ACTIVATION OF STUDENTS' COGNITIVE ACTIVITY IN THE HOMOLOGICAL TRANSFORMATION OF SECOND-ORDER SURFACES

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АКТИВИЗАЦИЯ ПОЗНАВАТЕЛЬНОЙ ДЕЯТЕЛЬНОСТИ СТУДЕНТОВ ПРИ ГОМОЛОГИЧЕСКОМ ПРЕОБРАЗОВАНИИ ПОВЕРХНОСТЕЙ ВТОРОГО ПОРЯДКА

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Annotation. This article discusses ways to enhance students' cognitive activity based on the study of the topic of orthogonal projection transformation. The homological transformation of second-order surfaces is used as examples.

Аннотация. В данной статье рассматриваются способы активизации познавательной деятельности студентов в основе изучении темы преобразования ортогональных проекций. В качестве примеров использовано гомологическое преобразование поверхностей второго порядка.

Keywords: second-order surfaces, homological transformation, descriptive geometry, knowledge, skills, activation, cognitive activity, plane, circle, ball, ellipsoid.

Ключевые слова: поверхностей второго порядка**,** гомологическое преобразование, начертательная геометрия, знания, навыки, активизация, познавательны деятельность, плоскость, окружность, шар, эллипсоид.

Solving the problem of determining the line of intersection of two bodies bounded by arbitrary (non-linear) surfaces, we are forced to build model curves as auxiliary lines. It would be desirable to avoid building them and proceed to solving the problem using a ruler and a compass. Unfortunately, neither classical methods nor the method of auxiliary projection can provide the possibility of such a transition.

The use of projective correspondences for solving problems, and in particular collinear ones, marked the beginning of a new method of descriptive geometry, which can be called the method of projective transformations. The method of projective transformations proceeds from the condition that the figures in question are not rigid, but can collinearly transform-deform together with the three-dimensional space in which they are located.

Knowing the law of transformation of plane curves, it is not difficult to perform the transformation of surfaces. Indeed, if we imagine that the flat figure depicted in Fig. 1 rotates around the SB axis, then we will get a visual representation of the homological transformation of curved surfaces.

With this rotation, the parabola will describe the surface of the paraboloid of rotation, and the circumference of the ball. If a hyperbola rotates instead of a parabola (Fig. 2), then hyperbolic and elliptical surfaces are formed, respectively, i.e. it can be concluded that an ellipsoid, a paraboloid and a hyperboloid of rotation can be homologically transformed into a ball.

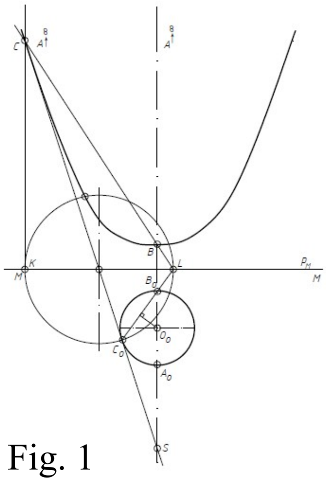

Fig. 1

Obviously, the practical implementation of such transformations makes it possible to significantly simplify the solution of many problems of descriptive geometry.

Let us use concrete examples to trace the nature and sequence of geometric constructions associated with the homological transformation of surfaces.

Just as with transformations of flat curves, the following conditions must be met in this case:

1) The center of homology should lie on the axis of rotation;
2) The homology plane must be perpendicular to the axis of rotation.

The graphical constructions that must be performed to convert a paraboloid of rotation into a ball are almost the same as the constructions for converting a parabola into a circle.

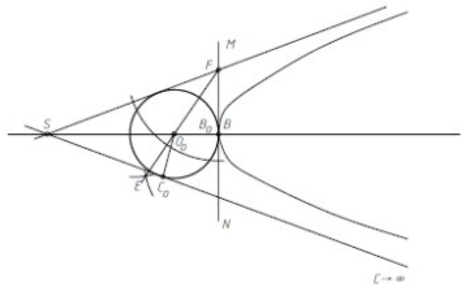

Fig. 2

The constructions differ only in that instead of a double straight MN (homology axis), a double plane P (homology plane) will appear.

In addition, in order to obtain a more economical solution to the problem, it turns out to be advisable to have a ball with a certain radius in front of a given value; therefore, constructions begin with projections of the ball. The center of the ball should lie on the axis of the parabola. The size of the radius of the ball is selected from the problem condition (the radius should be chosen as large as possible, this achieves greater accuracy of subsequent constructions). Depending on the size of the radius and the position of the ball, we determine the center and plane of homology.

Fig. 3 gives an idea of the graphical solution of the problem of converting a paraboloid of rotation into a ball.

The solution is executed in the following sequence:

1) From an arbitrary point 0_0, 0_0 of the axis of the parabola, we describe circles (projections of the ball) with a radius of a given value;

2) We determine the position of the homology plane P from the condition that the circle I, II, III, IV (projections 1,2,3,4, and $1^1,2^1,3^1,4^1$) along which the paraboloid intersects with the ball is a double line. Therefore, this circle will define the double plane of the transformation;

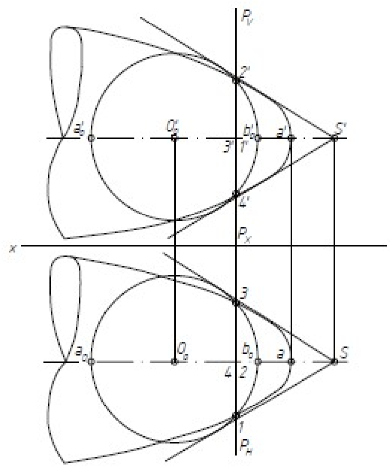

Fig. 3

3) We find the center of homology S as the vertex of a conical surface tangent to both surfaces.

Using the constructions performed in the above sequence, it is possible not only to transform the paraboloid of rotation into a ball of the desired size, but also to establish a homological correspondence with the plane P, the center S and a pair of double points AA_0. The considered method of transformation is fully preserved even if a hyperboloid or an ellipsoid of rotation is subjected to transformation.

It should be noted that unlike the perspective-affine transformation, which provides the transformation of an ellipsoid of rotation into a ball whose diameter is equal to the diameter of the circumference of the main meridian, homology allows you to transform an ellipsoid into a ball of any predetermined diameter. The practical expediency of using homological transformations can be shown by the example of solving the problem of determining the intersection line of an inclined elliptical cone with the surface of a hyperboloid of rotation (Fig. 4).

For the plane of homology, we take the horizontal plane of the projection H. It is advisable to take the diameter of the ball equal to the diameter of the horizontal projection of the hyperboloid, and its center is at the intersection of the axis of the hyperbola with the plane H. These conditions allow us to determine the nature of homological transformations.

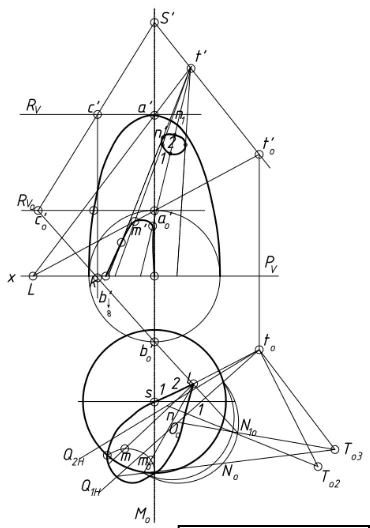

Fig. 4

The vertex of the hyperboloid A is transformed into the point A_0 of the ball (Fig. 4 shows only the frontal projections of points A and A_0). An infinitely distant vertex of the hyperboloid B is transformed into a point B_0.

In this case, it is not possible to determine the center of homology in the way described above, since the point of contact of a straight line tangent to hyperbolic and spherical surfaces is infinitely close to each other. Therefore, to determine the center of homology through the vertex of the hyperbola A, we draw a plane R parallel to the plane of projection H.

When converting the space that ensures the transformation of a hyperbola into a ball, the plane R is transformed into R_0, also parallel to H and passing through the point A_0.

Obviously, any transformed point C_0 of the R_0 plane will correspond to a point C of the R plane.

To find a pair of corresponding points, proceed as follows. At an arbitrary point in the plane R_0, we take point C_0 and draw a straight line C_0 to 0; the corresponding straight line will pass through the double point.

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