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Automatic Construction With Center Projection With Autocad

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Abstract— *The article discusses one of the methods of central projection of descriptive geometry and its practical application in scientific and technical aspects.*

Keywords—projection, projection plane, projection center, projection rays, projection.

1. INTRODUCTION

Various methods of constructing graphic images are studied by science - descriptive geometry.
Methods of descriptive geometry make it possible to depict existing and designed objects on a flat drawing, as well as to represent the shape of objects using a ready-made graphic image.
Information in the techniques of constructions, conditioned by the need for flat images of spatial forms, have been accumulating gradually since ancient times. For a long period of time, flat images were performed primarily as pictorial images. With the development of technology, the question of the use of a method that ensures the accuracy and usability of images, the ability to accurately determine the location of each point in the image relative to other points or planes, and by simple techniques to determine the size of the line segments of the figures, has become of paramount importance. We will restrict ourselves to studying only some of the methods of image on a plane used in technology - methods of constructing drawings.

2. MAIN PART

The image of spatial bodies on a plane is based on the projection methods, which is as follows. Let us agree on the plane on which the image of the object is built to be called the plane of projections. Center projections, for example, are photographs or images on a movie screen - in this case, the center of the projection is in the optical center of the lens of a photo or movie camera. In technical drawing, using the central projection method, perspective images of projected objects are built.
If you select a certain point in space - the center of the projection S and set several points, then together with the center they will define several straight lines - the projection rays (Fig. 1). If we intersect these straight lines by a plane called the projection plane, then at the intersection with the projection rays we get the projections of the given points.

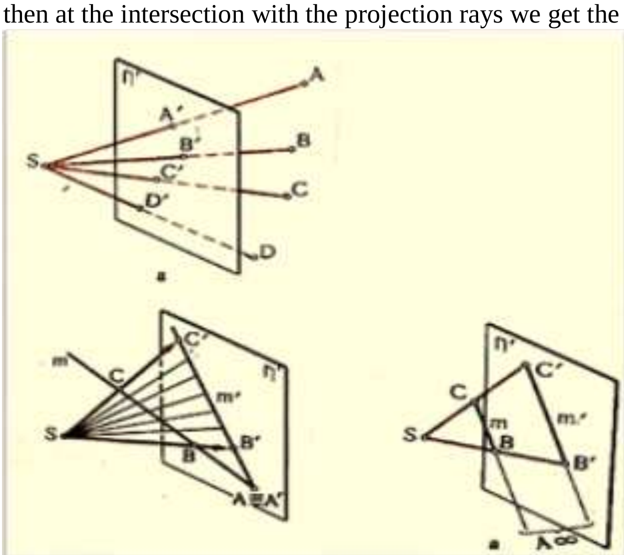

Figure 1

If the center of the projection is removed to infinity, then the projection rays will become parallel. The rays of such projection, called parallel, make sharp (oblique) or right angles with the projection plane.
Central and parallel projections are characterized by certain properties. Since the projection of points is a point on the projection plane, the projection of a figure onto the plane is the set of projections of all its points.

The projection of a straight line in the general case is a straight line passing through the point of its intersection with the plane of projections. If the projections of at least two points of the line are known, then the projection of the entire line is determined.

If the projection center and the projection plane are specified, then the projection of the point in space is uniquely determined - this is the point of intersection of the projection ray with the projection plane. The inverse problem of restoring a point to space from its projection is ambiguous, since a set of points belonging to the projecting ray is projected at one point on the projection plane. In the same way, by one projection of a geometric figure, as consisting of many points, one cannot judge its shape and position in space.

To ensure the reversibility of the drawing, we take two arbitrarily located projection planes P 'and P' '(Fig. 2) and two projection centers T and S. We project point A from the indicated centers onto these planes, we obtain projections A' and A ". Now, if we know the projection apparatus, i.e. two projections of a point and two projection centers, can easily restore a point in space. To do this, it is enough to draw two projection rays through the points and projection centers. These rays lie in the same plane G, defined by three points A ', A ", So they intersect, defining the desired point A. From what has been said, it follows that the images obtained from one or one two projection planes from two centers set a reversible projection model.

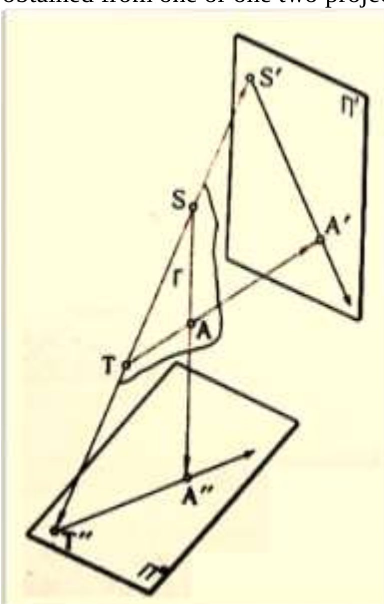

Figure 2

Depending on the position of the projection planes and projection centers, various projection image systems (models) can be obtained. The most common system used in engineering is the rectangular (orthogonal) projection system, or the Monge method.

A line projection can be constructed by projecting a series of its points. In this case, the projection lines in their totality form a conical surface or may be in the same plane (for example, when projecting a straight line that does not pass through the center of the projections, or a broken line and a curve, all points of which lie in the plane coinciding with the projection). For this reason, central projections are also called conical.

Obviously, the line projection is obtained at the intersection of the projection surface with the projection plane. But, as Fig. 3 shows, the projection of the line does not define the projected line, which are projected into the same line on the projection plane.

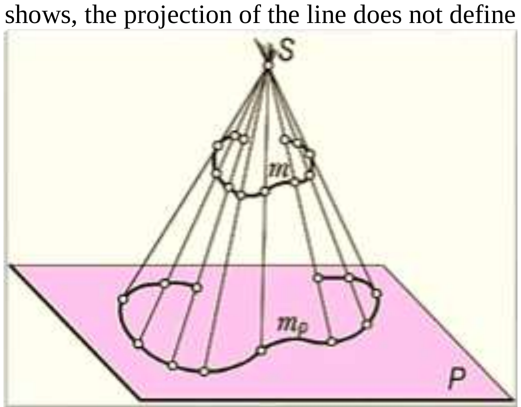

Figure 3

From point and line projection, you can go to surface and solid projection.

The method of central projection does not satisfy a number of conditions necessary for a technical drawing, namely: it does not provide uniformity of the image, complete clarity of all geometric forms, both external and internal, does not have measurability, does not have simplicity of the image.

Under artificial lighting, the rays of light spread radially in all directions. In fig. 4 we have reproduced the scheme of the arrangement of the falling shadows from the vertically standing rods with an artificial light source S. The rods are located along the circumference, and the ellipse, and the lamp (point S) is raised above the center of the circle.

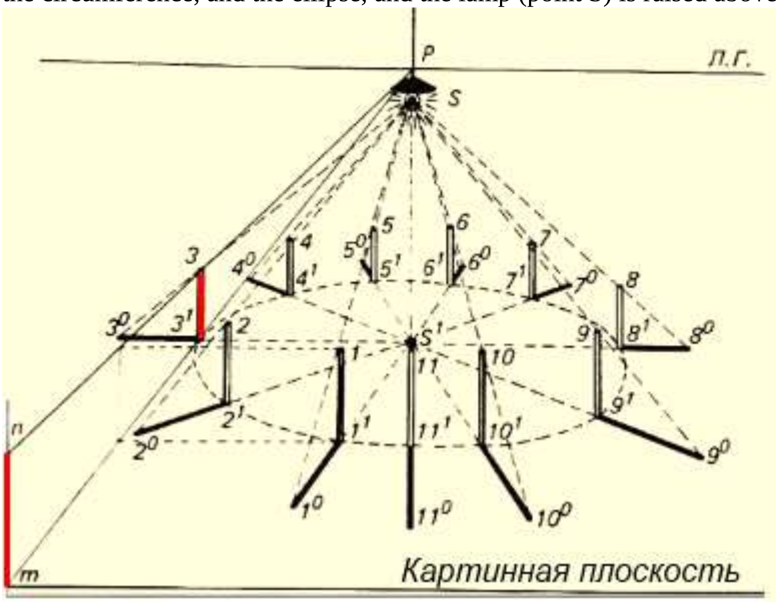

Figure 4

The rods in the foreground (1-11,10-101,11-111) cast shadows towards the viewer, as the light source illuminates them from the opposite side. For the rods on the left and right (3-31 and 8-81), the falling shadows have horizontal directions, since the light source is located on the side in relation to them. In the distant rods (4-41, 5-51, 6-61, 7-71), the shadows have directions into the depth of the picture, since the light source is placed closer to the viewer and illuminates them from the front. The higher you raise the light source, the shorter the shadows will be, and the lower you lower it, the longer the shadows will be. Shadows under artificial lighting always have a radial direction and converge at (point, S1) on the plane where the object's casting shadows are set. The length of the shadows is determined by the intersection of the light rays with the directions of the shadows (at points 10, 20, ... 110, etc.) So, for example, to build a falling shadow from the rod 1-11, it is necessary to draw a straight line from the point S1 through the base of the rod (i.e. through point 11) until the intersection at point 10 with a ray of light directed from the luminous point S through point 1. Fig. 4 shows the horizon line - LH, the point of view of the observer - P. If point P is connected to the base and top of any of the segments placed in a circle to the plane of the sky, then you can determine the actual size of any of the segments in the form of the height of the bar mn, as shown in Fig. 4. Thus, when the light source is taken more distant than the subject, then the shadows are directed towards the viewer. If the light source is closer than the subject, then the shadows will go to the horizon (1-11, 5-51).

Consider the following problem. Let given:

$| BC | = n; | CD | = m; \angle BAC = \angle SAD = \propto$

$\Delta ABC, \angle C = \angle D = 90°$

■ (| AC | = x -? @ | AD | = y @ R = | AD | = y-z-?)

$\Delta ABC \sim \Delta ASD$ from here (fig. 5)

Fig. 5.

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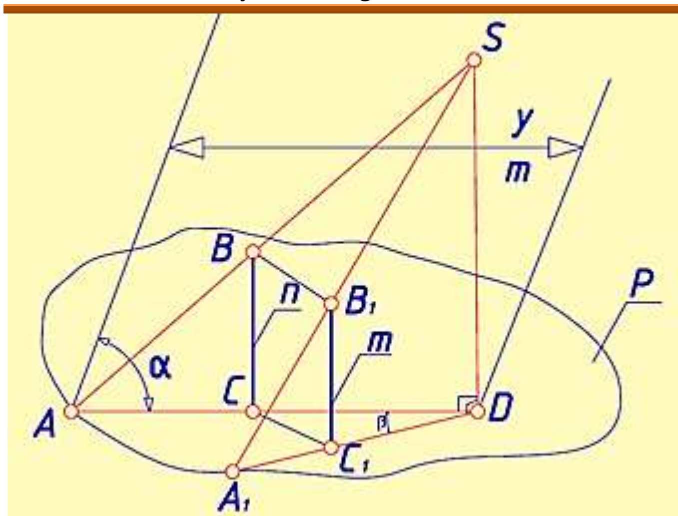

Figure 5

$x / n = \mathrm{ctg}\alpha$; $x = n\mathrm{ctg}\alpha$ (1)

this is the shadow of the rod standing perpendicular to the horizontal projection plane or $y = m\mathrm{ctg}\alpha$.
$AD / SD = \mathrm{ctg}\alpha$ or
$y / m = \mathrm{ctg}\alpha$ (2)

based on the data y $y / m = x / m$ or comparing (1) and (2) we obtain
$y-x = m\mathrm{ctg}\alpha - n\mathrm{ctg}\alpha = (m-n)\,\mathrm{ctg}\alpha$.
And so $R = CD = (m - n)\,\mathrm{ctg}\propto$.

3. CONCLUSION

After a few time, the BC rod is empty and occupies B1C1, that is, it rotates around the SD axis by an angle β. Let's define the relationship α, β, m and n. We will leave the solution to this problem to the reader.
Let us investigate (1) and (2) with central $X = n\mathrm{ctg}\alpha$ illumination (artificial) $y = m\,\mathrm{ctg}\,\alpha$ o <α <900.
if $\propto = o$ then $SA \to SA\infty$ then $SA \cap P \to (DA) \equiv SD\ [\ DA] \equiv [\ SA]$ a ray which belongs to the plane P.
if α = 90 ° then $[\ SA] \cap [SD] \to D$ - that is, $[\ SA] \parallel [DD]$ indeed in Euclidean space the rays [SD) and [CB) do not intersect, but in the projected space they intersect at an improper point $S\infty$. And so $[SD) \cap [CB) \to S\infty$.
if the rod is $CD \perp P$ and rotates around a circle of radius R, then its shadow always remains constant.
if the rod CD rotates in an ellipse then O0 <β <900 the shadow of AC1 is increasing, if 900 <β <1800 then the shadow of AC1, wake up decreasing.
Let the BC rod be located along a certain curve of the ellipse $x^2 / a^2 + y^2 / b^2 = 1$
$y^2 = b^2 (1-x^2 / a^2)$; $| y | = | \sqrt{((a^2-x^2) / a^2)} | = b / a \sqrt{(a^2-x^2)}$
$C_1 D^2 = x^2 + y^2 = x^2 + b^2 / a^2 (a^2-x^2) = x^2 + b^2 - (x^2 b^2) / a^2 = x^2 (1-b^2 / a^2) +1$
$| C_1 D | = | \sqrt{(1 + x^2 (1-b^2 / a^2))} |$
$m / n = (C_1 D) / (A_1 C_1) \to | A_1 C_1 | = m / n (〚1 + x^2 (1-b^2 / a^2)〛^2)^{(- 0.5)}$
So $| A_1 C_1 | = f (x) = m / n (1 + x^2 (1-b^2 / a^2))^{(- 0.5)}$ (2)
Let us examine the function (2)
$Df / Dx = 2m / n\, x (1-b^2 / a^2)^{(- 0.5)} = f'(x)$
$f''(x) = 2m / n (1-b^2 / a^2)^{(- 0.5)}$
$f'(x) = 0$; $2mx / n (1-b^2 / a^2)^{(- 0.5)} = 0$
$x_0 = 〚n (1- (b / a)^2)〛^{0.5} / 2m = \delta$ (3)
$f''(x_0) > 0$
mean at $x0 = \delta$ the shadow of the bar has a maximum value. Thus, the study of the problem with central (artificial) projection will make it possible:
1) The rod is located along a parabola, hyperbola, helicoid, etc. with central projection, build its shadow.
2) The analytical task of the shadow and its study makes it possible to automatically build a shadow using AutoCAD.

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