# Simulation and visualization of one-and-a-half-layer fabrics

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# Simulation and Visualization of One-and-a-half-layer Fabrics

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**Abstract.** In the scientific work, an analytical method is used, where formulas for calculating the main parameters of the structure of fabrics are derived from geometric models of the structure of one-and-a-half-layer weaves with an additional weft, and dependencies are determined with coefficients calculated on the basis of experimental data. The design includes the following stages: determination of the working out of the threads in the fabric, determination of the density of the fabric by the base and weft, determination of the calculated surface density of the rough and finished fabric. Visualization allows you to get a realistic image of the fabric on the screen without developing samples. The use of information technologies allows you to speed up the production cycle, improve the quality of design and reduce material costs

## INTRODUCTION

Currently, it is important to create trend structures of textile materials in a short time. It is also popular to develop a collection of materials that meet the same key needs, characteristics and motivations of the target audience, as well as express the creative concept of the designer. For training purposes, IT is also necessary to use information technologies to train textile specialists [1-7].

The requirements for updating the structure, raw material composition and color design of textile materials are constantly growing. And now the goal of any type of CAD is to improve the process of creating a fabric pattern with a reduction in material and time costs. At the same time, insufficient attention is paid to the design of one-and-a-half-layer fabrics [8-11].

Therefore, at the Department of Design and Fashion of the Vitebsk State Technological University, within the framework of the discipline "Computer-aided design systems", software products for the textile industry that can be used for educational purposes are considered.

## MATERIALS AND METHODS

For the purpose of teaching students the full cycle of designing one-and-a-half-layer fabrics at the Department of Design and Fashion of VSTU, the authors created a software product. The program structure was thought out. After analyzing similar software products for single-layer fabrics, it was found that a prerequisite for the complete design of one-and-a-half-layer fabrics is the presence of three autonomous sections of the program:

- construction of one-and-a-half-layer weaves;
- fabric design;
- calculation of the fabric installation on the machine (FIGURE. 1).

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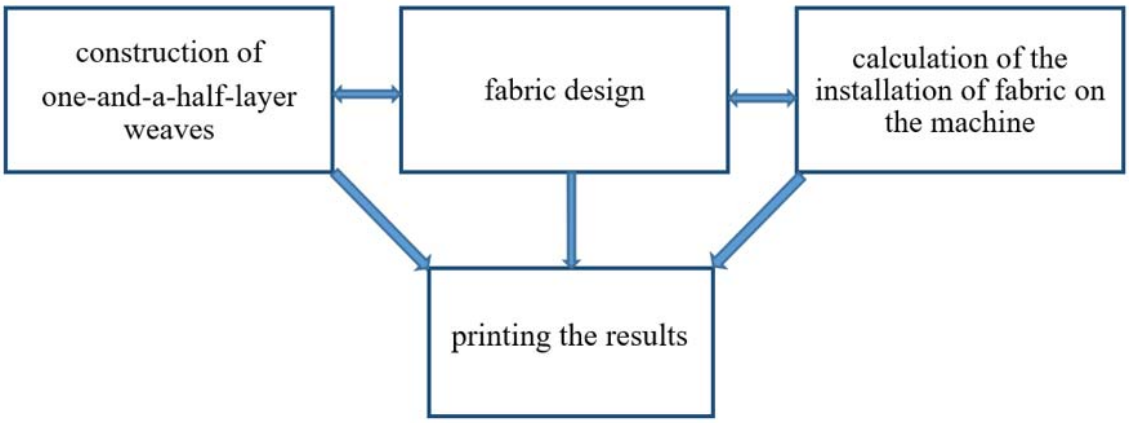


**FIGURE 1.** Scheme of operation of the tissue visualization program

It was decided to use each section of the program for training purposes, as well as to add the ability to print a report for compiling technical documentation.

The scientific work uses the analytical method. To do this, based on previous studies of geometric models of the structure of one-and-a-half-layer weaves with an additional weft, as well as sections of fabrics obtained experimentally, visualizations of geometric models of the structure are constructed in the Autodesk 3ds Max graphic editor (FIGURE. 2-3).

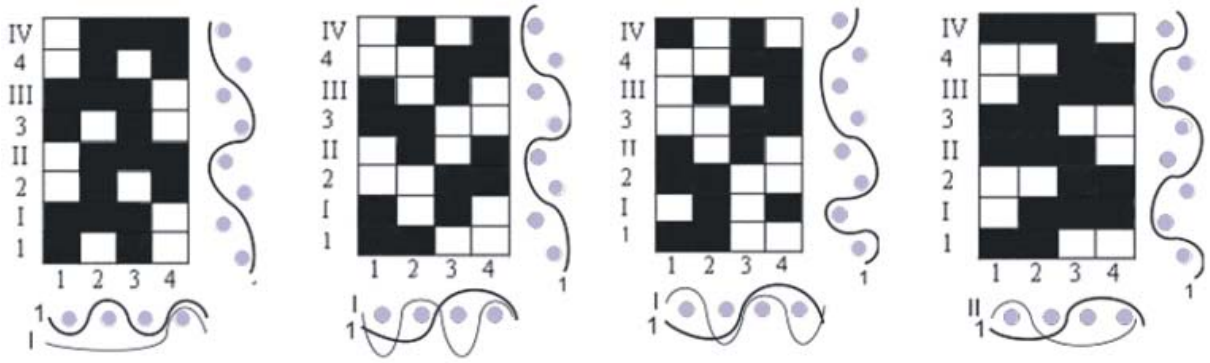

**FIGURE 2.** Cuts of one-and-a-half-layer fabrics with an additional weft

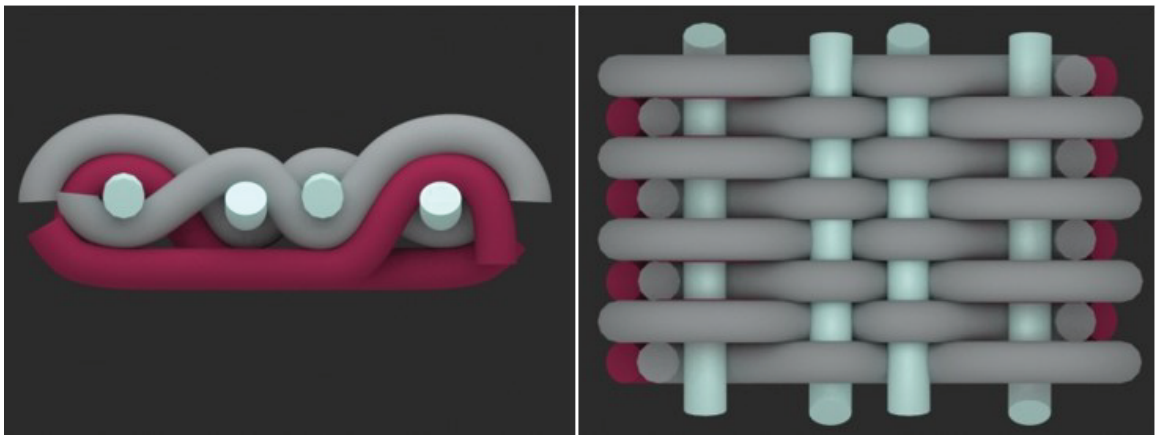

**FIGURE 3.** Visualization of geometric models of a building

Also, according to the incisions, it was found that the upper weft and the upper warp participate in the formation of the facial surface of the tissue. The user has the option to draw an arbitrary weave on their own, or use the base of the main class of weaves. The appearance of the window of the structural section of the fabric weave pattern is shown in Figure 4.

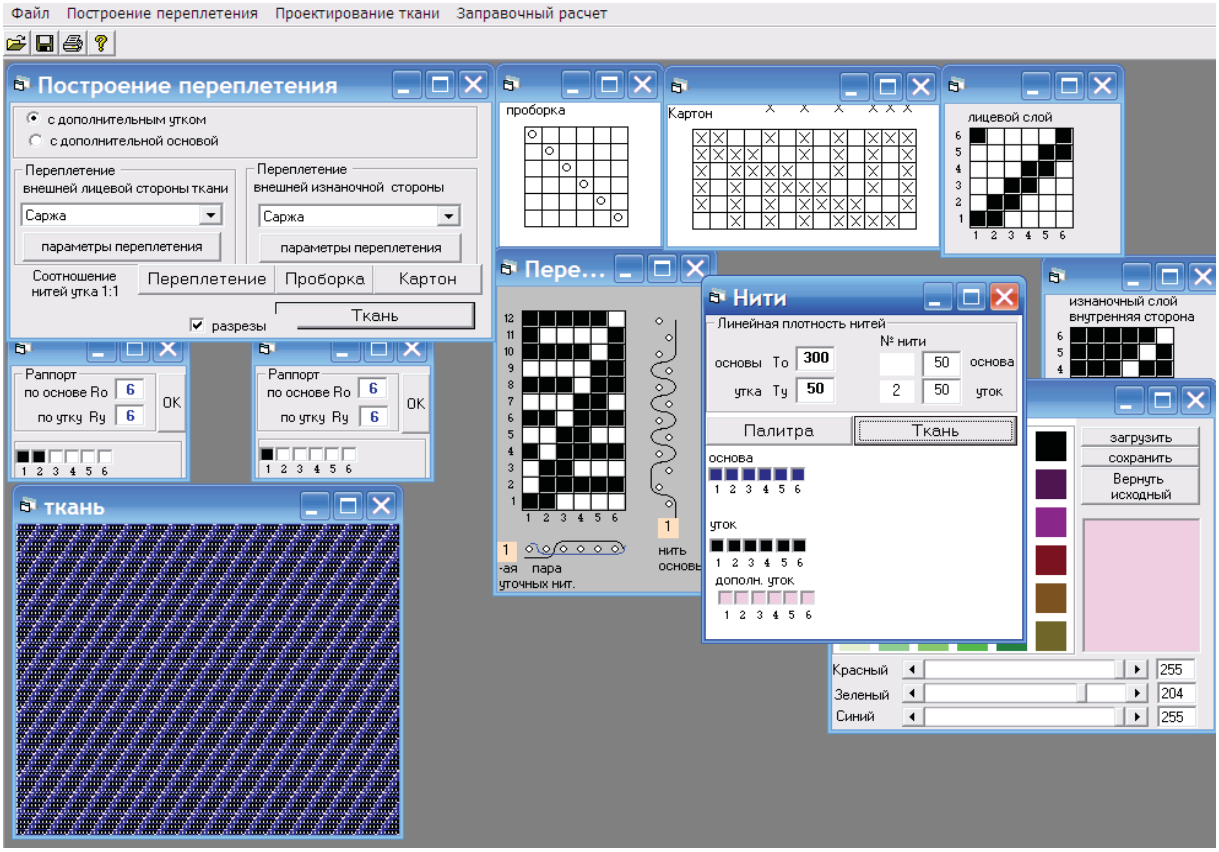


**FIGURE 4.** The program window when building a pattern of fabric weaving

The system automates the creation of new one-and-a-half-layer weaves; performs longitudinal and transverse cuts of the fabric. In this case, the user selects the color of the warp and weft threads, their linear density. After that, it is possible to visualize the projected tissue sample.

For the first section of the program, the stage of fabric design was chosen, since for educational purposes, the construction of the weave is most often used, as well as the construction of a complete pattern for filling the fabric on the loom. An important step in checking the correctness of the construction of the weave is the construction of a longitudinal and transverse section of a one-and-a-half-layer fabric [12-14].

The visualization of the fabric has a schematic representation. To match the color pattern with the real image as much as possible, the program uses the addition of additional effects that allow you to create a softer surface.

Pantone colors are designed for any type of textile. World experts once developed advanced color technologies in terms of selecting promising tones and creating paint. They are also engaged in the development of fashionable color trends, which are used by all civilized countries. According to the laws of semiotics, color materials affect people differently depending on their social and national identity or the conditions of color perception. The color palette in the program is standard. The user can change the digital values of each color, thereby creating a new palette.

Significant indicators of textile materials that have an emotional and aesthetic effect on a person in visual perception include: surface texture, color and pattern of interweaving. Currently, simple drawings of fabrics with an imitation of the surface of the weave structure that you want to touch with your hands are relevant.

The next important step in fabric design is the visualization of the sample. For the designer, it is important to create a collection of materials that can be produced at one filling station of the loom without changing the loom stock. In a production environment, it will usually take a long time to see the results of the work. And the software product makes it possible to reduce the time required to design a sample and create a series. To visualize a sample of the material, to represent all possible nuances of the development of the idea of a collection of fabrics based on one direction, use the option to change the color of the threads as directed by the designer (FIGURE 5).

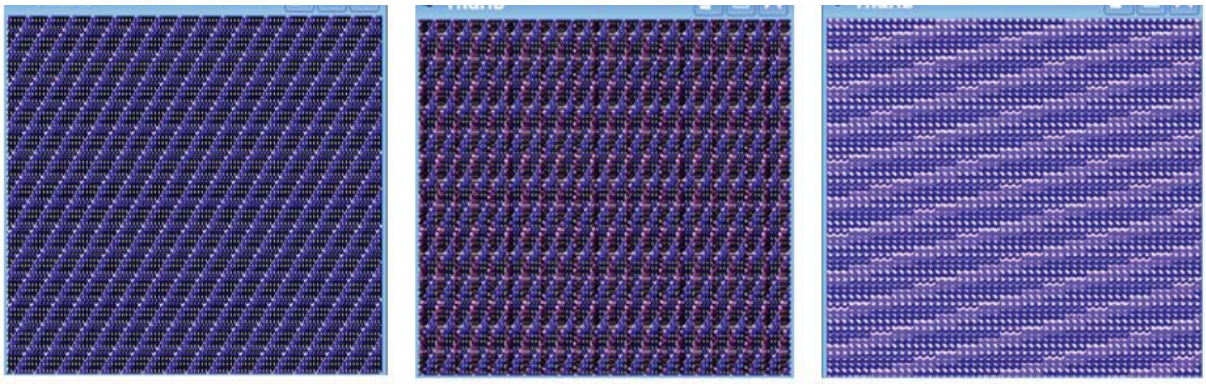

**FIGURE 5.** Changing the color of the threads in the sample

The program provides selection, adjustment, viewing of color rapports by base and weft, which are stored in the memory in various variants. It is also possible to change the thickness of the threads, and options with different thicknesses for each thread in the weave rapport are possible (FIGURE 6).

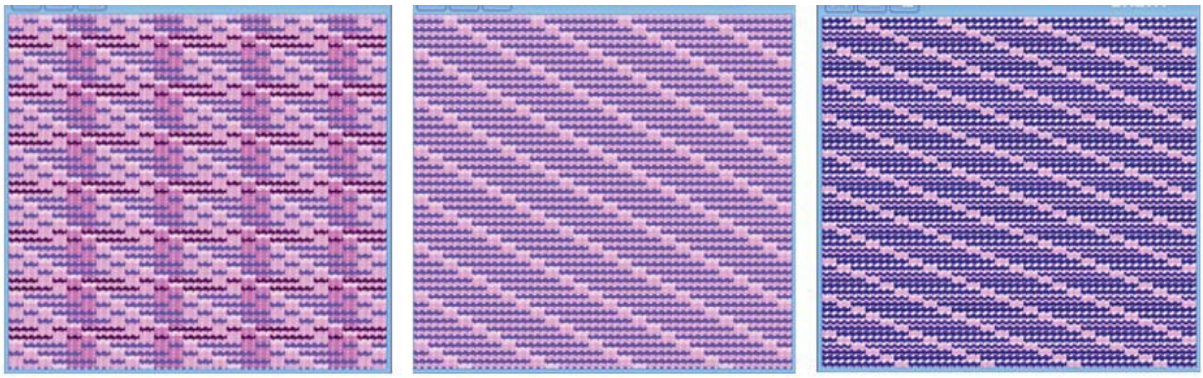

**FIGURE 6.** Changing the thread thickness

Computer-aided design is carried out in an interactive mode. In the program, you must enter all the necessary initial data for calculating the fabric to fill it on the machine. The calculation allows you to determine the percentage of error that occurs as a result of the design and compare the obtained values of the surface density with the calculated data.

The program has an empty field for entering print comments, fabric names, or calculations. The design data can also be stored in memory for use as input to the refueling calculation or printed out.

Computer-aided design is carried out in an interactive mode. The design of the fabric is carried out according to the design method for surface density according to standard formulas that are used in the design practice and developed at the Kosygin Russian State University. In the program, you must enter all the necessary initial data for calculating the fabric to fill it on the machine. The calculation allows you to determine the percentage of error that occurs as a result of the design and compare the obtained values of the surface density with the calculated data.

The program has an empty field for entering print comments, fabric names, or calculations. The design data can also be stored in memory for use as input to the refueling calculation or printed out.

## RESULTS AND DISCUSSION

A software product is created from three blocks that are interconnected. The output of each of the design blocks is available for printing. And they can also be input data for the next block. At the same time, it is possible to work in the offline mode of each section of the program. At any stage of the design, you can enter the values manually. Also, for training purposes, it is planned that the user will receive comments and explanations when entering invalid or incorrect values.

In the section of the program related to fabric design, a collection of fabric samples is modeled. In the sections of calculation for filling on the machine and design, a complete set of calculations is performed for the most common in the production of fabrics on looms.

To test the results of work in production conditions, a pure linen yarn with a linear density of 56 tex was selected. A collection of one-and-a-half-layer fabrics of the men's assortment of the costume group was developed. Calculations for refueling textile equipment, as well as data for the preparatory shop for preparing the machine for production, were carried out according to the calculations made in the described software product. As a result of the subsequent physical and mechanical studies of the samples, it was found that the error in calculating the projected surface density from the experimentally obtained one is less than 5 %, which means that the formulas entered in the program are correct for the design of one-and-a-half-layer materials from flax raw materials, and are also acceptable for use both in the educational process and for production conditions.

## CONCLUSION

As a result of the work carried out, a software product was created that allows both in the context of textile production and for educational purposes to automate the entire life cycle of textile production – from the design of the fabric structure to the finished textile product. For training purposes, the options for constructing fabric sections on the base and weft, as well as building longitudinal and transverse sections, have been added. Sample visualization allows you to get a realistic image of the artistic and coloristic design of the fabric on the screen without working out the samples directly on the loom. The use of information technologies allows you to speed up the production cycle, improve the quality of design and reduce material costs.

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