Natural Component in the Plan Composition Formation of Moscow Historical Settlements

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Abstract. The natural component in the formation of the historical settlements’ plan composition (on the example of the Moscow city) is studied in the article. A scientist Kudryavtsev believes that the main technique in the Russian medieval architects’ arsenal was the reception of the buildings’ location similarity, planning elements and compositional accents to the location of vegetation types on relief elements. This thesis was taken into account during conducting research on the subject to make a historical documentary compositional analysis of urban planning content - Petrov Drawing. The purpose of the analysis was to determine the drawing’s organic geometry of the Moscow 16th century plan, combined with the modern plan to confirm the truth of the town- documentary planning. In this research option, the combination of the compositional structural analysis’ method, which is typical for the art study, and the environmental approach, adopted to address issues of urban planning, are optimal.

1. Introduction

The most important and technically necessary moment is to conduct a compositional analysis of the urban area’s historical documents. The analysis is carried out both assessing the artistic significance of the document itself and its information accuracy. This is due to the fact that, landscape features are mainly preserved in the present state, at the sites of historical development, which perception is reflected in the historical plans, axonometric or prospects of cities in connection with the development from special viewpoints. It is possible to identify the missing components that can be returned during reconstruction and restoration work in the comparing process the existing state of the city’s composition and the state reflected on the document. [1].

The research theoretical basis was the works of Anshraf Mansour and Habib Mansour, Bart R., Grimm G., Zholtovsky I., Krinsky V., Mamaev N., Marutaev M., Penetorn D, Petrovich J., Pokrovsky G., Sazonov V., Federyakina V., Hambidge D., Sheveleva I., Shmeleva I., Elama K., Yakovleva M.

2. Materials and methods

The planning of a historical settlement is considered, based on archival sources in connection with the specifics of the research. The best combination is the compositional and structural analysis method, which is typical for the art study, and the environmental approach, used to solve urban planning issues. Moscow plan, dated 1597, which was discovered in the documentary archives of Peter the Great in 1837, so, it was called the Peter's Drawing, was analyzed in this paper. See figure 1.
Documentary compositional analysis, containing textual and graphic information is carried out in two stages, in accordance with the tasks to be solved:

1. the definition in the composition geometry of the Petrov’s Drawing, by identifying compositional nodes, axes, grids on the Moscow city’s historical plan;
2. finding details, elements, fragments of the Moscow modern plan, coinciding in its drawing with the geometry, obtained as a compositional analysis’ result of a historical document, and confirming, in turn, the truth of the urban planning information transmitted by the ancient drawing.

3. Results
The Petrov’s Drawing (Figure 1) is the Moscow city’s plan with a pronounced radial-ring layout, oriented with the upper west towards the west. The main plan’s compositional axis is the Moscow River, located on the drawing from top to bottom, close to the vertical. The central part of the city, the Kremlin is picturesquely spread on Borovitsky hill, within the boundaries of the fortress walls, erected at the end of the 15th century. The territory of the city, enclosed in the outer Zemlyanoy Val, is divided into quarters of residential buildings, building arrays with land and green spaces without building - gardens and vegetable gardens.

The most significant landscaped areas are Gosudarev Garden and Aptekarsky (since 1856, Alexander) garden within the Zemlyanoy Val.

The Pharmaceutical Garden, depicted as a regular rectangle with two rows of woody plantings is located beyond the Neglinka River, in the northwest of the Kremlin in the plan. The woody plantings within the Pharmaceutical Garden borders are determined by the axonometric image of trees with a shadow in the north direction.

The Pharmaceutical Garden is depicted as an organically complementary part of the territory close to the triangle in the Kremlin plan. See figure 2.

Figure 1. The Petrov’s Drawing 1597.

Figure 2. Pharmaceutical and the Gosudarev Garden on the Petrov’s Drawing, 1597.

In turn, the Gosudarev Garden is located in Zamoskvorechye, south of the Kremlin. It is a trapezoid elongated on the bases, oriented on the drawing from bottom to top in its shape in plan. It is visually perceived as a part of the city center, separated by a strip of the Moscow River from the Kremlin and Kitai Gorod territory. Autonomy and close proximity to the Kremlin, at the same time, allow us to consider the Gosudarev Garden as an important drawing and urban planning element (node). See Figure 2.
The division into the drawing and town-planning of the Gosudarev Garden significance on the Drawing determines some formality (in this case, inaccuracy) of the Petrov’s Drawing. Here, the layout mismatch of some town-planning elements, indicated on the Drawing, have been preserved to our time and can be considered as the current state. For example, the Kremlin’s plan does not correspond to modern drawing, which towers of the fortress walls were built at the end of the 15th century (100 years before the drawing). The plan with many reconstructions of the upper parts remains in the same place.

There is symmetry of the planning details’ rotation. See Figure 3b.

The implicit center of the composition is determined by the first two signs of the composition. Conventionally, the center is indicated by a yellow rectangle. See Figure 3.b.

The composition’s categories (patterns) in the garden’s internal layout allow extrapolating the obtained geometric constructions to the entire drawing as a significant drawing and town-planning element of the Petrov’s Drawing. This is possible with the introduction of several scale levels, used in the transition from parts to fragments of drawing elements, from fragments to elements, from small to medium scale, and from medium to large one.

A large scale can be determined from the overall dimensions ratio of the Gosudarev Garden, as one of the Drawing elements. The width ratio of the garden to its length (along the height of the drawing) is 1: 3., including a triangular section 1: 2. See Figure 4.

The division of the Gosudarev Garden plan in height by 3 parts, equal to its width.

The division of the Gosudarev Garden plan into fragments in accordance with certain proportions (1: 3; 1: 2) corresponds to the found horizontal line of equilibrium. It is shown by a thick red line in the drawing. The surface area of the garden above and below the equilibrium line is equal to both a square and a right-angled triangle, with an aspect ratio of 1: 2 with a common base.
Further, dividing the garden into fragments allows you to form a rectangular grid for the entire drawing with a cell, which horizontal and vertical dimensions are equal to the width of the Gosudarev Garden. See Figure 5.

![Figure 5. Rectangular equilateral grid on the Gosudarev Garden plan.](image)

The vertical and horizontal lines, the crosshairs of the vertical and horizontal lines that make up the rectangular grid, have a certain interaction with the streets, intersections, building lines, drawing of the Kremlin wall depicted in the drawing.

The ratio of the rectangle sides (part of the grid) where the Gosudarev Garden plan is inscribed 1:3, as it is said above. At the same time, one part of the plan is made in the form of a square, and the other in the form of a right triangle with an aspect ratio of 1:2. If we extend the inclined line of triangle with respect to rectangular grid to the intersection with the main compositional axis of the Moscow River plan, or rather cut off the its left bank water, and then apply a mirror image of this inclined line, which coincides with the middle of a squares column of the rectangular grid then it turns out that the viewpoint is significant from the Vodovzvodnaya Tower to the Spasskaya Tower of the Kremlin, according to the author of the article “The Destiny of the Blind”. This direction coincides with the line of sunrise on the summer equinox day on June 22 for the Moscow territory of the past and present states.

Duplicating oblique in two directions through nodes of a rectangular grid creates a variant of a rhombic grid, which fragments coincide with significant elements of the Moscow plan, and text with graphic details of the Drawing. See Figure 6a, in particular, with a Coat of the arms drawing, located in the upper left corner of the Drawing. See Figure 6b.

![Figure 6a. Petrov Drawing aligned with a rhombic grid.](image)

![Figure 6b. Coat of arms on the Peter's Drawing, combined with a rhombic grid.](image)

The next step in compositional analysis is to combine the two variants of the resulting rectangular and rhombic grids into one - rectangular-rhombic. The next research step is to consider the combination of a rectangular-rhombic grid with the Peter's Drawing in detail.
The most “active” is the Vodovzvodnaya tower, according to the geometry, on the Kremlin plan in the Peter’s Drawing. Through its location, there are the main lines of both a rectangular-rhombic grid, and additional construction lines (yellow lines). The orange-red line carries a certain physical meaning, connecting the Vodovzvodnaya and Spasskaya towers, as it was noted above. If you mentally connect the Vodovzvodnaya Tower and the diametrically opposite corner of the Kremlin walls, then there is a coincidence with the street that existed in the 16th century, passing through the Kremlin territory. The rest of the yellow lines are fairly easily captured by the grid nodes. One is an inclined right-angled triangle with an aspect ratio of 3: 7, the other is 5: 6.

Further grid’s study, consisting of rectangular and inclined elements, allows us to determine the outline of the Kremlin’s plan on the Drawing, which does not correspond to its true state, but, in the Drawing’s version, it is completely done, using the grid details. When the rectangular-rhombic grid is combined with the Kremlin plan, depicted on the Peter's Drawing, the brown outline is an image of the Kremlin wall plan on the Peter's Drawing, and the light blue line is the result of drawing the Kremlin plan on rhombic and rectangular grids. The brown outline almost completely covers the light blue outline of the Kremlin’s grid plan. See Figure 7. In Figure 7. Vodovzvodnaya and Spasskaya towers are indicated with purple circles to combine the Kremlin plan and the rectangular-rhombic grid.

![Figure 7. Combining of the Kremlin plan with a rectangular-rhombic grid.](image)

Thus, the compositionally organized the Petrov’s Drawing is organically combined with a rectangular-rhombic grid, developed on the basis of the compositional patterns where the Gosudarev Garden plan is built. When the Petrov’s Drawing is examined in detail, all the dominant elements of the Moscow city plan can be obtained directly from the grid, or as a result of simple geometric constructions taking into account the scale of the part, fragment, or drawing element under study. Additional crushing of the grid cells is possible in two and four times with a larger scale of the Drawing; a small one allows achieving the greatest coincidence of the town-planning elements geometry and the resulting grid.

It is possible to critically assess the existing state of historical development, especially in the environmental aspect, taking into account the landscape and technogenic environment, thanks to the obtained composite tool - a rectangular-rhombic grid.

In order to clarify this situation, we perform a combination of a rectangular-rhombic grid, obtained as a result of compositional analysis of the Moscow modern plan, copied from the precautionary zone of the Moscow city, maintaining the building proportions. At the same time, two versions of the Moscow plan - the 16th century and the modern one of the grid scale, found in the compositional analysis of the Petrov’s Drawing, is preserved.

The size of the Kremlin fortress wall, located parallel to the axis of the Moscow River, is determined in this case, as it is most accurately transferred to the Petrov’s Drawing in relation to the current state of the Kremlin’s plan. Figure 8.
Figure 8. The modern plan of Moscow, copied from the PZC. Central part.

In the drawing, a cut is made according to rectangular tablets, with the long side oriented north-south, from the Moscow PZC.

The PZC plan needs to be expanded so that the Petrov's Drawing plan and the modern plan coincide according to the chosen criterion - the Kremlin wall, which runs parallel to the axis of the Moscow River for the most accurate combination of the rectangular-rhombic grid with the Moscow modern plan. The rotation is carried out at 107 degrees. See Figure 9.

Figure 9. Reversal of the PZC drawing to achieve compliance with the Peter's Drawing and an increase in the rectangular-rhombic grid.

At the same time, the grid scale is increased by 3 times. This is due to the fact that the Moscow city area has increased significantly compared to the 16th century, and the scale also increased. A 3-fold increase gives a full inclusion of the Kremlin’s plan into the rectangular grid cell together with the rhombic grid, turns on and duplicates the leading main streets of the city center. Also, the rhombic grid accurately describes the city water bodies - the Moscow River and the drainage channel in a modern state. See Figure 10.

The rectangular-diagonal, obtained by geometric constructions, enlarge 3 times (the ratio of the Gosudarev Garden length 1: 3) in terms of the square cells size, has a 98 percent coincidence with the dimensions of the map-cases’ length on the Moscow PZC plan is an interesting fact.

The development sites of Moscow central part are examined for compliance with a rectangular-rhombic grid for greater clarity. In this case, it is assumed that the development coincides in the direction of its dimensions with the boundaries direction of the plots, reflected in the PZC drawing.
One can note an explicit orientation of the certain part’s boundaries of the plots with grid lines, both a rectangular and a rhombic position with a rather chaotic piling up of private and municipal property plots. Most of the sites are oriented exactly on a rectangular-diagonal grid, and does not coincide with the direction of the breakdown into map-cases. See Figure 11.

![Figure 10](image1.png)

**Figure 10.** Combining the design of the Moscow PZC with a rectangular-rhombic grid.

![Figure 11](image2.png)

**Figure 11.** Combining a fragment of a plan for the modern development of Moscow central part with a rectangular-rhombic grid.

In order to compare the coincidence magnitude with the rectangular-rhombic grid of the 16th century building direction and the current state, figure 12 is located with the coincidence of the 16th century residential building and the rectangular-rhombic grid in the upper right corner of the drawing.

![Figure 12](image3.png)

**Figure 12.** Combining a fragment of a residential development plan for Moscow central part of the 16th century with a rectangular-rhombic grid.
At the same time, there are two interesting, according to combining the moment:

1. The Kremlin organically fits into the square of the grid, increased by 3 times, both on the Petrovsky Drawing, and on the Moscow modern plan with taking into account the inconsistency of the Kremlin’s plan on the 16th century document and its true drawing.

2. The line connecting the Vodovzvodnaya and Spasskaya towers, both on the 16th century document and the drawing of the Moscow PZC coincides with the grid rhombic element. See Figure 9 and Figure 12.

4. Conclusion

Thus, the found composite tool - a rectangular-diagonal grid is organically combined with both the development plan, reflected on the 16th century document, and the development of the Moscow modern plan.

The developed methodology for determining the plans’ composition for historical settlements, in order to find details, elements, fragments of the Moscow modern plan, coinciding in their drawing with the geometry, obtained as a result of a historical documentary compositional analysis, despite the inaccuracy of some architectural and urban-planning objects’ image that have survived to this day (Kremlevskaya wall) confirms the truth of the urban planning information, transmitted by the ancient drawing.

The novelty of this research work is as follows;

1. A methodology for the compositional analysis of urban planning documents of the Moscow city, different in creation time, was developed.

2. A composite tool - a rectangular-rhombic grid organically combined with the Moscow plans of different times of creation was found.

3. A technique of compositional analysis “from particular to general”, detailing the image in the drawing for the purpose of emphasis, to planning the of the past, and then the present with its further development, has been developed, compared with the already known options for obtaining and using composite grids to create an artwork, or their critical analysis, (when the grids were placed within the boundaries of the canvas, drawing, or some other restriction without initial binding to any element, or the binding was carried out intuitively). And this is the most organic, because the city is a multifaceted and constantly changing system in time, which basis for the formation is both the will of man and the laws of nature.

In the future, further research work with the historical document Petrov’s Drawing is supposed to determine the reasons for the inaccurate depiction of the Kremlin fortress wall plan from a compositional point of view.

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