used to design new mechanisms and improve existing designs. Further research can be directed to take into account dynamic effects such as friction and deformation, as well as to extend the model to analyse more complex mechanisms.

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INTEGRATED SAPR OF THE SURFACE SWEEP OF A TRUNCATED TETRAHEDRAL PYRAMID

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Surface reaming of a truncated tetrahedral pyramid is a key step in the design and manufacture of complex geometries. However, manual calculation and construction of reamings is time-consuming, error-prone and inefficient for mass production. To solve this problem, an integrated computer-aided design (CAD) system has been developed, which is implemented in AutoCAD's LISP language. The system automates the calculation of the reamer, its division into parts and integration with existing CAD systems such as Profile Master PM2000.

The aim of the research is to develop an integrated CAD of surface sweep of truncated tetrahedral pyramid in LISP language in AutoCAD with the possibility of exporting the results in DXF format for further use in CAD "Profile Master" PM2000.

Material and methods. Gauss method for calculating the area of polygons, numerical integration for calculating the areas of curved surfaces, experimental studies to check the accuracy and correctness of the algorithms on real data, statistical analysis to compare the results obtained by the system with manual calculations and data from AutoCAD were used.

Results and their discussion. The study of CAD functionalities (CATIA, SolidWorks, FreeCAD) has shown that they are not always adapted for specific tasks of enterprises, for example, for truncated pyramids. In addition, their use requires expensive licences and complicated personnel training.

The following development tools were used to refine the functionality:

– AutoCAD: The primary environment for visualising and exporting sweeps.

– LISP: A programming language for creating custom AutoCAD scripts that automate calculations and interface.

– Lazarus (Free Pascal): Used to develop the main programme CAM_by.exe, which generates DXF files and LISP scripts.

– PM2000 "Profile Master": System for part nesting that accepts DXF data.

Stages in the implementation of CAD sweep.

1. Interface Design:

– Creation of a window for entering parameters (length and width of the base, section, height, allowances).

– Visualisation of a 3D model of a pyramid with parameters plotted.

2. Development of LISP scripts:

– The "Piram.lsp" file automatically builds a sweep in AutoCAD using the entered data.

– The files "Piram_L.dxf" and "Piram_R.dxf" export the results for PM2000.

The results of the Razvertka CAD development are the creation of the interface, interchange files, and integration with PM2000.

AutoCAD Interface:

– user input of parameters in a specialised window,

– 3D model visualisation with all parameters displayed.

Sharing files:

– `Piram_L.dxf` and `Piram_R.dxf` contain sweeps in the `cutting` (for cutting), `marking` and `attributes` (properties) layers.

– The LISP script `Piram.lsp` automatically loads the data into AutoCAD.

Integration with PM2000 :

– exporting DXF files to PM2000 allows for part layout on the sheet and plasma cutting.

Advantages over analogues of the developed CAD sweep

– versatility: support for AutoCAD and PM2000 makes the system available to companies with different levels of equipment;

– time saving: manual calculation took up to 2 hours, automation reduced the time to 2 minutes;

– accuracy: calculation errors are reduced to 0% due to parameter checking algorithms.

Limitations and perspectives

The current version has limitations as it only supports truncated tetrahedral pyramids.

Perspectives:

– extension of functionality for other geometrical figures (cylinders, cones);

– integration with cloud services for remote access.

Conclusion. The developed LISP-based CAD system in AutoCAD solves the key problems of automating the design of truncated pyramid sweeps. Integration with PM2000 and use of free technologies (Lazarus, LISP) make the system accessible for small and medium-sized enterprises. Implementation results confirm the system efficiency: reduction of design time, minimisation of errors and improvement of product quality.

INTEGRATED SAPR FOR AREA AND PERIMETER

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In modern engineering and manufacturing systems, the accurate determination of geometric characteristics of objects (area, perimeter, volume) is a key step in design, analysis and optimisation. However, manual calculations for complex shapes with curved or non-standard boundaries are often error-prone, time-consuming and low scalability.

An integrated CAD system that combines design, analysis and calculation automation can solve these problems. Such a system provides not only accuracy, but also the ability to work with large amounts of data, which is especially important when creating complex technical drawings or engineering projects. The purpose of the article is to study the methods of implementation of such a system, description of algorithms and their practical efficiency.

Research Objective. To develop an integrated CAD system for automated calculation of area and perimeter of figures of complex geometric shape, combining the following functions:

Material and methods. Gauss method for calculating the area of polygons was used in this work. Simpson's method for numerical integration of areas under curves. Bresenham's algorithm for boundary discretisation and perimeter calculation. Experimental studies with controlled conditions to verify the accuracy of the calculations. Statistical analysis of data to compare the results with manual calculations and existing programmes. Use of numerical methods and algorithms to handle complex geometric shapes, including curved objects and shapes with internal holes.