

## **Leonardo da Vinci incorporated his *Val di Chiana* map in his *Mona Lisa* painting**

“All our knowledge has its origins in our perceptions.”-Leonardo da Vinci.

### **Abstract**

Leonardo arranged the landscape in the *Mona Lisa* to hold two disjointed halves of one image. That image can be reassembled by juxtaposing two copies of the painting side-by-side. The newly reconstituted landscape corresponds to an actual place as depicted in Leonardo's *Val di Chiana* map. The identity of the sitter and opinions relevant to the background landscape will be considered. Leonardo's developments in the depiction of depth will be outlined. His technique of topographic perspective will be introduced. Analysis of these observations, along with Leonardo's investigations in perception, perspective, monocular and binocular vision, and cartography, will lead to understanding of his technique. Speculation as to Leonardo's motivation will include a pun on *La Gioconda* and his attempt at stereoscopy.

### **Introduction**

The *Mona Lisa* painting is traditionally viewed as mysterious. (See figure 1.) The enigmatic smile is emblematic of the notion that she and Leonardo are hiding secrets from the viewer. Efforts at solving this mystery or puzzle have largely focused on the sitter but perspective, as displayed in this work, will be shown to prove the answer to this puzzle.

Much effort on solving the puzzle has focused on the identity of the sitter, who is generally accepted as Madonna Lisa Gherardini, wife of a Florentine merchant, Francesco del Giocondo (hence *Mona Lisa* or *La Gioconda*). (Greenstein, 2004, 17-38) Many alternate candidates as the subject, have been, and are still being proposed, (Zaperi, 2010, 40) including a self-portrait as a woman. (Schwartz, 1988, 40-48) The traditional view as above, from Vasari, (2008, 294) is well supported by Zöllner, (1993, 115-138) and bolstered with recently discovered contemporaneous documentation dated October 1503. A handwritten note by Agostino Vespucci, a figure acquainted with

Leonardo, stated that he was working on three paintings, including a portrait of Lisa del Giocondo. (Dorfman, 2008, 39)



Figure1. Leonardo da Vinci: *Mona Lisa / La Gioconda*, from 1503, Oil on poplar panel, 79.4 x 53.4 cm, Louvre, Paris, Photo Credit: Réunion des Musées Nationaux / Art Resource, NY

In his thorough review of the evidence that Lisa Gherardini is, or is not, the subject of the painting, Greenstein questions whether or not the identity of the sitter matters, (2004, 32) as will be shown. The term *gioconda*, could be translated from Italian as “playful or jocular lady”. Thus we can rephrase Greenstein’s conclusion as: whether *La Gaconda* is, or is not, Mona Lisa, she remains a *gioconda*. So the exercise of identifying the sitter leads back to the conclusion that the painting is a *gioconda*, i.e., a jocular prank or puzzle.

The mystery has also been approached from the concept of the landscape as allegory. This has been thoroughly discussed by Webster Smith in “Observations on the Mona Lisa Landscape.” (1985, 183-199) He summarizes the views that the Mona Lisa landscape reflects the analogy that Leonardo drew, figuratively and literally, between the body of humans and the earth as a body. The article includes opinions such as that of Kenneth D. Keele; “*Mona Lisa* represents Leonardo’s concept of the formulation of the earth and the analogy so vital to him of the macrocosm of the world and the microcosm of man,” (Smith, 1985, 183) and Martin Kemp’s on the landscape as “a meditation on the human and terrestrial bodies.” (Smith, 1985, 184) This exploration, of the landscape as metaphor, does not help to solve the puzzle but does add to the painting’s mystique. However Smith does contribute some key observations:

[T]he surfaces of the upland lakes, both to the right and to the left, appear slanted or curved rather than horizontal, as though to indicate the curvature of the earth or, rather, ‘the sphere of water,’ and thus that the landscape represents not a mere view but the globe, ‘the body of the earth’ itself. It does appear that Leonardo introduced this effect of curvature on the basis of a concept rather than empirical observation (how comparable expanses of actual water would really look in the distance as seen from Mona Lisa's balcony) ...

Two sheets of water, one to the upper right, not far below the eye level of the figure, and the other, merely glimpsed, on the same level to the left, might be understood as parts of one enormous lake, and, seen together, these two indications of water describe a curvature, a bowed effect, across the panel.

Additional, concentric curves are suggested by the tongues of shoreline on the lower lake to the left and the streaks of light on its surface. 'The globe of our world,' Leonardo says in MS A (fol. 58v) '... is composed of water and earth, having the shape of a sphere,' although it is not perfectly round 'excepting in the places where the sea is, or marshes or other still waters.' In the Codex Hammer (fol. 34v) he specifies that the surface of any large and still body of water is everywhere equidistant from the center of the earth, even 'lakes placed at the tops of high mountains' and 'those that give rise to great rivers.' His diagrams of the world, in MS A and the Codex Arundel and also MS L, show schematically something like the Mona Lisa landscape as though in the full round: the entire globe, 'composed of water and earth,' the water surfaces all spherical, the earth here protruding above, there submerged beneath, the watery sphere. (Smith, 1985, 190)

The above does reiterate Leonardo's cosmological view being demonstrated in the painting, but it also illustrates the vast scale and depth portrayed in the landscape. The scale is "global". The distances portrayed require the inclusion of the curvature of the earth. This highlights the unusual perspective demonstrated by Leonardo.

### *Reconstituted Landscape*

At first glance, the painting seems to be a simple portrait of a lady at a balcony; we see the subject sitting in a loggia with a view behind her. (See figure 1.) But as we study the work, it becomes obvious that the perspective of the painting is most unusual. The perspective of the sitter is shown as viewed from eye level; she is gazing directly at the viewer. While the perspective of the landscape is that of an aerial view; the vantage point is at, or above, the highest peaks, looking out onto a vast territory. The enormous depth of this territory continues to a vaguely defined horizon – so distant that, as mentioned, the curvature of the earth is appreciable. A large section of the cosmos is revealed. Furthermore, we see that the horizon on one side does not match the horizon on the other side. To reconcile this mismatch we can consider two copies of the paintings viewed in tandem with a slight gap between them. (See figure 3a&b.) The

juxtaposed images allows the waters, referred to above as “two sheets of water, one to the upper right, not far below the eye level of the figure, and the other, merely glimpsed, on the same level to the left, [to] be understood as parts of one enormous lake”. With the surface of this reconstituted lake aligned, we can see that the horizon is thereby aligned as is the edge of the balcony. The painting has been purposely created in a way that the view of the balcony and the landscape on one edge continues on the other. (Bair, 2007, 173-177)

Compared to the old landscape, with its ambiguous sense of flow of its waterways and roadways, or waterways that resemble roadways, the new landscape shows a logical depiction of terrain. The newly reconciled landscape shows a distant mountain lake and a closer lake that flows into a meandering stream that joins a wider stream. That wider stream is crossed by a bridge that leads to a road which proceeds over a plain to a gap in a ridge of hills. The old landscape remains confusing; the new landscape could resemble an actual place.

Drs Carlo Starnazzi and Carlo Pedretti have identified features in the Mona Lisa landscape, as matching those in Leonardo’s *Val di Chiana* map. The bridge, behind the subject’s left shoulder in the painting, matches the medieval bridge, Ponte Buriano, and the lake behind her right shoulder matches Lake Chiana. (Owen, 2003) But that is not how they should appear, relative to each other. The reconstituted landscape would place these features, and others, in their proper relative positions. This new landscape does, in fact, resemble an actual place. It represents an aerial view over the Tuscan valley region of the Val di Chiana, seen from above Castiglion Fibocchi in the Pratomagno hills, looking in a south-south-easterly direction, towards Castiglione del Lago, on lake Trasimeno. A review of the reconstituted landscape allows one to match the painting to the area. That area is depicted in Leonardo’s *Val di Chiana* map.

### *Hypothesis*

These observations yield the key hypothesis of this article; that Leonardo incorporated the Val di Chiana, as depicted in his map, in the Mona Lisa landscape. To arrive at this

hypothesis it was necessary to reconstitute that landscape as described above. To further develop the hypothesis, the *Val di Chiana* map will be examined and a point-to-point correspondence of the map to the landscape will be reviewed. Aspects of Leonardo's landscapes will be compared to his maps. His techniques in creating landscapes and maps will feature their resulting similar characteristics. Further support for the hypothesis and implications for accepting it will follow.

### **Observations**

The *Val di Chiana* map (see figure 2.) is a topographic map, created by Leonardo, which shows the Chiana flowing from right to left into the Arno. At the top right is Lake Trasimeno with Castiglione del Lago then Perugia beyond them. Siena is at the bottom middle and Arezzo is in the top left. The bridge, Ponte Buriano, can be seen as it crosses the Arno upriver from the confluence with the Chiana. This map corresponds well with present-day maps with some distortions, especially with the course of the Tiber River. But the most obvious difference, from then to now, would be the Chiana itself. Leonardo's map features, what was then, a wide dove-shaped lake which has now been reduced to a narrow drainage canal. A road, which would correspond to a spur of the Roman road, Via Cassia, is shown in part, as it runs from the Arezzo plain, through the gap in the ridge of hills then along the base of the foothills below Cortina to Lake Trasimeno.

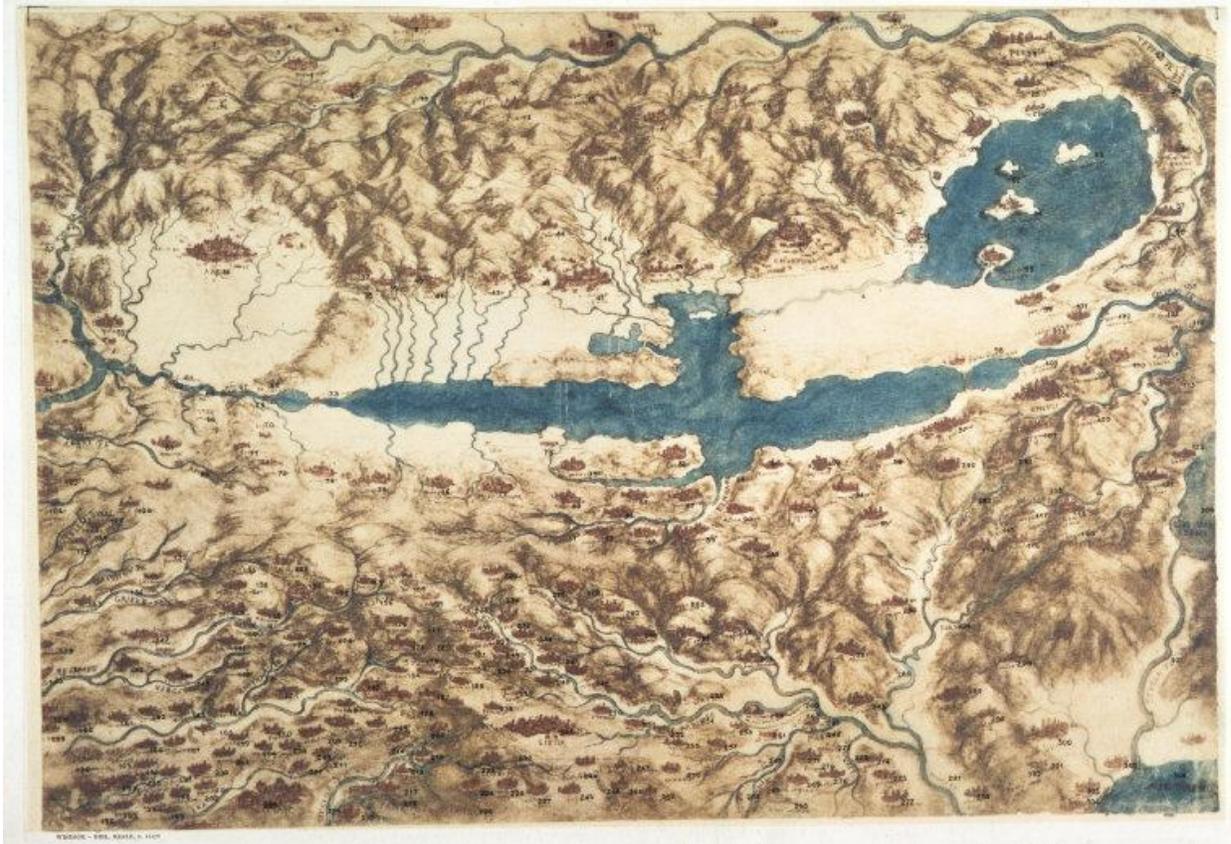
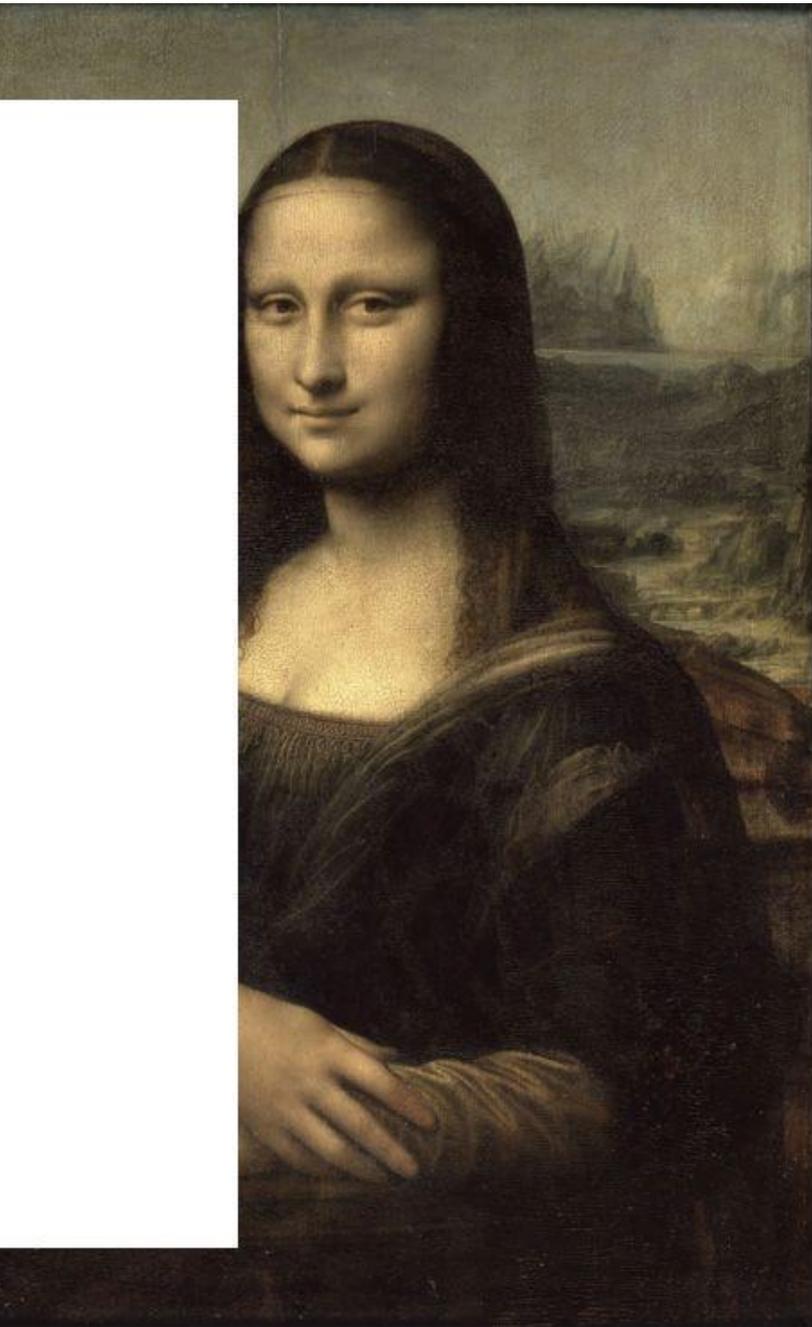


Figure 2. Leonardo da Vinci: *Val di Chiana*, (RL12278) 1502-3, 33.8 x 48.8 cm, pen and ink, watercolour, bodycolour and chalk on paper, The Royal Collection, Windsor, Photo Credit: Scala / Art Resource, NY

One can take Leonardo's *Val di Chiana* map, and consider a line from Castiglione del Lago to Castiglione Fibocchi (just off the left-hand edge of the map). Let us call this line, *ligna castigliona*. If one then rotates the map counter clockwise until the *ligna castigliona* is vertical, the line would correspond to the seam in the reconstituted Mona Lisa landscape. The reconstituted landscape, compared to the repositioned map, shows obvious correspondence. (See figure 4.)



Figures; 3a



3b.



4.

3a and 3b show the reconstituted landscape of the Mona Lisa. Compare the features along the seam of the juxtaposed halves with those along the line on the Val di Chiana map (fig 4.) This demonstrates the painting as a puzzle and reveals the solution.

A review of the reconstituted landscape allows one to match the painting to the map. It may also provide insight as to how the master created the work. As one follows the seam joining the two halves i.e., the *ligna castigliona*, from bottom to top, the landmarks correspond to the following sequence:

--from a point above Castiglion Fibocchi we see a slope of the Pratomagno (on the lower left), followed by

--the confluence of the Arno with Ponte Buriano (left) and the Chiana River (right) separated by the high ground between them, then

--a road meandering passed Arezzo (behind the subject) to a gap in a ridge of hills (left), then

--a ridge of hills (right), with the wide Chiana beyond them. Siena would be to the right (behind the subject), then

--the hills around Cortona leading up to Lake Trasimeno with the spit of land holding Castiglione del Lago (just to the left) and finally,

--the distant mountains to the horizon.

These features are linked together by a road. We can see its path from the Buriano bridge, veering through the plain towards Arezzo then through the gap in the ridge of hills where it would merge with the *ligna castigliona*. That would correspond to the route of the Via Setteponti – a section of the Via Cassia, mentioned previously, which joined Etruscan territory to Rome, through the Val di Chiana. Via Setteponti still runs through the Pratomagno, Castiglion Fibocchi and Ponte Buriano to Arezzo. (Repetti 1833, 375,607 & 723) There it is called the Via Cassia, which proceeds past Cortina through the Val di Chiana – a route Leonardo would have used. (See figure 5.)

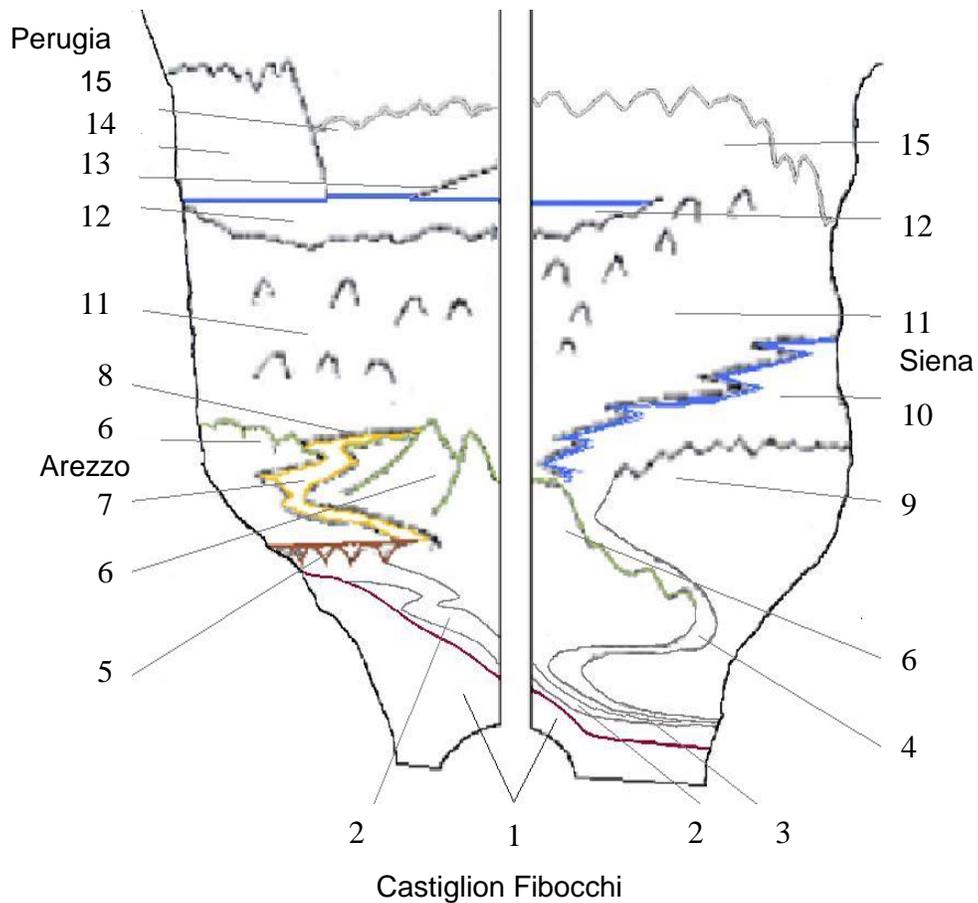


Figure 5. Schematic drawing outlining the features that correspond between the reconstituted landscape and the repositioned map:  
 1. Pratomagno. 2. Arno. 3. River confluence. 4. Chiana stream. 5. Ponte Buriano. 6. ridge of hills. 7. Setteponti road. 8. road in gap of ridge. 9. hills near Siena. 10. Chiana lake. 11. Cortona hills. 12. Trasimeno lake. 13. Castiglione del Lago. 14. island in Trasimeno. 15. mountains beyond lake.

These observations allow us to compare Leonardo's technique of creating depth in a landscape with his method of creating a topographic map. As described in his *Notebooks*, (da Vinci, 2005, 95) features closest to the viewer are treated with full color and lighting. Beyond that, the bands of terrain are treated to ever more muted color and diffused lighting until the distant lakes and mountains are depicted in a color-drained haze. This is the case in the *Mona Lisa*. If we review the work, we can start at the bottom with the proximal features such as the Pratomagno slope. It gets treated with the same full color and light, as the subject; in fact, the shoulder of the hill resembles the shoulder of the sitter. The band of features including the confluence of the Arno and Chiana with the bridge and high-ground, get less color and light. Likewise the bands of ridges, then Lake Chiana, then the Cortona hills, are each sequentially less saturated in color and light. Finally distant Lake Trasimeno and its surrounding mountains are washed of color and light. Bruno Mottin, in *Mona Lisa; Inside the Painting*, stated that "[t]his skilful use of aerial perspective, in which the depth of field is rendered by a gradation of colors, prevents us from noticing that the landscape in the *Mona Lisa* does not obey the rules of traditional perspective, but is rendered in a manner suggesting a relief map,..." (Menu, Mohen and Mottin, 2006, 66)

A topographic map is similarly assembled as bands of terrain sequenced one behind the other. The effect is like reading the tabs of a file cabinet. Thus Leonardo could recall a series of observations to create aerial maps or to create landscapes. However, the *Mona Lisa* landscape is not simply a bird's-eye view from one vantage point. There is no one point that an observer can view the slope of Pratomagno, the Buriano bridge and the surface of the distant elevated Lake Trasimeno. (Castiglion Fibocchi to Castiglione del Lago are separated by 50 km.) (Michelin map 563) The landscape should correspond to a birds-eye view, along the *ligna castigliona*, from a point above Castiglion Fibocchi, over the Arno, up the Chiana valley to Castiglione del Lago on Lake Trasimeno. If we try to recreate this on a program (such as Google Earth 3D), we see slight discrepancies. Firstly, it must be remembered that the now drained Chiana plain

was marshland back in the past. Secondly, the program tends to flatten height and slope, while Leonardo takes licence to enhance the hills and mountains. In particular, the high-ground separating the rivers at their confluence seems too high for a vantage point on or above the Pratomagno hills. It is depicted as it would appear to an observer at a lower elevation, closer to the banks. But from that vantage point an observer would be too low to see the surface of Lake Trasimeno. So a static view does not fit well.

If instead, we take a virtual fly-over, staying on the same heading as *ligna castigliona* as above, we would observe the sequence of vistas used to create the map. From above Castiglion Fibocchi we would see the slope of Pratomagno. We would then descend, as we flew towards the rivers, and the vista of the confluence with Ponte Buriano would appear. Likewise, as we continued in the same heading but at a higher elevation, the vista would match the distal sections of landscape on to Castiglione del Lago. In this manner we can appreciate the process that Leonardo used to compile these remembered vistas and reproduce them so faithfully. This treatment, which can be called topographic perspective, uses the cartographic technique of map making in depicting depth in landscapes.

## **Results**

The above has demonstrated the first objectives of this article, namely that;

- 1.) The *Mona Lisa* contains as background, a landscape image divided in two parts.
- 2.) The two parts can be reconciled into one image by aligning the two lateral edges, as outlined above.
- 3.) The reconstituted image depicts an actual place, namely the Val di Chiana as mapped by Leonardo, and
- 4.) That image consists of a sequence of vistas assembled in the form of a topographic map.

## **Discussion**

Support for these observations would include comparisons of the reconstituted image to photographic images obtained during an actual fly-over of the Val di Chiana. The original map and painting, along with early copies of the *Mona Lisa*, including uncropped versions, should be reviewed with consideration of the above. Further support would be the finding of any study sketches of the component vistas. Available support does exist in Leonardo's works in which the landscape is treated to topographic perspective. Examples of these, including the *Annunciation*, the *Madonna of the Yarnwinder* and the *Virgin and Child with St Anne and Lamb*, are discussed in the appendix. The discussion that follows will also bolster the hypothesis.

Descriptions of Leonardo's maps could well apply to his landscapes after 1500. Oberhummer, describing Leonardo's *Map of Tuscany*, reveals that the:

mountains, mostly crowned by towns, are drawn in perspective, with the light falling from the left (south). Rivers are indicated by double lines, towns and villages by vignettes. The second [*Val di Chiana*] map is similarly executed and embraces eastern Tuscany between Arezzo, Siena, and Perugia. The scale is about the same, but the orientation is to the east, and the light falls from the right (south). Besides the blue expanse of the lake Trasimeno with its three rather exaggerated islands, we notice in the Valle di Chiana a large and long sheet of water, no longer existing, which drains both to the Arno and the Tiber.

(Oberhummer, 1909, 546)

Both his maps and his landscapes feature topography that is drawn in perspective, with the vertical heights "exaggerated". There is a paucity or complete absence of vegetation or man-made features. Trees, towns and bridges are rare. When they do appear, they may be indicated as vignettes. Maps, by their nature, being projections of a curved surface of the Earth onto a plane, amend the laws of linear perspective. Distortions are required. Straight lines become curved and areas are expanded or contracted. The vertical axis can be flattened or enhanced. The scale, or point of view, of any vignette may not match its surroundings. These statements also apply to Leonardo's landscapes.

Oberhummer also offers his opinion on works that portray the above. Some of these are also referred to in the appendix:

His studies of Alpine scenery were not confined to the western Alps, as is shown by his geographical observations in the Adige basin and the artistic reproduction of mountain forms evidently taken from the Dolomites, and partly, perhaps, from the Karst. His preference for steep and rugged rocks and grottoes is seen in his treatment of the background of several of his most famous pictures. Among these are one of his greatest masterpieces, the portrait of *Mona Lisa* in the Louvre, and also the *Madonna of the Rocks* ("La Vierge aux Rochers"), which exists in two versions, one in the Louvre, the other in the National Gallery in London, of which the relationship has not been definitely explained; the *Madonna [and Child] with St. Anna [and Lamb]* and [*Madonna*]with the scales ("La Vierge aux Balances") [now entitled *Madonna of the Yarnwinder*]. (Oberhummer, 1909, 560-561)

### *Implications*

These observations should rekindle the ongoing debate as to the nature of Leonardo's landscapes; whether they are reproductions of a specific place or a synthesis of various elements. (Kemp, 2004, 219) In the case of the *Mona Lisa*, along with the examples in the appendix, it has been demonstrated that the landscape is actually the synthesis of a series of vistas of a specific place. This can be restated using Leonardo's terminology. The landscape is not simply a work of *fantasia*, i.e. imagination. Rather, Leonardo would use *intelletto*, i.e. the faculties of intellect, to survey and memorize an area and then recall and assemble a sequence of vistas. His *intelletto*, combined with *fantasia*, would transform each vista from the observed vantage point, to an aerial view, thus imagining a flight over that area.

### *Perspective*

These findings, of the reconstituted landscape matching a specific location and documented as a map by Leonardo, provide a unique opportunity to study his

innovative approach to perspective. Leonardo's treatment of perspective will be reviewed. By the time he was studying in the school of Verrocchio, linear perspective had been codified by Filippo Brunelleschi and Leon Battista Alberti in *De picture* (1435), and available in Italian as *Della pittura* (1436). (Wright, 1984, 52-71) Leonardo demonstrated his mastery of this perspective in the Cartesian grid-like study and final work with the *Adoration of the Magi* (1481), (Pedretti, 2000, 34) which remained unfinished. In his *Notebooks*, he referred to linear perspective as "nothing else than the seeing of an object behind a sheet of glass, smooth and quite transparent, on the surface of which all the things may be marked that are behind this glass." (da Vinci, 2005, 92) Using the phrasing; "nothing else", makes this statement seem dismissive, but Leonardo may be implying that there is more to the creation of depth than simply linear perspective.

Leonardo proceeded to consider the effect that the air, between object and viewer, would have on the depiction of depth. What he termed atmospheric perspective was masterfully demonstrated in the *Madonna of the Rocks* (1483). (Pedretti, 2000, 36) Yet he reached beyond atmospheric, in considering the limitless portrayal of depth available in cartography for use in painting, i.e. topographic perspective. As stated, cartography allowed, even demanded from Leonardo, the manipulation of linear perspective. With topographic perspective, a series of vistas are treated to atmospheric perspective and sequenced, as demonstrated, to diminished color and light. Instead of linear perspective's vanishing point on a distinct horizon, Leonardo's landscapes recede to a suggested infinity. To this end, Luba Freedman holds that Leonardo's innovation of the "blurred" horizon has been used to the effect that "one should lose oneself in look in the *Mona Lisa*." (1997, 181-94)

### *Motivation*

The question of how Leonardo came to hide a map in a landscape should start with a review of what is known. The means has been demonstrated by exploring his technique. The opportunity was present, as the map was likely in his workshop when he worked on the painting. Before starting the *Mona Lisa* (1503), Leonardo had travelled

through, and extensively studied the Arno and Chiana valleys. He was employed as a military engineer by Cesare Borgia, the notorious son of then Pope, Alexander VI, while Borgia campaigned through Romagna, including the Val di Chiana. Leonardo was also involved with Niccolò Machiavelli in a failed scheme to divert the Arno River away from Pisa during its hostilities with Florence. (Masters, 1998, 88) Leonardo created maps of the region including the *Val di Chiana* map (ca. 1502-3), which is part of the Royal Collection of his manuscripts at Windsor (RL12278).

For the motive as to why Leonardo came to create the *Mona Lisa* as he did, we must look beyond his well known pursuits in the arts and his enquiries in the sciences, and consider his jocular nature. There is less scholarly material regarding this aspect of Leonardo but there is evidence for his fondness for puzzles, puns, (Feinburg, 2004, 38-41) rebuses, (Marinoni, 1954, 186) and transformations. (Capra, 2007, 267-70) A most satisfying explanation for a motive in creating the *Mona Lisa*, involves Leonardo's taste for trickery. Leonardo is known to have been involved in entertainment and spectacles. For example, he apparently employed the intestines of a bullock which could fit into a small space. By means of a bellows, hidden in one corner and inflated to fill a room, he crowded people into another corner. (Vasari, 2008, 296) Vasari also provides the anecdote of the buckler, or round shield, which shows the extent to which Leonardo has gone, just to play a practical joke. It was left to be painted. But Leonardo turned the buckler into a monster which issued venom and smoke, and presented it in a way to startle his father. (2008, 287-9)

Leonardo used perspective to create an illusion with the *Mona Lisa*. The viewer is certainly manipulated by the master. He fools the viewer into the sense of depth created by the atmospherics of the landscape. A viewer accepts the effect even though the rules of logic are stretched to a surrealistic breaking point; the horizons to the left and right do not match, the waterways flow in a nonsensical manner and the perspective of the background is different from that of the subject. *Mona Lisa*'s loggia would seem to be situated on an impossibly high tower. The sense of distance is expanded beyond linear

perspective. Logically, there is so much wrong with the work; yet emotionally, the viewer seems compelled by it.

### *Visual Pun*

Leonardo, as a jester performing this trick of illusion, would be rewarded by observing the reaction it created in the viewer. The piece is relatively small (ca. 79 x 53 cm) and therefore portable. It was a commissioned portrait but it was kept by the artist, frequently displayed to visitors, and it remained with him throughout his travels even to the court of the king of France, Francis I. It now remains with the French and displayed in the Louvre museum of Paris. (McMullen, 1975) As discussed, whether *La Gioconda* is or is not Mona Lisa, she remains a *gioconda*. More to the point is who she is not. She is not a religious figure, nor is she a powerful and dangerous man; she is someone who would be safe to depict in a prank. In retrospect, a prank seems conceivable in a work with such a glaring error as a mismatched horizon and a clue in the bridge featured in the scene. Buriano bridge would be recognized by anyone familiar with the area. Another clue may be in the placement of the hands and the crossed arms, meant to point out a criss-crossed background (and, some would add, a cross-dressed subject). Leonardo would find it amusing to see who might realize the deception.

Accepting the painting as a prank or puzzle, places the *Mona Lisa* alongside his other portraits of women. These portraits generally follow a motif or theme. Leonardo's "Madonna" paintings follow conventional religious iconography with Mary looking on the Christ Child in a scene foreshadowing the Passion. In the *Virgin and Child with St. Anne and Lamb*, the sacrificial lamb seems the obvious reference. (Pedretti, 2000, 38) The winder, held as an upright cross in the *Madonna of the Yarnwinder*, recalls the Crucifixion. (Pedretti, 2000, 38) His non-religious female portraits, likewise, include visual emblems as clues to their identities. The *Portrait of a Woman* (Ginevra De'Benci) features a juniper bush behind the subject; juniper (or *ginepro* in Italian), being a pun with Ginevra. (Pedretti, 2000, 38) In *Portrait of a Lady with an Ermine*, the subject, fondling the pet, is Cecilia Gallerani, mistress of Ludovico Sforza. Sforza apparently commissioned the work and ermine was a reference to him. (Shell and Sironi, 1992, 47-

66) The *Mona Lisa* would seem to have a conspicuous absence of such references, until we consider the split landscape. It would be in keeping with the above that the *Mona Lisa* would also follow a theme. *La Gioconda*, or playful lady, features a prank or puzzle, namely a landscape hidden and finally solved.

### **Stereoscopy**

Play, for a genius such as Leonardo, should be considered as a legitimate pursuit and an opportunity for investigation and inspiration. An example is Leonardo's approach to the geometric games in *De Ludo geometrico*; his obsessive *ludo*, or game, of sectioning of the circle by lunes can be seen as a proto-calculus. (Capra, 2007, 270-274) This form of amusement as muse would occur with his exploration of optical illusions, which are basically experiments in which visual variables are controlled to investigate perception. We have discussed Leonardo's dissatisfaction with the Albertian approach to perspective, which is essentially monocular. Leonardo's investigation of binocular aspects of perspective is seen with the *Mona Lisa*. What has been described as a playful approach in the painting, proved a legitimate opportunity for investigating perception. "Leonardo correctly observed that because the eyes normally receive different views of a 3-D scene, it is impossible, even in principle, to convey a full sense of 3-D on a 2-D canvas...He puzzled over how we can see a single world of solid objects given the different eye views (now known as Leonardo's paradox)." (Ramachandra and Rogers-Ramachandra, 2009, 12) "Leonardo da Vinci struggled with the differences between the perception of a scene and a painting of it, which he reduced to the differences between binocular and monocular vision. He could not produce on canvas what, in the terminology of Ames, was an equivalent configuration. This was provided 300 years after Leonardo by Wheatstone's stereoscope." (Wade, Ono and Lillakas, 2001, 231) K. Veltman holds that, "[a]fter 1500, his major paintings can be seen as attempts to address one fundamental challenge: how to create effects of three-dimensional relief under carefully controlled conditions. Speaking anachronistically, he was trying to create auto-stereoscopic effects in paintings." (Veltman, 2009)

Leonardo's investigations of binocular perception lead him to attempt his own version of a stereogram with the *Mona Lisa*. Early copies, featuring two columns, have been cited to support unsubstantiated reports that the work was originally larger then cut down to its present size. Any cropping, of a *Mona Lisa* that originally included more of the two columns, remains a contentious issue. In the opinion of Martin Kemp, no such painting existed; copyists included full columns as their own invention. (Kemp, 2004, 219) In *Mona Lisa; Inside the Painting*, which documents the analysis of the actual panel, Élisabeth Ravaud relays evidence of trimming of the unpainted border, but not beyond the *barbe* i.e. crest of gesso and paint layer meeting a support frame. (Menu, Mohen and Mottin, 2006, 32) This seems conclusive for the painting as it exists in its present frame. But even this leaves open the possibility that a preliminary sketch, or a minimally painted larger panel, existed before it was cropped and framed. Or the remaining panel was previously kept in a frame that depicted these columns -- either painted or in relief.

While the existence of such a purported painting, holding two columns, is debatable, attempting to re-create it does prove fruitful. Consider three copies of the *Mona Lisa* arrayed in tandem with two columns extrapolated into position. These would create a stereoscopic arrangement. If the *Mona Lisa* as a stereogram was successful, a column would have been the central feature of the 3-D effect, prominently situated on the balcony, before the distant landscape. (See figure 6.)

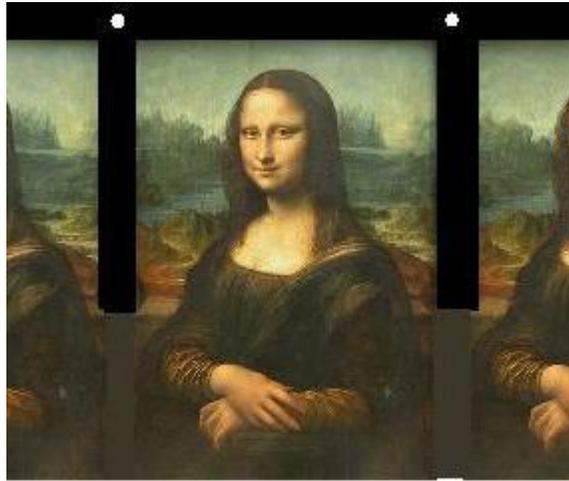


Figure 6. Mona Lisa Stereogram: Stare at the two white dots and cross the eyes until four dots appear. Reposition the eyes until the two central dots overlap. Look down at the reconstituted column and landscape. This illustrates the stereoscopic effect, easily shown on the small scale with a guide-frame that would be less satisfactorily seen on the larger scale of the actual painting. An original un-cropped painting, or frame, potentially included part of this image.

This is a painterly display of the very example discussed by Leonardo in his *Notebooks* under “Differences of perception by one eye and by both eyes,” where the column is the “object in relief t.”

Let the object in relief t be seen by both eyes; if you will look at the object with the right eye m, keeping the left eye n shut, the object will appear, or fill up the space, at a; and if you shut the right eye and open the left, the object (will occupy the) space b; and if you open both eyes, the object will no longer appear at a or b, but at e, r, f. Why will not a picture seen by both eyes produce the effect of relief, as [real] relief does when seen by both eyes; and why should a picture seen with one eye give the same effect of relief as real relief would under the same conditions of light and shade? (da Vinci, 1970, 29) (See figure 7.)

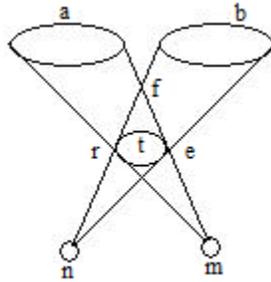


Figure 7. Differences of perception by one eye and by both eyes. (Image reversed to reverse mirror writing.)

It is more likely, however, that this attempt at stereoscopy proved unsatisfactory, for a number of reasons, including; the choice of foreground object, the scale of the painting, the position of the sitter and the lack of sufficient image overlap. The unfortunate choice of a column, being smooth and round, lacks the characteristics that would appear distinct from the vantage point of one eye to the other. Compared to the smaller scale images of stereograms in popular use, such as the Magic Eye™, the larger scale images of the painting would be more difficult for the viewer to appreciate as stereoscopic, without the use of special apparatus, such as the lenses or mirrors of a Wheatstone stereoscope. On the small scale, with the image overlap distance being less than the intraocular distance, it is easier for the viewer to converge their gaze to fully appreciate the phenomenon. On the larger scale of the paint panel, with the image-overlap distance being much larger than the intraocular distance, it is more difficult for the viewer to diverge their gaze to appreciate the phenomenon. Placing the painting at a distance where convergence, instead of divergence, of gaze could be used to appreciate the phenomenon, would greatly diminish the 3-D effect.

Another factor that diminishes the stereoscopic effect would be the placement of the sitter, which does hide the meeting area of the disjointed landscape but distracts the viewer during eye convergence. And finally, the painting fails to provide more image

overlap beyond the columns. If a painting, or preliminary work as in figure 6, had existed, an unsatisfactory result could have lead Leonardo to crop out the repeated elements. Or damage, such as the fissure on the remaining panel, (Menu, Mohen and Mottin, 2006, 36) may have lead to loss of part of the original. Cropping, to create symmetry, may have followed, giving us the painting we know today.

The *Mona Lisa* can be considered Leonardo's failed, or incomplete, attempt at creating a stereoscopic effect. This concept should be viewed in the context of statements made by Vasari. From *Lives of the Artists*:

It is clearly evident that because of Leonardo's understanding of art, he began many projects but never finished any of them, feeling that his hand could not reach artistic perfection in the works he conceived, since he envisioned such subtle, marvellous, and difficult problems that his hands, while extremely skilful, were incapable of ever realizing them. (2008, 286-7)

And despite the appearance of the *Mona Lisa* as a completed painting, Vasari held that "after toiling over it for four years, he left it unfinished." (2008, 294) As an incomplete stereogram, Vasari would be correct in referring to it as unfinished.

Leonardo would have stumbled upon stereoscopic phenomenon, as happens to anyone while staring at a repeated geometric pattern, such as tile-work. Just this sort of repeating pattern is actually featured in the stitching on the collar of *Mona Lisa's* dress. The eye fatigue resulting in depicting such demanding detail, would inevitably lead to the cross-eyed view needed to appreciate this small-scale stereoscopic effect. Such incidental findings could have inspired a larger scale attempt at stereoscopy.

Another noteworthy feature, again relating to perspective, is seen from what remains of the columns. The bases of the columns are another departure from linear perspective. The convergence lines, imagined from the parallel edges of the column bases, do not recede to a single vanishing point on the horizon, as expected. Rather, the lines of the left column base converge at the sitter's right eye, while the lines of the right column base converge at the sitter's left eye. This deliberate depiction by Leonardo is seen as

his intent for the viewer to do likewise, i.e. cross our eyes to see the left column and background with the right eye and vice versa with the left eye.

Another work that should be considered potentially auto-stereoscopic is his *Last Supper*. Leonardo has been described by Bandello as staring at his work with the *Last Supper*. “He might labour on the piece all day without a break, then leave and not be seen for the rest of the week. He was observed on one occasion staring at the painting for several hours, then making one or two tiny brush strokes, then leaving.” (Bandello, 1554, 121) Leonardo could have been checking for stereoscopic opportunities; his composition, with the figures and food items arrayed in sequence along the horizontal line of the table, would be suitable for stereoscopic effects. (Ciuffreda and Engber, 2002, 37-40) Unfortunately the image quality of the painting may be too deteriorated to see any auto-stereoscopic effect that Leonardo could have intended.

## **Conclusion**

To summarize the second part of this article, Leonardo presents us with an enigma in the *Mona Lisa*. The two parts of the landscape, with their mismatched horizons, and incongruous terrain, represent a puzzle to be solved. The figure, *La Gioconda*, hiding the unimagined confluence of this landscape, will be our playful guide, in solving this *gioconda*, or puzzle. She smiles knowingly, while looking directly at us and pointing to both edges of the panel. We follow, as she indicates the hint of columns seen along those edges. We see that the bases of each column have their lines of perspective converging, not to one point, but instead back to the eyes of Mona Lisa; the left lines converge on the right eye and the right lines converge on the left eye. We understand this as a direction to look back to the columns with our eyes converged. The two columns resolve into a stereographic image of one column. The resulting reconstituted landscape, likewise is revealed – puzzle solved.

Thus it has been demonstrated that the *Mona Lisa* is an elaborate and sophisticated puzzle. Leonardo perpetrated this prank as a visual pun on *La Gioconda* as the playful or jocular lady, and as an incomplete stereogram resulting from his investigations of

binocular perception. The *Mona Lisa* landscape, as such, is disjointed and unlikely while the reconstituted landscape provides a plausible setting displayed as a topographic map. In fact, it matches an actual place, namely, the Val di Chiana as mapped by Leonardo.

This article presents findings that should stimulate scholarship in the fields of Art History and Cartography. Art Historians are challenged to reconsider the current interpretation of the *Mona Lisa*, in particular, and of Leonardo's landscapes, in general. Meanwhile Cartographers are challenged to take the findings of the landscapes matching specific locations and develop tests to measure the strength of this hypothesis.

## **Appendix**

Topographic perspective has been demonstrated here with the *Mona Lisa* as a fly-over view of the Val di Chiana. Charles Nicholl, in his Leonardo biography, (appropriately subtitled *Flights of the Mind*), seems to imply as much, for the part of landscape visible under the wing in the *Annunciation* with a part of the *Map of Tuscany*. (Nicholl, 2004, 47-53) This is an early example of Leonardo's use of topographic perspective that corresponds to a particular place. The view is looking east from the mouth of the Arno River. On the left (below the angel wings,) are the Pisan hills then the *palude* (wetlands) with the gap between Montecatini, to the north, and the Monte Albano range with distinctive "mnemonic icon" peak of Monsumano, to the south. On the right is the view up-river, past a city that should be, but doesn't quite resemble Pisa, with high peaks on the south bank, to the distant and highest mountains, on to the horizon. That, incidentally, would place his hometown of Vinci, hidden, behind the angel's head. Some years after painting this work, Leonardo would produce the *Map of Tuscany* (c.1503), outlining his plan to divert the Arno through Serravalle. Thus the painting came to feature the Arno with its actual course on the right and the proposed course on the left.

The landscape in the *Madonna of the Yarnwinder* corresponds to the Adda River. The view is looking north, up the Adda River from Vaprio with Trezzo sull'Adda, then steep banks up river, then valley towards the Lecco arm of Lake Como, on the left side of

landscape. The high Alps along the horizon are seen on the right side. The area is featured in Leonardo's *Map of the Adda at Trezzo* and drawing of the *Ferry Crossing at Vaprio*. A problem arises, as the Madonna and child are shown on high ground with a bridge below them. The physical features fit best with a view from the hills above Villa d'Adda, looking north, up river, with a bridge at Brivio. But there is no record of such a bridge at that time. A possible solution is that the bridge is at Trezzo with the high ground near Vaprio (either imagined, or the exaggerated slope of a steep and rocky river bank) or that the initial vista is positioned very far across the Po plain in the Apennine range above Piacenza.

There are various potential candidate locations to correspond with the landscape for the *Virgin and Child with St. Anne and Lamb*. A good fit is one based on the *Storm over Valley* drawing and the Monte Rosa area discussed in his *Notebooks*. The view is looking north-west, from Mt Barone towards Mt Rosa (Dufour) across the Val di Sesia, with a valley to Rima San Giuseppe on the right and the main Sesia valley with Piode on the left.

All these landscapes, along with that in the *Mona Lisa*, demonstrate topographic perspective. They include sequences of mountainous terrain not appreciable from one vantage point, but assembled as a series of fly-over vistas, imagined above the highest peaks. It is the man-made features, of bridges and buildings, as scarce as they are, with which Leonardo takes the most licence. These do represent some difficulty with matching. But allowing for Leonardo's tendency to exaggerate the vertical height of hills and mountains, the natural features provide the best match for the landscapes to particular places.

## References

Bair, D. 2007. *Discovering Da Vinci's Daughter*. Raleigh, N.C., USA: Lulu Press inc.

Bandello, M. 1554. *Novelle*. Lucca: Edizioni Joker.

Capra, F. 2007. *The Science of Leonardo; Inside the Mind of the Great Genius of the Renaissance*. New York: Doubleday.

Ciuffreda, K. J. and Engber, K. 2002. "Is One Eye Better Than Two When Viewing Pictorial Art?" *Leonardo* 35 /1: 37-40.

da Vinci, L. 1970. *The Notebooks of Leonardo Da Vinci*, (Volume 1), ed. Richter, J. P. New York: Dover Publications.

da Vinci, L. 2005. *Leonardo's Notebooks*, ed. Suh, H. A. New York: Black Dog and Leventhal.

Dorfman, J. March 2008. "The 'Mona Lisa': Case Closed." *Art & Antiques* 31/3: 39.

Feinberg, L. J. 2004. "Visual Puns and Variable Perception: Leonardo's Madonna of the Yarnwinder." *Apollo* 160: 38-41.

Freedman, L. 1997. "The 'Blurred' Horizon in Leonardo's Paintings." *Gazette des Beaux-Arts* 129/6: 181-94.

Google Earth TM. views over the Val di Chiana, Italy.

Greenstein, J. M. 2004. "Leonardo, Mona Lisa and La Gioconda. Reviewing the Evidence." *Artibus et Historiae* 25/50: 17-38.

Kemp, M. 2004. *Leonardo*, New York: Oxford University Press.

Marinoni, A. 1954. *I Rebus di Leonardo da Vinci, Raccolti e interpreti*, Firenze: L.S. Olschki.

Masters, R. D. 1998. *Fortune Is a River: Leonardo da Vinci and Niccolò Machiavelli's Magnificent Dream to Change the Course of Florentine History*. New York City: Free Press.

McMullen, R. 1975. *Mona Lisa: The picture and the myth*, Boston: Houghton Mifflin.

Menu, M., Mohen J.P. and Mottin, B. 2006. *Mona Lisa: Inside the Painting*, New York: Abrams.

Michelin map 563 regional, Toscana, Umbria, San Marino, Marche, Lazio, Abruzzo. (distance calculated).

Nicholl, C. 2004. *Leonardo da Vinci: Flights of the Mind*. New York: Penguin Group.

Oberhammer, E. 1909. "Leonardo Da Vinci and the Art of the Renaissance in Its Relations to Geography." *The Geographical Journal* 33/5: 546.

Owen, R. 2003. "Leonardo's maps solve Mona Lisa landscape puzzle." *The Times*: 21.

Pedretti, C. 2000. *Leonardo Da Vinci*, Surrey, U.K.: TAJ Books.

Ramachandran, V.S. and Rogers-Ramachandran, D. 2009. "Seeing in Stereo: Illusions of Depth." *Scientific American Mind*: 12.

Ravaud, E. 2006. "Mona Lisa's Wooden Support." In *Mona Lisa: Inside the Painting*. ed. Menu, Mohen and Mottin. New York: Abrams. 32-37.

Repetti, E. 1833. *Dizionario Geografico Fisico Storico della Toscana, Vol 1*. Firenze: Università degli Studi di Siena

Shell, J. and Sironi, G. 1992. "Cecilia Gallerani: Leonardo's Lady with an Ermine." *Artibus et Historiae* 25: 47-66.

Veltman, K.H. 2009. "Leonardo da Vinci and Perspective." *Leonardo Studies*: 1.

Wade, N.J., Ono, H, and Lillakas, L. 2001. "Leonardo da Vinci's Struggles with Representations of Reality." *Leonardo* 34: 231.

Schwartz, L. 1988. "The Mona Lisa Identification." *The Visual Computer, Springer-Verlag* 4: 40-48.

Smith, W. 1985. "Observations on the Mona Lisa Landscape." *The Art Bulletin* 67/2: 183-199.

Vasari, G. 2008. *The Lives of the Artists*, translated by Bondanella, J.C. and Bondanella P., Oxford, U.K.: Oxford University Press.

Wright, D.R.E. 1984. "Alberti's De Pictura: Its Literary Structure and Purpose." *Journal of the Warburg and Courtauld Institutes* 47: 52-71.

Zapperi, R. 2010. "Abchied von der Mona Lisa." *Weltkunst* 80/1: 40.

Zöllner, F. 1993. "Leonardo's Portrait of Mona Lisa del Giocondo." *Gazette des Beaux-Arts*: 115-138.