aesthetics & architectural composition

proceedings
of the dresden
international
symposium
of architecture 2004

ralf weber / matthias amann (eds.)

Content

© 2005
Aesthetics and Architectural Composition.
Proceedings of the Dresden International Symposium of Architecture 2004
erscheint im
pro Literatur Verlag, D-82291 Mammendorf
Herausgeber: Ralf Weber/Matthias Albrecht Amann/
Lehrstuhl Raumgestaltung, TU Dresden.
ISBN 3-86611-022-7

Printed in Germany

Tomás García-Salgado:

Form in Site and Perspective

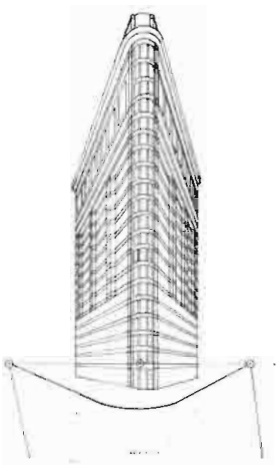


Fig. 1 *The 'Flatiron' anamorphic perspective effect*

Our approach to form in architecture and painting is based on its visual analysis in site. Of course, several other aspects as time, context, materials and constructive principles, are considered to make 'beautifulness' understandable in more tangible words.

Asking to ourselves if there is something in common between the Flatiron building and Leonardo's Last Supper, we might say that both images are easily recognizable; but why they are? The Flatiron's silhouette has become an urban landmark because it defines an urban spot, while Leonardo's illusionistic scene has become the universal icon of the 'drama' due its unique spatial composition, so the point is, what qualities made their form singular?

Its beauty and dimensions have inevitably stroked anyone who has admired Brunelleschi's dome, but how the eight principal ribs were raised to achieve its perfect form? We will see how materials and constructive principles can rule form when both challenge gravity.

According to Vitruvio's precept about the Eustylos temple, the central span of the columns should be increased up to 3 diameters. When Palladio borrowed this precept for the loggias in Villa Rotonda it was not pursuing a functional solution, rather an aesthetical one. He was mindful of all Vitruvian precepts but willing to replay them under his own *concinnitas* principle.

THE FLATIRON BUILDING PERSPECTIVE-ECHO

The Flatiron building (New York, 1902) becomes an urban icon due its privileged position at the junction of Broadway and Fifth Avenue. Its name, the flatiron, was dubbed by passers-by due its triangular form, which only is perceived in perspective at street level. The building exterior shape follows the form of the lot although its architectural plan was composed as a rectangular layout. The liken façades at the narrow angle and the heavy cornice over the top two-stories, are the most important features that made us familiar and recognizable the Flatiron's form.

Supposing the corner was it rectangular instead of triangular, what name do the passers-by may have given to the building? For sure not the 'flatiron' or 'the corner of the twenty-three skiddoo' —an anecdotic name, "...because the drafts created by the height of the new Flatiron Building at Twenty-third Street raised women's petticoats, and constables had to skiddoo the men who came to peek." (Dupré, 1996). Curiously, its semiotic nickname endures over the anecdotic one. If the Flatiron were not triangular surely it would not have been added to the US National Register of Historic Places.

It seems that Daniel Burnham's wanted to emphasize the building's verticality by giving all windows a vertical proportion. The two façades at the narrow corner are almost identical, only its length varies dimensionally to fit the lot size. But when the building is seen in perspective no difference between façades can be noticed due its anamorphic perspective effect (Fig. 1). In other words, depending on the observer's position, a slight difference between the two resembling façades can be confusing to assert which one is the larger or the shorter.

The Flatiron icon-image can only be perceived at street level, from a spot where the building is seen it at its narrow edge, otherwise, it would appear like many other buildings in New York. As the Flatiron's narrow angle is less than 30 degrees it allows the observers entirely to capture it within its visual field. Furthermore, as the streets vanish the same direction its façades do, its whole form becomes increased visually by the perspective-echo they produced. Such perspective-echo occurs when the vanishing points of a building are close enough to each other and coincidental with the urban layout at the same time. This is what makes the Flatiron building unique, nor its steel-cage constructive system, nor its elaborated cornice and lofty façades of limestone; it is in a phrase, due the harmony between its architectonic form and urban perspective-echo.

Architecture is a material fact while painting is an imaginative one, having in common the expression of form within the space. Thus architecture and painting produce different genres of space: one is real while the other is illusory.

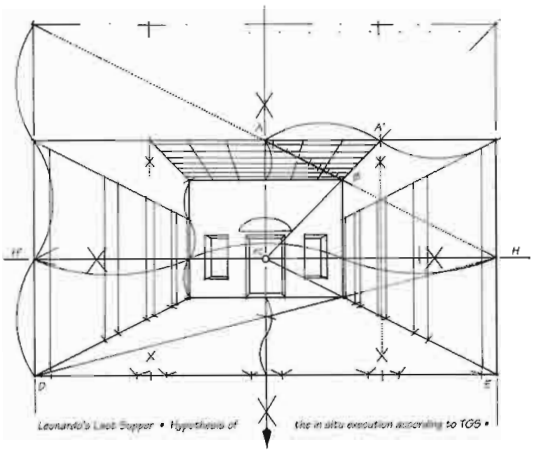


Fig. 2 *The author's hypothesis for the outlining of The Last Supper*

Fig. 3 *Teoretical reconstruction of Leonardo's refectory according to J. Manzanares and the author.*

LEONARDO'S LAST SUPPER PERSPECTIVE OUTLINING

In order to depict the Biblical story of the Last Supper (c. 1495), in the refectory of *Santa Maria delle Grazie* (Milan), Leonardo needed to create an illusory space on the wall. However there is no evidence of how he might have conceived the spatial connection between both the real and illusory refectories. There also is no evidence, weather he was aware of Ghirlandaio's Last Supper (*Ognissanti*, Florence, 1480) or the possible influence the former might have had from Andrea del Castagno (Florence, c. 1445). But the idea of painting architectonic motifs on the walls was already practice in Pompeii and Ercolano, where complicated perspective effects were achieved during the so-called Second and Fourth Styles. Our interest on this genre, especially in Leonardo's Last Supper, is about how an illusory space within a real space can be endowed with a perspective-echo.

I was very lucky in having the opportunity to set foot on Pinin Brambilla's scaffold, in front of the Last Supper, when she was restoring the fresco in 1994. Unique chance to reach Leonardo's vantage point and verify in place the perspective 'image-formation' of the scene as he saw it all the time. So I place myself exactly at Leonardo's eye level, at the center of the fresco, and at a distance of 4.425 m. Once in there what I saw was hard to believe: all the apostles figures appeared to me so well proportioned, without any body shape marginal distortions, lively discussing in a room almost 'real', with all its architectural and decorative elements well rendered in perspective, making me feel the illusion to be inside the scene. Solely from the vantage point one can perceive the apostles' size as if they were about our own size, in so far we might feel tempted to rebuke Judas. In other words the perceived scene from this unique point resembles nothing to the numerous well-known photographs.

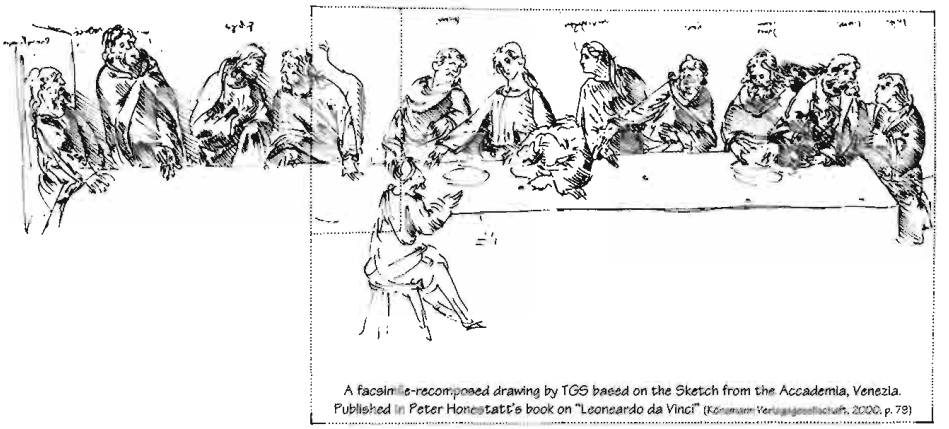
From this vantage point one can easily verify how the upper vanishing-line of the tapestries perfectly aligns with the feet of the liernes – at the lateral walls of the real refectory. In the frontal view, the feet of the liernes also align with the false architrave that frames the fresco, occluding the entire view of the coffering ceiling at the same time. These visual alignments between the illusory scene and the real refectory are what produce a perspective-echo, making the fresco belong only to the refectory of *Santa Maria delle Grazie*. It can never be understood without this unique spatial relation, so thanks heaven Napoleon threw over the idea of moving it to Paris.

The way Leonardo might have outlined the perspective of the Last Supper has been always an intriguing question. More precisely, the method he used. There is not one extant sketch related to the perspective construction. The most alike is the Accademia sketch for the composition of the apostles at the table. So looking an answer for this enigma, my hypothesis of the *in situ* execution stands on the perspective analysis of the fresco itself (García-Salgado, T., 1998), as it is shown in (Fig. 2).

OUTLINING THE FORM IN PERSPECTIVE

(1) The painting thoroughly covers the breadth of the wall, which is about 8.85 m, sizing in height a little more than a half of its width.

(2) As a first step, Leonardo marked out the visual horizon (H-H') of the scene at half-height of the area about to paint, putting the vanishing point (PC) at the center of line H-H'.



A facsimile-recomposed drawing by TGS based on the Sketch from the Accademia, Venezia.
Published in Peter Honestatt's book on "Leonardo da Vinci" (Könemann Verlagsgesellschaft, 2000, p. 79)

Fig. 4 *A facsimile-recomposed drawing by the author based in the original "Accademia Sketch" as published in: Honestott, P. (2000). Leonardo da Vinci. Germany: Könemann Verlagsgesellschaft mbH.*

(3) As he was left-handed, he determined point (A') on the right side of the wall after dividing the upper line into quarters. Then, where the visual line A'-PC intersects with line A-H point B is determined. Notice that point B defines the depth of the rear wall. Thus the perspective shape of the coffering ceiling was, deduced directly on the wall by means of these elementary tracings. At her studio, in Santa Maria delle Grazie, Pinin Brambilla kindly showed me a large infrared-photograph in which Leonardo's tracings for the coffering ceiling were clearly captured on the arriccio (a plaster coat underlying the final painting coat). I counted seven and a half coffers as they recede to PC, the same I was estimated before seeing Brambilla's photo.

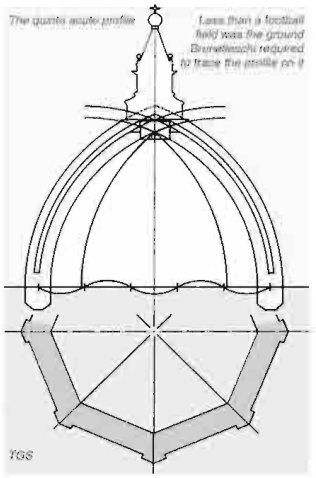
(4) The depth of the floor was even easier to obtain. It is determined where line D-H intersects with line PC-E. Notice how the whole composition can be divided horizontally and vertically in thirds, if theoretically the coffering ceiling extends upwards till is completed. An overwhelming perspective like this should destroy the horizontal dominance of the table (Fig. 3). Either way, it was not feasible to do it even if Leonardo wanted to, because the lunettes of the vault restricted the pictorial area. Therefore to avoid losing the effect of depth he wisely chose to leave exactly one-half of the coffering ceilings exposed to sight.

(5) Point H determined the so-called 'diagonal vanishing-point' (dvp), being distance the interval between PC-H that corresponds to the aforesaid 4.425 m. Over the baseline, the tapestries' sequence can directly be proportioned as if they were in real dimensions. So by carrying lines from each one of the baseline-marks to the dvp till they intersect with the corner-line of the floor, the tapestries' receding perspective is deduced.

(6) According to my hypothesis, Leonardo's Last Supper depicts a perfect square room in perspective. At the time of the extant sketch of the Accademia, it seems that the room was not yet fore sought as part of the composition since the apostles' table shows a higher visual horizon. It rather seems the apostles' table was adjusted in site after the room's perspective was outlined.

In my opinion, Leonardo was not a complicated man but rather an ingenious one. I believe that he probably outlined the illusory architecture directly on the wall, based on his 'legitimate construction' principle: "A-B is the prove" (MS. A 41a). And his distance concept: "The eye f and the eye t are one and the same thing..." being "f " the distance, and "t" the direction of it (Richter, 1970). Both geometrical precepts correspond in my drawing respectively, to the line D-H, and to the mathematical expression PC = dvp.

Despite the fact that the apostles' table and the room were not conceived at the same time in the composition, they appear as if they were. When and how this happens still remains a mystery. Besides the two preparatory drawings, the W12541r and the Accademia sketch, there is not other reliable evidence we can trust to infer the formal composition of the scene. In my understanding as a draftsman, the Accademia sketch could be the key to solve the mystery. As the sketch's paper sizes 29 x 39.2 cm, too short to contain the apostles' table in one piece, the scene was split in two. However what really matters here is what the artist may have envisioned through the sketch. By recomposing the split-sketch into a single one, as I did it in (Fig. 4), we probably may be able to see what was on the artist's mind... and it looks more like a unified scene; strongly resembling the final



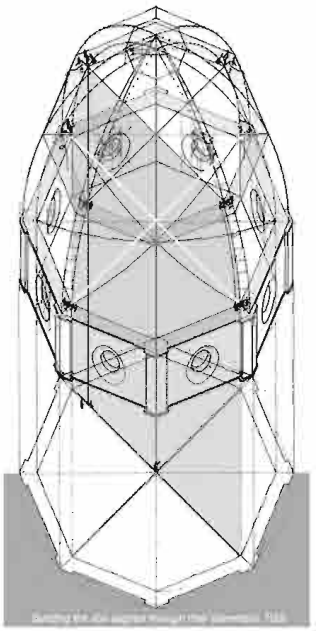


Fig. 5 *The dome's quinto acuto profile*

Fig. 6 *The ribs' survey construction according to the author's hypothesis*

composition, as we know it today. A lower table's visual-horizon and the apostles' regrouping seem to be the only differences between the final composition and the Accademia sketch.

Actually the Accademia sketch has a higher visual horizon because of Judas' isolated position at the table. Otherwise, by lowering the horizon, his enhanced body at the first plane would disrupt the whole composition. In my opinion, Judas' integration at the table helped to solve the apostle's arrangement in groups of three. A remarkable feature of the composition that was adjusted and depurated once Leonardo settled them all into the illusory architecture, right there on the wall.

BRUNELLESCHI'S DOME-DRAWING

Architecture, as construction, lies upon constructive principles either learned by tradition or invented to solve new problems. Working materials to their limit of strength can drive builders to invent new constructive forms, as when the Pantheon's concrete vault was built in Rome. Attempting the solution to span the dome of Santa Maria del Fiori (Florence) was a great challenge for the best builders during the early Renaissance, although the materials to be employed were already well known at the time: marble stone, sandstone, limestone, bricks, clay-tiles, chestnut-tree, oak, iron bars, iron nails, iron clamps and mortar, among others. Hence the real challenge was to imagine a new way to apply and bring them all to their limit of strength under an uncertain constructive system.

Three unavoidable restrictions were imposed from the beginning: the already settled octagonal plan of the dome, the 42 m height at the top of the tambour, and the 45.43 m span to cover —the largest one ever undertaken. Vasari, Manetti, and more recently, Battisti, Salvadori, and King, give us a detailed account of Beunelleschi's enterprise. An enterprise in which a ground scaffold, or wooden center support, could not be employed either to support the eight main ribs or the vault itself.

Brunelleschi's formal solution was as rational as effective. He traced the curvature of the eight pointed arches by means of the so-called *quinto acuto* profile. A profile generated by the curvature of the intersected arches when its radius measures four-fifths of the given span (Fig. 5). A vault like this has about half the tendency to burst in comparison with a semispherical one, been its horizontal thrusts reduced too. Choosing the quinto acuto profile was a clever idea of Brunelleschi's side because it enabled the dome to rise as much as the wardens of the opera wanted to. However they refused the idea of a double dome. But Brunelleschi, having in mind "to built for eternity", convinced them of such idea by arguing that an outer shell would protect the dome's inner shell from rain, humidity, wind and lightning.

To give the stones form and then after controlling their assemblage along the *quinto acuto* profile was the main problem to solve for the ribs erection. A wooden sectioned template could have been useful to guide the quarries in casting the ribs' stones —around 560 tons of white marble. Such a template(s) must have relied on life-sized drawings in order to assure both form and assemblage. Battista suggests that Brunelleschi leveled a place, close to the Arno River in Florence's valley, to trace the vault's plan on the ground (Battisti, 1989). However, it seems to me that not only did the octagonal plan need to be traced on the ground but so did its profile, since the quarries needed both references to shape three-dimensionally the stones. Thus only minimal adjustments were required to attach one stone to the other, after the ox-hoist lifted them one by one into place.

Nevertheless it remains a question: how the ribs construction was surveyed? King has suggested: "Filippo ran a cord (...) outward from the center of the dome to the inside edges of the masonry." (King, 2000). But actually the dome has not one center but eight of them, lying in pairs over each diameter of its octagonal base. In my opinion, Brunelleschi might have used the center of the dome only as a visual reference to keep the ribs aligned at their diameters. In such a way that running cords along the diameters of the dome's base, and doing the same at any other level he wanted to survey, both set of cords must 'visually' overlap to each other when seen form the center of the dome standing on the nave's floor (Fig. 6). But how the perfect form of the dome was exactly achieved still remains a mystery.

The internal curvature of the vault was lead by the eight main ribs since the shell's brick walls were rose after them. The herringbone brickwork prevented the walls from falling inwards until the new stone chain came to secure them, a necessary reinforcement to stabilize the dome during construction, as Salvadori says: "...because the uppermost ring completed acts as a key stone for its meridional arches and prevents them from falling inward." (Salvadori, 1990). Two more meridional arches, intersecting all the rings, reinforced each side of the octagon having as a result a well-unified vertical-horizontal constructive system.

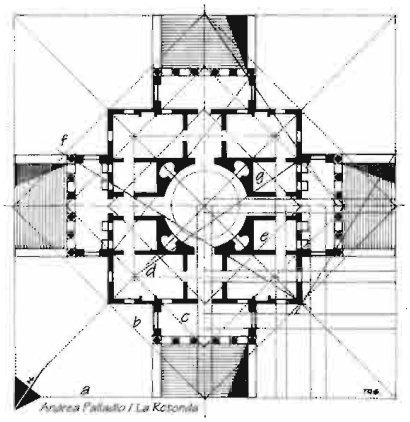


Fig. 7 *The Rotonda and its surrounding landscape.*
Photo: Tomás García Nicolín

Fig. 8 *The Rotonda proportion analysis by the author*

The prominent form of the eight main arches, in white marble, speaks not only on behalf of a constructive true but also of an aesthetical one. The small, visible circular windows around the outer shell suggest where the invisible meridian arches pass by. The circular windows on the octagonal tambour follow the form of those along the nave's sides. The red tiling all around the dome's exterior shell harmonizes with the surrounding roofs of houses, churches and public buildings. Walking through *Via dei Servi*, from *Piazza della S.S. Annunziata*, one can perceive the dome as an urban landmark stretching its perspective all along the street. As the Twin Towers did in New York until 9/11, Brunelleschi's dome proudly defines the city landscape from any spot around Florence valley until nowadays. Thus the visible and invisible constructive elements, carried out to their limits, are what make the dome unique. Sadly it is not yet finished; the so-called *gabbia del grillo* highly criticized by Michelangelo, still remains undone.

LA ROTONDA IN PERSPECTIVE AND PROPORTIONS

As main sources of Palladio's works we have his treatise, The Four Books (I Quattro Libri), and buildings, which gives us little room to hypothesize or theorize about his architecture. One can experience a timeless sense of beautifulness when surveying his buildings, especially the Villa Rotonda. As we know, gracefulness cannot be attributed to one single part or element of a building since it is precisely the whole work that causes it. So the question here is how to understand, geometrically, Palladio's idea of 'the whole'.

In the proem of his book Palladio proudly acknowledges: "I proposed to myself Vitruvio for my master and guide..." (Palladio, 2000). Being faithful to him by following his firmness (firmitas), usefulness (utilitas), and beautifulness (venustas) principles. According to Vitruvio's precept about the Eustylos temple, a colonnade should be spanned two diameters and a quarter of a column, while the central columns at the frontal and rear façades should span up to 3 diameters. It was not due structural restrictions why Palladio borrowed this precept for the Rotonda loggias; it rather was pursuing a subtle expression of its formal appearance. So he slightly opened the central span of the columns of the loggias to break its static composition. Most of the well-known buildings inspired in Palladio's Rotonda miss this aesthetical feature, including Jefferson's Library in Virginia.

The Villa Rotonda was not conceived as part of an urban tissue as Brunelleschi's dome was; neither did it involve major constructive problems, except for beauty and design. He constructed an idealized architecture according to his own idea of beauty, "in which the whole will correspond to its parts, of the parts relating to one another, and of these to the whole..." (Palladio, 2000). Palladio struggled to fulfill his idea according to Iddio Benedetto, which claimed, "the most beautiful parts (of the human body) should be exhibited at sight and the less onerously in hidden places." (Palladio, 2000). It is almost word by word the justification Palladio gave for architecture, when he said: "even ourselves, in building, we will place all the principal and observable parts at uncovered places and the less beautiful ones at the most hidden places..." (Palladio, 2000). As consequence all the domestic services were hiding at the ground plan of the villa. In the end, such controversial prejudice was demolished 40 years later, when Michelangelo obtained from Pope Julius II his approval for the Sistine Chapel nudes, by arguing that the whole human body is beautiful because

it is God's creation.

The villa genre as such was new at the time, as it is today the original idea of a transparent factory successfully achieved by Günter Henn in Die Gläserne Manufaktur, in Dresden (Germany). Besides the rustically functions, the villa was also conceived as recreational house to satisfy the new way of life the flourishing commercial society was demanding. Palladio took this opportunity to envision a new architectural program, having some times the chance of selecting the landscape siting for the villas. For instance, he advised Paolo Almerigo where to place the Rotonda in a land of his property near by the Bachiglione River and very close to Vicenza City. At the spot, he choose a flat ground at the summit of a mildly high hill so the villa could gain view from the distance, having the surrounding high hills as a background.

This envision of the exterior flows to the core of the villa itself, more precisely, to the rotonda chamber. And reciprocally, the inner space flows outwards throughout the loggias and vanishes into the horizon. In Palladio's words: "As it enjoys from every where of beautiful views, some of which are limited, some more extended, and others that terminate with the horizon; there were made loggias in all the four façades..." (Palladio, 2000). This idea, of a surrounding space going in and out of the house, is what justified the Rotonda's double symmetry or apparent redundancy of its loggias composition (Fig. 7).

Analyzing the Rotonda's plan, all the geometric relations among spaces and elements that we might found can hardly be interpreted as non-intentional ones. They rather seem to have been consciously planed as a perfect geometric puzzle tightened by invisible lines. Silvio Belli, Palladio's friend from the Accademia Olimpica of Vicenza, wrote a treatise on proportions (Belli, 2002), which may have influenced Palladio's practice in architecture. Since Belli's book did not contain any practical applications and Palladio's book did not explain any particular villa proportions, we must find some clue to link them. Such a clue might be Belli's "la simile", as interpreted by Wassell-Williams (Belli, 2002), and Palladio's own precept about "dell'altezza delle stanze" (Palladio, 2000), since both can have the same geometric interpretation.

Instead of presenting the Rotonda proportions in numbers I believe is better to show them geometrically, without mattering if there is or not visual continuity among all the chambers, since the idea of 'the whole' does not necessarily mean they have to be seen at once. According to The Four Books, the width and length proportions of the chambers —in Vicentine feet— are: 12: 30 (loggias), 15: 26 (main chambers), 11: 15 (small rooms), 6: 15 (corridor access), and radius = 30 (rotunda room). Heights are: columns, 18; between the ground floor and the main floor, 10; main chambers, 21(3/4) and the attic, 7. These proportions vary a little according to Semenzato's accurate measuring of the building in place (Semenzato, 1990). Our analysis of the Rotonda proportions combines Palladio's original ratios, Semenzato's verification of the main hall accesses, and some measurements and photographs of my own (Fig. 8).

SQUARES WITHIN SQUARES

(1) Taking as limit of the building the four fly-stairs, a virtual square (a) can be generated.

(2) Square (b) is obtained by inscribing the four corners of the building within a 45º rotated square; passing by the plinth of the extreme columns of the loggias until reaches the center of the fly-stairs. Observing the building from any of the fly-stairs, first step, it makes sense the relation between (a) and (b) squares since no one of the other loggias can be see it except the one in front of us.

(3) Taking now the center of the latest step-nose at each one of the fly-stairs, a new 45º rotated square (c) can be traced. This square runs across the main chambers and loggias diagonally, passing by its interior corners and chimney's border.

(4) Where the diagonal lines of square (a) intersect with square (c), a new square (d) is conformed. As a cord can be stretched along the perimeter of square (d), it could have been helpful during construction for measuring. Notice how square (d) crosses all the chambers' entrances, whether at its centers or sides.

(5) From the thresholds of the four main entrances, one last 45º rotated square (e) can be traced. This square perfectly inscribes the nucleus of the house and also becomes coincidental with several door-sides.

(6) The smallest square corresponds to that of the nucleus of the house. It measures 30f, as the long side of the loggias, and inscribes the rotunda room as well its four inner stairs.

(7) Line (f) represents a diagonal within a main chamber. Notice how (f) reaches the center of a column in the loggia while relating other inner elements of the house. Plotting a perpendicular to (f) at the main chamber's corner, new relations can be founded.

(8) Other interesting relations can be deduced by tracing diagonal lines into the small chambers, as it is indicated by line (g).

(9) Even more remarkable and unexpected relations can be explored by superimposing a transparent sheet over Fig. 7, as follow: to begin with, draw on a crystal paper an orthogonal axes-system at its center. Then superimpose the crystal paper making coincidental its orthogonal axes with that of the Rotonda's plan. Now, slowly start rotating the transparent sheet until its axes encounter some elements of the house, such as columns, room corners, thresholds, door sides, window sides, walls and stairs. Performing this exploration, it becomes evident and comprehensive what the concept of 'the whole' and 'the parts' mean in Palladio's architecture.

CONCLUSIONS

Brunelleschi envisioned the dome's form before building it while Leonardo created the illusory space of the Last Supper during its execution process. Composition, as the arrangement of the parts in correspondence to the whole, was the leading precept in Palladio's architecture, whereas its material form reflects his own idea of beauty. The Rotonda four loggias gracefully integrate the surrounding landscape likewise the Flatiron façades absorbs the urban layout as an echo of its form itself. As we saw, through these four examples, there are not preestablished rules leading form in design, it rather seems is the architect or the artist who made them. In plain words, creativity has been and will be the fountainhead of form.

GARCÍA-SALGADO, Tomás | Researcher of the Faculty of Architecture | UNAM, Mexico | tgsalgado@perspectivegeometry.com

BIBLIOGRAPHY:

1 Dupré, J. (1996). Skyscrapers. New York: Black Dog & Leventhal Publishers, Inc.

2 Garcia-Salgado, T. (1998). La Perspectiva de la Ultima Cena de Leonardo da Vinci. Ciencia y Desarrollo, 24 (143), 34-47.

3 Richter, J. P. (1970). The Notebooks of Leonardo da Vinci. New York: Dover Publications, Inc.

4 king, R. (2000). Brunelleschi's Dome. New York: Walter & Company.

5 Salvadori, M. (1990). Why Buildings Stand Up. USA: Norton & Company.

6 Palladio, A. (2000). I Quattro Libri della'Architettura. Milano: Ulrico Hoepli.

7 Belli, S. (2002). On Ratio and Proportion. In S. R. Wassell and K. Williams, Translation and Commentary (pp. 71-94). Firenze: Kim Williams Books.

8 Semenzato, C. (1990). L'architettura della Rotonda. In Adrea Palladio la Rotonda. Milano: Electa (pp. 45-100).