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Processing of Construction Geometric Structures in Computer Graphics

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ABSTRACT: This article explains the process of modelling technical details in the automotive industry using computer and geometric modeling. It has been studied that such processes as sloping, winding and shearing are based on the methodology of three-dimensional modeling. The study of discriminants of two-dimensional and three-dimensional hypersensitivity has allowed us to propose the identification of deviating and twisted lines and the recipient families of surfaces using analytical and numerical methods, respectively. This methodology has been developed to create 3D modeling tools of ALT (automated design systems) for wrapping and cutting layers.

The shape of the surface of the details is an important design and technological task in the development of various products, both in the automotive industry. A special role in this task is to address the issues related to the interaction between the product and the document. The surface of the product obtained after treatment with the instrument consists of a family of bending surfaces and transient curvature.

KEYWORDS: geometric and computer modeling, objects of shaping, envelope, enveloping, cut-off layers.

I. INTRODUCTION

Computerization of engineering tasks is one of the main ways to increase productivity in the field of pre-production of a machine-building enterprise. Design of special equipment and technological equipment based on volumetric modeling, development of drawing documentation, preparation of control programs for CNC equipment — all these tasks can be solved with the use of a number of CAD/CAM systems. SAE systems allow you to perform analysis and optimization of design solutions. Such systems have found wide application in all industries, and over the past decade our country has accumulated quite a lot of experience in their use [13].

However, in the conditions of strict market requirements to reduce the time of design and production preparation, to improve the quality of products, it is necessary to reach a qualitatively new level of computerization. This level provides the application of the CALS methodology, the essence of which is continuous information support for developers at all stages of the product life cycle (LCI).

The strategic solution of the transition to CALS technologies involves the use of integrated solutions in the following areas: -

end-to-end computerization of the entire range of engineering tasks in the design and preparation of production, with the choice of basic CAD/CAM/CAE systems and support for the necessary data formats for the exchange of design and technological information;

- organization of a single project database to support all stages of HCI, computerization of design and production preparation management based on the use of PDM systems;

- taking into account the factor of cooperation of enterprises when working on the project. The use of special tools that support the rapid exchange of design and technological information between the customer and the Executive, the processes of collective decision-making.

Computerization of engineering tasks. As a rule, even a small enterprise uses several CAD/CAM systems today. The variety of systems used is not always justified, but in General, the presence of systems of different levels,

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depending on the type and complexity of the designed products and the tasks to be solved, is economically feasible. The market for CAD / SAM systems is very dynamic, so even a group of specialists of an enterprise that chooses such a system can often find it difficult to assess the advantages of several systems. The number of examples of successful use of various CAD / CAM is constantly growing, and specialists are getting more and more opportunities to present themselves with an objective picture of this market.

Taking this opportunity and supporting the thesis about the dynamics of the CAD/CAM systems market, we want to announce for the first time in the Central print edition about the appearance of another new development on the Russian market - CAD/CAM Cimatron E. This system is based on modern industrial standards, computer technologies that are now basic for engineering systems, takes into account the latest trends in the development of CAD/CAM systems and includes the full potential of the Cimatron IT system widely used in the world, including in Russia.

CAD/CAM is one of the key tools in the technical preparation of production. Based on the analysis of the work of many large enterprises and small firms, it can be argued that even more widespread in the coming years will be systems for analyzing technological processes, such as Moldflow-for plastic casting. perforge - for forging and stamping, MSC. Autoforge - for sheet stamping, etc. The joint use of control and measurement machines and CAD / CAM also represents a large reserve for improving the quality of products and applying "reverse engineering" technologies. There is a constant increase in interest in technologies for rapid production of full-scale samples (Rapid Prototyping, Rapid Tooling), in which CAD models are the source information. Modern computer technologies allow you to create essentially "virtual workshops" in engineering bureaus and perform modeling of product manufacturing processes. Unfortunately, in real workshops today, the picture is different: the lack of modern machines or the use of machines with technologically outdated CNC stands often does not allow you to produce products with the same quality and in such a time as planned.

Of course, all these and many other problems are new for most managers and engineers, but a certain circle of specialists has already formed who can transfer experience with CAD/CAM systems, while at the same time setting new tasks for the computerization of technical production preparation services.

One of these tasks is the integration of all data obtained using various CAD systems. In countries where the share of design engineering using CAD systems is already very significant, specialists and specialized firms in large projects perform a significant amount of work on the transformation of data formats, "model treatment". However, working out the information interaction of different systems using neutral formats or direct interfaces is only part of the solution to this problem. The integration of all information (the results of the activities of all specialists), with the possibility of its repeated use, is a great challenge. In practice, still derive all the information is on paper, it is not just the outdated content of our Standards, but the unwillingness of actors to accept information in electronic form, nesposobnosti our services technical documentation manage electronic archives, etc. the Solution to this problem the creators of CALS-technologies see primatene PDM systems.

The Shape of the surface of the details is an important constructive and technological task in the development of various products among the machine industries. In this task, a special place is allocated to solve issues related to the interaction of the product and the instrument. The surface of the product, which is obtained after processing with Instrument, will consist of a series of bending surfaces and passing curvature. Therefore, in the process of formation of the form, along with the development of a mathematical model of bending, issues of installing a Real surface – covering surface model are solved [1-2]. Many methods have been developed based on different approaches aimed at obtaining the shapes of these objects in order to obtain a series of curved and covering lines and surfaces. The more they are used, the more differentiated are geometry or kinematic methods. In recent times, the possibilities of modern computer technologies are actively and successfully used to model The Shape of the surface.

In addition to bends and covers, in practical applications, it is often required to obtain models of detachable layers [3]. For the research of removable layers, different methods are used, which are used in the modeling of bending and covering surfaces. In this, only one of the objects of form in certain literature, research in different ways is feared.

Thus, the objects will consist mainly of layers of bends, covers and erases. In modeling them, there are a number of unresolved or completely unresolved questions in many tasks. This is due to the lack of a uniform methodology that, if necessary, can identify the discriminant and the categories of coverage lines and surfaces, as well as the full possibility of computer modeling of modern geometries, polygonal and rigid bodies.

II.MAIN PART

LAYING THE FUNCTION OF MODELING THE SURFACE FORMS. Research of bending lines or series of surfaces is carried out in many works. Most often they are based on differential geometry or kinematic methods. In its

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place, using these methods, the relationship between the parameters of the bond between the line or surfaces and the parameters of their categoriesadorlik equations are formed. According to the rules, in practical tasks, these equations are transtsendent, which leads to complexity both in solving it and in determining the bending as a whole.

Another direction of determining the bending lines or series of surfaces is based on the study of the surface and hyperspace discriminant. These surfaces and hyperplasms are formed as a result of the indication of the series of lines and surfaces to be obtained in the process of formation in an environment of greater volume. Its volume is greater than the volume of the medium in which the line and surface are located in the unit [4-7]. In this process, a range of discriminants is determined, mainly of two-dimensional surface or differential properties of large-dimensional algebraic surfaces. Determination of discriminant points on the given surface equation in an indefinite form, as well as on the equations consisting of the same surface differential parameters [8] is proposed in the work. The calculation of the discriminant is done by the numerical methods of mathematics and non-linear programming, which is not an easy task. This surface is not brought on by discriminant and criminant analysis.

The peculiarities of the indication of orthogonal shades of the algebraic surface of different sizes [5, 6, 9] are presented in the research work. Examples of multiple exorbitant manifestations of hypercholesterolemia discriminants [6] are presented in the study. Methods of reducing the orthogonal shadows of two-and three-dimensional surfaces to flatness and hypertexity [10-11] are described in the work.

The analysis of these studies shows that the study of the peculiarities of the reduction of orthogonal shadows of the surface and hyperplasia in flatness and hypertexity is effective in a number of cases when determining the category of bending lines or surfaces by both analytical and numerical methods, allowing to solve these tasks. Below are the results of the study of orthogonal shades in giving two-and three-dimensional hyperplasms of different shapes in coordinate plane and hypertexities.

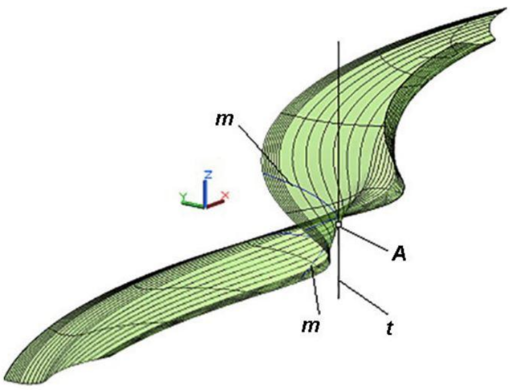
Let the two-dimensional surface under study is given in an indefinite form

$$F(x,y,z)=0 \qquad (1)$$

andy *XY* the texture coordinate is orthogonal to the ball. bushings of profiling of discriminant or SW branches reference essays. Enugu mos keladigan techically criminy or krivoshipno guns. Crystal silver glitter techiegirl, Z coordinate Ekiga parallel bullis,

$$F_z(x,y,z)=0 \qquad (2)$$

it is written with an equality in appearance. (1) it is proposed to view the equation as a new Surface equation. In it, (1) and (2) equations (1) Determine the intersection line on which the surface contour line to the equation is calculated. The studies carried out show that the points on the curvature obtained from the intersection of the surfaces of the planes are parallel to the coordinate planes XZ and YZ and are extreme. Parallel to the axis of the coordinate Z – which gives the direction of the shading of the fighter planes (picture 1). Such points can include the point of Assembly, the point of bending and individual points of the surface.



1-picture. The helical surface, its sections m and the plane n, the coordinates ZY and ZX parallel, the intersection of these parts t at point A

It follows that the D discriminant of the surface is an association of a category of extreme points associated with the ligaments,

$$D = \sum_{i=1}^{n} \min f(x,z) \vee \max f \ (x,z)\big|_{x=ai},$$

if(1) we write the equation exactly in the form of y= f (x,z), and in the field of its definition, z is a coordinate variable.

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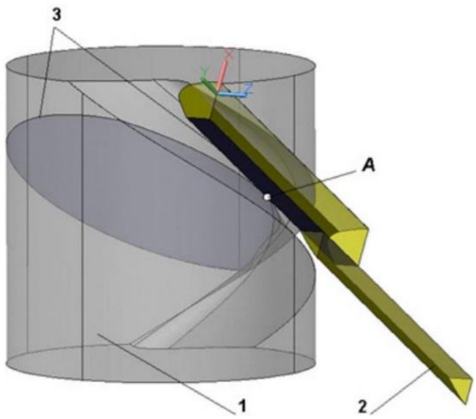
The result obtained from the study of the differential characteristics of the surface chrominant makes it possible to suggest one of the coordinates of the calculation of the coordinates of the observed points using quantitative methods of determining the conditional extremum of one of the coordinates, for example, y at another given value of x. The independent variable in this case is the Z coordinate.

The illustration of this result can be a model of screw strips or instruments with a cylindrical surface (Figure 2). Here, the screw trimming of the YZ coordinate plane overlay has a extreme point A in relation to the XY coordinate plane. This point determines one of the points of the profile of the cylindrical surface, the instrument intersecting with the given screw surface of the product. This point coordinators can be determined by both analytical and quantitative methods.



2-picture. The solid models are the 1 organizers and the 2 instrument, and the 3 are their intersection in the plane of the YZ coordinates, a point is the intersection of these

Thus, if we consider (1) the equation as a congruent flat curvature aksi that is, the surface equation in the R3 environment, then this category curvature can be determined by both analytical and quantitative methods in the unit position. By analytic methods, we solve (1) and (2) equations together and calculate the extreme value of another coordinate by putting its quantities as a conditional connection to one of the coordinates. The third coordinate accepts a discrete value.

After that, we will consider orthogonal projection on two dimensional surfaces with the help of the given parametric equations:

$$x = f_1(u,v),\ \ y = f_2(u,v),\ \ z = f_3(u,v). \qquad (3)$$

With the expression of the plane in the image above, the direction of the projection is parallel to the – Z axis and is reflected in the image below:

$$F(u,v) = f_{1u} \cdot f_{2v} - f_{2u} \cdot f_{1v} = 0. \qquad (4)$$

This equation*u*, *v*establishes a connection between the parameters. This equation as well as (3) create an opportunity to determine the surface discriminant with the participation of the equation. Also this equation in the system of coordinates*U* and*V* for coordinates, we can take μ as the equation of the curve.Criminalμ' the Surface (3) forms a curve μ line on this surface using the equation. A surface like this can be written as follows:

$$(\mu \subset F) \subset R^2 \rightarrow (\mu' \subset \Phi) \subset R^3.$$

Here F (4) is given by the equation.

μandμ' the study of curved lines allows to place (3) crimp points of the surface relative to the corresponding coordinate planes. This result is similar to the result obtained for the surface identified above. The D discriminant of the Surface (3) in this case will consist of combining many points, exactly as follows:

$$D = \sum_{i=1}^{n} \min f_1(u,v) \vee \max f_1(u,v)\Big|_{f2(u,v)=a_i}, \qquad z = f_3(u,v).$$

The variable is considered one of the parameters of the surface in this connection, the surface under study is cut by the series of parallel surfaces to the *ZY* coordinate plane.

Among the practical tasks, there is a need to determine the mining of a category of two-parameter surfaces. Thus, if the set of surfaces is determined using two independent parameters, it is best to investigate$\sum_1$ it is reflected in the appearance of four-dimensional hyperopia

$$F(x,y,z,u,v) = 0, \qquad (5)$$

here*u* and *v* independent parameters of movement.

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This way u and v the direction of their arrows corresponds to the hyperspace coordinate. This is reflected as follows in the view that the hyperspace equation is connected

$$F_x \cdot (x - x_0) + F_y \cdot (y - y_0) + F_z \cdot (z - z_0) + + F_u \cdot (u - u_0) + F_v \cdot (v - v_0) = 0, \quad (6)$$

here x_0, y_0, z_0, u_0, v_0 – Ncoordinate of points on the surfaceatasi.

In order for these hyperspace points to be placed on the U axis in parallel hyperspace, it must fulfill the following condition:

$$F_u(x,y,z,u,v)=0. \quad (7)$$

Four-dimensional hyperspace of a (7) equation$\sum_1^1$ if we look at it as an additional equation for (5) and (7), then the result of the intersection of (5) and (7) hyperspace is a three-dimensional surface$\sum_2$ determined. This is u orthogonal criminant hyperplasia by Axis$\sum_1$.

The hyperspace equation related to this hyperspace will have the following appearance:

$$F_{ux} \cdot (x - x_0) + F_{uy} \cdot (y - y_0) + F_{uz} \cdot (z - z_0) + + F_{uu} \cdot (u - u_0) + F_{uv} \cdot (v - v_0) = 0, \quad (8)$$

herex_0, y_0, z_0, u_0, v_0 – points in this K hyperspace.

Formed in three-dimensional space (6) and (8) hyperplasms$\sum_2$ associated with hypertension.

hypertensive Crimean points (5) fulfill the following condition

$$F_v(x,y,z,u,v)=0, \quad (9)$$

Additional four-dimensional hyperopia$\sum_1^2$ (9) equality is determined as a result. And so on, $\sum_1$ the orthogonal view of the hypertensive krimantin is reflected on the $0V$ axis using four-dimensional (5) and (9) s, as well as three-dimensional$\sum_3$ it is considered hyperbole. In this case, the hyperspace equation (9) depends on the hyperspace equation and is written as follows

$$F_{ux} \cdot (x - x_0) + F_{uy} \cdot (y - y_0) + F_{uz} \cdot (z - z_0) + + F_{uu} \cdot (u - u_0) + F_{uv} \cdot (v - v_0) = 0, \quad (10)$$

here x_0, y_0, z_0, u_0, v_0 – Lcoordinate points on the surface.

Three-dimensional$\sum_2$ and$\sum_3$ intersection of hyperspace$\sum_4$ forms a two-dimensional surface. And so on$N$, $K$and$L$ the points are not only related to self-induced hyperopia, but also at the same time$\sum_4$ two-dimensional surface, both (6), (8), (10) formed with hyperplasia$\sum_4$ it is considered to belong to the plane connected to the surface. From these equations

$$u - u_0 = \frac{-A \cdot F_{uv} + A_1 \cdot F_v}{\Delta},$$
$$v - v_0 = \frac{A_1 \cdot F_u + A \cdot F_{uu}}{\Delta},$$

we form equations. Here

$$A = F_x \cdot (x - x_0) + F_y \cdot (y - y_0) + F_z \cdot (z - z_0),$$
$$A_1 = F_{ux} \cdot (x - x_0) + F_{uy} \cdot (y - y_0) + F_{uz} \cdot (z - z_0),$$
$$\Delta = F_u \cdot F_{uv} + F_v \cdot F_{uu},$$

$\sum_4$ the corresponding plane equation to the surface is, if it is expanded

$$(x - x_0) \cdot \begin{vmatrix} F_x & F_u & F_v \\ F_{ux} & F_{uu} & F_{vu} \\ F_{vx} & F_{uv} & F_x \end{vmatrix} + (y - y_0) \cdot \begin{vmatrix} F_y & F_u & F_v \\ F_{uy} & F_{uu} & F_{vu} \\ F_{vy} & F_{uv} & F_{vv} \end{vmatrix} + + (z - z_0) \cdot \begin{vmatrix} F_z & F_u & F_v \\ F_{uy} & F_{uu} & F_{vu} \\ F_{vz} & F_{uv} & F_{vv} \end{vmatrix} = 0. \quad (11)$$

As a result, the series of surfaces with two parameters (5) follows

$$|F_x| + |F_y| + |F_z| \neq 0 \quad \text{va} \quad \begin{vmatrix} F_{uu} & F_{vu} \\ F_{uv} & F_{vv} \end{vmatrix} \neq 0.$$

fulfilling the condition (5), (7) and (9) it is determined using the system of equations.

Thus, the results obtained give an opportunity to determine the category of bending and covering lines and surfaces both as an analytical method by obtaining the equality of their relations between the parameters of the line or surface parameters and the parameters of the series (usually complex), and by quantitative methods that do not require obtaining such equations. These results were used not only for the materialization of computer polygonal and solid bodies with bending and covering, but also for the formation of a form third object – erasing volumes. The results obtained are confirmed by the reliability and effectiveness of the experiments conducted.

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Modeling of surfaces of the constellation curvature. Design of cutting instrument in the practical tasks under study, the need arises to determine the congruent curvature category associated with the centroid instrumentument, flying without a slip on the centroid of the product. SuchR^3several auxiliary surfaces are formed when describing the congruent curvature category in the medium. The analysis of the geometry of these surfaces by means of the CAD-system allows to determine the effect of the instrument installation parameters on the product as well as The Shape of the curvature category on the bending shape. As an example, we will consider the curvature series associated with the movement of the centroid - circle on another centroid - circle. Suppose that the centroids radiusi respectivelyR_1andR_2, let the series of curvature is given by the following parametric equation$x= x(t)$,

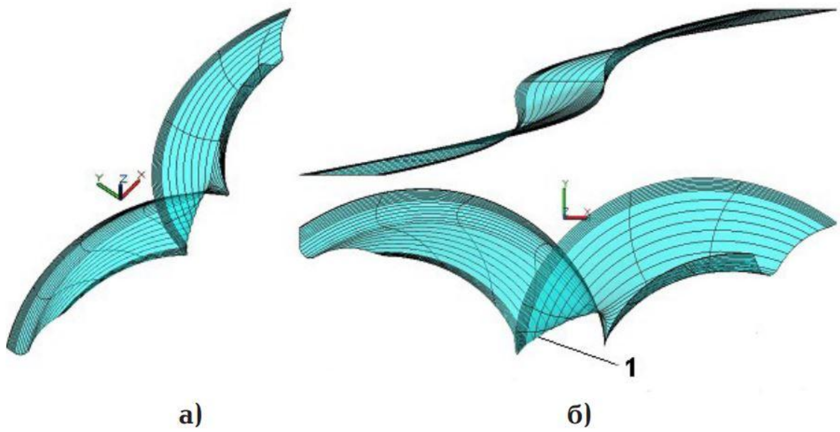
$$y= y(t).$$

This collection R^3after reflection in the medium, we get a surface with the following equality in appearance

$$x_s = x(t)\cdot \cos k\varphi - y(t) \cdot \sin k\varphi - A\cdot\sin \varphi ,$$
$$y_s = x(t)\cdot \sin k\varphi + y(t) \cdot \cos k\varphi - A\cdot\cos \varphi ,$$
$$z_s= p \cdot \varphi,$$

here φ – curvature set parameter, k = $\frac{R_1+ R_2}{R_1}$,as well as p – constanta big scratch.

After comparing the system of equations (12) with the cylindrical screw surface equation, it is possible to conclude that the surface of the cylindrical screw surface is caused by affin expression. It follows that the resulting surface is quasi – quasi-porous. One of such surfaces is a computerized Model 3 (a)- shown in Figure. In order to obtain the curvature of the series of lines seen, it is performed by lowering the orthogonal shade of the surface modeled on the coordinate plane (Figure 3(b)-figure). 3 (a)-for the model shown in the figure, the surface is the curvature curve associated with the horizontal ocher circle. This model uses the visualization mode to investigate the effect of product installation on The Shape of the bending parameter in relation to the instrument.



3-picture.Screw model of the surface (a) and its orthogonal projection (b); 1-Surface discriminant (the deflector part of the profile)

Another example of computer modeling is the determination of the curvature bundle holder (instument profile) associated with the initial accuracy that is not visible in the pilot, environment without a slip on the circumference. 4-the figure shows the two curvature categories for the two positions of the instrument in relation to the product. 4 (A)-in the picture, instument has a positive push(approach) in relation to the organizers, 4 (b) - in the picture has a positive push (move away). As a result, in the first case, the profile of the tooth is not only evolvent, but also a noticeable transient deviation in size. In the second case, 4(b)-there is no transient deviation in the picture, the tooth profile increases, which increases the tooth strength when compressing, but the tip of it is sharpened.

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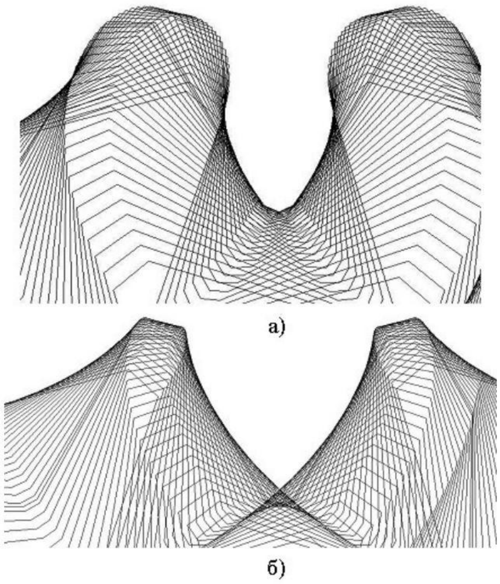
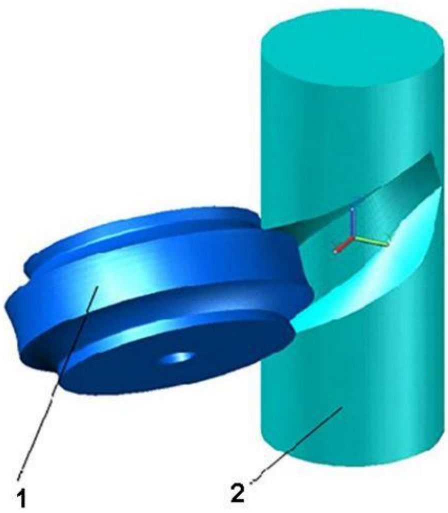


4-picture. The profile series of instruments is associated with a straight line that circulates around the circle: the connection of positive (a) and negative (b) means with respect to the product

Experiments on computer modeling of shading of a series of lines in a plane or in a later plane in an environment of their reflection the bending forms of a series of curvatures allow to obtain a qualitative pace not only from the current profile form, but also from the convenient location of the organizers and instrument.

Computer modeling of solid bodies shape. Another direction of the research of the main objects of formation is the modeling of computer-aided solid bodies by the interconnection of product and instument models in accordance with the chosen kinematic scheme. Cutting instument in the design process, along with profiling the formation of The Shape of its parts, the research of the cutting process plays an important role. The computer program developed in the Alt environment is based on the modeling of solid bodies and performs the formation of a detailed surface by instrument. Instument the process of modeling relationships between rigid bodies and organizations is carried out on the basis of the use of logical operations. 5-the figure shows the modeling of the formation of cylindrical organizers of cutting the screw disc. The result of modeling is the coverage surface of this line.



5-picture. Screw cutting (1) and cylinder forming (2) model of disc cutting

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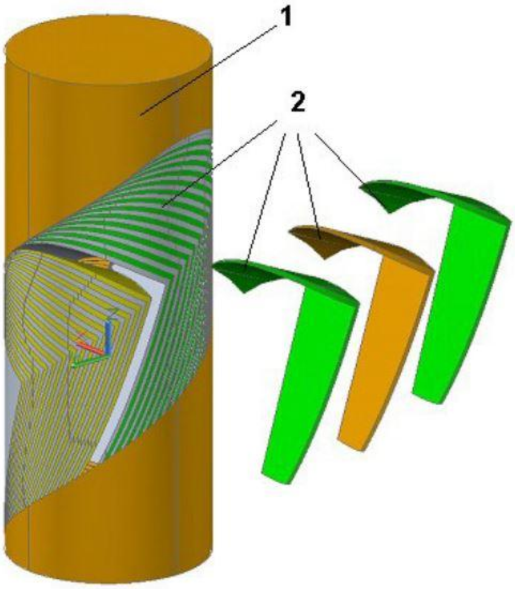
In addition to obtaining the coverage surface of the forming product, the process of subsequent creation of this surface is modeled, which means that the probability of transient curvature, the configuration of the erasing layer and the loading of the cutting sides of the instrument are established. As a computer modeling options, the scheme of stretching is described in Figure 6. In it is shown the model of the cylindrical organizers of the detail and the model of the final milling layers to be removed from it. On the basis of models of solid bodies, quantitative characteristics can be obtained about the shape, quality and volume of the detachable layers.



6-picture. After the formation of the detail Model (1) and the deleted layers (2)

The configuration and size of the removable layer for the status being seen will not change during processing. If we remove the model of the cutting layers after the formation in the detail model, it is possible to investigate the presence of curvatures passing through the side surface of the milling machine as well as the covering plane obtained from the plane that forms it.

In addition to obtaining a suitable profile, the algorithm and models modeling the formation of solid bodies in the function of an elongated flat scheme makes it possible to monitor the process of sequential cutting of interruptions between the wheel teeth, the configuration of the cutting layer and the loading of the cutting sides. In addition to the characteristics of the listed qualitative cutting process, it is possible to obtain the quantitative parameters of the proposed modeling: the size of the layer, the side cutting edges of the instrument, as well as the additional sides. There is an option to set The Binding of volumes, which is removed from the size of the cutting parameter. Analysis of these parameters allows you to specify the value of the cutting parameter for each transition, the value of the transitions, as well as the optimal value of the depth of cut.

The specified capacity is shown in Figure 7. It shows the model of the gear wheel organizers and dolbik instruments in the process of formation, as well as the model of the layers to be solved with the instrumentument.

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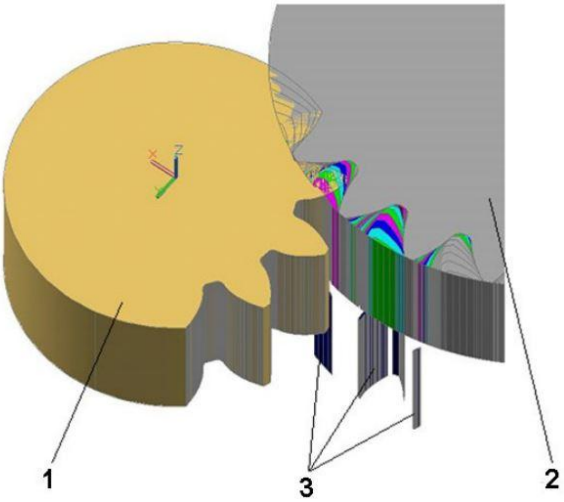

7-picture. Instrument Model (1), organizers (2), as well as clipped layers (3)

Modeling of computerized rigid bodies without pruning allows to obtain two main forms of object – the covering surface and erasing layers. In a number of tasks, such an approach can be the main thing when solving or filling out a given task, in the need of geometric modeling.

III. CONCLUSION

Conducted experiments have shown that the proposed method allows to determine the discriminant and covering lines and series of surfaces by analytical and quantitative methods, as well as the deactivating layer of Alt means, with a single position. Bunda successfully uses the opportunity of computer modeling of modern geometries, polygonal and rigid bodies.

The method of modeling the surface of the proposed technical product formation makes it possible to solve the following tasks:

- to develop a mathematical model of the surface and hyperspace, obtained on the basis of the designation of lines and series of surfaces with a greater ambient volume from the volume of the environment in which the categories are located;

- perform the reflection of the surface and hyperspace obtained by orthogonal shading, in accordance with the plane and hypertekism; the resulting series of bending and covering lines or surfaces can be determined in a single position, either by analytic or quantitative methods, by linking the parameter of The Shape of the lines or surfaces, usually without complex equations and without a Category parameter.;

- obtaining a new model of surfaces formed by flat curvature categories associated with the instrument centroidi flying without a slip on the centroid of the product; visualization of such surfaces on the computer allows to monitor the change in The Shape of the bending categories of profiles due to the optimal location of the product and the instrument and the dependence on the;

- creation of a model of solid bodies of volumes that are erased on the basis of an analysis in which there is an opportunity to give the optimal value of the number of approaches and giving parameters in the formation;

Thus, the proposed methodologies perform modeling in the process of product formation on a single theoretical basis using both analytical and quantitative methods, as well as modern computer technologies in layers bending, covering and erasing with instruction.

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