
GEOMETRIC MODELING IN CAD

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Abstract:	Keyword
The article examines the use and implementation of geometric projection devices in computer-aided design systems using AutoCAD as an example.	engineering education, projection methods, projection analysis, modeling.

Introduction

In the modern world, the basis of all transformations is innovative high-tech engineering activity, the quality and results of which directly affect the economic, social and cultural well-being of society. Engineering practice often involves the systematic application of scientific and technical knowledge with reference to design, construction, development, in connection with the professional training of an engineer, such requirements as the ability to technical creativity, spatial imagination and projective vision, possession of the logic of the construct of three-dimensional geometric thinking are presented.

Intensively developing economy and production require a corresponding change in the content of education, adjustment of the principles and methods of education, as well as the use of modern and information technologies in education that meet the requirements of scientific and technological progress and the needs of the individual.

At present, in connection with the widespread introduction of BIM technologies (Building Information Model) and PLM technologies (Product Lifecycle Management) into science and production, a complex and very important issue of modern engineering for cooking arises, including the development of educational programs and new training courses.

This is due to the fact that a temporary engineer must not only be able to use modern CAD software, but also do it effectively. In this regard, the issues of parametric design, which allow solving the problems of optimization and creation of user databases, are of great relevance.

The Engineering Graphics Discipline in the system of technical education is included in a number of basic general education disciplines. This discipline is the basis of graphic literacy, which is of particular importance in the conditions of modern production, equipped with machine tools with program control, robot equipment and automated design systems. Such training begins in universities with the courses "Descriptive Geometry" and "Engineering Graphics", which use modern information tools and therefore have recently merged with such a discipline as "Computer Graphics". Traditional method with the use of drawing tools is a thing of the past, leaving room for 3D Making and performing 3D models of parts and assemblies according to sketches, followed by the implementation of 2D working drawings and their refinement in accordance with GOST, according to ESKD and international standards, in CAD systems.

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Among the main disciplines that are the foundation of engineering education, it is descriptive geometry, which is not only the technology of images and drawings, but also forms the basis for the geometric model of construction and computer graphics. Descriptive geometry is based on the method of projections and the implementation of the corresponding APPProjection Aratov. There are central (conical) projection and parallel (cylindrical) projection (oblique and orthogonal). All of these devices are also implemented in modern automated design (CAD) systems. Let's consider their features on the example of the AutoCAD environment.

2D modeling systems involve the construction of drawings on the plane specified by the X and Y axes, i.e. obey the rules of orthogonal projection. In 3D modeling systems, a three-dimensional model is displayed on the monitor screen in the general case, as an arbitrary parallel projection (axonometry). The display of standard views is carried out on the corresponding TV panel and includes ortho and standard isometric projections. To automatically extract orthogonal projections from a 3D model, use the T-VIEW and T-DRAW commands. Thus, the direct task of descriptive geometry is realized - the construction of projections of geometric image on the plane (monitor screen) according to the spatial original (3D model).

In addition, isometric projections in AutoCAD can be obtained not only as standard views of a three-dimensional object, but also in the form of a 2D drawing. In this case, isometric design is carried out by the ISOORTO team, which allows you to modify the isometric view of a 3D object by aligning objects on three bases Isometric axes. The construction of isometric circles, arcs and interfaces is carried out by means of the "Izokrug" pair of the ELLIPSE team. When constructing visual images of various architectural structures, central (conical) projection is used, which in AutoCAD is implemented by means of the CAMERA command, which sets the camera and the position of the target to create and save 3D in the id of objects in perspective.

At the same time, by varying the elements of the apparatus of perspective projects that determine the properties of the camera, it is possible to investigate the visibility of the resulting image. In addition, by changing the position of the point of view relative to the stationary geometric system, it is possible to obtain a linear perspective with three vanishing points of parallel lines.

For the design of typical buildings and structures, specialized applications such as SPDS Graphics are usually used, which make it possible to simplify the performance of work from specific engineering specialization. But for the development of uniform objects, structures, assemblies, there is a need for creation of new databases. In this regard, it is very important to study the basic capabilities of CAD to create user databases.

Thus, obtaining visual images in CAD is the result of the implementation of appropriate geometric devices, the use of which is becoming increasingly important with the development of information technologies. For the effective use of various graphical environments, the solution of complex design problems, it is necessary to rely on the theoretical basis provided by descriptive geometry.

At the same time, it is advisable to conduct training of future specialists on fairly simple typical examples with a gradual increase in the level of complexity of applications. Performing the same tasks manually and using CAD demonstrates to students the wide possibilities and advantages of the latter.

In this regard, a special interest is the modeling of engineering problems traditionally solved in projections with numerical marks (orthogonal projections on one plane). Thus, modeling for a task to determine the "boundaries of earthworks" is associated with the need to create complex topographic surfaces, as well as surfaces of one slope for curved sections of roads, which are linear paths enveloping families of straight circular cones, in the brushes of which lie on a certain spatial curve (Fig. 1, 2).

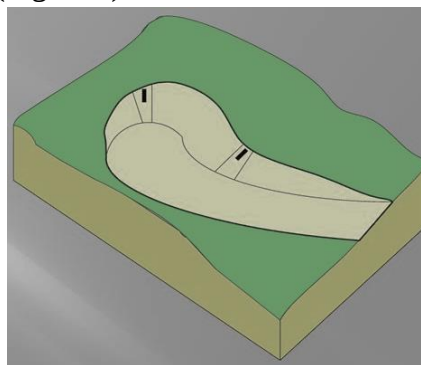


Figure 1. Modeling the task of determining the "boundaries of earthworks".

Thus, the demonstration of the potential of modern software for effective methods of its use, based on the theoretical foundations of descriptive geometry, is of great importance in engineering training. In the course of a certain TV work on the creation of models, students acquire knowledge and skills in the practical solution of engineering problems using graphic methods and form the skills of creating design documentation, which is a condition for high-quality education and training of future specialists. This, undoubtedly, will specialize in the intensification of training with a simultaneous improvement in the quality of training of engineering personnel who own modern information technologies.

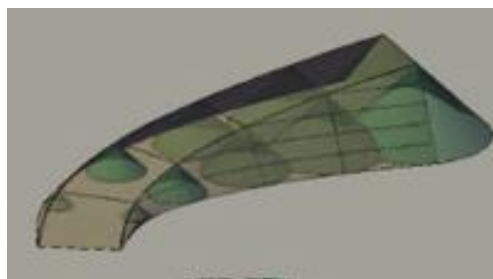


Figure 2. Modeling the surface of the same slope.

The forming surface at one end braces along the guide, the other along the horizontal plane. As a result of the movement of the forming along the horizontal plane, a flat curve is obtained at the intersection, which can be considered, in this case, as a guide. Then the

surface of an equal-length slope can be part of the onoid. Let's consider the algorithm for constructing this surface in AutoCAD Civil 3D.

The determinant of the surface of an equal-length slope (part of a conoid) is:

- 1) nap- a segment of a straight line AB; forming - a segment of a straight line of constant length. The horizontal projections of the forming and guiding are perpendicular;
- 2) the forming surface (segment) slides at one end along the guide, the other along the horizontal plane $H = xOy$.

In general, the surface of an equal-length slope can be constructed by a surface that is in contact with a one-parameter set of straight circular cones with a vertical axis (the vertices of these cones lie on the guide (straight) AB, and the bases on the horizontal plane H). That is, the forming cone can be considered as a permanent forming surface of an equally different slope (part of a conoid). The forming surface is determined by a straight line passing through point E, which cuts through two intersecting lines AB and CD (points A, B, C, D, E are given by coordinates x, y, z), Fig.3.

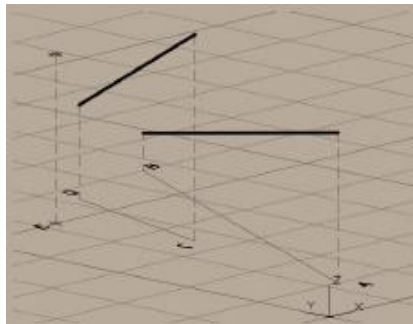


Fig.3 - Data for determining the forming surface of an equal-length slope

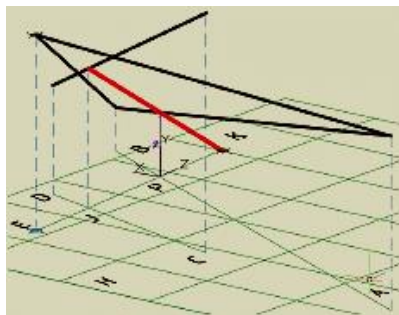


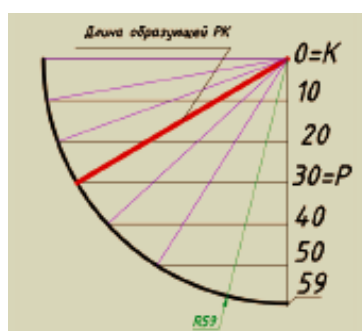
Fig.4 – Determination of the forming surface of an equal-length slope

It is known that through the point E and two intersecting lines AB and CD, the only straight line EP passes, defined by the intersection of the straight line CD with the plane of the beam of straight lines (point J). The bundle of straight lines is given by point E and the straight line AB (Fig. 4). Having constructed a straight line, the forming surface of the equal-length slope of the RC is found. Point K is the point of intersection of the straight line EP with the plane H, i.e. determine the coordinate $z = 0$ (zero otm etc) Direct EP. Next, find the high mark of the point P. In Fig. 4 This elevation is 30, which is determined

by the trivial measurement of the segment. If projections are used, then this value is determined by calibrating the EC segment.

To determine the other forming parts of the conoid (the surface of an equally long slope), a circle of radius R is drawn equal to the natural value of the segment of the forming one - the size of the RC, shown in Fig.5. By construction, this radius is $R = 59$. This circle is dissected by horizontal lines, the distances between which, on a scale, are equal to The unit of altitude elevation is a linear scale (in the example, the linear scale is 10). Lengths at the segment of the RC can be considered as a constant forming cones.

Thus, the demonstration of the potential of modern software for effective methods of its use, based on the theoretical foundations of descriptive geometry, has a great interest in engineering training.



Rice. 5 – Determination of the angle of inclination of the surfaces of an equal-length slope

In the course of a certain TVwork on the creation of models, students acquire knowledge and skills in the practical solution of engineering problems using graphic methods and form the skills of creating design documentation, which is a condition for high-quality education and training of future specialists. This, undoubtedly, will contribute to the intensification of training while improving the quality of training of engineering personnel who are proficient in modern information technologies.

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