lines, the so called receding lines, are drawn without using the same procedure used on the preparatory drawing, but he rather places them approximatively without using the rigorous geometric process. Nevertheless, it would have been hard to determine these receding lines with the perspective rules since ... based on the Albertian method ... they would have had their origin into a vanishing point outside of the painting”. (Bellucci, 2017, pp. 73).

Maybe the truth is in the middle because, according to the results that will be presented later in the next sections, the formal inaccuracies represented in the preparatory Uffizi’s drawing seem compatible with the one observable in the painting. Thus, Leonardo might have used the same technique, already used in Uffizi’s drawing, to draw the perspective grid from scratch directly on the painting.

The rule used in the preparatory Uffizi’s drawing was proved to give an inaccurate perspective projection, compared to Alberti’s rule (García Salgado, 2020; Apollonio & Gaiani, 2020). However, this rule, maybe invented by Leonardo itself, even if it is inaccurate, it is still a rule based on a rigorous geometrical construction, which can be performed without requiring him to access the distance point and that wouldn’t have required him to draw the receding lines completely by eye.

The conjecture presented by García-Salgado about the possibility of the existence of another preparatory drawing cannot be excluded, but according to the assumption that will be presented in the next sections, an additional drawing would have been neither needed nor required.

## 2. *The painting*

The painting is dated back to 1482 c., it was drawn with charcoal, watercolour ink and oil on an assembled poplar wooden table of 244 x 240 cm.

It was commissioned by Augustinian monks and it was intended as a panel for the high altar in the monastery of San Donato in Scopeto, located outside Florence's city walls. Leonardo accepted to finish the commission in thirty months, but he never completed the work because he moved to Milan at the court of Ludovico il Moro.

The scene has as a subject the celebration of the feast of the epiphany when all the people, Magi and shepherds, respond to the call of Christ. Leonardo composed the figures in a semicircle around the Virgin Mary and the Child with the Magi in the foreground. In the background, on the right, a multitude of horsemen and knights are engaged in a brawl right in front of a building in ruins pictured on the left (Parenti, n.d.). The building at a first glance seems different from the one represented in Uffizi's preparatory drawings but after more careful observation it can be noticed that their overall composition is analogous, it is configured with two flights of stairs separated by three arcs, only the viewpoint and some minor details are different. This building was interpreted by many as a building in ruins/demolished, or under restoration/ construction, nevertheless, the IR reflectography recently unveiled several workers committed to lifting construction materials such as wooden pylons which would tend to favour the conjecture of the reconstruction of the temple rather than its demolition (Bellucci et al., 2012, pp. 45) similarly of what was already observed in the preparatory Uffizi's drawing.

## 3. *Analysis of the representation technique*

This section will discuss a step-by-step explanation of how the analysis of the drawing was carried out, in order to infer the probable drawing technique used and, from that, to deduce how

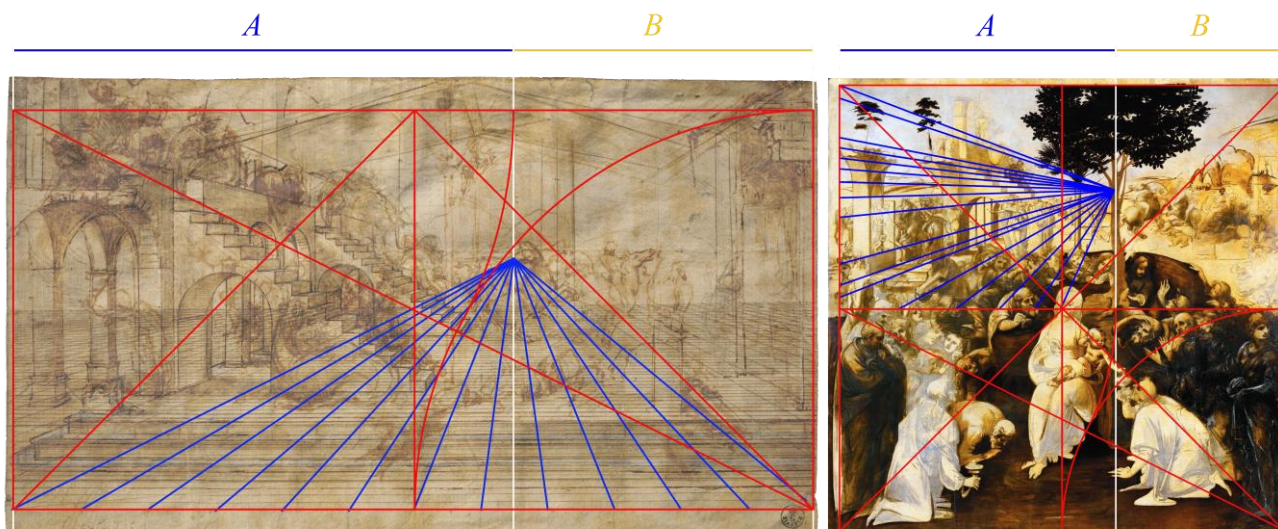
Leonardo probably carried out the perspective construction. We will only focus on the construction of the building with stairs and we will compare the results with the results presented in our previous works on the preparatory drawings (Apollonio & Gaiani, 2020; Apollonio et al., 2021), and other works investigating the same topic (García-Salgado, 2020).

### 3.1 *Extrapolation of the Vanishing point*

It is common knowledge that if the height and distance of the viewpoint from the picture plane are known it is possible to reverse-project the 2D drawing back into 3D space by just imposing some additional geometrical constraints on the scene. When dealing with standard traditional buildings with straight walls and 90-degree angles the additional constraints needed for the reverse projection of the drawing in 3D space are basically already imposed, thus, the core of the problem boils down to the identification of the position of the viewpoint with regards to the picture plane.

According to the well-known perspective rules the viewpoint belongs to the line known as the line of vision/sight or principal axis, which is perpendicular to the picture plane. The intersection point between this line and the picture plane is the same point where all the projections of all the lines perpendicular to the picture plane converge, known as the principal vanishing point or simply vanishing point. Therefore, to find the viewpoint starting only from a drawn perspective we first need to find the principal vanishing point.

To extrapolate the principal vanishing point from central perspectives such as the one used in the Adoration of the Magi, it is straightforward since the projected lines that, are perpendicular to the picture plane, automatically manifest their vanishing point by extending them up to their intersection. In paintings with relevant deformation, or inaccuracies by the author, this procedure sometimes does not return a univocal intersection point, so the result needs to be adjusted or averaged. That is not the case for the Adoration of the Magi, because Leonardo was very precise while tracing those lines, and about the deformation of the wooden support, even if they are not negligible for restorers and conservators (Palma, et al., 2019; Guidi, et al., 2004), they are not particularly relevant for the scope of our research



**Fig. 5:** Use of the golden ratio for the placement of the vanishing points in the Uffizi's drawing and Painting

due to the scale of the drawing in relation to the magnitude of the deformation. Furthermore, we can cross-check the result with the hole of the little nail used by Leonardo to trace the vanishing lines, which is clearly visible in the IR reflectography, and as expected all the edges that extend along the vanishing lines converge almost always exactly to that point.

Before moving on to the next step of the process, which is the extrapolation of the distance of the viewpoint, it is worth mentioning the peculiar placement of the vanishing point. It is slightly offset on the right of the painting's vertical axis and exactly placed on the golden ratio of the width of the painting. As Frosinini et al. report, this point is located on the horizon line and it is placed on the golden ratio with regard to the width of the painting (Frosinini et al., 2017).

The same placement was also observed in Uffizi's preparatory drawing as shown in Fig. 5 (Bellucci, 2017, pp. 73).

This observation is surely a clue in favour of the theory that Leonardo might have used the same construction for both drawings, however, even if the vanishing points are placed in the same spot with regard to the drawing's widths the positioning of the building with stairs on the painting is slightly offset to the right compared to its position on the Uffizi's drawing.

Even if in the painting the construction grid on the ground plane is not as clearly traced and visible as in Uffizi's drawing, we can see in the lesser-painted areas of the reflectography some of the vanishing and receding lines that he used to draw

the building in ruins. This aspect alone would probably be sufficient, for someone, to prove that he didn't transfer the drawing from cardboard, but rather rebuilt the entire perspective layout from scratches.

There is another interesting parallelism worth further investigation between the viewpoints used in the painting and in one of the preparatory drawings. In this case, the preparatory drawing of reference is the one housed at Louvre and the comparison concerns the facts that in both the drawing and the painting he might have used multiple viewpoints to construct different parts of the same scene, for further details about the study that presents the probable use of multiple viewpoints in Louvre's drawing refer to (Apollonio, et al., 2021).

The graphical artefact of using multiple viewpoints to represent the same space was something often observed in paintings and drawings by artists from the past. When this graphical licence was used after the diffusion and consolidation of Brunelleschi's "legitimate method" (as Alberti named it later), we can almost certainly say that it was a conscious error. For example, some of the views by Canaletto, Bellotto, Marieschi, Guardi o Carlevarijs, made use of this licence for artistic reasons (Giordano, 2014; Trevisan, 1999). However, in the case of Leonardo's drawings, we can not say for sure if he was conscious of his error or not, since the method was at its earliest age.

García-Salgado (2020), in his study of the Adoration of the Magi, proposes a solution where

the Virgin with the infant Jesus and all the other characters in the foreground are placed in a ditch under the ground plane and can exist in the same 3D space with the architecture in the background. This hypothesis is undoubtedly prospectively accurate, however, it is hard to verify if this was Leonardo's constructive process since the scene in the foreground does not have any grid or any other straight line that could be used to anchor it.

On the contrary, if we impose to keep both the background and foreground scenes on the same ground plane we would necessarily have to impose two different viewpoints, one for the background scene and one for the characters in the foreground, thus the two scenes could not coexist in the same 3D Euclidean configuration space analogously to what Leonardo did in his studies housed at Louvre's

In our opinion, this last conjecture is the most probable because Leonardo was not very concerned about using different viewpoints in the same scene as we have shown in the study about the Louvre's preparatory drawing, where he used up to three different vanishing points in the same scene (Apollonio et al., 2021). So, since he already committed the same formal inaccuracy but still managed to make a balanced scene, he might have applied the same rule in the final painting. Furthermore, drawing rigorously such a complex scene with multiple ground planes sounds unreasonably complex for the use that this painting would have had.

### *3.2 Imposition of the viewpoint distance*

We observed that in the painting we might have multiple viewpoints, however since our focus is the building in the background we will work on its viewpoint only. The focus of our study is only the building because, as we saw, it is the only element that is present and precisely drawn both in Uffizi's preparatory drawing and the final painting, so focusing the study on this element only would help us draw more accurate conclusions.

As said, there is a clear and coherent vanishing point used by Leonardo to draw the building, so to find the position of its relative viewpoint in space and reverse-project the 2D drawing back into the 3D space we need to find the distance of the viewpoint from the picture plane. For comparison's sake, which we will carry on in a later section, we impose to have the picture plane passing through the vertical wall of the closer

flight of stairs, this choice might look odd now because some of the elements of the scene would now be in front of the picture plane, however, we are not trying to imply that Leonardo placed the picture plane in that position, we are only trying to compare what he did in the Uffizi's drawing and in the painting, thus placing the picture plane like this would simplify the construction and the later comparison.

From here we now only need to find a line that lies on the ground plane that is angled at 45 degrees with respect to the picture plane.

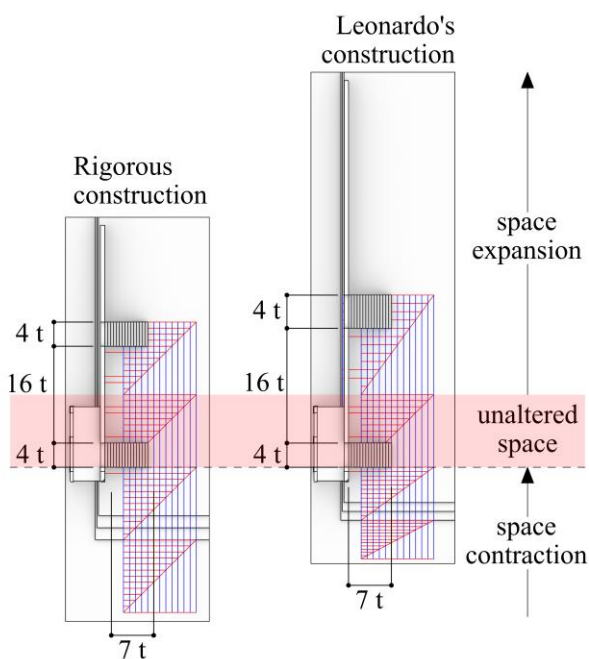
To find the viewpoint distances in the preparatory drawings we followed the rule of the 45 degrees line in both previous studies (Apollonio & Gaiani, 2020; Apollonio et al., 2021). In Uffizi's drawing the entirety of the construction grid is clearly visible so it is easy to find the 45 degrees line of reference. However, it is now known that the construction used by Leonardo was not theoretically accurate and the lines, that he drew, that should be 45 degrees in 3D space are actually not parallel to each other in 3D space, but are parallel in the drawing, thus only one can be the 45 degrees line of reference and the grid traced in correspondence of the other angled lines would be stretched and not made by squares. In the previous study, the 45 degrees line that was imposed to be the accurate one was the one which started from the bottom left corner of the frame which was imposed to be the picture plane, thus the space expanded the farther it went from the picture plane in the direction of the line of sight (both the grid and the structure with stairs expand together with the space following the same rule). If we would have chosen a different picture plane and a different reference 45 degrees line the space would have shrunk on one side of the plane and extended on the other.

On the contrary, in the Louvre's drawing, there was no construction grid that we could have used, so we imposed the arcs on the wall perpendicular to the picture plane to be circular arcs, this allowed us to find a square and its diagonal on the ground plane that we used as references to find the 45 degrees line and thus the distance of the viewpoint from the picture plane.

The painting is in a hybrid situation, in fact, there are portions of the grid still visible on the ground plane close to the flights of stairs, so somewhere lost under layers of paint next to those spots there might have been once the trace of a 45 degrees line that Leonardo might have used as

starting point to draw the receding lines, but no evidence of that line was found, for that someone even conjectured that Leonardo might have even drawn them by eye (Bellucci, 2017, pp. 73).

So we cannot use a line directly drawn by Leonardo, and on the contrary, all the arcs on the wall perpendicular to the picture plane are very skewed and by using them as the only constraint the parallax error would be not negligible. Thus since we cannot use either the circular arc method or rely on a 45 degrees line directly drawn by Leonardo we have to find a new constraint. The question that we are trying to answer is if Leonardo could have used or not, in the painting, the same inaccurate but rigorous perspective rule that he applied to Uffizi's drawing. Thus, to put to test this theory, we assume that Leonardo used the same reference plan for both the preparatory drawing and the painting. There are three pieces of evidence in favour of this theory, the first is that the number of arcs and the overall configuration of the building are basically the same, (except for some minor details such as the pillars on the left are thinner, the size of the arc under the stairs is bigger, and the parapet of the balcony is shorter, but none of these details changes the overall configuration of the plan).

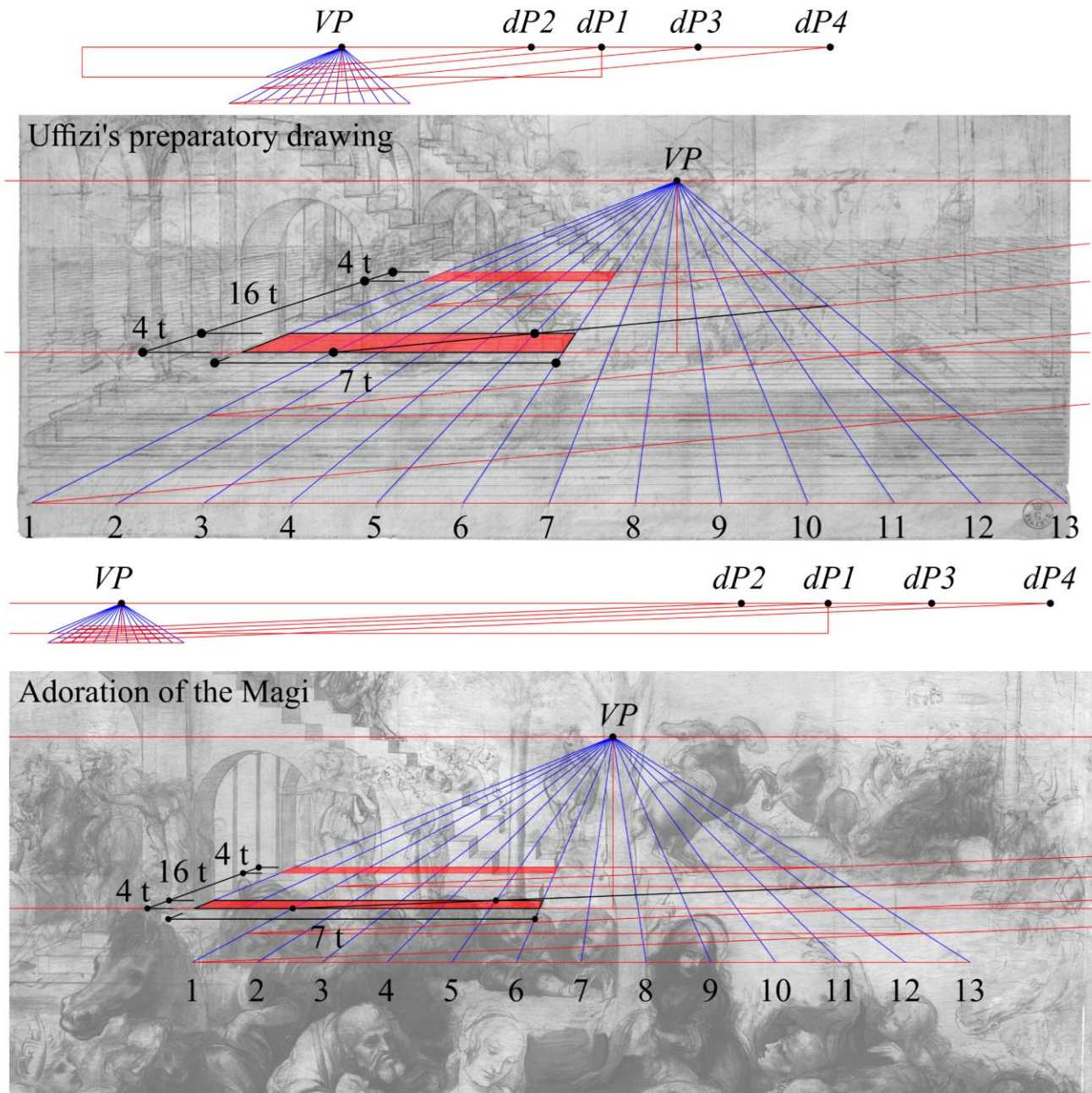


**Fig. 6:** Uffizi's top view of the building with stairs. On the left is the rigorous plan that Leonardo might have used as starting reference, and on the right is the actual plan that Leonardo inaccurately drew according to his inexact perspective construction. For this construction, the picture plane was placed on the dashed line.

The second piece of evidence is that the receding lines under the stairs, which are barely visible in the reflectography of the painting, seem to divide each flight of stairs into the same number of modules used in Uffizi's drawing (four for each flight of stairs). Lastly, the stairs have the same number of steps. Our reconstruction of the plan that Leonardo might have used as starting reference for Uffizi's preparatory drawing is shown in Fig. 6. In the same figure, you can also see the plan that Leonardo's inaccurate perspective construction represents. There are innumerable possible versions of that plan according to where the picture plane is set, but in any of these variants, the space drawn by Leonardo gets stretched or compressed along the line of sight.

Given the assumption that the building in ruins might have the same plan, we imposed the ground connection of the closer flight of stairs to be divided into the same number of grid modules used in Uffizi's drawing, 7 x 4 square tiles, considering as left boundary the arc wall, as right boundary the first step, and as top and bottom boundaries the width of the stairs. So we marked the ground connection of the closer flight of stairs of the painting, by tracing Leonardo's strokes, after that, we divided the resultant skewed rectangle with a grid of 4x7 tiles, and then we identified a projection of the first 45 degrees line passing through the intersections of the grid following the exact references of Uffizi's drawing (refer to Fig. 7 to visualize the first 45 degrees line, represented in black and the two reference points used to trace it). Then we added, along one of the receding lines, 7 more grid modules on the right and we numbered only 13 of them (starting from the third mark from the left) to visualize the same layout of the grid observed in Uffizi's drawing. After that we drew the rest of the receding lines according to Leonardo's inaccurate rule, namely, we traced the projection of the remaining 45 degrees lines by drawing them parallel to each other rather than making them converge to their accurate vanishing point.

At this point, we obtained a 12x48 grid that we use to place the second flight of stairs, the pillars and the arcs. To place some of the elements that lie outside this 12x48 grid we extended it where needed as in Uffizi's drawing. In Fig. 7 you can see Leonardo's construction of Uffizi's drawing on the left, compared with the reproduction of the same construction on the Adoration of the Magi painting conjectured by us on the right. What's immediately



**Fig. 7:** Comparison between Uffizi's preparatory drawing (top) and Adoration of the Magi (bottom). The grid on the Uffizi's drawing was marked by tracing Leonardo's strokes, the grid on the Magi drawing was conjectured following the same principle applied on the Uffizi's drawing. The construction seems to perfectly fit the painting too. ("t" in the pictures stands for "tiles")

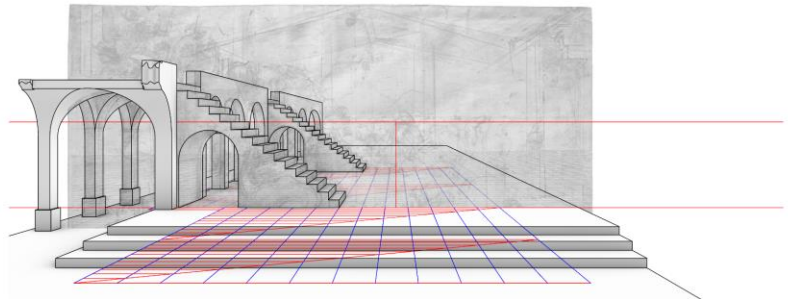
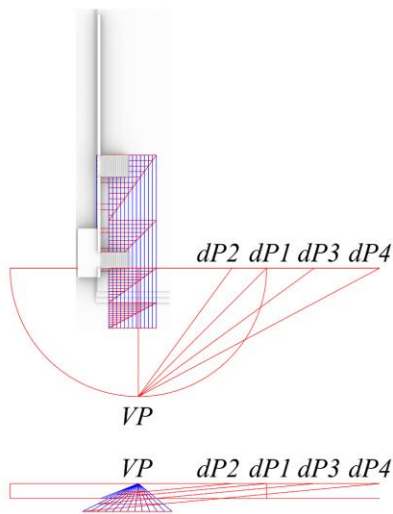
observable is that, in the painting, the ground connection highlighted in red of the farther flight of stairs, which was obtained by construction and not by marking Leonardo's strokes, is perfectly aligned with the actual strokes drawn by Leonardo, this means that the Uffizi's construction is perfectly compatible with the painting as well.

### 3.3 Construction of the 3D model

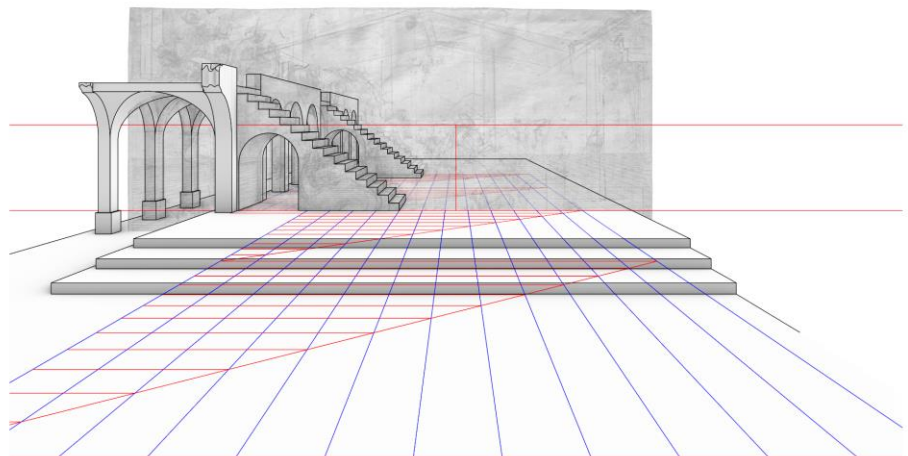
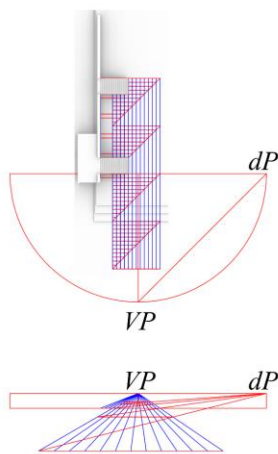
Even if the reconstruction of the ground connection would suffice to draw some conclusions, in order to validate even further our conjecture and to see what was the amount of error that Leonardo might have committed, we proceeded to build the 3D model from the drawing.



### Uffizi's preparatory drawing construction drawn by Leonardo



### Uffizi's preparatory drawing Rigorous perspective construction

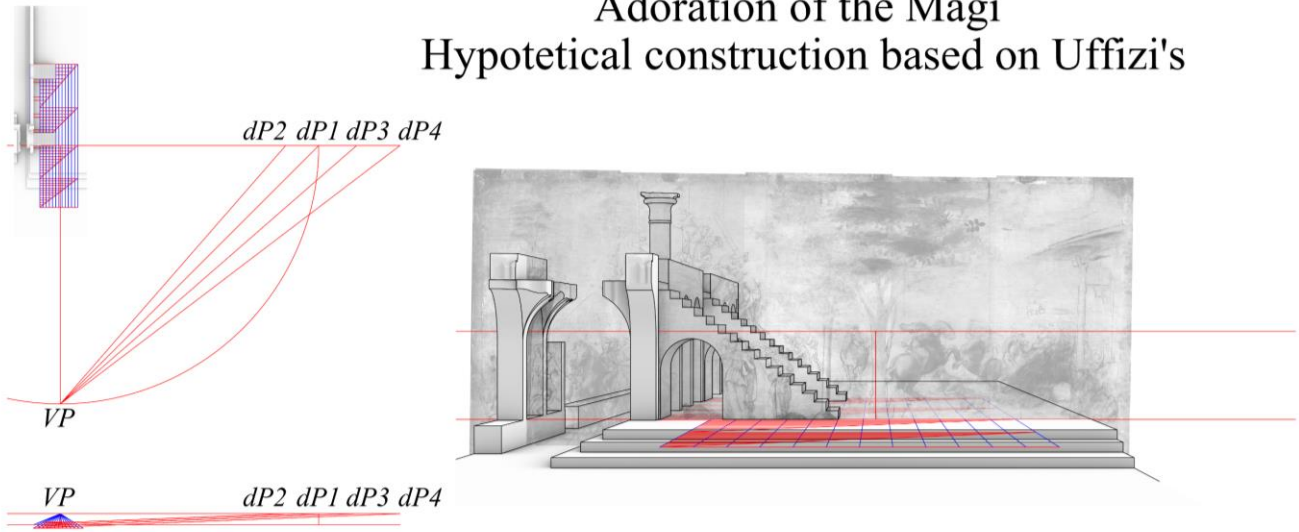


**Fig. 8:** 3D models built based on Uffizi's preparatory drawing. On the top the model obtained by reverse projecting the strokes drawn by Leonardo. On the bottom the conjectured 3D model as if it was drawn with correct perspective rules.

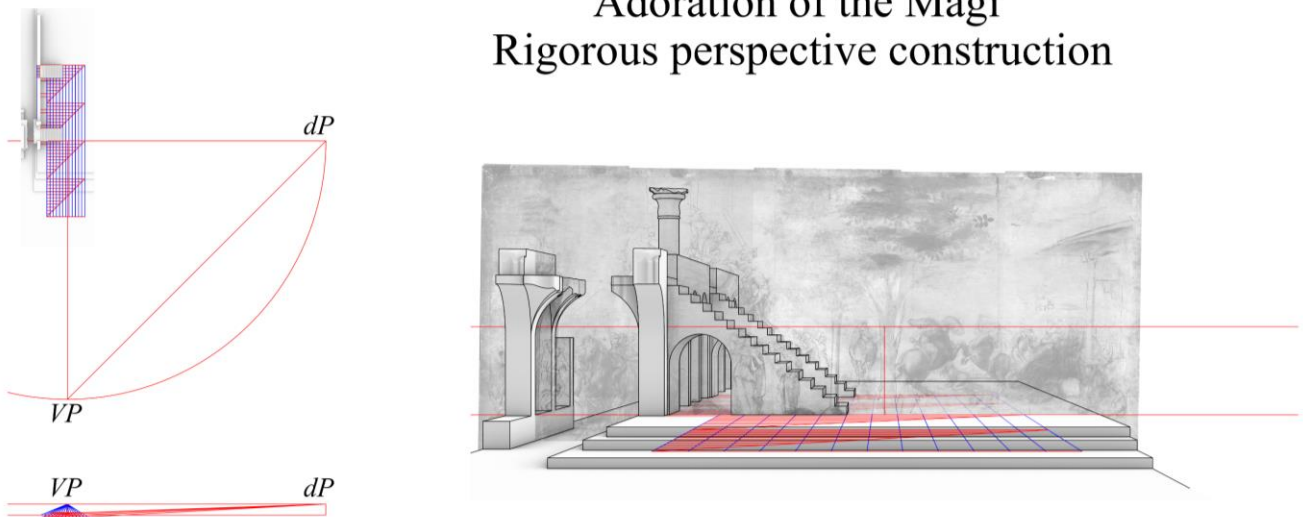
So, we first completed the 2D projection of the building in ruins by anchoring its ground corners at the grid that we have drawn in the last step and by setting its height by comparison with the painting. Even if we based the placement of the ground connection points following the grid obtained by construction, this procedure returned a surprisingly accurate result that could be almost 100% overlapped with Leonardo's painting. At this point, to add the third dimension, we rotated the draw and all the relative constructions vertically along the XZ plane and we placed the viewpoint in 3D space sliding the vanishing point

along the Y axis and we moved it to the distance calculated in the previous section. The reverse projection from one single image, as we know, requires additional constraints, thus we reverse-projected the grid on the ground plane first (receding lines and vanishing lines) so that we could have used it as a reference to constrain all the other points in space. In fact, after that, we were able to reverse-project the rest of the wireframe of the 2D drawing into the 3D space by sliding each end of each segment along its relative view line passing through the viewpoint and constraining its sliding by alignment with the

### Adoration of the Magi Hypotetical construction based on Uffizi's



### Adoration of the Magi Rigorous perspective construction



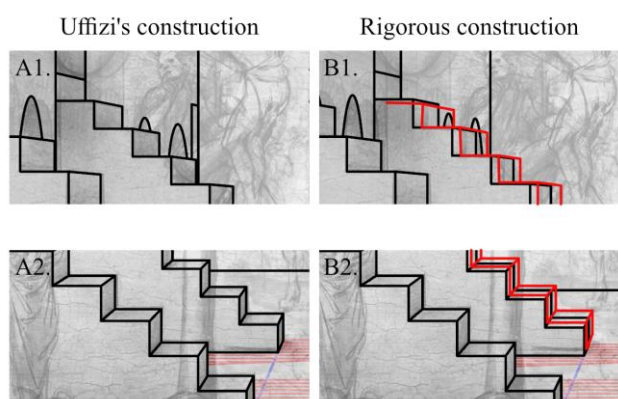
**Fig. 9:** 3D models built based on the Adoration of the Magi's painting. On the top, the conjectured model based on Uffizi's construction. On the bottom, the conjectured model as if it was drawn with accurate perspective rules.

reverse-projected grid. After obtaining the 3D wireframe of the building in ruins the process to build the relative surfaces was straightforward. By placing the camera in the exact coordinates of the viewpoint we can observe an almost perfect match between the 3D model and the painting, only minor misalignments are observable in the arcs in ruin on the left, since they were drawn by Leonardo himself less rigorously. At this point, the question that comes spontaneously is: how is it possible that both our conjecture and

García-Salgado's give accurate results with Leonardo's drawing? The answer is pretty trivial, and it is because the viewpoint for the Adoration of the Magi is much farther from the building in ruin compared to what Leonardo did in Uffizi's preparatory drawing. This makes the building very squashed and skewed, thus the error that Leonardo's inaccurate method adds to the rigorous Albertian construction shrinks down to almost nothing. This happens because the 45 degrees projected lines even with the Albertian

construction are almost parallel since their vanishing point is very far. So, the approximation carried out by Uffizi's method applied to the Magi painting becomes almost negligible.

We can observe this principle by comparing Fig. 8 and Fig. 9: Fig. 8 compares Leonardo's inaccurate construction and the rigorous one, constructed on Uffizi's preparatory drawing, and it is immediately evident how much difference there is between the two versions; Fig. 9 represents the same comparison but this time built on the Adoration of the Magi painting, in this case, the difference is very hard to see unless we take a closer look as shown in Fig. 10. As you can see the inaccurate Uffizi's construction (on the left) perfectly matches the painting strokes, while the rigorous construction (on the right, marked in black) is slightly offset with respects of the strokes drawn by Leonardo (marked in red). Nevertheless, if you look at the 3D model from the side, the deformation of the arcs farther from the picture plane is much more visible, as shown in Fig. 11.

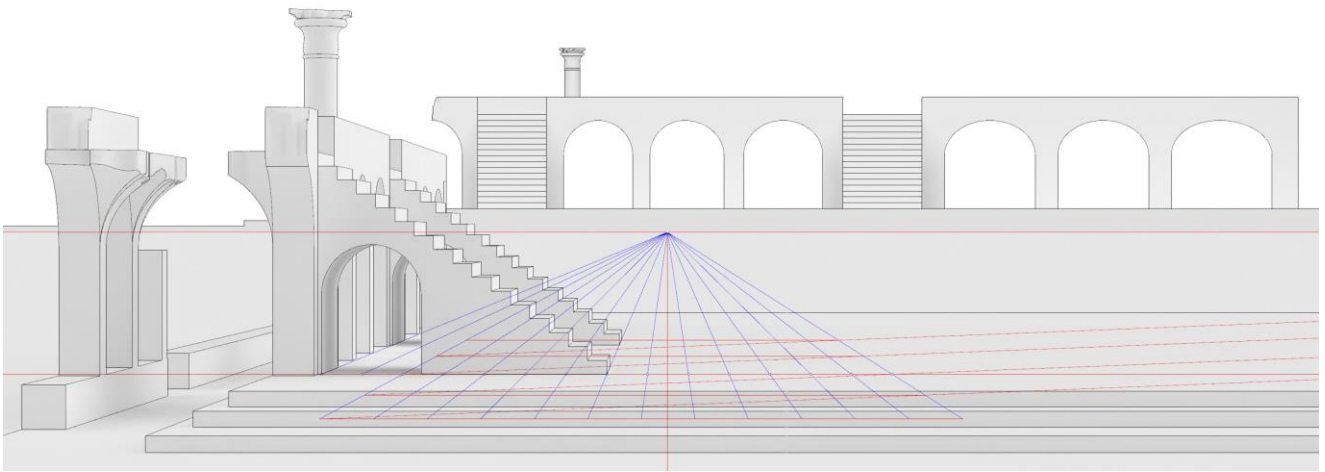


**Fig. 10:** On the left, Adoration of Magi's reflectography perfectly overlaps with the construction based on Uffizi's sketch. On the right, the rigorous construction, based on Alberti's rule, is slightly offset compared to Leonardo's draw (in red). Details extracted from Fig. 9.

#### 4. Conclusions

The contribution shows how the inaccurate construction used by Leonardo in Uffizi's drawing is compatible with the painting. However, it is also true that, with minor adjustments, the rigorous perspective construction would also give acceptable results. The amount of error of one method or the other could easily fit inside the thickness of Leonardo's strokes, thus both theories are plausible, and hence it is impossible to prove unequivocally the definitive correctness of either one of the two theories. Nevertheless, these

studies and results seem to be more in favour of Leonardo using the same construction that he used for Uffizi's drawing. In fact, it is plausible to believe that the Artist would have preferred to use the same method that he adopted in the preparatory drawing that he specifically prepared to anticipate what he would have drawn in the painting. Furthermore, the plans and elevations of the buildings with stairs in both the preparatory drawing and the painting quite perfectly fit in the same grid. Some scholars conjectured that there might be a lost preparatory drawing chronologically placed between Uffizi's drawing and the painting that he might have used to apply one of the tracing techniques from cardboard to wood that would not require redrawing the perspective grid from scratch. However, even if one cannot say for sure if Uffizi's drawing was the last one or not, we can certainly say that the construction lines used to guide the perspective construction, namely the receding lines and the vanishing lines, are still very well observable from the reflectography, thus it would have been redundant to draw those line if he wouldn't have used them and rather transferred the draw directly on the final medium. Nevertheless, it is also true that Leonardo changed the point of view, so there is not an exact match between the two representations, so a lost sketch might still be possible, however, even if he was in his thirties, he was already a trained draftsman so he was perfectly capable to redraw the perspective layout from scratch without needing to test the new configuration with an additional sketch. The differences observed between the last known preparatory drawing and the painting might have been added for composition requirements, maybe to free some space to add the crowd embracing the Virgin and the Infant; or it might also be possible that his keen eye noticed that his inaccurate construction generated less visible errors when the viewpoint was farther away, and since he might have wanted to use it for practical reasons, despite the inaccuracy, he might have decided to move the viewpoint to hide more the inaccuracy. It could also be possible that Uffizi's drawing itself was a way to put to test the unpopular perspective construction because he knew that he would have rebuilt it on a bigger scale and it would have been impossible to converge the 45 degrees lines to a univocal vanishing point since it would have been several meters outside the wooden board.



**Fig. 11:** 3D models built based on the Adoration of the Magi's painting realized following the same construction used by Leonardo in Uffizi's drawing. Composition of the perspective view and the orthogonal view of the lateral façade. The arcs are more and more wide and elliptical the farther they are from the picture plane.

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