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# **KOMPAS-3D: A New Module of a Well-Known Software Package**

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**ABSTRACT:** In this article, we want to highlight some of the features of KOMPAS-3D that can significantly improve the design efficiency, as well as give a number of examples of practical use of this system. The power and speed of modern personal computers allow you to assign them tasks that a few years ago were the exclusive prerogative of expensive workstations. In these conditions, fewer and fewer engineers are content to use a computer only for the production of drawing and design documentation. Users need a comprehensive solution to a number of design problems. These include product modeling, calculation, and development of the manufacturing process.

**KEYWORD:** KOMPAS-3D, design, three-dimensional model, solid modeling, primitive, sphere, prism, pyramid, cone, cylinder, frame.

## **I. INTRODUCTION**

The main tasks that the KOMPAS system solves are 3D-forming a three-dimensional model of a part in order to transfer the geometry to various calculation packages or development packages of control programs for CNC equipment, as well as creating design documentation for the developed parts [1].

A common procedure for modeling a solid body is the sequential execution of Boolean operations (addition and subtraction) on three-dimensional primitives (spheres, prisms, cylinders, cones, pyramids, etc.).

Different systems implement different ways to set the shape of volume primitives:

- entering parameters for a primitive of the type selected from the list (for example, entering the radius of a sphere or the dimensions of a parallelepiped),
- performing such a movement of a flat shape in space, the trace of which determines the shape of the primitive (for example, the rotation of a circle around the axis forms a sphere, and the displacement of a polygon—a prism).

The second, more flexible method is implemented in KOMPAS-3D. It allows you to create such types of volume primitives that are difficult (or impossible) to form in the first way.

The flat shape on which the body is formed is called a sketch, and the formative movement of the sketch is called an operation.

The sketch is drawn on a plane using standard drawing and graphics tools of the KOMPAS-GRAPH editor. All image building and editing commands, parameterization commands, and service capabilities are available. The only exception is the inability to enter some technological designations and design objects. A user who is familiar with working in KOMPAS-GRAPH will not find any fundamental differences between the order of creating a fragment and a sketch. A sketch, like a fragment, can be parametric [2].

You can transfer an image from a drawing or fragment that was previously prepared to a KOMPAS-GRAPH to a sketch. This allows you to create a three-dimensional model based on existing drawing and design documentation.

The sketch can be located in one of the orthogonal coordinate planes, on a flat face of an existing body, or in an auxiliary plane whose position is set by the user.



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To perform some operations (for example, copying around a circle), you need to specify an axis (the axis can also be a straight edge of the body). If the orthogonal planes, faces, and edges that exist in the model are not sufficient for construction, the user can create auxiliary planes and axes by setting their position in one of the ways provided by the system. For example, an axis can be drawn through two vertices or through a straight edge, and a plane can be drawn through three vertices or through an edge and a vertex. There are other ways to set the position of auxiliary axes and planes [3].

The use of auxiliary structural elements significantly expands the possibilities of building a model.

There are two aspects of parameterizing a three-dimensional model in KOMPAS-3D.

First, each sketch can be parametric. The following types of parametric relationships and constraints can be imposed on its graphical objects:

- Verticality of straight lines and segments
- Horizontal lines and line segments
- Collinearity of line segments
- Parallelism of lines and segments
- Perpendicularity of lines and segments
- Vertical alignment of feature points of objects
- Horizontal alignment of feature points of objects
- Mirror symmetry
- Equal radii of arcs and circles
- Equality of lengths of segments
- Touch curves
- The Association of the characteristic points of objects
- Affiliation points of the curve
- Fixing the characteristic points of the objects
- Fixing and editing dimensions
- Assigning the size of a variable name
- Setting analytical dependencies (equations and inequalities) between variables.

The sketches implement the variational parameterization ideology, which is familiar to users from working with drawings and fragments of the KOMPAS GRAPH.

Secondly, when creating a model, the system remembers not only the order of its formation, but also the relationships between elements (for example, the belonging of a face sketch or specifying an edge as a path for a kinematic operation). Thus, the hierarchical ideology of parameterization of volume constructions is implemented [4].

The presence of parametric relationships and constraints in the model, of course, affects the principles of its editing.

In KOMPAS-3D, you can change the parameters of any element (sketch, operation) of the model at any time. After setting new parameter values, the model is rebuilt according to them. At the same time, all existing links in it are saved. For example, the user changes the depth of the extrusion operation and its sketch; as a result, another sketch built on the end of the body formed by this operation still remains on this end (and does not "hang" in space in its former place).

It should be emphasized that after editing an element that occupies any place in the build hierarchy, you do not need to re-set the build sequence of subordinate elements and their parameters. All this information is stored in the model and is not destroyed when editing individual parts of it.

A convenient (though rarely used) editing technique is "dragging" operations with the mouse directly in the build tree. You can use it to quickly fix an error in the build order.

You can delete any operation from the model by selecting it in the build tree and pressing the < Delete>key.

If the model has been edited in a way that makes it impossible for any of its elements to exist, taking into account parametric relationships, KOMPAS-3D issues a corresponding diagnostic message. It specifies the specific reason for the conflict or loss of connection between the model elements (for example, "the Operation lost the reference object" "the Reference surface has changed", "Empty sketch", "self-Intersection of the contour", etc.). The help system contains recommendations for possible ways to fix the error.

When developing the KOMPAS-3D functions and interface, we took into account the working methods inherent in machine-building design. Focusing the system on creating models of specific parts that contain typical

structural elements makes it easier to perform the most typical operations. These include the chamfering, rounding, and hole operations discussed above.

Creating custom sketch libraries is another way to automate builds. For example, you can create a library of parametric sketches that contain flow profiles, and then use them to create models of rotation bodies.

A convenient method for modeling products that differ only in some structural elements is to use a previously prepared model as the base body (it is called a blank). Subsequent work with such a basic body ("gluing" and "cutting" additional volumes) is no different from working with the body obtained by the operation on the sketch. When using a preform, keep in mind that it is not copied to the model, but exists in it as a link to its own file (a preform can be compared to inserting a fragment with a link to a KOMPAS-GRAPH drawing). After editing a model that is used as a preform by other models, all changes are passed to files that contain a reference to the preform.

In addition to commands that are directly related to building a three-dimensional model, the user has numerous service options at his disposal. Their use allows you to control the display of the part, make various measurements, and form flat images of the part.

To change the display of a part, you can use the commands to control the scale of the display of the part in the window, and the commands to move (rotate and shift) the part in space. There are several ways to display a part: wireframe, display without invisible lines or with thin invisible lines, halftone and perspective halftone display. You can set surface properties (color, gloss, transparency, etc.) for each individual face or for the entire part. If you specify a part material from the library, its optical properties are taken into account when displaying the model in halftone [5].

You can measure various geometric characteristics: distances between vertices, edges, and faces in any combination, measure the length of edges and perimeters of faces, and measure the area of faces. Calculation of mass-inertial characteristics of the parts (volume, mass, coordinate center of gravity, axial and centrifugal moments of inertia of areas principal axes of inertia) (Fig. 1).

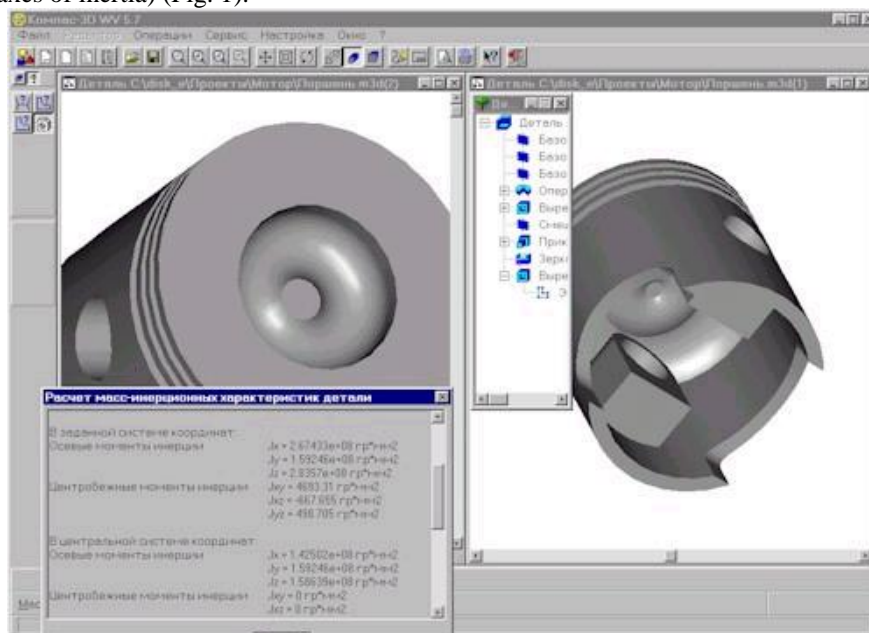


Fig. 1. Calculation of mass-inertia characteristics.

Using the appropriate command, you can create a flat image (a kind of "drawing blank") of a three-dimensional model. You can choose any combination of projections, zoom, view layout parameters, and ways to display invisible lines and transition lines. The resulting image is placed in the KOMPAS-GRAPH drawing file (\*.cdw); its further design (dimensioning and technological designations, filling in technical requirements, etc.) is made by the usual means of the drawing and graphics editor.

KOMPAS-3D provides the user with a variety of tools for obtaining flat images of the model - from printing a frame or halftone image that is visible on the screen, to automatically creating a KOMPAS-GRAPH drawing

that contains selected views of the part. In this drawing, all the image editing, sizing, and technological notation commands familiar to users from working with KOMPAS-GRAPH graphic documents are available.

When creating flat images of a part, you can choose not only its standard projections (left view, top view, etc.), but also any custom orientation of the part. This allows you to quickly get high-quality images of parts for catalogs, text documents, etc. In Fig. 4 shows a fragment with gear parts intended for placement in the spare parts catalog.

You can also create sections and sections of a part. Let's look at a practical example of using this feature.

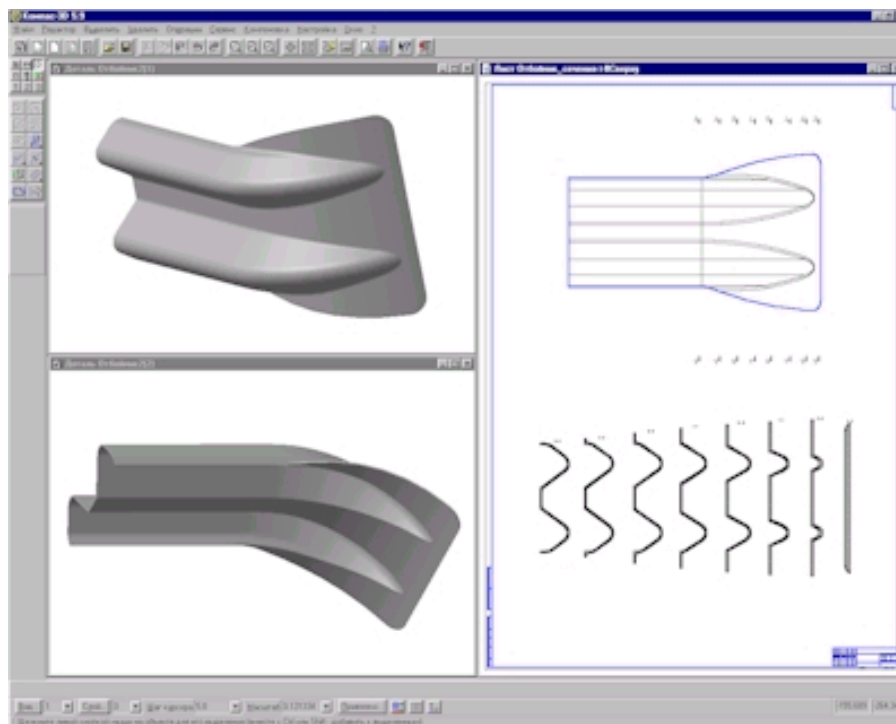


Fig. 2. Three-dimensional model of the bump and a set of its sections

A die and a punch are required for stamping the bump (road fence parts). They are made on a milling machine. To control the shape of the manufactured matrix and punch, a set of templates is required that correspond to the bump sections every 50 mm. Building such sections using descriptive geometry methods is an extremely time-consuming task. To simplify it, you can use the KOMPAS-3D functions. Forming a three-dimensional model of the bump (Fig. 2, on the left), set the position of the cross-section planes and call the build command for the part drawing. All the necessary sections, as well as the specified part types, will automatically appear in the new KOMPAS GRAPH drawing (Fig.5, right). A 1:1 scale printed drawing sheet is used to produce templates.

Usually, when using a three-dimensional modeling system, you first create a model of the product, and then (if necessary) create flat images of it (for example, working drawings of parts).

However, sometimes you need to build a three-dimensional model of a part that has already been documented (this usually happens when using previously developed parts in newly designed products). This is where the full integration of the KOMPAS – KOMPAS-3D and KOMPAS-GRAPH components comes in handy: images from any KOMPAS graphic documents can be used to build a three-dimensional model. It is particularly effective to build models in this way that are formed by a small number of operations on complex contours. For example, the edge model shown in Fig. 6 (right), built in a few seconds by squeezing out a contour taken from the corresponding KOMPAS drawing (Fig. 3, left). Of course, more complex parts take a little longer to build, but using existing geometry in graphic documents (where possible) helps reduce the time it takes to build the model.

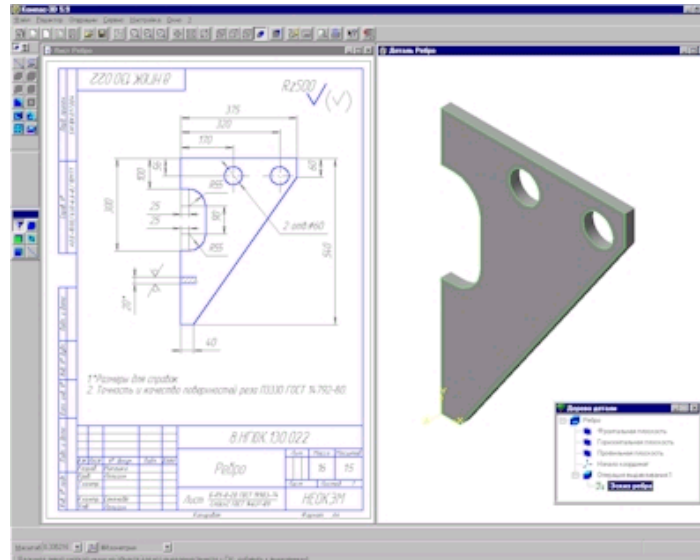


Fig. 3. Using ready-made documentation when building a three-dimensional model.

## II. CONCLUSION

By releasing the KOMPAS-3D system, ASCON is taking another step towards meeting the needs of its customers in solving design and construction problems.

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