The Last Supper (Vienna 195r): a new geometrical study and a hypothesis on its architecture

Angelamaria Aceto

The making of the *Last Supper*, Vienna 195r, (fig. 1) is traditionally connected to a letter by Gregorio Cortese (1480-83/1548), in which the clergyman states that he had tried to engage Raphael for the decoration of a refectory whose construction, the letter implies, Cortese had supervised. According to the document, Raphael had declined the invitation, forcing Cortese to turn to a less famous, though promising young artist. The refectory is identified with that of the Abbey of San Benedetto in Polirone, south-east of Mantua. However, the document itself remains problematic, as John Shearman has convincingly maintained.[1] Aside from the question of the integrity of the letter, one of the main issues consists in the difficulty in matching what is described in the letter with the topography of the abbey and with its *refettorio grande*, for which the fresco is believed to have been designed and which – not a minor detail – was built in the last quarter of the fifteenth century, and thus predated the letter. Likewise, the relation of the Vienna drawing to another sheet of the same subject at the Royal Collection at Windsor Castle remains unclear.[2] The Vienna sheet shows characteristics that are still strongly Florentine, as we shall see, though the same handling of the pen may be found in drawings for the *Disputa on the Holy Sacrament*, so a dating around 1508 or earlier should be contemplated. On the other hand, the Royal Collection sheet reflects Raphael's Roman experience and is generally believed to have been executed around 1514.[3]

While only further documentary evidence can throw light on certain questions, the careful scrutiny of the sheet's layers has led to the unveiling of a geometrical study in blind stylus that to my knowledge has never been commented upon and that, although unrelated to the *Last Supper*, raises further questions about Raphael as a designer and as a draftsman. Furthermore, little attention has been paid to the architectural elements of the sheet which offers clues about the original location of the work, as well as about a possible iconographical source. It is to these two aspects that the following pages are dedicated.

***

The drawing is executed in pen and ink over indications in leadpoint, visible with the naked eye, but more clearly legible in the infrared reflectography (IRR) (fig. 2). The leadpoint drawing is extremely free, showing the thinking hand at work – Raphael testing and retesting the position of the apostles before turning to the indelible ink. This is clearly a variation on Leonardo's theme of the *Last Supper* in Santa Maria delle Grazie, Milan, in which the artist explored the emotional and psychological reaction of the Apostles to the betrayal announced by Jesus. Raphael's composition is no less effective in conveying the urgency and the drama of the moment.

The leadpoint underdrawing confirms that Raphael intended from the onset to develop part of the scene only, a common practice when thinking of large scale compositions. Two of three compartments are drawn, the head and shoulder of an apostle having just been swiftly indicated on the far right. However, the remaining of the page is not blank. The employment of raking light reveals a clear geometrical study on the top right corner in blind stylus.[4] Though only partially drawn, there are enough elements to identify it with a construction for a hexadecagon, that is a sixteen-side polygon (fig. 3). First, Raphael draws three sides of an octagon inscribed in a circle. He builds an isosceles triangle from whose vertex he draws a segment intersecting the circumference: the pinhole visible on the arc locates one of the vertexes of the hexadecagon. The same construction takes place moving on clockwise, though here Raphael indicates only the vertex of the isosceles triangle with the compass arcs. A third vertex of the hexadecagon is created by the intersection of the orthogonal line to the diameter with the remaining drawn circumference. This construction line is traced just next to a grey vertical mark (in either lead or, more likely, graphite) on the right that demarcates a darker portion of the paper, indicating a different exposure to light of this section of the sheet. The rendition in figure 6 aids us to visualise a finished hexadecagon, the visible blind stylus lines in red.

Made up of pinholes, straight ruled lines and compass marks, such studies challenge the connoisseur for their anonymous character, so that establishing both their authorship and their precise purpose is an objectively difficult task. Additionally, blind stylus can be difficult to detect with the naked eye. All such factors account, in part, for the lack of attention these traces had in the related literature. More broadly, drawing scholarship has been primarily concerned with identifying and systematising the large amount of material that has come down to us. Naturally and rightly, questions of connoisseurship have been a primary concern. But a growing body of evidence is showing how much the field can gain from an archaeological approach to the object. The reading of the drawing's materiality and of its stratigraphy can enhance our understanding of the artefact, throw light on working processes, as well as contributing to more traditional questions of connoisseurship.[5] I would suspect that more such marks exist on Raphael's sheets that await to be uncovered, and that many others have been destroyed, for being judged not 'collectable'.

Geometrical exercises of the type described were eventually meant to solve practical questions of planning and proportioning in both paintings and architecture.[6] In a manner akin to the extremely succinct sketch at the bottom centre of the sheet, with which Raphael fixes the distribution of the figures around the table, the geometrical study on the sheet in Vienna gives us a glimpse into the artist's use of drawing as a cognitive tool and into his mathematical mind.

Geometry was an essential tool he had mastered as a young painter, and the blind stylus was his most versatile medium. Geometrical constructions are behind many of Raphael's drawings for pictorial compositions, an important aid in achieving proportion and balance. Indeed, a handful of geometrical studies have come down to us. Among these one should mention a study for a dome at the Ashmolean

Museum in pen and ink, perhaps for Agostino Chigi's chapel in San Maria del Popolo, Rome,[7] and, more relevantly to us, a perspectival grid in blind stylus on the verso of a metalpoint sheet at the British Museum, showing a study for the *Coronation of the Virgin* of c. 1503-4 (Rome, Musei Vaticani). The latter has only recently been fully discussed and persuasively connected to the perspectival construction for the Annunciation predella for the same painting.[8]

Since his first steps as an artist in his native city of Urbino, Raphael would have participated in a visual and literary culture deeply embedded with mathematical ideas. Piero della Francesca's manuscripts, *De Prospectiva Pingendi*, and the *Libellus de quinque corporibus regolaribus*, respectively dedicated to Federico da Montefeltro and to his son Guidobaldo, were among the highlights of the library in the Ducal Palace. In the former, Piero dedicates a full page to the perspectival projection of the hexadecagon, illustrated by a careful drawing (fig. 4).[9] When translating Vitruvius' rounded temple, Renaissance artists would imagine it on eight axis and thus with a *peristasis* of sixteen columns.[10] Among the most notable of all is the interpretation of Piero's pupil, Donato Bramante, as seen in the Tempietto di San Pietro in Montorio whose design was already underway around 1502.[11]

Always reactive and able to absorb visual and cultural stimuli with great ease, Raphael clearly participated in this lively atmosphere, as demonstrated by the fact that he employed a hexadecagon building with sixteen columns, when planning one of his most celebrated (painted) architectural settings, that is, the temple in the *Marriage of the Virgin* for Città di Castello (Milan, Pinacoteca di Brera), signed and dated 1504 (fig. 5)[12]. It has been largely demonstrated how the understanding of geometry provided Raphael with the solution to create a radically new composition, one that essentially overcame the juxtaposition of planes as seen in Perugino's painting of the same subject at the Musée des Beaux-Arts in Caen. The sixteen-sided building generated space, its perspectival projection being key in conveying harmony to the whole.[13] It is tempting to regard the Vienna geometrical study, otherwise difficult to place, as part of the process of thinking for the *Marriage of the Virgin.* But this sequence supposes that the study was executed five years or so before the sketch for the *Last Supper*, and on a larger sheet. The re-use of paper at a chronological distance was indeed common, but what can the object itself tell us?

The sheet carries a watermark, a tulip, still undescribed in the major watermark catalogues.[14] The sheet is certainly cropped at the top and at the right-hand side. The cropping on the right is also evident from the verso, where Raphael draws nudes on a larger scale in various poses. The present dimensions of the sheet, the position of the watermark, the orientation, number of chain lines, and the distance between them all suggest that Vienna 195r (26.3 x 27.7 cm) may have been executed on the watermarked half of a royal sheet (this measuring c. 44 x 60.8 cm and commonly used), and then further cropped (fig. 6).[15] The geometrical study therefore must have occupied a more prominent position on the paper than it now does, with the construction lines developed on a larger piece of paper. One wonders if the

unfinished character of the Vienna *Last Supper* could have been dictated by the presence of the stylus study: this was not a quick thought to be obliterated by other sketches – as was customary – but a geometrical demonstration to be valued and preserved. It should be emphasised that the stylus indentations must have been much more visible to Raphael than to us today, as the paper was flattened through time due to handling and, possibly, conservation interventions.

A better understanding of the structure of the paper used by Raphael throughout his career, and indeed a comprehensive overview of Raphael's watermarks, which we are regrettably still lacking, may provide precious indications on the dating of the Vienna paper and indirectly of the geometrical study. In light of the available evidence, the relation of the Vienna geometrical study to the *Marriage of the Virgin* must remain hypothetical. But further food for thought is offered by a sheet at the Royal Collection by Leonardo[16], to whose graphic work Raphael must have been exposed as early as c.1502-1503 (fig. 7), at the time of the senior master's sojourn in Urbino and surrounding areas as architect and engineer of Cesare Borgia. On the Royal Collection sheet Leonardo draws various architectural and geometrical studies, the most prominent of which shows how to build an octagon from a given line. The octagon – from which the hexadecagon derives – is surrounded by early studies for the Milanese *Last Supper*. The sketches may have been executed over a period of five years or so, between c.1490 and 1495, the geometrical and architectural studies preceding those for the Milanese *Last Supper*. In the 1490s Leonardo was closely involved as a scientific consultant in major architectural projects, including the construction of the tribune of Santa Maria delle Grazie, Milan, which will be eventually capped by a hexadecagonal *tiburio*. The conceptual consonances between the Royal Collection drawing and the Vienna *Last Supper*, both carrying studies for related polygons and the same figural subject, are apparent and remarkable. Leonardo's sheet demonstrates that such juxtaposition was indeed possible, even if its explanation and full significance remain still unclear.

***

The architecture on Vienna 195r plays a major role in the economy of the composition, leading to the suspicion that its function was primarily aimed at solving the problem of articulating a group of thirteen figures within a compact spatial setting. Raphael conceives the latter as a monumental, yet austere, simple interior, whose contrast with the domestic contemporary settings seen in prestigious examples of Quattrocento Florentine *cenacoli* is most evident. Raphael is naturally trying to convey a sense of great depth and to suggest the same visual continuity with the viewer's space for which Leonardo's rendition is renowned. The drawing offers enough clues to let us imagine with a certain degree of confidence that the design was conceived to fit a type ofrefectory in use since the fifteenth century, showing a rectangular hall surmounted by a barrel vault and articulated into lunettes and *unghie* (also known as *volta unghiata*). The short ends of this type of vaulted refectory were often divided in three lunettes.[17] The setting painted by Beato Angelico for one of the panels of the Armadi degli Argenti

(Museo Nazionale di San Marco, Firenze) helps to visualise the type of hall I am describing, but several examples existed in and outside Florence by the end of the fifteenth century. One of these, the Cenacolo della Calza in Florence, for which Francesco di Cristofano, called il Franciabigio (c.1482 – 1525) would paint a *Last Supper* (signed and dated 1514), is heavily dependent on our drawing (fig. 8).[18] Raphael indicates the *unghie* of the actual space with few strokes of the pen, the pointed arches having been slightly cropped at the top. Assuming that the Vienna design was indeed for a fresco commission, one has the impression that Raphael was well-informed about the refectory that would host it.

The presence of the three *peducci* introduced a challenge for the designer and the future viewers in situ. Yet Raphael exploited the tripartite division of the wall by introducing three full-length pilasters, which are clearly part of the *architectura picta*, in so disrupting the fluidity of the narrative even further. An example of a tripartite illusionist framework on monumental scale may have been offered to Raphael by Perugino's *Crucifixion* in Santa Maria Maddalena de' Pazzi, Florence. But Perugino's design has a Roman, archaeological flavour, its Corinthian columns leaning on wide pilasters ostensibly alluding to triumphal arches. Rather, Raphael seemed to have had something else in mind.

A stratigraphic reading of the Vienna sheet reveals Raphael's creative process, visual culture and fervid imagination. Leadpoint in hand Raphael places the main compositional elements of two thirds of the architecture. These are clearly visible with the naked eye, but the IRR (fig. 10) aids us in reading this exploratory underdrawing. Two lunettes are swiftly drawn on the far left of the sheet. The IRR also reveals more clearly a transverse arch under which Raphael draws one of the apostles: he is seen energetically jumping between two bays in the foreground, his head superimposed onto a rectangular capital, a detail that indicates the presence of another pilaster behind the one in the foreground. A few strokes of the leadpoint also suggest a transverse arch on the opposite side but parallel to the former, under which an apostle, arms crossed and facing the viewer, possibly Judas, is placed. The long table is thus positioned under a sequence of three bays, as was noted by Theobald Hofmann in 1909, when he rendered the architecture of Vienna 195r as a plan (**fig. 9**).[19] The scholar also interpreted the space depicted in the drawing as a groin vaulted hall, but perhaps misinterpreted some details. First, he read what I believe are the *unghie* of the actual space as half-cross vaults. Second, behind the pilasters he imagined the refectory space as two bays in depth on the left, and one bay deep in the centre. The result is curious and not at all predicative.[20] In fact, Raphael clearly draws an additional bay in still greater depth with few strokes of the leadpoint in the centre: **figure 10** shows the back wall seen in the far distance with the lunettes (the one in the centre fully drawn and the one of the left and right just indicated), and a corbel. The latter is visible at the height (but behind) the forehead of the apostle to the right of Christ, his hands on his chest, very possibly St Peter. What Raphael thus generates a six-bay – or a two aisle, tripartite – hall (**fig.11**). Conceptually, such a space is remarkably close to the plan of the

Cenacle on the Mount Zion in Jerusalem at the first floor level of the building complex (**fig. 12**). In jotting down his first thoughts for the architecture in leadpoint, Raphael would seem to be evoking an illustrious model, to which he must have had indirect access.

The location of the Church of the Cenacle in Jerusalem was associated at least since the reign of Constantine with the event of the Last Supper and with the First Christian Pentecost. The remains of the south nave and of the presbytery of the twelfth century abbey church of St Mary, damaged over the course of the thirteenth century, the space was identified as precisely where the meal was consumed.[21] The room is articulated into six bays surmounted by gothic groined vaults. When it is compared to Raphael's refectory, the spatial consonances are evident, although in the drawing Raphael opens the long wall to allow the beholder to participate in the *mise en scène.*

From North to South Italy the mimesis of buildings from the Holy Land was a widespread phenomenon from the Middles Ages throughout the Renaissance.[22] Drawings and written accounts by pilgrims circulated, especially from the first half of the fourteenth century, when the Franciscans acquired the site and the adjoining chapel of the Holy Spirit, building a convent and a cloister.[23] The introduction of the printing press in the fifteenth century encouraged a wider and easier circulation of descriptions, often with topographically accurate images. Among the most noted examples was Bernhard von Breidenbach's *Peregrinatio in Terram Sanctam* of 1486, with woodcuts by the Dutch designer Erhard Reuwich. His reproduction of the Mosque of Omar, incorrectly identified by many travellers to the Holy Land as the Temple of King Solomon, with its polygonal and arched shaped exterior, may be one of several stimuli behind the creation of the temple in the *Marriage of the Virgin* at Brera[24] From the end of the fifteenth century, translations of the sites of the Holy Land materialised in Italy as *Sacri Monti*, Varallo in Piedmont being the first of its kind. Such sites provided pilgrims with the opportunity of experiencing the sacred chapels and churches of Jerusalem without undertaking long and potentially dangerous travels. Among these*Sacri Monti*, one may be particularly relevant to us.

In 1500 a group of Franciscans took possession of a medieval hermitical site on the hills of the Camporena forest, near the municipality of Montaione, between Florence and Siena, devoted to the cult of San Vivaldo.. By 1505, under the supervision of the little-known fra' Tommaso da Firenze, the site begun to be enriched by chapels and oratories: a note appearing in a catalogue listing the convents of the Franciscan Osservanza of c.1509 eloquently describes the site '*ad loco devoto et amoeno constructus, ad Sepulcri Domini in Jerusalem cum variis sacellis et aediculis in similitudinem locorum sacrorum, quae exstructa sunt in Sacro Monte Sion et Monte Oliveti; etenim colles et valles hujus loci valde similes sunt illis Hierosolimitanis'*[25] leaving no doubt on the mimetic intensions of the initiative. Known as the *Sacro Monte di Vivaldo* or *La Gerusalemme di Toscana*, its role as a major devotional destination was acknowledged under Pope Leo X, when indulgences were granted to pilgrims who

visited and prayed there, as documented by pontifical letters of 1513 and 1516. The first was drafted by Beltrando Costabili, the Ferrarese ambassador in Rome; the other was drafted by Cardinal Bernardo Dovizi da Bibbiena in his Florentine residence (almost needless to say, both men were personalities with whom Raphael was closely associated). In the latter document 34 *loci* are cited, among which the '*ecclesia Montis Sion, ubi Christus coenam fecit cum suis discipulis.*'[26] Though lacking mention of the chapel of the Cenacle in the 1513 pontifical document could lead one to believe that its construction had not been realized, the relevant ideas and plans were already in place in the first decade of the sixteen century, as the note of c.1509 mentioned above suggests. The architecture of the chapel shows a vocabulary deriving from Florentine examples dating from the second half of the fifteenth/beginning of the following century, with some elements recalling the work of Simone del Pollaiuolo, called il Cronaca (1457-1508).[27] No less important to highlight in this context is the close involvement of important Florentine families as patrons, including the Gaddi, Pitti, Bardi and Manelli, whose coat of arms appear on the complex of the Mount Zion.

It has been repeatedly remarked in the related literature that the realization of San Vivaldo shows, more than any other *Sacri Monti* that proliferated in Italy, a philological restoration of the source, both in relation to the general topography and to the architecture of specific sacred sites. As far as the planimetry was concerned, the room of the Vivaldo Cenacle appeared as a Florentine translation of the Jerusalemite church, showing a six-bay hall (fig. 13). The parallels with the Vienna *Last Supper* are clear. Indeed, there is no evidence of a direct contact between Raphael and Vivaldo. But the devotional site materially testifies to the long-standing and lively circulation of Jerusalemite models in and around Florence, particularly so at the time of the artist's sojourn in the area and, notably, the accurate knowledge of the architecture of the Church of Cenacle. That Raphael may have had access to such sources is a hypothesis that should be contemplated.

If my suggestion is correct, the layers of the Vienna 195r would illustrate Raphael's search for eloquent form by drawing ideas from a visual repertoire which is both deep and broad. In a manner akin to the temple of the *Marriage of the Virgin* at Brera, the beholder's assimilation of the painted architecture with the 'real' place would have created an atmosphere of deep spirituality. However, as with the apostles, whose position Raphael modifies when turning to the indelible ink, so with the architecture his thoughts evolve with incredible rapidity. Pen in hand, he 'carves out' a less complex architecture that corresponds with the Florentine type of Renaissance refectory seen above, showing a single barrel vaulted hall. Raphael does so by emphasising certain details in pen: he pulls out the *unghie* and the lunettes on the left-hand side, on the back wall and on the foreground, the transverse arches being no longer visible. The central bay drawn in leadpoint and seen in the distance in figure 10 is now hidden by the dense hatching of the pen. On the barrel vaulted ceiling, Raphael can place two lamps. They

provide the main source of light, suggesting dark hours of the day, a novelty in the Renaissance iconography of the *Last Supper*, yet a learned reminder of the time of the day the event had begun ('When evening came…').[28]

This contribution develops part of my paper presented at the symposium. I thank the organizers, Achim Gnann and Marzia Faietti, for the invitation and the possibility to publish the material. Thanks also to Hannah Singer, Paper Conservator at the Albertina, Vienna, for providing precious images of the paper, to Mauro Mussolin and Leonardo Pili whose work on Michelangelo's drawings has taught me a great deal and to architect Manuela De Leo for the digital elaboration of figs. 6 and 11. My deepest gratitude goes to Professor Francesco Paolo di Teodoro, without whom I would not have been able to correctly identify the geometrical study. The infrared reflectography (IRR) of the drawing, here published, was carried out the Albertina photographic department using OSIRIS Infrarot camera / Rodagon; 1:5,6; f=150mm IR. The contrast of the image has been slightly enhance by the present author to allow better legibility of the leadpoint lines.

[1] See Shearman 2003, vol. 1, pp. 221-230. For a recent entry on the drawing see B. Thomas in *Raphael* 2017, p. 128, cat. 41, and for an argument in favour of the relation with the letter by

Cortese see A. Gnann in *Raffael* 2017, pp. 231-232, cat.69, and idem, in *A Quintessence of Drawing* 1997, p.52, cat. 14, the last two entries also for previous bibliography.

[2]The Royal Collection, RL 12745, which is very possibly Raphael's modello for an engraving. For a recent discussion of the drawing and corresponding print see P. Emison, in *Marcantonio Raimondi* 2016, pp.183-184, cat.43 with bibliography. See E. Mitsch, in *Raphael in der Albertina* 1983, pp. 94-95, cat. 29, fig. at p.94, for a copy in the Bier Collection, Copenhagen, of the left portion of RL 12745, including a saint introducing a patron, and therefore suggesting that the design may have been conceived for a fresco.

[3] Based on style, but also on the watermark, as indicated by M. Clayton, in *Raphael and his circle* 1999, pp. 114-117, cat. 29.

[4] 'A geometrical study' is mentioned in the caption to the drawing in Joannides 1983, cat. 264. There is a reference to some 'metalpoint lines and vertical lines 30 mm from the right edge' in A. Gnann, in *A quintessence of drawing. Masterworks from the Albertina* (cited above, note 1).

[5] In this context I limit myself to citing Mussolin 2013, pp.145-165; Bambach 2014; Ambers, Higgitt, Saunders 2010, and the literature on Raphael and blind stylus, for which see Monbeig-Goguel 1987; Kemp, Kang 2006, pp. 76-85; Kang 2006; Kang 2015, pp. 80-101. See also Tordella 2008 for a more general overview on the use of blind stylus in the sixteen century.

[6] In this regard, see also the contribution by Angela Cerasuolo in this volume.

[7] For which see C.L. Frommel. in *Raffaello architetto* 1984, p.135, p. 135, cat. 2.3.9. Ashmolean Museum WA1846.199 verso.

[8] BM Pp,1.67. See Kang 2006 and Kang 2015 (cit. above note 5).

[9] Della Francesca 2016, book I, folio 10r (in the example at Reggio Emilia, Biblioteca Panizzi, Mss. Regg. A 41/2). On Piero della Francesca, Raphael, Vitruvius and architectural drawing, an important contribution is Di Teodoro 2002.

[10]On this specific question see Günther 2001 at pp. 293-294.

[11] For the question of the dating see now Cantatore 2017 at pp. 153-156.

[12] On the mathematical and scientific environment of Urbino in the 1490s in relation to Raphael's education see Dalai Emiliani 1987.

[13] See De Vecchi 1973, especially fig. III.

[14] The watermark measures c. 6.7cm, and has some analogies with Piccard 1961-1997, cat. 1509 and Briquet 1923, cat. 6657. Distance between chain lines of the paper c. 3.9 cm.

[15] On paper formats see Zappella 2001, I, especially, pp. 43-99 and p. 333. I am in debt to Mauro Mussolin and Leonardo Pili, who have extensively worked on Michelangelo's paper, for their insight into this specific question. The chronology of the verso poses the same problems as the recto with a dating that has oscillated between the Florentine and the early Roman period.

[16] For a reading of the Royal Collection drawing, with previous literature, see P. Marani in *Il Genio e le passioni* 2001, pp.124-126, cat. 27.

[17]For an overview on the question of Florentine refectories a fundamental reading remains Vertova 1965, especially pp. 40-41 for the evolution of the architecture. See more recently Acidini Luchinat, Proto Pisani 1997.

[18] As also noted by Mckillop 1974, p.48 for whom 'The Calza *Last Supper* approximates more than any other a small drawing by Raphael in the Albertina, and I suspect that the source is somewhere in Raphael's art, taken from this or from studies no longer extant'. She also remarks on the dependence on the same drawing of the frescoed *Last Supper* in Santa Maria dei Candeli which she attributes to Franciabigio, in the use of full-length pilasters, but this seems to have been an existing situation rather the artist's choice, as clarified by Vertova 1965, pp.61-63.

[19] See Hofmann, 1909, II, p.45, text and fig. XXXI.2.

[20] As also noted by E. Mitsch, in *Raphael in der Albertina* 1983, p. 95 'Hofmanns Grundisserekonstruktion der Halle mit vorspringender Rückwand im Mittelteil ist unrichtig, wie schon aus den von der Decke herabhängenden Lampen hervorgeht."

[21] The site on Mount Zion in Jerusalem is the result of an extremely stratified situation that changed over the centuries. See Coldstream 2004; Plommer 1982.

[22] The literature on the subject is vast. For more recent contributions, with ample bibliography and contributions also on Vivaldo, see Barbero, Roma 2008; Benvenuti, Piatti 2013; Bartal, Vorholt 2015.

[23] For an overview of pilgrims' written accounts see Gensini 2008, esp.156, text and note 40.

[24] Burns 1984 esp. p. 381 and p.399, note 9. For a summary on the question of Raphael's ancient and contemporary sources for the Brera Tempietto, discussed in the context of Bramante's Tempietto di San Pietro in Montorio, see Rosenthal 1964; Bruschi 1969, pp.1031-1035 and

more recently Cantatore 2017, at pp.157-161. Ekserdjian 2018 noted that the Church of Sant'Angelo in Perugia also has a sixteen-column ambulatory. The building is included in a view of the Sobborgo of Sant'Angelo, Perugia, in a drawing by Raphael at the Ashmolean Museum, Oxford (WA1846.10 recto).

[25] In Wadding 1933.

[26] For a summary of the visual and written evidence on San Vivaldo see Vannini 1989. On the nature of the 1516 document, see Gualdo 2004.

[27] On the architecture of the Vivaldo Sacro Monte, with references to the wider bibliography on Vivaldo, see Pacciani 1987, pp. 49-53 and 159-161, specifically pp.160-161 for the relation of the Vivaldo Mount Zion to Jerusalem's; Pacciani 1989; Pacciani 2004, pp. 129-142. See Pacciani 1992, pp.195-205 on the broader question of the reception of Jerusalemite models in the Renaissance also in relation to San Vivaldo.

[28] Matthew 26, 20-29 and Mark 14, 17-25.

Captions – THERE ARE 13 IMAGES BUT THE ARTICLE IS SHORT

1. Raphael, *The Last Supper*, pen and ink over leadpoint, a separate geometrical study on the top left in blind stylus, c.1508. Vienna, Albertina
2. Infrared reflectography (IRR) of the drawing shown in fig.1
3. Detail of figure 1 seen in raking light, showing a construction for an hexadacagon.
4. Piero della Francesca*, La figura de octo facce degradata in sedici reducere*, De Prospectiva Pingendi, folio 10, Reggio Emilia, Biblioteca Pannizzi Ordered
5. Raphael, *The Marriage of the Virgin*, 1504 (Milan, Brera)
6. A finished hexadecagon, with Raphael's study highlighted in red. The scheme shows the possible original royal format (in grey) of the sheet
7. Leonardo , *Studies for the Last Supper, how to build an octagon from a given line, two octagonal plans or studies for a dome and arches, ca.* 1490-95, Royal Collection, Windsor Castle, Windsor
8. View of the architecture of the refectory of the Calza with Franciabigio's *Last Supper* in the background, Florence, Convitto della Calza
9. Hofmann's reconstruction of the plan of the drawing in figure 1
10. Detail of the IRR in figure 1, the contrast enhanced for better legibility of the leadpoint

11. Author's reconstruction of the plan of the room of the Last Supper seen in the drawing in figure 1
12. Plan and elevation of the Church of the Cenacle in Jerusalem, XII century (from Plommer 1982)
13. Plan and elevation of the complex of the Mount Zion, Sacro Monte di Vivaldo, Montaione, showing the six bay structure of the Chapel of Cenacle (from Pacciani 1987)

Cited bibliography

Acidini Luchinat, Proto Pisani 1997 = C. Acidini Luchinat, R. C. Proto Pisani, a cura di, *La tradizione Fiorentina dei Cenacoli*, Firenze 1997.

Ambers, Higgitt, Saunders 2010 = J. Ambers, C. Higgitt, D. Saunders, a cura di, *Italian Renaissance Drawings. The technical examination of Old Master drawings. A symposium in conservation*, London 2010.

A Quintessence of drawing 1997 = *A Quintessence of Drawing. Masterworks from the Albertina*, catalogo della mostra (New York, Solomon R. Guggenheim Museum, 20 giugno – 24 agosto 1997) Milano 1997.

Bambach 2014 = C. Bambach, *On the role of scientific evidence in the study of Leonardo's drawings*, in *Leonardo da Vinci's technical practice. Paintings, drawings, influence*, proceedings of the international conference (London, National Gallery, 13-14 gennaio), a cura di M. Menu, Paris 2014, pp. 223-253.

Barbero, Roma 2008 = A. Barbero, G. Roma, a cura di, *Di ritorno dal pellegrinaggio a Gerusalemme. Riproposizione degli avvenimenti e dei luoghi di Terra Santa nell'immaginario religioso tra XV e XVI secolo*, proceedings of the conference (Università della Calabria, 12-13 maggio 2005), Ponzano Monferrato (AL) 2008.

Bartal, Vorholt 2015 = R. Bartal, H. Vorholt, a cura di, *Between Jerusalem and Europe. Essays in Honour of Bianca Kühnel*, Leiden 2015.

Benvenuti, Piatti 2013 = A. Benvenuti, P. Piatti, a cura di, *Come a Gerusalemme: evocazioni, riproduzioni, imitazioni dei luoghi santi tra Medioevo ed età moderna*, Florence 2013.

Briquet 1923 = C. M. Briquet, *Les filigranes. Dictionnaire historique des marques du papier dès leur apparition vers 1282 jusque'en 1600*, 4 voll, Leipzig 1923.

Bruschi 1969 = A. Bruschi, *Bramante architetto*, Roma 1969.

Burns 1984 = H. Burns, *Raffaello e "quell'antiqua architectura"*, in *Raffaello architetto*, catalogo della mostra (Roma, Campidoglio, Palazzo dei Conservatori, 29 febbraio – 15 maggio 1984), a cura di C.L.Frommel, S. Ray, M. Tafuri, et alii, Milano 1984, pp. 381-404.

Cantatore 2017 = F. Cantatore, *Bramante e il Tempietto: il progetto e le sue trasformazioni*, in *ll Tempietto di Bramante nel Monastero di San Pietro in Montorio*, a cura di F. Cantatore, Roma 2017, pp.253-184.

Coldstream 2004 = N. Coldstream, *The late twelfth-century rebuilding of the Cenacle on Mount Sion and the fortunes of a style*, in *Perspectives for an architecture of solitude. Essays on Cistercians, art and architecture in honour of Peter Fergusson*, a cura di T. N. Kinder, Turnhout 2004, pp. 101-107.

Dalai Emiliani 1987 = M. Dalai Emiliani, *Raffaello e i poliedri platonici*, in *Studi su Raffaello*, Atti del Congresso Internazionale di Studi (Urbino-Firenze, 6 - 14 aprile 1984), a cura di M. Sambucco Hamoud, M. L. Strocchi, 2 voll., Urbino 1987, I, pp. 93-109.

Della Francesca 2016 = P. Della Francesca, *De Propsectiva Pingendi*, 1472-1475, *Edizione nazionale degni scritti di Piero della Francesca*, edited by M. Dalai Emiliani, O. Besom, C. Maccagni *et alii*, 4 vols., III.A/II (Disegni)????, curated by R. Migliari, L.Baglioni, F. Fallavollita *et alii*, Rome 2016, pp.35-37 Could you please control edited and curated??

De Vecchi 1973 = P. De Vecchi, *Lo Sposalizio della Vergine di Raffaello*, Firenze 1973.

Di Teodoro 2002 = F.P. Di Teodoro, *Vitruvio, Piero della Francesca, Raffaello: note sulla teoria del disegno di architettura nel Rinascimento*, in "Annali di Architettura", 14, 2002, pp.35-54.

Ekserdjian 2018 = D. Ekserdjian, The Temple at Jerusalem in the Italian Renaissance Imagination', in *Tomb and Temple: Re-imagining the Sacred Buildings of Jerusalem,* a cura di R. Griffith-Jones and E. Fernie, Woodbridge 2018, pp.164-80.

2018 (in stampa).

Il genio e le passioni 2001 = *Il genio e le passioni. Leonardo e il Cenacolo: precedenti, innovazioni, riflessi di un capolavoro*, catalogo della mostra (Milano, Civico Museo d'Arte Contemporanea 21 marzo - 17 giugno 2001), a cura di P.C. Marani, Milano 2001.

Gensini 2008 = S. Gensini, *Un luogo di pellegrinaggio sostitutivo: la "Gerusalemme" di San Vivaldo in Toscana*, in Barbero, Roma 2008, pp. 151-166.

Gualdo 2004 = G. Gualdo, *Lettera di notifica delle indulgenze di Leone X (19 febbraio 1516)*, in *Una "Gerusalemme" toscana sullo sfondo di due Giubilei :1500 – 1525*, (Atti del Convegno di studi, San Vivaldo-Montaione, 4 - 6 ottobre 2000), a cura di G. Gensini, Firenze 2004, pp.122-127.

Günther 2001 = H. Günther, *La ricezione dell'antico nel Tempietto*, in *Donato Bramante. Ricerche, proposte, riletture*, a cura di F.P. Di Teodoro, E. Bentivoglio, Urbino 2001, pp. 267-302.

Hofmann 1909 = T. Hofmann, *Raffael in seiner Bedeutung als Architekt*, 4 voll., Leipzig 1909.

Joannides 1983 = P. Joannides, *The drawings of Raphael with a complete catalogue*, Oxford 1983.

Kang 2015 = E-S. Kang, *Achieving proportion and balance:an early stage in Raphael's design process*, in *Raffael als Zeichner/Raphael as Draughtsman. Die Beiträge des Frankfurter Kolloquiums*, Städel Museum, Frankfurt [Michael Imhof Verlag, Petersberg], 2015, pp. 89-101.

Kemp, Kang 2006 = M. Kemp, E-S Kang, *Costruire la composizione,* in *Raffaello da Firenze a Roma*, catalogo della mostra (Roma, Galleria Borghese, 19 maggio -27 agosto 2006), a cura di A. Coliva, Milano 2006.

Kang 2006 = E-S. Kang, *Raphael's 'Annunciation' Predella Panel and a Perspective Drawing*, "The Burlington Magazine", vol. CXLVIII, 2006, pp. 545-548.

McKillop 1974 = S. McKillop, *Franciabigio*, Berkley 1974.

Marcantonio Raimondi 2016 = *Marcantonio Raimondi, Raphael and the image multiplied*, catalogo della mostra (Manchester, Whitworth Art Gallery, The University of Manchester, 20 settembre 2016 - 23 aprile l 2017) a cura di D. Morris e E.H. Wouk, Manchester 2016.

Monbeig Gougel 1987 = C. Monbeig Gougel, *Le Tracé invisible des dessins de Raphaël. Pour une problématique des techniques graphiques à la Renaissance*, in *Studi su Raffaello,* Atti del Congresso Internazionale di Studi (Urbino-Firenze, 6 - 14 aprile 1984), a cura di M. Sambucco Hamoud, M. L. Strocchi, 2 voll., Urbino 1987, I, pp. 377-389.

Mussolin 2013 = M. Mussolin, *Michelangelo e i disegni di figura: alcune considerazioni sulla carta e sull'uso dei fogli di Casa Buonarroti e del Gabinetto Disegni e Stampe degli Uffizi*, in *Michelangelo als Zeichner,* Akten des Internationalen Kolloquiums Wien, Albertina Museum, 19 – 20 novembre 2010, a cura di C. Echinger-Maurach, A.Gnann, J. Poeschke, Münster 2013, pp.145-165.

Pacciani 1987 = R.Pacciani, *L'architettura della chiesa e delle cappelle:note di una ricerca*, in *Gli abitanti immobili di San Vivaldo il Monte Sacro della Toscana,* a cura di A. Agnoletto, C. Fabre, F. Cardini et alii, Firenze 1987, pp. 49-172.

Pacciani 1989 = R. Pacciani, *L'architettura delle cappelle di S. Vivaldo: rapporti stilistici e iconografici*, in "*La "Gerusalmme" di San Vivaldo e i Sacri Monti in Europa*, a cura di S. Gensini, Pisa 1989, pp. 299-331.

Pacciani 1992 = R. Pacciani, *La "Gerusalemme" di S. Vivaldo e le informazioni sull'architettura dell'antica Gerusalemme nel primo '500*, in *Sacri Monti. Devozione, arte e cultura della controriforma*, a cura di L. Vaccaro, F. Ricardi, Milano 1992, pp.195-205.

Pacciani 2004 = R. Pacciani, *Un brano della "Città leggibile" di San Vivaldo: la cappella del Monte Sion: fondazione, committenti, destinazioni*, in *Una 'Gerusalemme' toscana sullo*

sfondo di due Giubilei, proceedings of the symposium in italiano please!! (San Vivaldo, Montaione, 4 - 6 ottobre 2000), a cura di S. Gensini, Florence 2004.

Piccard 1961 - 1997 = G. Piccard, *Findbücher der Wasserzeichenkartei Piccard im Hauptstaatsarchiv Stuttgart*, 17 voll., Stuttgart 1961 - 1997.

Plommer 1982 = W. H. Plommer, *The Cenacle on Mount Sion*, in *Crusader art in the twelfth century. The British School of Archaeology in Jersualem*, a cura di J. Folds, Oxford 1982, pp. 139-166.

Raphael in der Albertina 1983 = *Raphael in der Albertina.* Aus Anlass des 500. Geburtstages des Künstlers, catalogo della mostra (Vienna, Albertina 7 settembre - 12 novembre 1983), a cura di E. Mitsch, Vienna 1983.

Raffaello architetto 1984 = *Raffaello architetto*, catalogo della mostra (Roma, Campidoglio, Palazzo dei Conservatori, 29 febbraio – 15 maggio 1984), a cura di C.L.Frommel, S. Ray, M. Tafuri et alii, Milano 1984.

Raphael and his circle 1999 = *Raphael and his Circle. Drawings from Windsor Castle*, catalogo della mostra (Londra, The Queen's Gallery, 21 maggio – 10 ottobre 1999, Washington, D.C., The National Gallery of Art, 14 maggio – 23 luglio 2000, Toronto, The Art Gallery of Ontario, 6 agosto – 15 settembre 2000, Los Angeles, The J. Paul Getty Museum, 31 ottobre 2000 – 9 gennaio 2001) a cura di M. Clayton, London 1999.

Raphael 2017 = *Raphael. The Drawings*, catalogo della mostra (Oxford, Ashmolean Museum, 1 giugno – 3 settembre 2017), a cura di C. Whistler e B. Thomas con A. Gnann e A. Aceto, Oxford 2017.

Raffael 2017 = *Raffael*, catalogo della mostra (Wien, Albertina, 29 settembre 2017 – 7 gennaio 2018), a cura di A. Gnann, mit einem Vorwort von K. A. Schröder und Beiträgen von A. Gnann, B. Thomas und C. Whistler, München 2017.

Rosenthal 1964 = E.E.Rosenthal, *The antecedents of Bramante's tempietto*, in "Journal of the Society of Architectural Historians", 23, 1964, pp. 55-74.

Tordella 2008 = P.G. Tordella, *Forme dell'idea e dialettica invenzione-esecuzione nel disegno tra Quattro e Cinquecento. Il ruolo delle punte acrome* , in *Le techniche del disegno rinascimentale. Dai Materiali allo stile*, Atti del convegno internazionale, Firenze, Kunsthistorisches Institut 22 - 23 settembre, a cura di M. Faietti, L. Melli, A. Nova, "Mitteilungen des Kunsthistorischen Institutes in Florenz", 52, 2008, pp. 109-130.

Wadding 1933 = *Annales Minorum*, a cura di L. Wadding, XV, Quaracchi 1933, pp. 375-376.

Vannini 1989 = G. Vannini, *S. Vivaldo e la sua documentazione materiale:lineamenti di una ricerca archeologica*, in *La "Gerusalemme" di San Vivaldo e i Sacri Monti in Europa*, a cura di S. Gensini, Pisa 1989, pp. 241-270.

Vertova 1965 = L. Vertova, *I cenacoli fiorentini*, Torino 1965.

Zappella 2001 = G. Zappella, *Il libro antico a stampa: stuttura, technche, tipologie evoluzione*, 2 voll., Milano 2001.