APPLICATION OF 3D SKIRT DESIGN IN THE CONTEXT OF EFFICIENCY AND SUSTAINABILITY

Original scientific paper
DOI: 10.5937/CT_ITI25005P

Marija Pešić[1,*], Ineta Nemeša[1,a], Nadiia Bukhonka[1,b], Danka Đurđić[1,c], Valentina Bozoki[1,d]

[1]University of Novi Sad, Technical Faculty „Mihajlo Pupin“ Zrenjani, Djure Djakovica bb, Zrenjanin, Serbia
[*]e-mail: marija.pesic@tfzr.rs; ORCID ID: 0000-0002-3745-7771
[a]e-mail: inetavil@gmail.com; ORCID ID: 0000-0003-2552-3097
[b]e-mail: nadiia.bukhonka@tfzr.rs; ORCID ID: 0000-0002-2753-2440
[c]e-mail: dankadjurdjicsd@gmail.com; ORCID ID: 0009-0003-4369-8306
[d]e-mail:valentina.bozoki10@gmail.com; ORCID ID: 0009-0000-4045-3539

ABSTRACT: *Considering the rapid changes in the fashion and clothing industry, digital technologies represent an important tool for improving the efficiency and sustainability of production processes. This paper explores the application of 3D software tools in the skirt design process, with a particular focus on time savings, waste reduction, and visualization capabilities prior to making the first trial sample. Using CLO 3D software, a digital model of the skirt was developed and compared with the conventional approach in Modaris software. The analysis includes a comparison of the duration of production, flexibility during changes, visual control. The conducted analyse show that the 3D construction and visualzation enables faster design iteration and a reduction in the number of sewn first samples, which contributes to sustainability through a more rational use of materials. It can be concluded that the integration of 3D programs for the construction and visualization of garments represents a significant step towards the digital transformation of the fashion industry.*

Keywords: *3D design, CLO 3D, Modaris, sustainability, skirt.*

PRIMENA 3D PROJEKTOVANJA SUKNJE U KONTEKSTU EFIKASNOSTI I ODRŽIVOSTI

APSTRAKT: *Uzimajući u obzir brze promene u modnoj i odevnoj industriji, digitalne tehnologije predstavljaju važan alat za poboljšanje efikasnosti i održivosti proizvodnih procesa. Ovaj rad istražuje i analizira primenu 3D softverskih alata u procesu konstrukcije suknje, sa posebnim fokusom na uštedu vremena, smanjenje otpada i mogućnosti vizuelizacije pre izrade prvog probnog uzorka. Koristeći CLO 3D softver, razvijen je digitalni model suknje i upoređen sa konvencionalnim pristupom u Modaris softveru.*

Analiza obuhvata poređenje trajanja proizvodnje, fleksibilnosti tokom korekcija i izmena, i vizuelnu kontrolu. Sprovedena analiza pokazuje da 3D konstrukcija i vizuelizacija omogućavaju bržu iteraciju dizajna i smanjenje broja sašivenih prvih uzoraka, što doprinosi održivosti kroz racionalniju upotrebu materijala. Može se zaključiti da integracija 3D programa za konstrukciju i vizuelizaciju odevnih predmeta predstavlja značajan korak ka digitalnoj transformaciji modne industrije.

Ključne reči: *3D dizajn, CLO 3D, Modaris, održivost, suknja*.

1. INTRODUCTION

In recent years the fashion industry has been going through a significant transformation due to the impact of sustainability, digitalization and increasingly demanding consumer needs. In this context, digital technologies, especially 3D software for clothing design and production, are becoming key tools for improving the design, production and evaluation processes of clothing products. In a modern environment, where speed of product launch on the market, waste reduction and resource optimization are of crucial importance, 3D design can provide efficient planning, visualization and testing of garments even in the developing stage, without the need to create physical prototypes of clothes samples [1-3].
At the same time, growing demands for sustainability in the fashion industry are directing attention towards technologies that enable the reduction of material, energy and time consumption, while simultaneously preserving the aesthetic and functional qualities of the product. Digital fashion and virtual prototypes represent an alternative to traditional production, contributing to the reduction of the ecological footprint through virtual collections, 3D trial and a reduced number of physical samples [3,4]. Companies such as Nike, Adidas, Zara, Hugo Boss and others are already demonstrating how 3D technologies and digital tools can become part of a wider sustainability strategy [5-7].
According to the results of some research, the great pressure on designers is related to the speed of placing the product on the market. A faster and faster launch of collections is required in order to achieve continuity in renewing the offer in stores. Research and application of digital and virtual technologies in the field of clothing design are of great importance in the transformation of the clothing and fashion industry, which is based on value propositions that integrate ethics, aesthetics and innovation. New digital technologies are leading the textile industry towards the 4.0 industrial revolution, which is aimed at creating smart products, processes and the entire production [8].
The use of 3D skirt designs as a specific garment is an example of how digital tools can be integrated into practice with the aim of increasing environmental, economic and production efficiency. Thanks to software such as CLO 3D, Browzwear and others, it is possible to precisely develop models, visualize the silhouette on the avatar, simulate the fall of fabric and optimize material consumption without physical tests [3, 4].
This paper analyzes the application of 3D skirt design as a methodological framework for process improvement in terms of production time, material consumption, reduction of physical samples and communication between actors in product development. Special emphasis is placed on the comparison between traditional (2D) and modern (3D)

approaches to clothing design, as well as on the possibilities that 3D design offers in the field of sustainable development of the fashion industry [1, 4, 8].
The aim of the work is to examine to what extent and in what way 3D design contributes to increasing efficiency and sustainability in the process of developing clothing products, with a special focus on the skirt as a model that is representative and suitable for virtual testing. This work contributes to contemporary research in the field of digitization of fashion, sustainable design and technological optimization of product development.

2. DEFINITION OF DIGITALISATION AND ITS IMPORTANCE IN THE CLOTHING INDUSTRY

Digitization represents one of the key technological changes that is shaping the ways in which businesses function, communicate and develop products. Although the term digitization is often used in different contexts, its meaning is still not unambiguously defined in professional and scientific literature. Depending on the context and industry, digitization can mean different levels of transformation – from a simple transition from analog to digital records, to deep changes in business models with the use of artificial intelligence, machine learning and process automation [2, 9, 10].

Figure 1: 3D product design by Adidas created using Browzwear software [https://dtech.fitnyc.edu/projects/adidas-browzwear].

In business practice, digitization is most often used to describe the process of converting analog information into digital records, which can then be used to improve efficiency through structuring, standardization, and automation of activities [2, 9]. The basis of that process is the electronic collection, processing and analysis of data, which enables strategic and operational decisions to be made in real time.
In the clothing industry, digitization has multiple applications – from digital garment design, through virtual prototyping and 3D design (Figure 1), to production automation, digital marketing and e-commerce. This industry uses digital tools to respond to the ever-increasing demands of the market for faster product development, personalization, supply chain transparency and sustainability [1, 2, 10].

By using 3D software solutions, it is possible to reduce the number of physical samples, speed up the decision-making process and improve cooperation between designers, manufacturers and retailers [10].

3. DIGITAL TECHNOLOGIES AS TOOL FOR IMPROVING SUSTAINABILITY IN CLOTHING DESIGN

Digital technologies have multiple effects on improving sustainability in the fashion industry. Their application enables more efficient use of resources, reduction of waste, optimization of the production process and greater transparency in the supply chain.

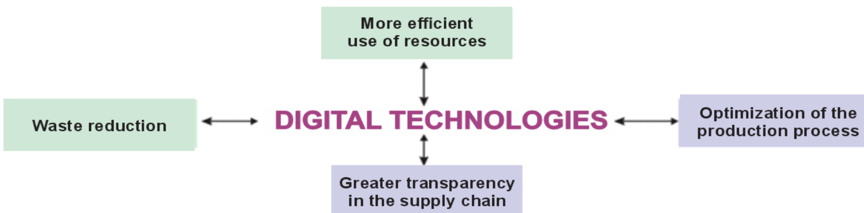


Figure 2: The impact of digital technologies on sustainability through key production segments (figure created by author).

Automation of processes and work with digital tools open up new opportunities for personalized production, flexible working environment and reduction of stocks, i.e. overproduction, which is one of the biggest problems of the fashion industry. By using big data analytics and predictive algorithms, it is possible to predict demand more accurately and thus avoid stoks [10 -13].

Traditional models of collection development relied on multiple physical prototyping, manual construction of cuts and the creation of waste in the process of experimentation. With the introduction of tools for computer-aided design (CAD), 3D simulation, parametric modeling and digital prototyping, designers and constructors today have the ability to make informed and responsible decisions in the early stages of the process [12,13]. One of the most important contributions of digital tools is the 3D visualization of clothing models using software such as CLO3D, Browzwear or Optitex. These tools enable virtual testing of construction, fit, material fall, silhouette and size – without the need to physically make samples. In this way, textile waste, the number of physical prototypes and the total consumption of materials are significantly reduced [12,13].

CAD systems for construction and tailoring, such as Lectra, Gerber and Modaris, enable the precise construction of clothing forms, automatic grading of sizes and optimization of the arrangement of cutting parts, which achieves the maximum utilization of materials [14]. Integrating these systems with fabric databases and virtual avatars further improves design accuracy and shortens collection development time. 3D design and visualization open significant opportunities for the development of the concept of fashion on demand, which contributes to personalization and mass customization, thus producing pieces that meet the real needs of consumers, reducing stock and increasing the likelihood of long-term use of clothing items [15]. Through parametric tools, it is possible to change dimensions, style, colors and materials without the need to reconstruct the basic model, which supports a sustainable approach to "designing for reuse" and "product longevity" [3, 6]. In addition, digital technologies in design enable real-time collaboration between designers, construction teams and clients. By using digital platforms to exchange visuals and technical specifications, faster validation of ideas is enabled, thus reducing development time and the number of iterations [1, 7].

4. APROACHES TO 3D CLOTHING DESIGN

The development of 3D simulation tools in the fashion industry intensified during the 1990s and 2000s, where two key approaches were distinguished:

- "3D in 2D" - Creating a design directly on a 3D avatar, after which the molded parts are converted into 2D tailoring elements.
- "2D in 3D" - A more traditional method where 2D cut pieces are placed on virtual mannequins or avatars to simulate the appearance of clothing in the digital space.

These approaches enable optimization of the entire design and production process, reducing costs and time needed to finalize collections.
Sometimes these two approaches are combined to develop advanced CAD systems. Today, a large number of 3D CAD software for design and virtual prototyping of models are available, commercially offered by the companies shown in Table 1 [16].

Table 1: Comparison of the characteristics of modern 3D software in the context of application in the fashion industry

Software	Application	2D/3D support	Simulation	Price
CLO 3D	industrial design	Yes	Realistic	Low
Browzwear Vstitcher	Industrial product development	Yes	Advanced	High
Optitex 3D	Serial production	Yes	Advanced	High
Marvelous Designer	industrial design, animation	No/only 3D	Visual	Low
Styler 3D (Linctex)	3D design, virtual rendering	Yes	Realistic	Middle
Modaris 3D Fit (Lectra)	Industrial product development	Yes	Advanced	High
Tuka 3D (Tukatech)	Industrial product development	Yes	Advanced	High
Gerber Accumark 3D	Industrial product development	Yes	Advanced	High
Audaces 360	Industrial product development	Yes	Realistic	Middle

5. EXPERIMENTAL PART

Despite the increasing availability and development of advanced digital tools, the practice of designing clothes in most fashion companies in Serbia still dominantly relies on traditional CAD systems, such as Lectra, Gerber and Optitex. These tools are primarily used for construction, grading and preparation of custom parts, while their potential for 3D simulation and virtual prototyping is rarely used to its full capacity.

Based on practical insights and cooperation with the domestic industry, it can be concluded that a small number of brands have licenses for 3D software such as CLO 3D, VStitcher, Optitex 3D, but even when they are present, these tools are most often not actively used in everyday practice. The lack of trained staff, getting used to older work methods, as well as the initial investment in training and integration of new tools, are the main obstacles for the wider application of 3D design in the domestic context.

For this reason, the experimental part of the work was designed to compare two approaches to the development of the same model of a women's skirt. As a basis for comparison, a skirt model was chosen that was realized in two ways:

- The first approach relies on the method that is most often used in domestic companies, that is, on manual digitization and modeling in Modaris (Lectra) software, which is the standard in most companies in Serbia.
- Another approach involves the application of a modern software solution for 3D design and visualization in the CLO 3D program, which enables virtual testing of the construction, appearance and behavior of materials on an avatar.

5.1. Methods

5.1.1. CLO 3D

The CLO 3D program was developed by a team of experts at the Korean company "CLO Virtual Fashion Inc." and was presented for the first time in 2009. It enables the simulation of garments in a virtual space before the start of production. Over the years, CLO 3D has experienced dynamic development, with frequent upgrades bringing new advanced cut and fabric simulation tools, improved user interface, and better integration with other software solutions [8, 11].

CLO 3D enables the creation of digital clothing prototypes that can be viewed from all angles, i.e. in a 3D virtual space, while simulating the fabric's behavior in real conditions [8]. Key functions of the CLO 3D program:

• 2D Tools for drawing basic cuts (line, curve, internal line, dart...)

• 3D Simulation and realistic visualization of cuts in 3D space with a momentary trial of the garment on a virtual avatar

• Display Avatar and adjust body measurements

• Fabric library with physical parameters (thickness, elasticity, friction...) with the possibility of importing your own textures and pattern mapping

• The sewing simulation function, that is, the joining of parts as in reality with the simulation of stretching, wrinkling and layering of seams.

• Ability to display material tension on seams (strain map)

• Export of high-resolution images and 360° display of models and interactive presentations

• Ability to export and import files in PDF, DXF, AI formats [8, 11].

5.1.2. Lectra- Modaris

Modaris is a software package that has the possibility of digitization, computer construction, modeling and grading of tailoring parts, as well as creating variants of clothing models [17].

Lectra is one of the leading manufacturers of computer CAD systems in the textile industry. It was founded in 1973 in France, and the Modaris program was released in 1984. the program provides tools for creating basic constructions, modeling different stylistic variants, as well as automatic or manual grading of sizes. The use of Modaris contributes to greater precision, efficiency and consistency in the development of apparel products, thereby reducing the need for physical prototypes and speeding up the entire collection development process. The software is used in education, design and industrial production. There are two ways of making tailoring parts in a computer program. One is direct construction in a computer program, while the other involves manual construction on paper and then transferring the cut parts through a digitization process to the computer [17].

5.2. Materials

Description of the skirt model. The skirt model shown in Figure 3 is an asymmetric skirt with a flap that closes with two decorative buttons placed on the upper part of the front. The skirt is of medium length and follows the body line. The size in which the skirt was made is 38.

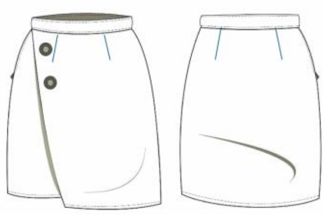
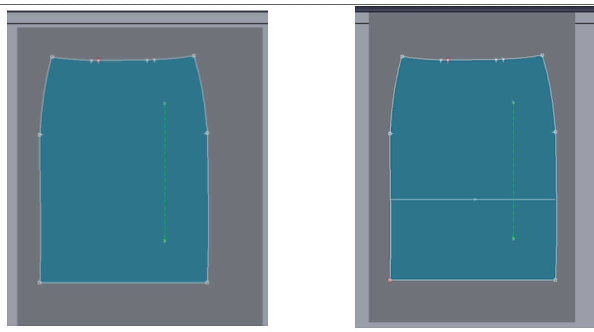


Figure 3: Technical sketch of the skirt model

In Modaris (Lectra) software, the basic cut of a woman's skirt was first digitized, whereby the paper cutas transferred to a digital format using a digitizer. After the successful digitization, the modeling phase was started, where the original cut parts were modified in accordance with the design solution. The process of creating a model of a women's skirt in the Modaris program consists of the following stages:

1. Digitization of the basic cut
   - The paper cut of the woman's skirt was transferred into digital format using a digitizer.
2. Preparation of the front part for modeling
   - The front cut is symmetrically opened using the Symmetry function over two points (F5) along the front center line. (Figure 4a)
   - Unnecessary type 2 points were removed with the Fusion function (F3), then converted to type 1 points and deleted. (Figure 4b)



a) b)

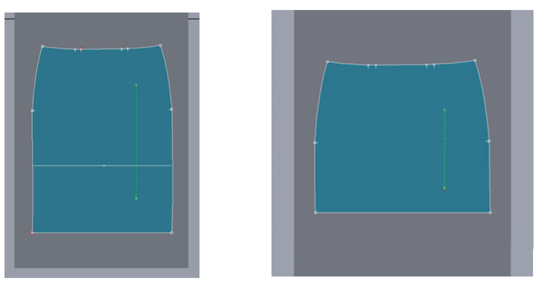
Figure 4: a) Opening the front cutting part, b) erasing unnecessary points

3. Changing the length of the cutting parts

• Markings of the new length of the cutting parts by adding Relative points on the contour reduced (picture 5a),

• Creating a parallel line. The exact values of the positioning of the relative point and the cutting parts are entered in the dialog box (Fig. 5a).

• By activating the function of cutting across two points, the new length of the cut parts is defined (picture 5b).



a) b)

Figure 5: a) Determining the new length of the skirt, b) the front cut part of the skirt with the remodelled length

4. Duplication and separation of cutting parts

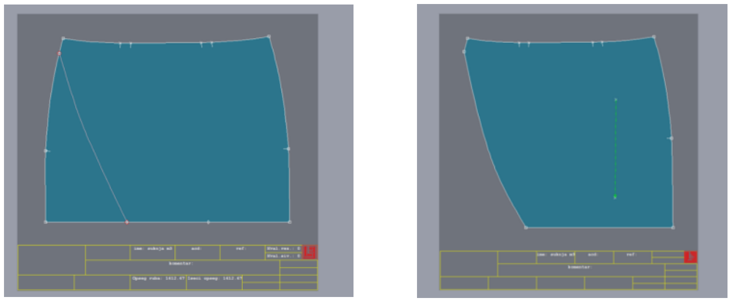
• The cutting part is duplicated using the F1 function (click on the line and move), defining the distance with the entered value.

• The cut function (F4) draws an internal line and separates it as a separate part.

6. Preparation of cutting points

• The relative point is placed 3 cm from the waist on the hip line - it represents the starting point for cutting the upper front part.

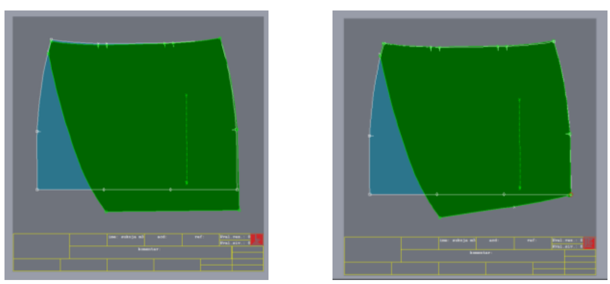
• Using a Bezier line, a cutting line for the folding front part was created



a) b)

Figure 6: a) adding a relative point and creating the cutting line of the front part, b) cutting the cutting part along the drawn curved line.

7. Sharing the model and shaping the curved lines
   - The sequence is divided into three parts to obtain a 2/3 skirt (Figure 6a).
   - Bezier line (F1) was used while holding the Shift key to obtain the desired curve.
8. Cutting along a curved line
   - With the F5 function, the cutting part is cut according to the constructed curved line.
   - The points on the curved line are simplified with the F5 function, for smoothness.
   - Reshaping the line along the length of the new cutting part (Figure 6b)
9. Assembly and centering of parts
   - The Bezier line was used to center and shape the cut parts.
   - The F3 function centers the parts to match the corresponding points (Figure 6)



a) b)

Figure 7: Reshaping the length line and assembling the cut parts of the skirt

10. Marking button positions

• The buttons are marked with a relative point and a species designation of 37.

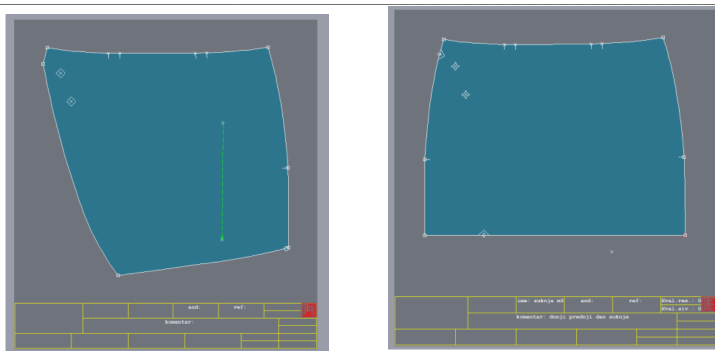

a) b)

Figure 8: a) marking the position for sewing on holes, b) positioning the place for sewing on buttons

11. Assembling the back of the skirt

• The F8 function was used to mount the rear part and reshape it

Procedure for creating a skirt model in CLO 3D:

1. Starting a new project and choosing an avatar

• From the base of available avatars, one of the offered avatars of the female body is selected,

• Changing avatar body dimensions using the Edit Measurements option, where new body dimensions can be precisely adjusted. In this case, the body dimensions corresponding to ready-made size 38 were taken.

• The avatar is displayed in a 3D window, while its silhouette is automatically displayed in a 2D window, facilitating the construction of tailoring parts (Figure 9).

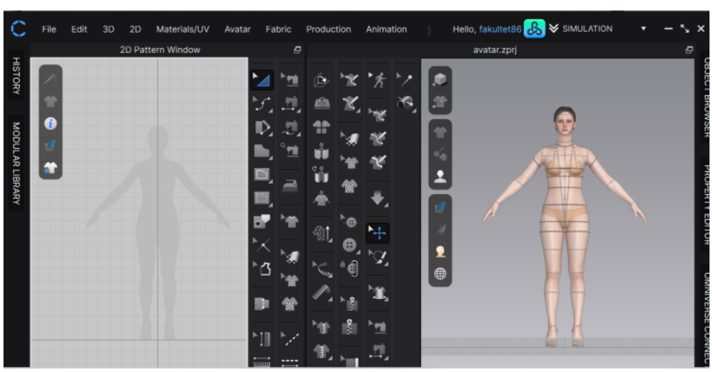
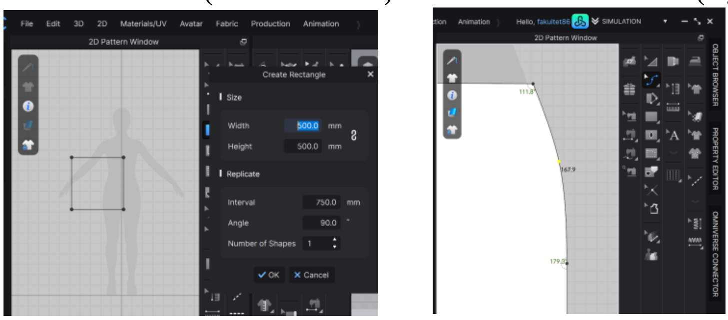


Figure 9: Avatar creation in 3D window and its shade in 2D window

2. Construction of the basic shape of the skirt

• Skirt modeling starts by drawing a rectangle in the 2D window, with dimensions: width = ½ hip circumference + allowance for comfort and height = skirt length.

• Tools are used to shape the side seam:
Edit Pattern + Edit Curvature (to curve the line) as well as Edit Curve Point (Figure 10)



a) b)

Figure 10: a) Rectangle creation, b) curvature creation

3. Dart creations

• Grommets are created using the Add Dart tool. The position and size of grommets are precisely defined numerically in the dialog window (Figure 11).

4. Placement of cutting parts

• Tailoring parts (front and back) are placed automatically with the help of the function: Auto Arrangement - which positions the parts on the avatar according to the type of garment (Figure 11).

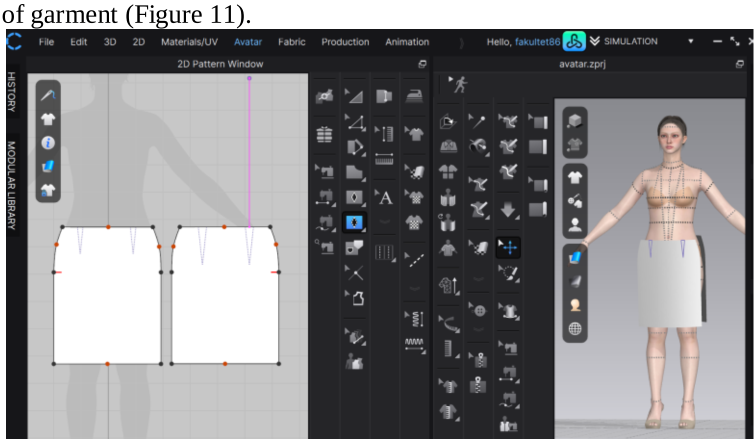


Figure 11: Dart creation in 2D window and Arrangement of cutting parts in 3D window

5. Sewing and simulation

• Joining of cut parts was done with the tool: Segment Sewing

• After all the parts were connected, a simulation was run to check the behavior of the fabric and the construction of the skirt.

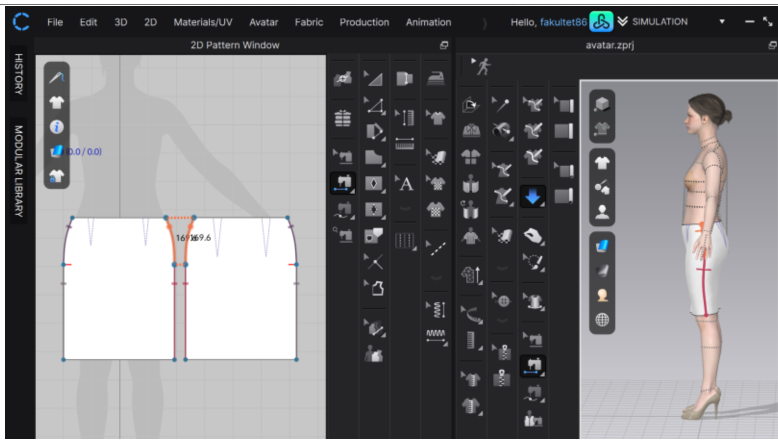


Figure 12: Sewing and simulation

6. Defining the material

• Material information (eg fabric type, thickness, elasticity, weight) is entered in the Fabric Property Editor.

• Material is dragged onto a 3D model from the library, resulting in a realistic fabric drop in virtual space.

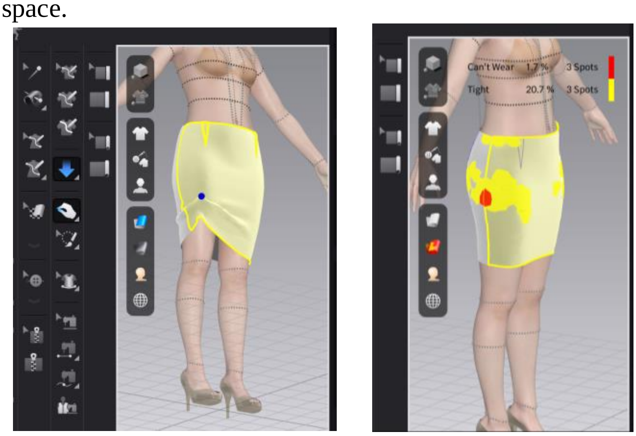


Figure 13: a) Fabric drop testing, b) strain map

7. Fit analysis

• After the simulation Fit Map and Strain map was turned on. It shows the tension of the fabric by colour and visualizes the areas where the material is under stress.

8. Modeling the straight skirt into the desired model according to the technical sketch.

• The front cutting part is duplicated first

• Using the functions Edit curve point and Edit curvature reshapes

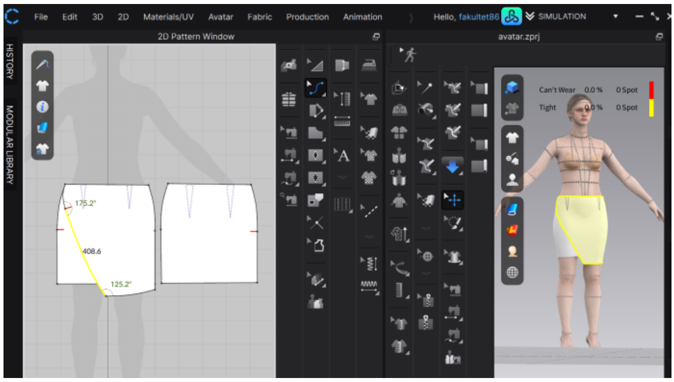


Figure 14: Final presentation of the skirt model

9. Final processing and presentation of the model (Figure 14.)

6. COMPARATIVE ANALYSIS OF MODARIS AND CLO APPROACEHS IN SKIRT DESIGN

In order to assess the effectiveness and potential of modern digital tools for constructing and visualizing clothing, a comparative analysis of the same model of a woman's skirt was carried out in two different software environments - Modaris (Lectra) and CLO 3D.

Table 2: Comparative analysis of women's skirt model creation in Modaris and CLO 3D software

	Modaris approach	CLO 3D approach
Time required for production	95 minutes (multiple steps, manual processing). Note: the time depends on the experience of the operator	45 minutes (faster development directly on the avatar). Note: the time depends on the experience of the operator
Visual inspection of the model	Limited visual assessment	Realistic 3D simulation in real time
2D cuting parts creation	Accurate, but after manual digitization	Accurate, created by drawing
Possibility of comfort testing	No integrated simulation	Simulation of material behavior, movement and falling
Size grading	Gradation is more precise and flexible, using detailed control by points, segments, multiple rules for various sizes.	CLO is not primarily intended for precise industrial grading
creating a tailoring image	The fitting in cuting pictres is precise, but requires technical knowledge and additional steps and the use of the Diamino program.	It is possible to create a "Snapshot of Pattern" and connect 2D and 3D views, but there is no professional marker system

7. CONCLUSIONS

Digital technologies in the field of clothing design and construction are a key tool for improving sustainability, efficiency and flexibility in the fashion industry. By introducing tools for 3D visualization and simulation, such as CLO 3D, it is possible to significantly reduce the need for physical prototypes, accelerate collection development and more accurately assess the behavior of materials on a virtual body.
The experimental part of the work, in which the modeling of a woman's skirt in Modaris software and the CLO 3D platform was compared, pointed out key differences in production time, visual control, adaptability and potential for virtual testing. While Modaris is still a dominant presence in domestic fashion businesses, its use remains mostly limited to 2D CAD processing. On the other hand, CLO 3D enables faster and more intuitive model creation with a realistic representation of fabric construction and behavior. The work shows that the application of 3D tools not only contributes to the improvement of the design process, but also represents an important step towards the sustainable transformation of the fashion industry. Bearing in mind the low representation of these tools in the practice of domestic companies, it is necessary to work on staff education, integration of modern software and adaptation of educational programs in order to ensure the competitiveness and innovation of the sector in accordance with global trends.

FUNDING
This work was supported by the Provincial Government of the Autonomous Province of Vojvodina, Provincial Secretariat for Higher Education and Scientific Research of the Republic of Serbia (Decision on Approval of Funds No 001064141 2024 09418 003 000 000 001 04 003).

REFERENCES

[1] Wu, E. (2024). The Impact and Pathways of Digitalization on the Development of the Fashion Industry, *Highlights in Business, Economics and Management, WEPM Vol, 46, DOI: 10.54097/8kwv5n85*
[2] Avadanei., M., Rosca., M., Vatra, D., Loghin, E. (2022), Digitalisation in the supply chain of the fashion industry – Study case, The 18th Romanian Textiles and Leather Conference CORTEP 2022, DOI: 10.2478/9788367405133-031
[3] Ren, R., Shen, L., Xu, H. (2022). *Research on Digital Transformation and Upgrading of Fashion Industry Under the Background of Big Data*, Proceedings of the 2022 International Conference on Artificial Intelligence, Internet and Digital Economy (ICAID 2022) DOI: 10.2991/978-94-6463-010-7_2
[4] Morandi, A., Tonelli, C. (2023). The impact of 3D technology on sustainability in fashion luxury product design: evidences from an exploratory analysis.Politechnico Milano, 2022-2023.
[5] Inditex annual report, https://annualreport2023.inditex.com/en/medioambiente, accessed 18.6.2025.

[6] Hugo Boss annual report, https://group.hugoboss.com/en/sustainability/news-downloads/sustainability-reports accessed 18.6.2025.
[7] Rinaldi, F. R. (2019), Fashion industry 2030 : reshaping the future through sustainability and responsible innovation . s.l. : Bocconi University Press, Milano. https://heuritech.com/fashion-industry-digital-transformation-innovation/accessed 18.6.2025.
[8] Papachristou, E., Tatsi, N. Z. (2024). A review of 3D design knowledge and its impact on creativity in fashion design education, Communications in development and assembling of textile products Doi: 10.25367/cdatp.2024.5.p266-277
[9] Glogar, M., Petrak, S., Mahnić Nagli, M. (2025). Digital Technologies in the Sustainable Design and Development of Textiles and Clothing—A Literature Review, *Sustainability*, *17*(4), doi: https://doi.org/10.3390/su17041371
[10] Jankoska, M., Stevkovska Stojanovska, R. (2024). The impact of 3D design and virtual simulation in garment creation, XIV International Conference Textile Science and Economy, Zrenjanin, Serbia
[11] Brlobašić, Šajatović, B., Šabarić, I., Karin F. (2024). The contribution of digital technology in the field of clothing production from the aspect of ecology and the education system, 14th international conference Textile Science and Economy.
[12] Hee Choi, K. (2022). 3D dynamic fashion design development using digital technology and its potential in online platforms, *Fash Text* **9**, 9. https://doi.org/10.1186/s40691-021-00286-1
[13] Dai, L., Zhou, J. (2009). The Application of 3D Digital Technology to Fashion Design. *Asian Social Science*, 4 (6). https://doi.org/10.5539/ass.v4n6p57.
[14] Avadanei, M., Blaga, M., Kazlacheva, Z. (2022). Best practice of sustainable products of sustainable product development trough 3D - design and visualization, International Symposium "Technical Textiles - Present and Future". DOI: https://doi.org/10.2478/9788366675735-037
[15] Fashion and on-demand production | McKinsey, accessed 18.6.2025.
[16] Abu Sadat Muhammad Sayem, Digital Fashion Innovations: Advances in Design, Simulation, and Industry. Manchester Metropolitan University
[17] https://www.lectra.com/en/fashion/products/modaris accessed 18.6.2025.