Conclusion. We have developed electronic educational and methodological complex that will form part of the master's thesis and will be very useful to other master's students when studying the subject "Differential Geometry" and working on their theses.

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INTEGRATED SAPR FOR THE JACK SEMI-AUTOMATIC SEWING MACHINE

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The **Jack** semi-automatic sewing machine is a specialised machine for making decorative stitches on shoe tops. It allows you to create complex patterns, ornaments and designs with high accuracy and speed. The machine performs stitches according to a pre-loaded programme, which minimises the impact of human error. **DXF** (Drawing Exchange Format), which supports vector images and precise stitch coordinates, is used to transfer designs.

Material and methods. Bresenham's algorithm for discretisation of curves and their transformation into a sequence of points, Simpson's method for numerical integration for calculation of areas of complex figures are used in this work. Experimental studies to verify the accuracy and correctness of the algorithms on real data. Statistical analysis to compare the results obtained by the system with manual calculations and AutoCAD data. Optimisation of needle trajectories of a semiautomatic sewing machine using algorithms that minimise sewing time and equipment wear.

Results and their discussion. The integrated computer-aided design (CAD) system for the Jack semi-automatic sewing machine is a comprehensive solution that combines all stages from design creation to its realisation in the production process. The main task of the system is to convert graphic data from CAD software such as AutoCAD into a format understandable to the equipment, taking into account all technical constraints and sewing quality requirements.

The process starts by importing a DXF file created in AutoCAD. CAD reads this file, analysing its geometry and structure. Each line or arc in the file has exact vertex coordinates, and layers encode the type of line (e.g. contour or fill). A specialised file parsing algorithm is used to extract this data correctly. This algorithm allows to get the coordinates of line nodes, parameters of layers. The result of this algorithm is visually presented in Figure 1, where the structure of processed data is demonstrated.

Next, the objects are divided into stitches - a key data preparation step for the Jack semi-automatic machine. For straight lines this process is relatively straightforward, but curved objects such as circles or spirals require a special approach. Here, sampling is applied at a specified step size that matches the resolution of the Jack equipment (typically 0.1 mm). This allows smooth curves to be converted into a sequence of points, which will then be used to control the needle movement. The Bresenham algorithm, one of the most efficient methods of converting vector lines into discrete points, is used to perform this task. The algorithm provides high accuracy and minimises errors in the conversion. The implementation of the algorithm is shown in Figure.

```
import ezdxf
def read_dxf(file_path):
doc = ezdxf.readfile(file_path)
msp =  doc.modelspace()
```

```
geometry = []
for entity in msp:
if entity.dxftype() == 'LINE':
geometry.append({'type': 'LINE', 'start': entity.dxf.start, 'end': entity.dxf.end})
elif entity.dxftype() == 'CIRCLE':
geometry.append({'type': 'CIRCLE', 'centre': entity.dxf.centre, 'radius': entity.dxf.radius}))
return geometry
```

Figure – Example code in the Python language

CAD also performs additional operations to optimise needle routes. This is necessary to minimise machine running time and prevent self-intersection of stitches, which significantly increases the durability of the equipment. The optimisation algorithms take into account not only the geometric characteristics of the pattern, but also the technical limitations of the Jack semi-automatic machine itself, such as minimum line length or maximum arc radius.

As a result of CAD work, a file is created ready to be loaded into the Jack semi-automatic sewing machine. This file contains complete information about each stitch, including its coordinates, type and parameters.

Conclusion. The integrated CAD for the Jack semi-automatic machine greatly simplifies the process of creating and realising decorative elements for shoe uppers. It combines design, geometry analysis, route optimisation and machine data preparation to ensure high accuracy and speed of production. This system is particularly useful for small businesses where design flexibility and minimising human error are required.

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KINEMATIC ANALYSIS PROGRAMME LEVER MECHANISM

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The kinematic analysis programme for a lever mechanism consisting of different assur groups is a tool for calculating the positions, velocities and accelerations of the links in the mechanism. Assur groups are the types of lever systems described in the "assur" module, including crank, four-link and other mechanisms. The programme is based on mathematical models implemented in a programming language and allows for detailed analysis of the dynamics and statics of mechanisms.

The aim of the study is to develop a kinematic analysis programme for a lever mechanism consisting of different groups of assur:

1. determines the position, velocity and acceleration of links depending on geometrical parameters and rotation angles;
2. implements algorithms to analyse kinematics and dynamics.