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THE ISSUE OF CHOOSING A RATIONAL METHOD FOR SOLVING POSITIONAL PROBLEMS DEPENDING ON INITIAL CONDITIONS

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Abstract *– The paper addresses the selection of methods for solving epure exercises in the course "Descriptive Geometry". It evaluates the number of necessary graphic constructions depending on the chosen solution method. It is shown that while projection transformation methods are more visual and versatile, they require more graphic constructions under certain initial conditions than conventional methods. An example of such a problem is provided, illustrating the solution using transformation methods and their application. The impact of the spatial arrangement of given geometric objects on the number of graphic constructions required to solve the problem is illustrated.*

Keywords *Descriptive geometry, method of projection plane transformation, graphic constructions, horizontal line.*

Problem statement. In solving descriptive geometry problems, the accuracy of the obtained result significantly depends on the number of graphic constructions used. The choice of the solution method largely depends on the complexity of the task. However, besides the set of geometric objects given in the problem statement, their spatial arrangement significantly influences the choice of the most rational solution method.

Analysis of recent research. Most works on the choice of solving descriptive geometry problems note that using projection transformation methods allows for a more visual result with relatively fewer constructions. This assertion is valid because obtaining results for complex problems without transformation methods requires deep theoretical knowledge and practical skills in graphic constructions. Additionally, it increases the inaccuracy of the results and the likelihood of errors. Projection transformation methods provide simpler and clearer visualizations, which is especially important when dealing with complex spatial configurations. However, insufficient attention is paid to the impact of initial problem conditions on the choice of the most rational solution method, which can significantly affect the efficiency and accuracy of the final result.

Formulation of goals (Problem statement). The goal of this work is to explore the rationality of choosing a solution method depending on its initial conditions. By examining how different initial spatial arrangements of geometric objects affect the complexity and accuracy of the solution, we aim to identify the most efficient methods for some scenarios.

The main part. Consider the following problem:

Initial condition: Point $A(A_1,A_2)$ and line $l(l_1,l_2)$ (Fig. 1).

Task: Construct a square *ABCD* with diagonal *BC* on line *l*. The graphical initial condition is represented in Fig. 1.

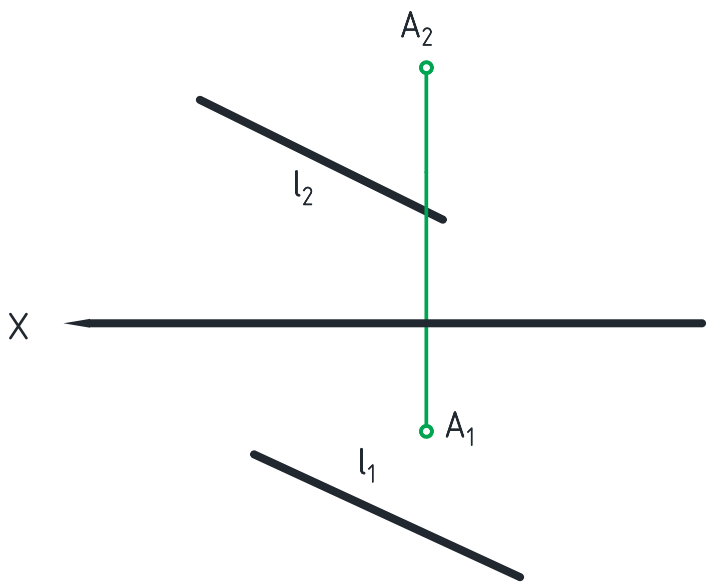

Fig. 1. The graphical initial condition

Consider the solution to this problem without using projection plane transformation methods (Fig. 2). It consists of the following steps:

1. Construct plane Ω *(h,f)* perpendicular to line l and passing through point *A*.
2. By intersecting the constructed plane Ω with the given line *l*, find point *O*, the intersection of the diagonals of the sought square *ABCD*. This is done using an auxiliary plane – intermediary $\Delta(\Delta_2)$, which intersects Ω along line *a*. Point *O* is found as the intersection of lines *l* and *a*.
3. Using the right triangle method, obtain the true length of segment *AO*, half the length of the diagonal of the sought square *ABCD*.
4. Using an auxiliary point *3* and the right triangle method, find point *B*, equidistant from point *O* as point *A*.
5. The two remaining vertices of the square – points *C* and *D* – are constructed as symmetrical to known points *A* and *B* relative to point *O* along directions *AO* and *BO*.

As shown, this solution method requires a large number of constructions, negatively affecting the accuracy of the result and increasing the risk of errors.

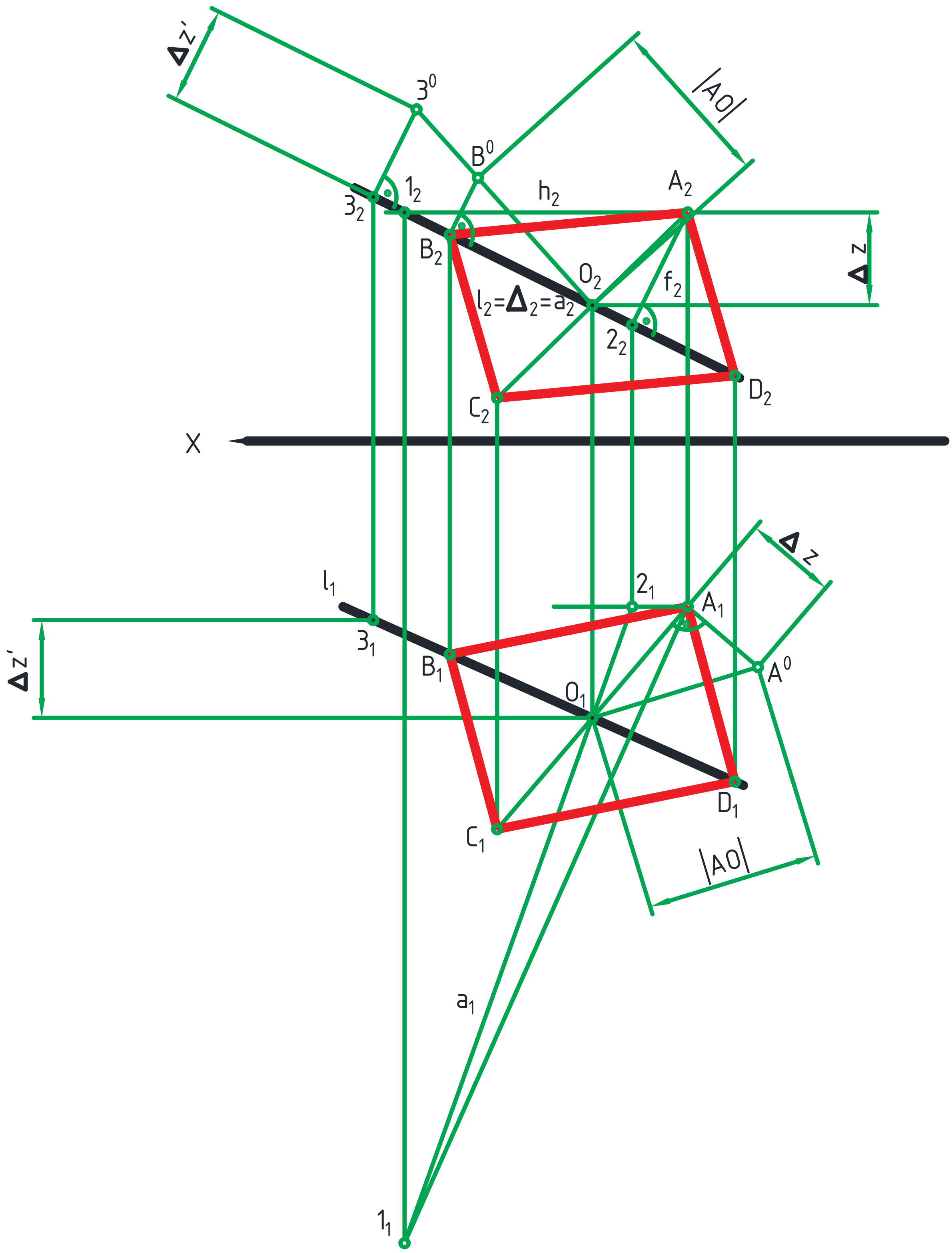

Fig. 2. Solution without using projection transformation methods

Now consider the problem solution using the method of changing projection planes (Fig. 3). Since all geometric objects and the future result – square *ABCD* –

are located in one plane, transform this plane into a level plane. The construction occurs in two stages:

1. Transition from the given coordinate system $x\frac{\Pi_2}{\Pi_1}$ to the new one $x_1\frac{\Pi_4}{\Pi_1}$, where x_1 is perpendicular to h_1 of the plane.
2. Change the system $x_1\frac{\Pi_4}{\Pi_1}$ to the new one $x_1\frac{\Pi_4}{\Pi_1}$, parallel to the found Σ_4.

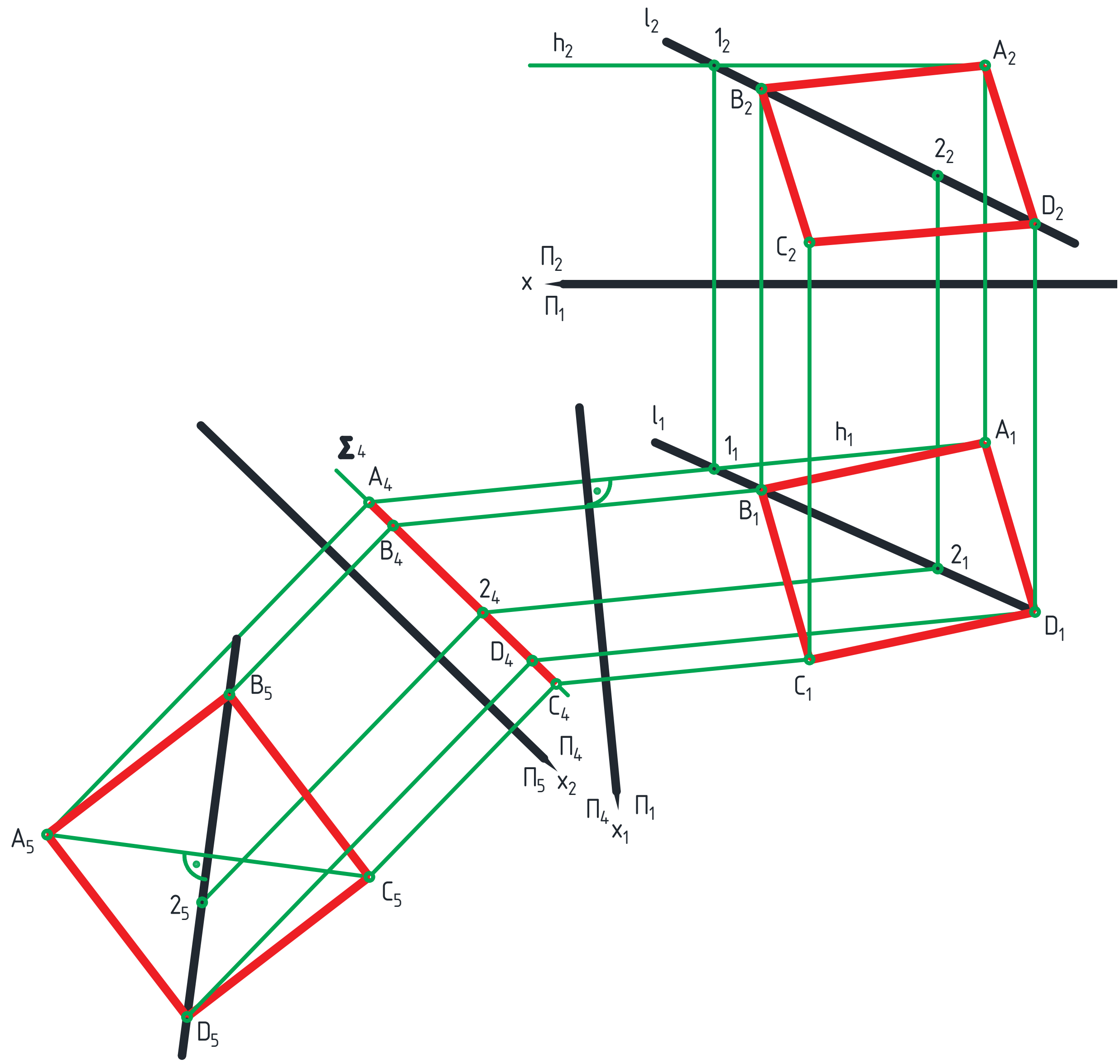

Fig. 3. Solution using projection plane transformation methods

It is evident that the second method is much simpler and clearer, requiring significantly fewer constructions. Additionally, it is more convenient to visualize using computer graphics.

Now change the initial problem condition. Instead of the general position line *l*, take the horizontal *h* (Fig. 4).

First, solve the problem without using projection transformation methods. Geometrically, all steps coincide with those described above. However, since the line given in the condition is a special position line, the number of required constructions is significantly reduced (Fig. 5).

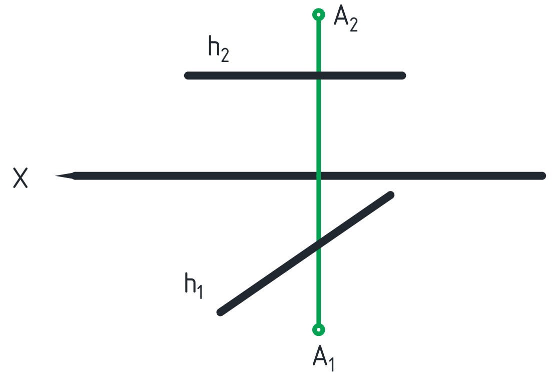

Fig. 4. Changed initial condition

The plane becomes a horizontal projection plane, simplifying the location of point *O*. To construct point *B*, equidistant from *O* by half the diagonal length of the square, directly use the h_1 projection of line *h*.

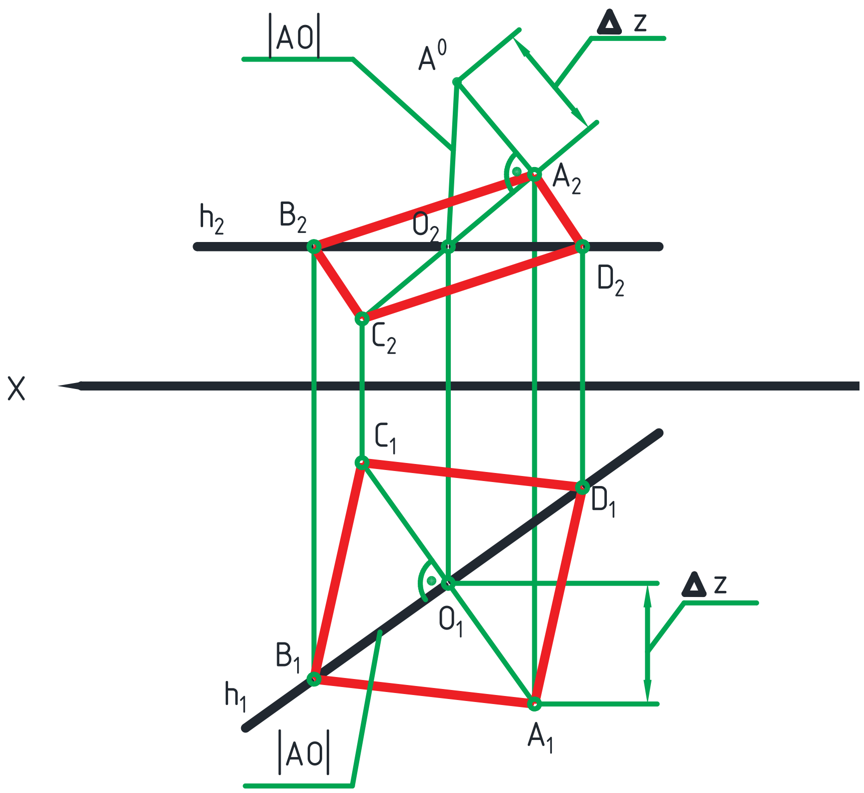

Fig. 5. Solution with changed initial condition without using projection plane transformation methods

Comparing the solutions using the projection plane transformation method for the initial and changed initial problem conditions (Figs. 3 and 6), the number of required geometric constructions is almost unchanged. This consistency highlights the method's efficiency in simplifying spatial relationships. However, solving the problem without projection plane transformation methods under the initial and changed conditions significantly differs in the number of constructions (Figs. 2 and 5). The traditional method for the initial condition involves numerous steps, increasing the risk of errors and reducing accuracy. When the initial condition changes to a horizontal line, the problem simplifies, yet the traditional method still requires more constructions. Thus, the projection plane transformation method remains more efficient and consistent, regardless of the initial conditions.

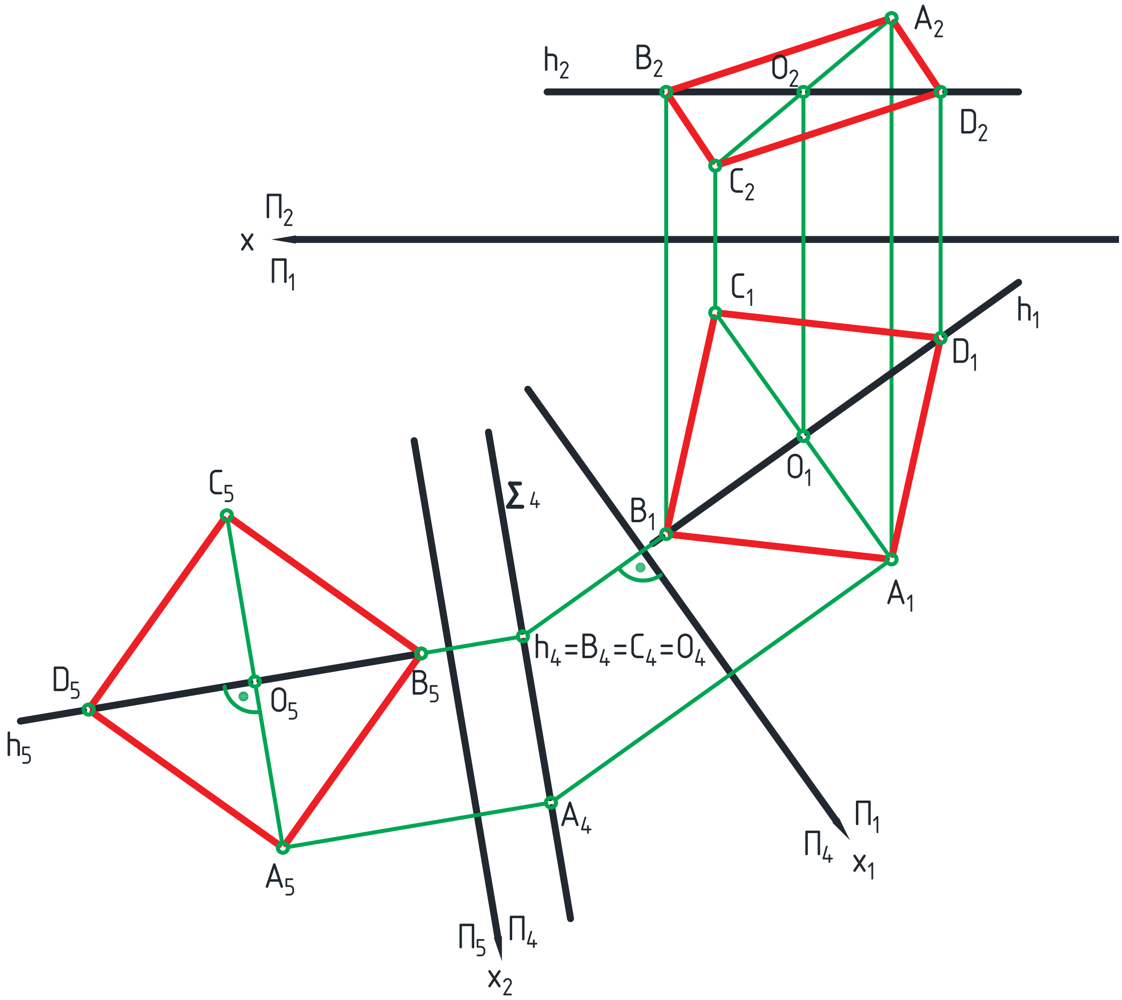

Fig. 6. Solution with changed initial condition using projection plane transformation

Conclusions.

1. Methods of solving problems using projection plane transformations are sufficiently universal and visual, allowing in most cases to find a result with minimal graphic constructions. These techniques streamline the process of transforming complex spatial configurations into simpler, more manageable forms, enhancing the clarity and efficiency of the solution process. By leveraging the inherent properties of projection planes, such methods provide intuitive visualizations that facilitate accurate problem-solving across a wide range of scenarios.
2. However, to choose the most rational solution method, it is necessary to analyze the geometric characteristics of the objects in the initial condition. While projection plane transformations offer significant advantages in simplifying complex problems, the suitability of this approach depends on the specific geometric properties and spatial relationships involved. Factors such as the arrangement of geometric objects, their alignment with principal planes, and the presence of special position lines all influence the effectiveness of projection techniques. Therefore, a thorough understanding of the problem's geometric context is essential for selecting the most appropriate and efficient solution method.

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