

# CHOICE OF DISTANCE FROM CENTER OF PROJECTION TO PICTURE PLANE IN GEOMETRICAL APPARATUS OF PERSPECTIVE

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**Summary.** In the article there is an argument of statement about the fact that there are perspectives in a geometric apparatus which is close to visual perception, the centre of projection takes up position at point which is remote from the picture plane on a distance, quadrupling the height of eyesight.

**Keywords:** visual perception, perspective.

*Formulation of the problem.* Let's imagine that we are sitting in a basket of an air- balloon and we are rising to clouds. If we are moved through a board and give a glance at the earth, we will see that with rise of height the subjects located on the earth as though come crawling to our feet, and their length decreases. Meanwhile if we execute prospects of a three-dimensional scene with different heights of the point of view and constancy of distance from the center of projection to the picture plane, we will see that with increase of height of the point of view the sizes of the central projections of pieces of straight lines, perpendicular the picture plane, increase, and the central projection of a subject directs to the line of the horizon.

Thus, the task about a choice of the main elements of creation of prospect depending on height of the point of view exists in the nature and deserves to find time for its decision.

*Analysis of recent research.* Unfortunately, the science doesn't know about existence of the problem caused by influence of height of the point of view on feeling of depth of space at contemplation of prospect, – the science is silent what to do with the main elements of creation of prospect at change of height of the point of view. It isn't surprising that in educational literature the composition of prospect is stated in the assumption that the distance from the center of projection to the picture plane is constant and does not dependent from height of the point of view [1].

*Formulation of article purposes.* Thus, the purpose of the real work – to offer the rule of a choice of distance from the center of projection to the picture plane depending on height of the point of view which provides creation of the prospect close to visual perception.

*Main part.* Let's consider results of restoration of the main elements of creation of prospect in Saint Anthony's poliptikh of a brush Piero della

Francesca and on Masaccio's fresco "Trinity". Results of reconstruction of the device of the central projection showed that in a scene "Lady Day" of the poliptikh Saint Anthony of Piero della Francesca's brush spatial constructions were executed provided that the distance from the center of projection to the picture plane made 8 m [2], and in Masaccio's fresco "Trinity" – provided that the distance from the center of projection to the picture plane made 6 m [3]. On the one hand, results of restoration of the main elements of perspective constructions with a sufficient accuracy will be coordinated with results of experiment according to which for creation of the prospect close to visual perception, the distance from the center of projection to the picture plane has to equal about 8 m [4]. On the other hand, we felt deep disappointment when contrary to expectations didn't find in the experimental data obtained at research of spatial constructions in creations of masters of Renaissance, any regularity.

After a while we paid attention that if to take the distance relation from the picture plane to the center of projection of S to its height of H, in the poliptikh Piero della Francesca the distance from the picture plane is up to center projections more than its height by 4,0 times, in Masaccio's fresco – by 3,53 times, and in the experiment made by us by definition of conditions under which the prospect comes nearer to visual perception, – by 4,7 times, that is the numbers close turn out 4. The rule according to which "the perspective image on the picture plane, most close to visual perception, turns out only is provided in V. E. Peterson's textbook when it consists in limits of a corner  $28^\circ$ . Practically for convenience of constructions the corner  $28^\circ 4'$  – a corner usually is accepted at top of an isosceles triangle with the basis, twice smaller heights" [5]. Therefore, the corner  $14^\circ 2'$ , that is a half of a corner  $28^\circ 4'$ , corresponds to top of a rectangular triangle in which one leg is more than other leg by 4 times.

We will present a rectangular triangle in which length of a bigger leg is equal to distance from the picture plane to the center of projection, and length of a smaller leg – its height. If to appropriate to a corner at the top coinciding with the center of projection the value equal  $14^\circ 2'$ , the distance from the picture plane to the center of projection will be more than its height by 4,0 times, that is we will receive a ratio between distance from the picture plane to the center of projection and its height, close to number which was revealed at reconstruction of the device of the central projection in the poliptikh Piero della Francesca and Masaccio's fresco "Trinity".

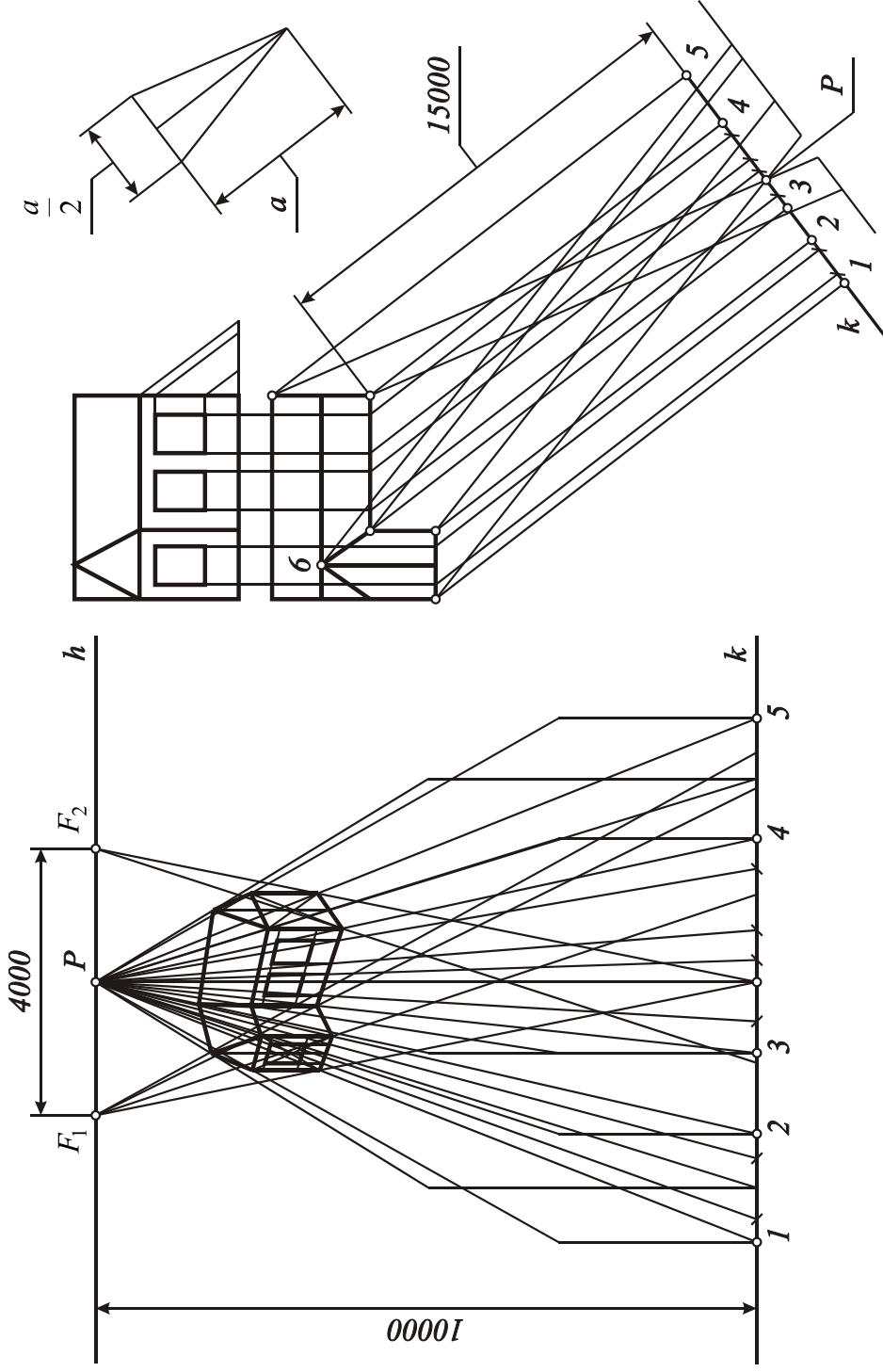


Fig. 1. The prospect of geometrical object provided that distance from the center of projection to the picture plane doesn't depend on height of the point of view.

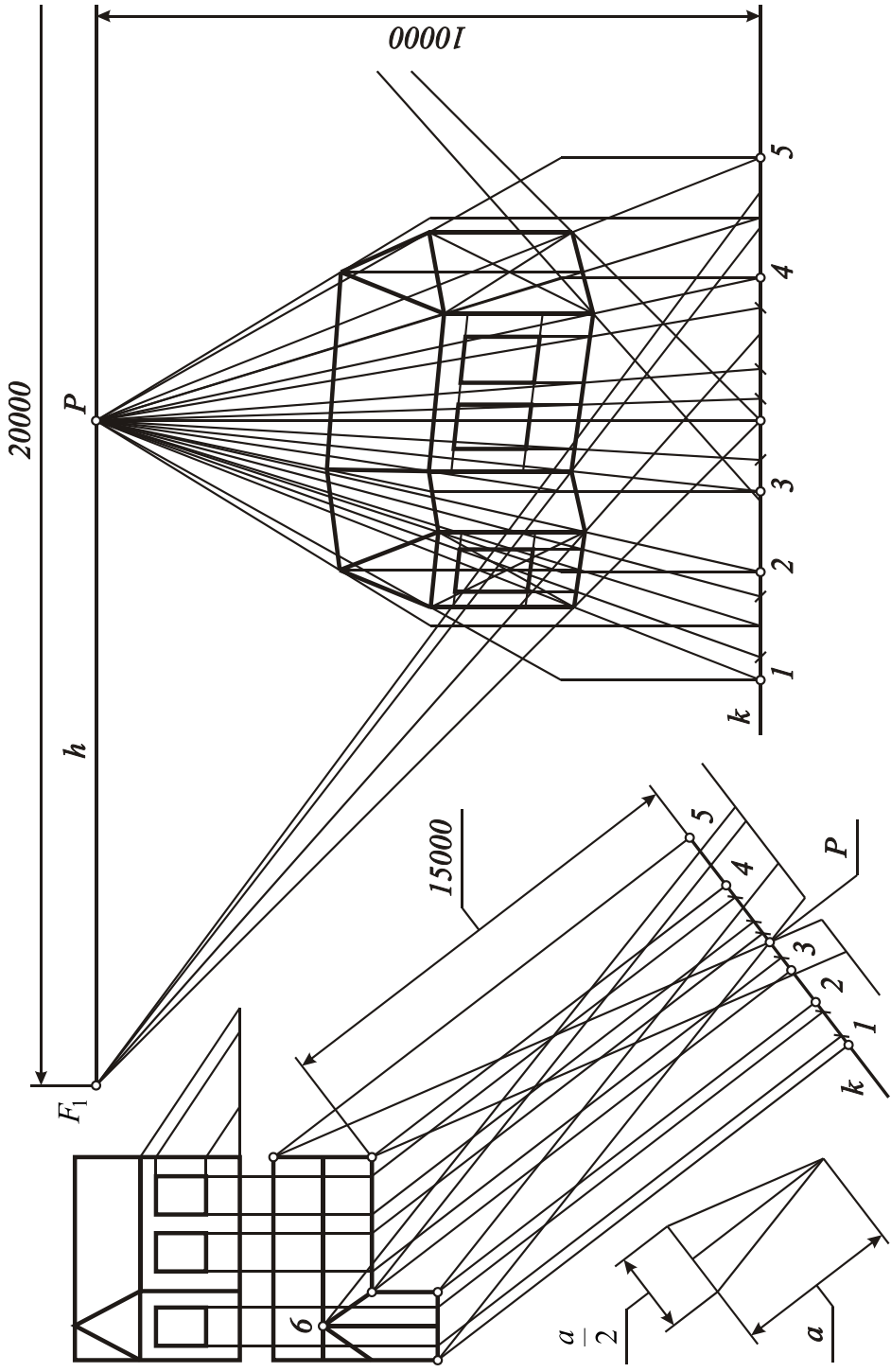


Fig. 2. The prospect of geometrical object provided that distance from the center of projection to the picture plane more than height of the point of view in 4 times.

We will assume that the center of projection has to defend from the picture plane on distance at which height of the point of view fits into a corner  $14^{\circ}2'$  between the main beam of sight and the straight line drawn from the center of displaying in the basis of the main point of a picture. We will consider creation of prospect at an arrangement of the point of view in the main point of a picture P, and the center of projection of S – in the point remote from the picture plane on the distance equal to 8 m. Thus the provision of the picture plane was chosen so that sides of angle, carried out from a projection of the main point of a picture to the subject plane and equal  $28^{\circ}4'$ , were tangents to the plan of geometrical object. We will lift the point of view on height equal to 10 m, and we will leave distance from the center of projection to the picture plane without changes. We will show 1 creation of prospect in fig. provided that the distance from the center of projection to the picture plane doesn't depend on height of the point of view. Now we will consolidate the point of view at the height of 10 m, and we will increase distance from the center of projection to the picture plane to 40 m. We will show in fig. 2 creation of prospect provided that distance from the center of projection to the picture plane more than height of the point of view by 4 times.

We will present results of creation of both prospects in fig. 3. We will pay attention that in the picture constructed at constant distance from the center of projection to the picture plane with rise in height of the point of view the sizes of the central projections of pieces of straight lines, perpendicular the picture plane, increase, and the central projection of a subject directs to the line of the horizon. While in the picture constructed provided that the distance from the center of projection to the picture plane is more than height of the point of view by 4 times, with increase in height of the point of view the sizes of the central projections of pieces of straight lines, perpendicular the picture plane, decrease, and the central projection of a subject comes nearer to the basis of the picture plane. It means that the prospect placed in the right part of fig. 3 is closer to visual perception, than the prospect presented in the left part of fig. 3. Really, experience of visual perception prompts that with rise the subjects located under us as though move away from the line of the horizon, and their length decreases by height.

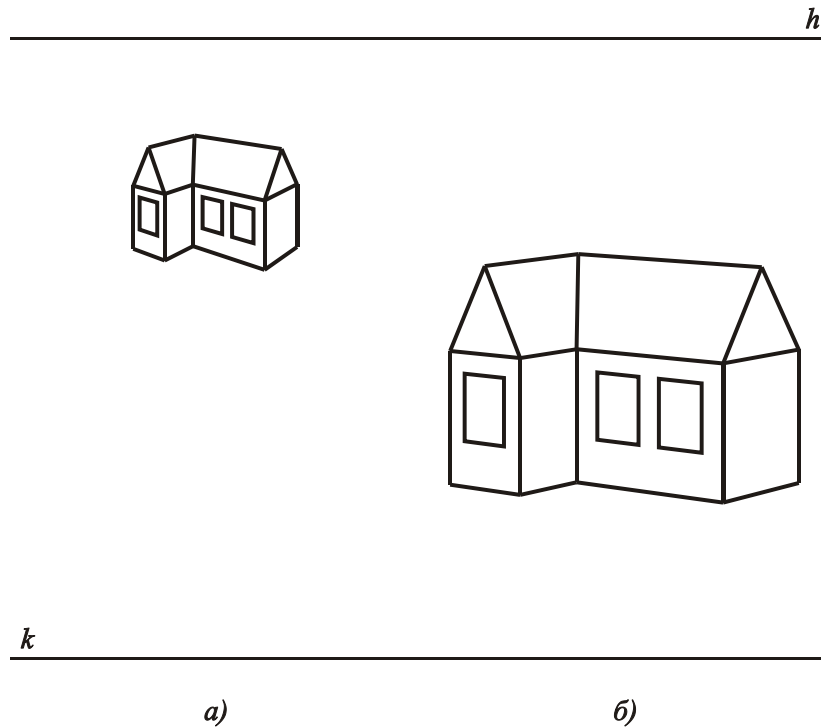


Fig. 3. Object prospects provided that distance from the center of projection to the picture plane: a) doesn't depend on height of the point of view; b) more than height of the point of view in 4 times.

Once in work by [6] us it was suggested that with increase in height of the point of view the sizes of the central projections of pieces of straight lines, perpendicular the picture plane, remain without changes if the distance from the center of projection increases to the picture plane in direct ratio to height of the point of view, but it wasn't told what has to be proportionality coefficient. Now we can give the formulation of the following rule of creation of the prospect closer to visual perception, than the prospect constructed by the rules stated in works of masters of Renaissance:

that the prospect transferred space depth better, arrange the center of projection in the point remote from the picture plane on the distance four times exceeding height of the point of view.

We not for nothing mentioned space depth in definition of the rule. It is caused by that the prospect is result of transformation of three-dimensional space to the two-dimensional plane and therefore to transfer to the planes the vision of space and the subjects enclosed in it without loss of information on their form and mutual situation isn't possible. From this it follows that if we win in the accuracy of transfer of width and height of a subject, we lose in transfer of its length and vice versa, than more precisely we give depth of space, subjects with big violations of visual perception we display width and height of a subject [7]. Really, if the picture shown in the right part of fig. 3, transfers space depth better, the picture located in its left

part reproduces the extent of geometrical object on width and height more precisely. However masters of Renaissance for this purpose also created prospect that in full accordance with picture which the person sees from a window, to transfer to the picture planes just space depth, – therefore from two options of prospect we prefer what with the greatest reliability gives the subject size measured in the direction, perpendicular the picture plane.

*Conclusions.* Thus, the rule connecting a distance choice from the center of projection to the picture plane with change of height of the point of view is submitted. It is shown that application of this rule strengthens feeling of depth of space at contemplation of prospect. We will notice that in textbooks on descriptive geometry at creation of prospect from the low or high points of view it is recommended to use prospect on the inclined plane [1]. However the prospect on the inclined plane transmits change of visible width of a subject depending on height of the point of view through artificially entered linear distortions, but the prospect on the inclined plane doesn't solve a problem about transfer of visible length of a subject with raising of the point of view. From this it follows that work on improvement of the device of the central projection has to be continued.

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