METHODICAL RECOMMENDATIONS FOR DETERMINING THE VISIBILITY OF GEOMETRIC SHAPES IN PERSPECTIVE DRAWINGS

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***Annotation**. This article describes the content of the solution of positional problems by the method of central projection, scientific and methodological recommendations for determining the visibility-invisibility between geometric shapes in positional problems.*

***Keywords**. Perspective, position problem, central projection, straight line, plane, point of intersection, line of intersection, clear image, visibility-invisibility, competing point.*

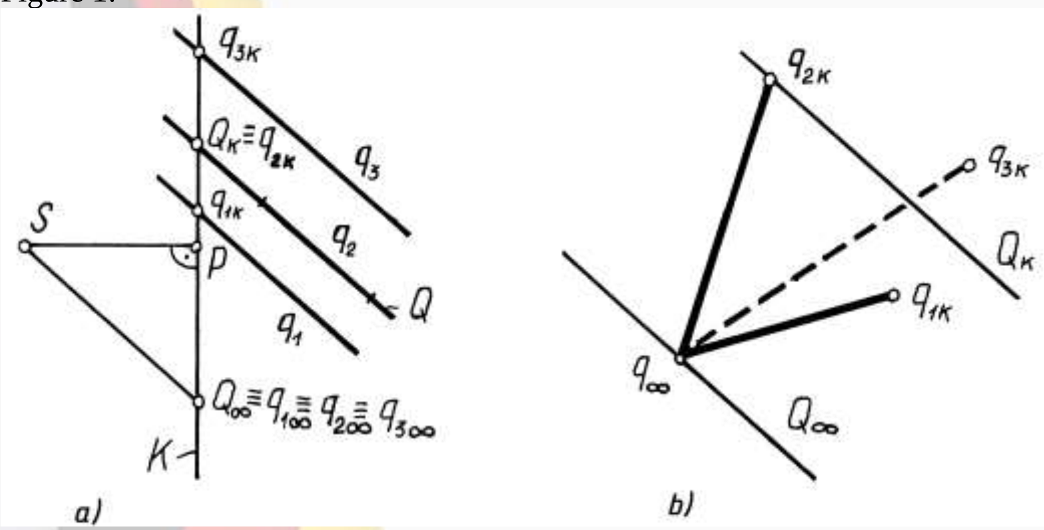
From our many years of teaching experience, it is well known that while students can solve positional problems using ready-made algorithms when mastering central projections, many of them cannot "get inside" it, that is, cannot imagine it. The main reason for this is the lack of development and popularization of methods for determining visibility in central projections. So, this problem has been neglected in education and other literature. It is one of the scientific and methodological issues that needs to be addressed.

We now define the straight line and the plane and the invisible parts of the planes in relation to their relative positions.

Let S be the point of view in space and K the plane of the picture. In the central projections, the plane of the picture is considered transparent. The trace QK in the picture and the descent line are given by the plane Q through Q∞, in which lies the straight line q2 and the straight lines q1 in front of it and q3 in the back relative to the observation point of the plane Q (1- picture, a).

The straight lines q1, q2, and q3 are represented by the points of intersection and the traces of the picture. Figure 1, b, shows its perspective at a certain angle. In determining visibility and invisibility, the shapes in this example are intertwined. It should also be noted that the perspective image does not have to show a point of view in solving positional problems, it can be restored if necessary. In this example, since the straight lines are parallel to each other and to the plane Q, their point of intersection Q∞ lies on the line of descent of the plane q∞.

Figure 1:



Now let us analyze the image in Figure 1, b. From this it is visible if the image trace of the straight line is located in the space bounded by the image trace QK of the plane and the descending line Q∞ (q1) and the straight line is invisible if it is located outside this distance. (q3) is obvious (compare with Figure 1, a).

Let us consider other cases of the relationship between a straight line and a plane.

Figure 2, a, shows the plane Q of the image trace QK, the plane Q given by the descent line Q∞, and the straight line t given by the image trace tK and the point of intersection t∞. Whether or not a straight line is visible depends on the location of its tK picture trace between the plane and the Q∞ intersection line of the QK picture trace. The part of the line that starts with tK is visible. In this example, the straight line t intersects the plane Q.

Therefore, the part of the straight line t starting from tK and its point of intersection with the plane N (tKN) is visible. To determine the point of intersection of a straight line t with the plane Q, we draw an arbitrary plane T through t.

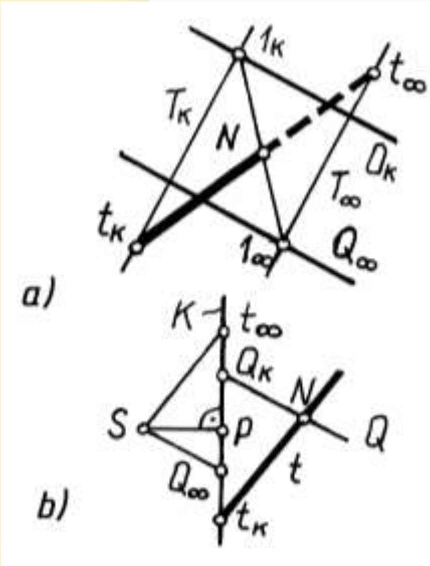


Figure 2

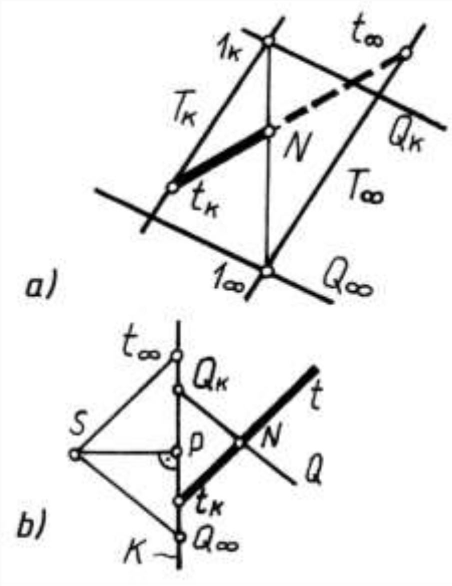
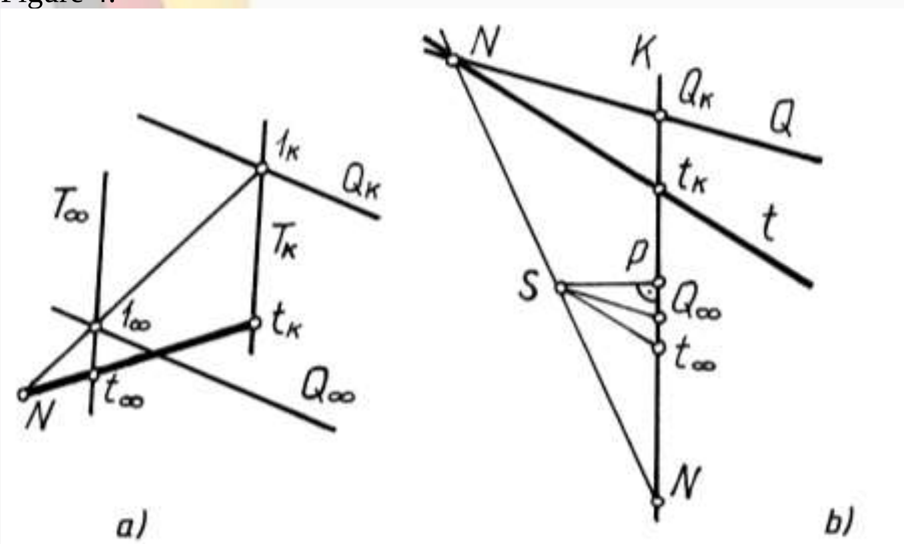


Figure 3

The planes of the set ∞1 can be passed through t. The image trajectory of the plane T is parallel to the line TK and the line of intersection T∞, which we obtain in an arbitrary and convenient direction. We find the line of intersection of the planes Q and T 1 (1K, 1∞). It, in turn, intersects the given line t at point N to determine the point of intersection of the plane t and Q. From this it is clear that the Nt∞ part is invisible. Figures a and b in Figures 3 and 4 show similar drawings, in which the tKN part of the straight line is also visible.

Figure 4:



Now we determine the point of intersection of the straight line f with the plane Q (Fig. 5, a). through f we pass the auxiliary plane F and define its line of intersection with Q 1 (1K, 1∞). The straight lines f and 1 intersect at point N, which determines the point of intersection of f with Q. This will make the fKN part of the straight line f invisible. Figures 6, 7, and 8 also show the identification of the point N where the line f intersects with the plane Q, as well as the invisible parts. They also make the fKN part of the straight line invisible.

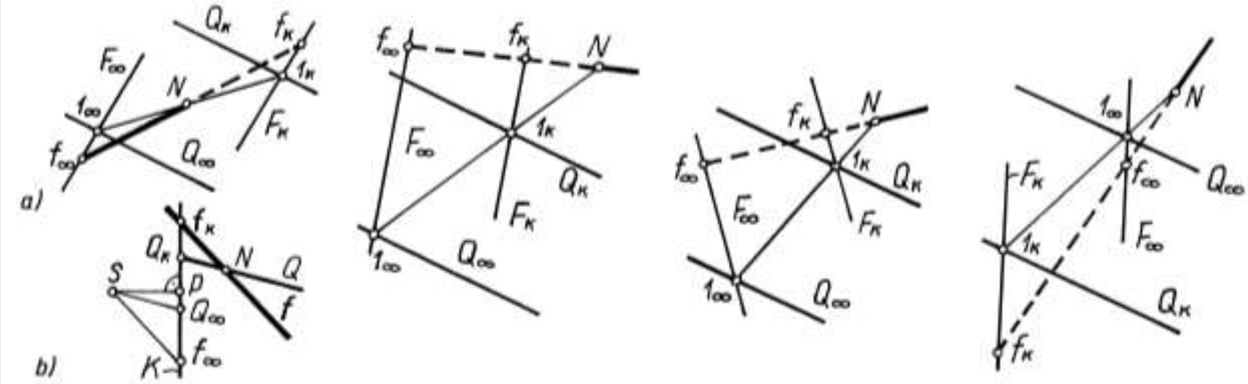


Figure: 5 Figure: 6 Figure: 7 Figure: 8

Figure 9, a and b, shows a straight line q overlapping the image trace Q of the plane Q and the image trace QK. qKq∞ is visible because it is close to the observer. The line of the straight line starts from qK and moves away from the plane Q.

The straight lines q1 and q2 in Figure 9 are invisible because they are behind the plane Q.

Figure 10 shows the triangles ABC lying in the N plane and DEF lying in the Q plane. Find the line of intersection of the two planes. Since the two planes intersect in a single straight line, it suffices to find two points corresponding to it. Based on this, we combine the picture traces of the given planes with the point of intersection 1K of NK and QK, and the point of intersection of their intersection lines N∞ with Q∞ 1∞. The straight line 1 (1K, 1∞) is the line of intersection of the planes N and Q.

The triangles lying in the planes intersect along the GT part of line 1. The given triangles are located in the lower part of the planes Q and N relative to the observer, because the plane N rises from NK, the plane Q from QK, parallel to the planes of parallelism SN∞ and SQ∞, respectively. If only the triangles are left in this example, they will look like Figure 10, b.

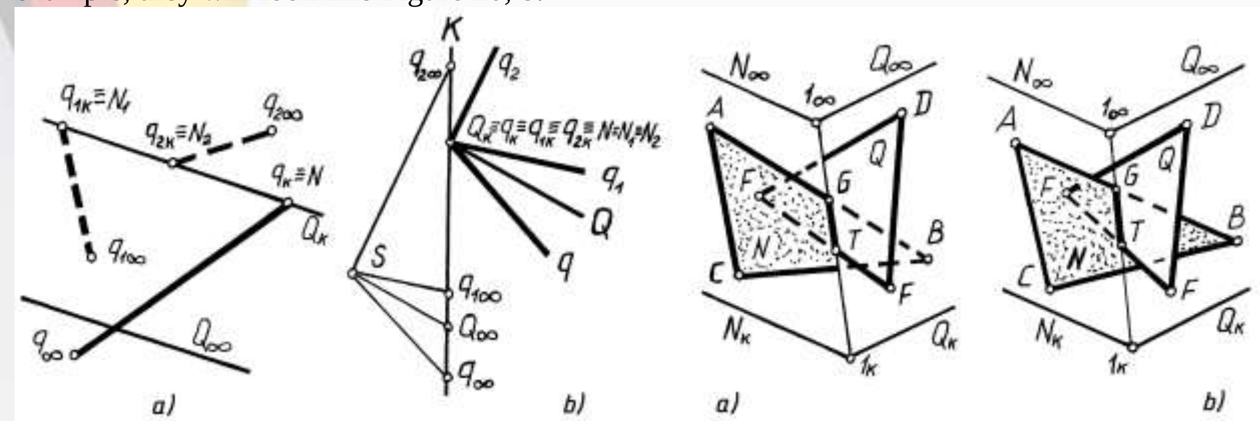
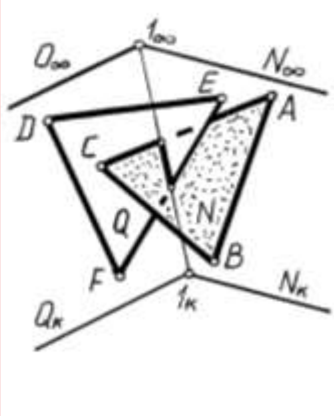
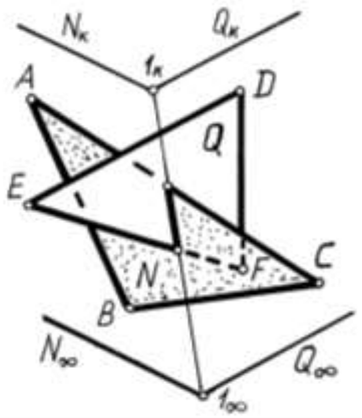


Figure: 9 Figure: 10 (hollow)

Now let us analyze the case where the triangles are located on the sides forming the convex parts of the planes (Figure 11). In this example, the ends C∈N and E∈Q of the triangles are visible.

If the location of the planes is arranged as shown in Figure 12, we observe their convex side, and if arranged as shown in Figure 13, we observe the concave side at the intersection of these planes.





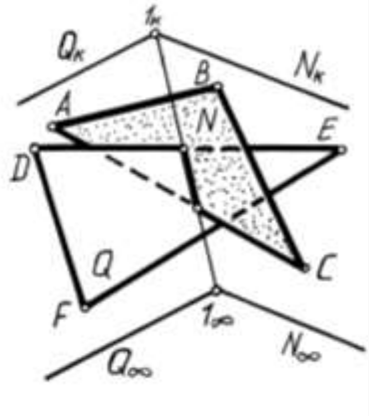


Figure 11 (convex) Figure 12 (convex) Figure 13 (hollow)

Based on the above analysis, the following conclusions can be drawn to determine the visibility and invisibility in the process of solving positional problems.

Rule 1. If the picture trace of a straight line is located on the side of the line of intersection of the plane from the picture trace (or between the QK picture trace of the plane and the descending line Q∞), it intersects the plane from the image trace (tK) of that line the part (tKN) up to point (N) is visible (Figures 2 and 3).

Rule 1.1. If the point of intersection of a straight line (t) with the plane (Q) (N) is on the opposite side of the line from the point of intersection (t∞) to the picture trace (tK), then the straight line the plane will intersect not in the same direction but along its opposite direction. In this case, the straight line intersects the plane in the abstract (or intermediate) space of the geometric apparatus of the perspective, and Rule 1 remains valid (Figure 4, a and b).

Rule 2. If the picture trace (fK) of a straight line is located on the opposite side of the plane to the line of intersection (Q∞) of the plane relative to the picture trace (QK), then it intersects with the plane from the picture trace (fK) of this line the part up to point (N) becomes invisible (Fig. 5, a and b).

Rule 2.1. Also, Rule 2 remains valid even if the point where the straight line intersects the plane is in the intermediate or abstract space of the perspective geometry (Figures 6, 7, and 8).

Rule 3. If the point of intersection of the straight line q with the plane Q belongs to the picture plane K (i.e., qK and N overlap) and its point of intersection is the plane of intersection of the plane q∞ with the plane Q∞ if the picture trace is located on the opposite side of the QK, then the qKq∞ part of this line is visible (the straight line q in Figure 9).

Rule 3.1. Also, if the point of intersection of the straight line (q1 and q2) (q1∞ and q2∞) is located between QK and Q∞ of the plane or on the opposite side of Q∞ relative to QK, then this line is 'rinmas will be. This is because such lines are located behind the plane Q relative to the observer (straight lines q1 and q2 in Figure 9).

Important aspects of this information include:

First of all, it provides a conscious approach to positional issues. This, in turn, encourages students to look for other options, such as creative thinking, activates their cognitive activity, and limits their blind use of problem-solving algorithms.

Second, this process not only develops students' spatial imagination, but also expands it.

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