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RESEARCH ON THE PROCESS OF BUILDING DRESS SHAPES IN 3D SPACE

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Abstract: The article explores the potential for designing virtual clothing models based on material characteristics and evaluating the quality of fit using the automated CLO3D program. To inform the selection and prediction of viable solutions for the development of the company's industrial collection, the study presents findings from a periodic analysis of parameters such as shape, fragmentation, and fabric texture of women's dresses from the "Carolina Herrera" brand over the period from 2000 to 2024. Based on the research findings, a collection of hourglass-shaped women's dresses was designed, considering the characteristics of typical figures with varying fullness and height. To determine suitable clothing forms for different body types, a comparative analysis was conducted between real samples of basic size shirts and virtual shirt forms developed using the CLO3D program. The study revealed that the shape of the virtual clothing created in the CLO3D program is influenced by the development of the virtual mannequin, which is based on the projection parameters of the real mannequin, and by the completeness of information regarding the physical and mechanical properties of the materials.

Keywords: women's dresses, basic shape, silhouette, artistic and constructive signs, typical figure, CLO3D.

Introduction. The contemporary fashion industry offers a diverse range of products designed to cater to various needs. Despite this, mass-produced clothing that fits well on the basic societal body type continues to be popular. Consequently, women with different body types often have to restrict their wardrobe to garments with wide silhouettes or those made from elastic materials. Numerous researchers have suggested various approaches to designing aesthetically pleasing and harmonious clothing for women whose figures deviate from the typical body type. [1-3] and includes the possibility of manufacturing individual clothes in industrial conditions through automated systems. However, despite the widespread adoption of automated systems in the garment industry, even for popular brands, the creation of form-fitting garments for body types of different fullness and height is particularly attractive, for example, for garments with a slimming silhouette. the task of meeting needs has not yet been fully resolved.

To create aesthetically harmonious clothing forms for various body types, it has been proposed to address the task of forming a rational assortment of clothes by developing different model types based on the construction of basic sizes. [4]. It is known that fashion trends are shown in fashionable figures (models), and clothing forms, elements, proportions are defined in model parameters.

To study the forms of women's dresses and their evolution over time, a research task was established to examine clothing elements using examples from renowned brands. The American luxury brand Carolina Herrera[5], which holds a significant market presence today, was selected for this analysis. The objective was to analyze the dresses in its collections. An analysis was conducted on the elements of dresses spanning twenty-four years, from spring-summer 2000 to 2024, encompassing a total of 834 dress models. Twenty artistic and constructive features of the dresses were examined, with key indicators including shape, silhouette, solution, sleeve style, length, fragmentation, lift (front drape), waistline, degree of breast adhesion, shoulder line, sleeve shape, and additional indicators such as sleeve length, sleeve width at the neckline depth, front drape style, collar types, additional decorations, additional decorative elements, color, and fabric patterns. This comprehensive analysis resulted in a total of 16,680 indicators across the twenty constructive-artistic features, ensuring the credibility of the study. Notably, the article focuses on the fundamental indicators of shape formation, namely shape, segmentation, and fabric texture (see Figure 1).

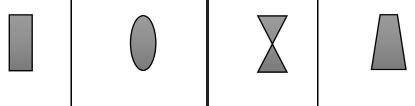
Figure				Fragmentation						
				Overall	Coquette	Blouse + skirt	Coquettish bra+ coquettish skirt	Two fragmented	More than two	Another
										
Plaid	Plain	Peasent style	Geometric	Combined	Facture	Floral	Mixed	Plain	Striped	Floral
Fabric texture										

Figure 1. An example of indicators of shape, fragmentation, fabric texture.

It is known that designing clothing models of various spatial forms is a complex process, wherein maintaining the desired clothing shape requires ensuring coherence, balance, and proportionality among all elements of the model composition. Creating spatial clothing forms largely depends on the interconnection of components: "shape - structure - material". [6]. The impact of fabric on the integrity of form and design is significant. Factors such as fiber composition, shearing, stretching, warping, stiffness, and thickness, along with the garment's packaging (whether single-layered, multi-layered, or combined) and technological methods, collectively contribute to the garment's overall shape.

Considering these variables, an analysis was conducted comparing the prevalence of rectangular, oval, hourglass, and trapezoidal shapes across collections from 2000 to 2024. The graphical representation in Figure 2 depicts the trend indicators, revealing the hourglass shape as the predominant form throughout the 24-year period under study. It is notable that there exists a periodic pattern in the oscillation frequencies of the hourglass shape. Specifically, an examination reveals that the initial peak of this shape's indicator occurred in 2002, surpassing all other shapes under scrutiny. Subsequently, a sharp decline ensued, reaching its nadir of 8.3% by 2007, followed by a resurgence to 82.2% in 2011, maintaining considerable prominence for the ensuing three years until 2013. Further analysis indicates that the subsequent trough occurred at 12.5% in 2018, with a subsequent growth peak at 83.6% in 2023. Remarkably, the periods of heightened popularity of the hourglass shape appear to recur approximately every decade on average. A comprehensive comparison of all deviation and growth indicators over the entire study period reveals a notable increase in the significance of the hourglass shape. Conversely, in the case of rectangular models, an opposite trend is evident. Initially, rectangular shapes held the highest prevalence among all shapes under examination, registering at 72.2% in 2000, followed by a sharp deviation in 2002 to 6.25%, and then a subsequent increase to 57.1% in 2003. Similar fluctuations persisted throughout the period, with the final deviation indicator at 5.4% in 2023 and a growth point of 26 in 2024, comprising 5%.

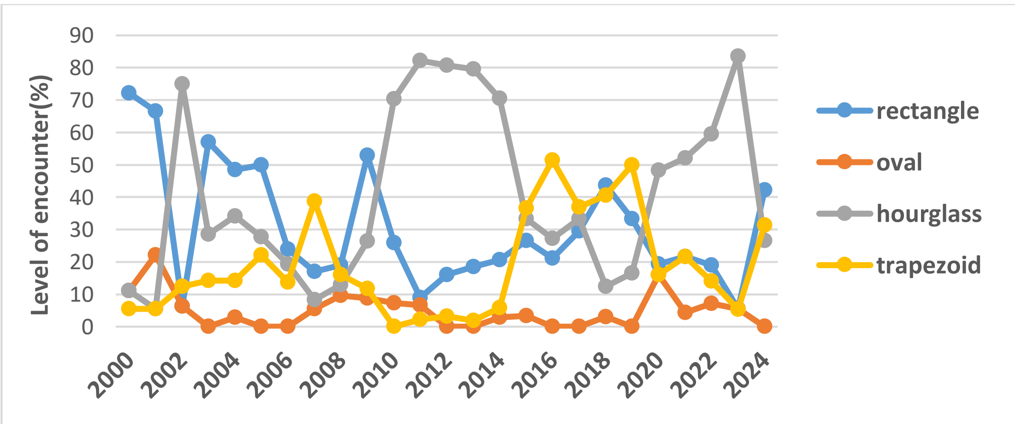


Figure 2. The dynamics of changes in the shape of dresses in the period 2000-2024.

Additionally, an analysis of the cleavage indicators of shirts, focusing on the front view, was conducted to understand their influence on garment shape. These indicators were categorized into longitudinal and transverse cleavage types, with the results presented graphically in Figure 3. The graph reveals that in 2000, the percentage of shirts with an unsplit single front part was the highest among all studied indicators, at 61.1%. However, this percentage declined over time, dropping to 31.25% in 2002, 11.7% in 2009, 9.25% in 2013, and 8.7% in 2021, demonstrating a clear trend of deviation. By 2024, the share had increased to 21.8%, indicating a continuous growth rate from 2022, yet this figure remains significantly lower than at the beginning of the studied period. The frequency of the "fiber + skirt" fragmentation type within the cross-sectional fragmentation category has shown a notable increase over the 24-year study period. Initially, its share was relatively low, recording 5.25% in both 2000 and 2001. However, by 2002, this figure had risen to 31.25%, continuing to increase to 44.4% between 2006 and 2013, and reaching 50% in 2015. Although there was a deviation point at 21.9% in 2018, the frequency demonstrated consistent growth, achieving 52.3% by 2022. Overall, this type of fragmentation increased by 41.3% in 2024 compared to the beginning of the study period, indicating its growing relevance in recent years.

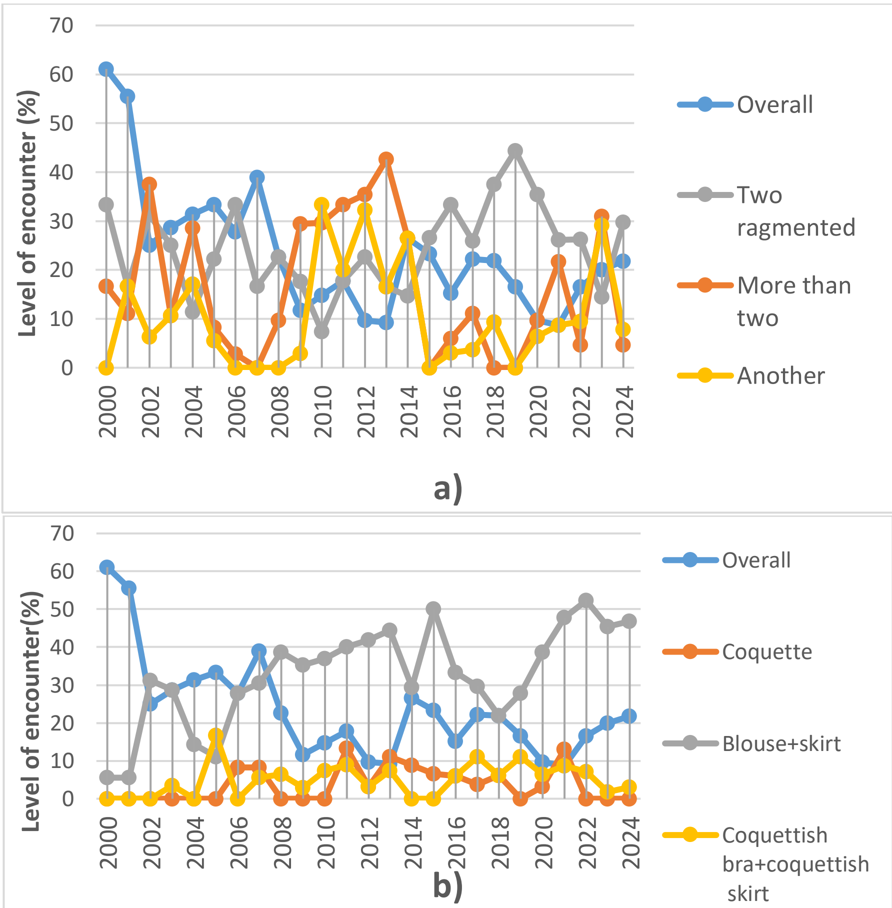


Figure 3. The dynamics of changes in the segmentation of shirts in the period 2000-2024: a) longitudinal; b) transverse.

The study also examined the texture and patterns of fabrics used in dress models. Information on prints and fabric surfaces of models over the past 3 years is presented in Figure

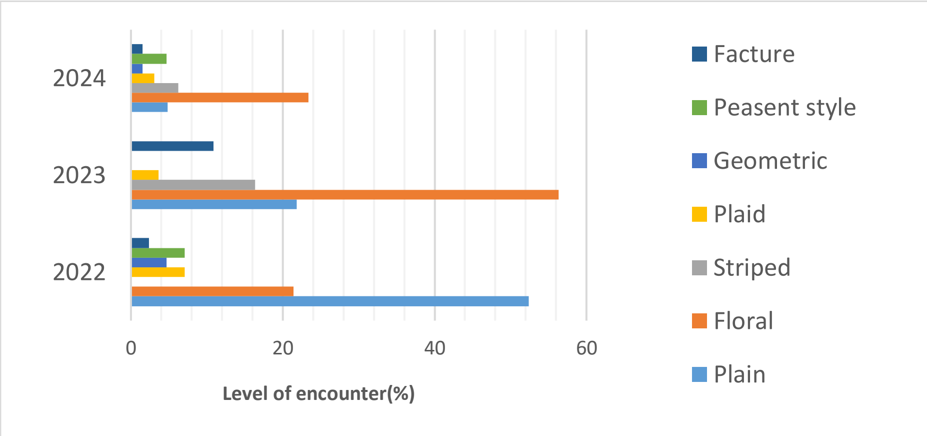


Figure 4. Frequency of occurrence of textures and patterns of materials used for brand dress models over the past 3 years.

According to the diagram, in 2022, colored fabrics comprised the largest share, accounting for 52.4% of all studied brands. However, this share increased to 21.8% in 2023 and then decreased by 4.8% in 2024. Among printed fabrics, floral prints exhibited a high frequency, with their occurrence rates being 21.4% in 2022, 56.3% in 2023, and 23.4% in 2024, demonstrating their predominance among the investigated fabric surface characteristics. Additionally, striped print models, which were entirely absent in 2022, appeared with a share of 16.3% in 2023 and decreased to 6.2% in 2024. A periodic study of modern fashion trends enables the prediction of traditional clothing forms. Additionally, the studies identified the frequency of various combinations of constructive-compositional elements in fashion models. Based on the research findings, a database of graphic images depicting these constructive-compositional signs was developed to aid in the formation of a rational assortment of women's dresses.

In the collection of dresses, it is possible to make decisions by creating new forms of clothing models with the help of three-dimensional automated systems to determine the aesthetically-suitable clothing models for different body types and its constituent elements. Today, using the CLO3D system, it offers opportunities to create a virtual clothing model shape based on material properties and check the quality of clothing fit. The advantages of CLO3D include synchronization and ease of use for sewing operations, supporting multi-layer sewing processes, and enabling the creation of folds on any seams and garments. The software offers improvements in speed and quality through new multi-level modeling, supports various physical properties of materials, and provides a high level of visualization. Additionally, CLO3D is widely compatible with other programs such as 3DS Max, AutoCAD, Maya, Softimage, Lightwave, Poser, Daz Studio, Vue, and Modo. [7].

The objective was to analyze the conformity of the shape and fit of a clothing model developed using the program to the real-size dimensions of 170-88-93. An hourglass shape was selected as the foundational basis for the women's dress collection. Sketches of dresses and corresponding design documents were created based on graphic elements and proportions, ensuring an aesthetic and quality fit for various body fullnesses and heights in the dress collections. Following fashion trends, the clothing samples were composed of cotton gauze. The fit and shape of the garments were evaluated on a basic size mannequin.

To develop virtual clothing in the CLO3D automated program, it is crucial to create an avatar that corresponds not only to arc parameters but also to the projection parameters of a real mannequin. A virtual avatar was generated by inputting typical mannequin dimensions, including projection dimensions such as the transverse diameter of the bust and the front-back diameter along the circumference of the bust (Figure 5).

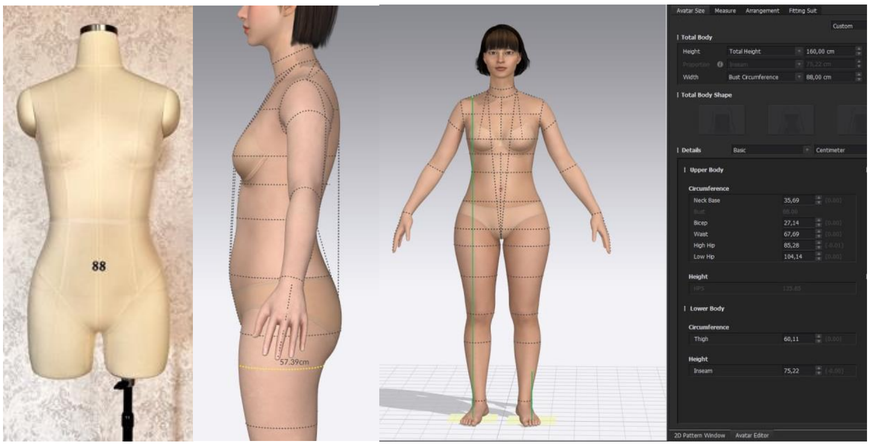


Figure 5. Typical mannequin and 3D avatar.

The shape of the silhouette of dresses with extended hems is influenced by the fact that the length of the hem cut creates pleats according to the nature of the fabric. In order to design a virtual sample of clothing in a 3D system, it is important to include the properties of the fabric in the program. In the "fabric" section dedicated to gasification placed in the working window of the CLO3D automated program, the database defining gasification properties is very extensive, and they are shown in the form of a hierarchical scheme in Fig. 6.

The entry of fabric data into CLO3D is categorized into three classes. The first class, "Information," includes general details about the fabric such as its name, coding, information about the person who worked on it or is currently working on it, as well as the fabric's construction and artwork solutions. The second class, "Material," contains information about the appearance, structure, and optical properties of the front and sides of the fabric. The third class, "Physical Property," is crucial for fabric simulation and includes data on the fabric's physical-mechanical properties. This encompasses elasticity, displacement, bending, wrinkling, stiffness, moisture, density, and friction.

Each property typically requires specific information for the fabric's body and warp direction, as well as for the right or left side.

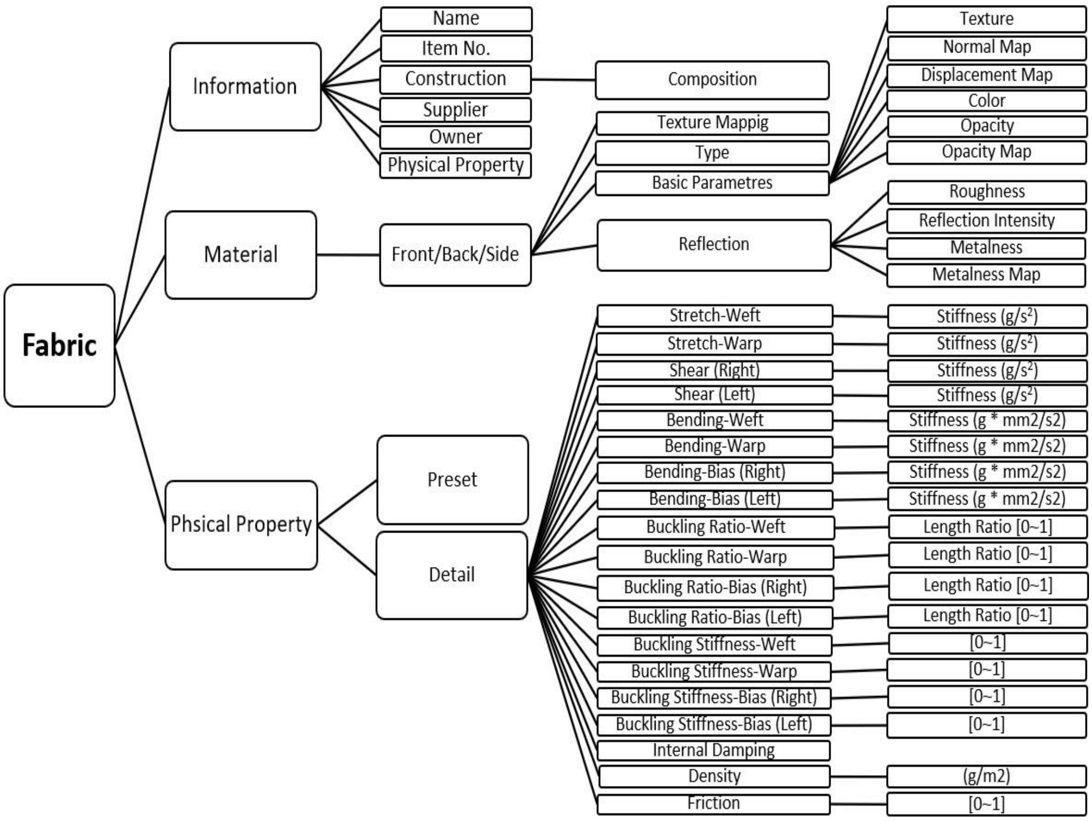


Figure 6. Data entry system for fabric in CLO3D automated software.

The inclusion of real fabric properties in these indicators necessitates laboratory analysis. It was found that some of the required physico-mechanical properties of the fabrics are already included in the program's database. The characteristics of three different types of cotton fiber fabrics selected for the dress sample, as listed in the program's cotton fiber materials database, were determined under the conditions of the SANTEXUZ laboratory at the Tashkent Institute of Textile and Light Industry. The analysis covered various properties, including composition, texture, thickness, surface density, non-creasing, and air permeability indicators. The results of this analysis are presented in Table 1.

Table 1. Physico-mechanical properties of gauze selected for women's dresses

Fabric No	Fiber composition	Interweaving	Thickness (mm)	Surface density (g/m^2)	Crinkle resistance %		Air permeability (dm^3/m^2.sec)
					warp	weft	
1	100% cotton	satin	0,20	121,83	48,8	51,1	107,1
2	100% cotton	Linen	0,25	112,76	46,6	45,5	395,3
3	100% cotton	satin	0,20	119,9	51,1	53,3	119,8

Based on the parameters obtained for fabric properties in laboratory conditions, the following indicators were introduced as input data for the gasification simulation in the CLO3D program: composition, construction, thickness (mm), buckling stiffness (weft, warp), density (g/m²), and weight (g/m²). In accordance with the project documents, dress patterns were developed in the program, and a virtual clothing sample was created (Figure 7).

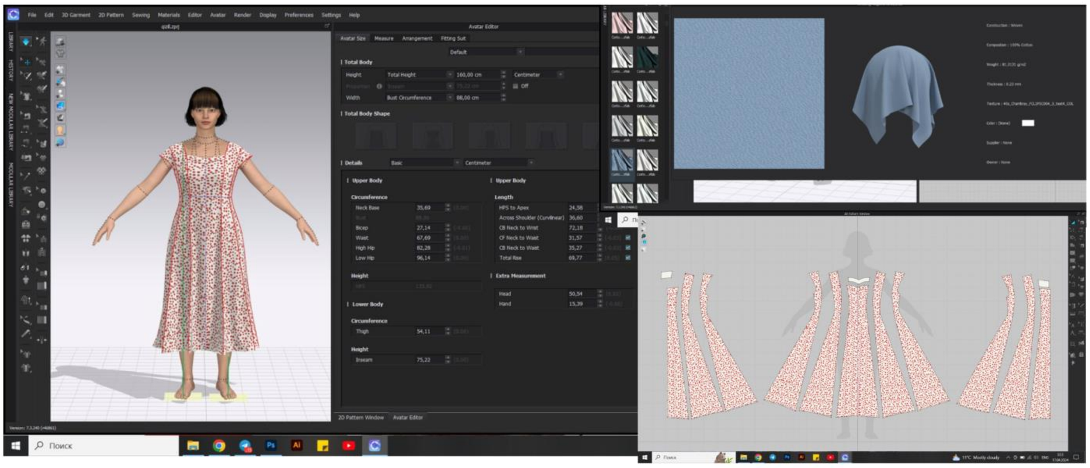


Figure 7. Fabric window of CLO3D system.

To evaluate the compatibility between the virtual dress forms obtained in CLO3D and the real dress forms, the angles of the hem of the dress relative to the bust line were measured. For Sample 3, the left hem spread of the real dress was 7.66°, and the right angle was 9.33°. In the virtual dress, the left hem spread was 10.20°, and the right angle was 11.18°. The differences between them are 2.54° and 1.85°, respectively. Similar discrepancies were observed in other models. Figure 8 presents the results of comparing the compatibility of real and virtual clothing forms. There is a noticeable difference in the level of similarity between the real and virtual models, indicating that identical results cannot be assumed.

Figure 8. The angle of spread of clothing forms from the bust line.

Based on the research, the following conclusions can be drawn: Typical figures with different fullness and height were analyzed based on a periodic study of parameters such as shape, fragmentation, and fabric texture of "Carolina Herrera" brand dresses from 2000 to 2024. Considering these characteristics, and by choosing practical solutions for the formation of the industrial collection of the enterprise, a collection of women's hourglass-shaped dresses was developed. This was achieved by creating a database of graphic elements of clothing. Using the CLO3D program, it was determined that the accuracy of the virtual clothing form is influenced by the development of the virtual mannequin based on the projection parameters of the real mannequin and the completeness of the information regarding the physical and mechanical properties of the materials.

It is not always feasible to fully study the characteristics of gas parameters presented in the program under laboratory conditions. Expanding the functionality of CLO3D automated systems and enhancing them for designer specialists in the development of industrial assortment collections offers numerous advantages. These improvements are particularly beneficial for determining aesthetically harmonious models through virtual views of clothing forms created for different types and individual figures. Key benefits include the ability to create a diverse clothing assortment in a short period of time, saving both time and various expenses.

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