

DESIGN SOLUTIONS FOR WOMEN'S SHIRTS USING OPTITEX 3D SOFTWARE: AN EFFECTIVE APPROACH FOR GARMENT ENTERPRISES

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Abstract. 3D fashion design is becoming an inevitable trend in the digital transformation process of the garment industry. The study proposes the application of Optitex 3D in women's shirt design to test the efficiency in terms of time, cost, and technical accuracy compared to traditional methods. Through user surveys and simulation experiments, the study shows that 3D technology can optimize product development and support small and medium enterprises to improve their competitiveness. The results provide a suitable approach for the garment industry in the current digital context.

Keywords. 3D design; Optitex; fashion simulation; women's shirts; CAD/CAM; digital technology in apparel; product optimization.

1 INTRODUCTION

In the global fashion industry, under pressure from the need for product personalization, fast prototyping speed, and pressure to reduce production costs, the application of digital technology, especially 3D simulation design, is becoming an inevitable trend. 3D design technology changes traditional product development and contributes to restructuring the production value chain, from design and testing to product marketing.

One of the typical software in this field is Optitex 3D - an integrated CAD/CAM solution developed by EFI, which helps to combine 2D technical Pattern making and 3D fashion simulation in real-time. The software allows precise control of technical parameters, realistic material simulation, and sewing technique analysis (tension map, fit analysis), optimizing product development and minimizing sample testing costs [1, 2].

Compared to software such as CLO3D or Browzwear, Optitex 3D has an advantage in the industrial environment thanks to its ability to integrate directly with the production system and easily export technical patterns and material data. According to a report by EFI [3], brands such as Zara and Nike, when applying Optitex, have shortened the sample time by 30 - 40% and reduced technical errors by 25% during mass production.

However, in Vietnam, the implementation of 3D design in the garment industry is still limited, mainly due to the lack of technological infrastructure, software licensing costs, and specialized human resources. In addition, applied research focuses on virtual Simulation without deeply exploiting the application potential in practical enterprises' production-consumption value chain.

From that reality, the topic "Designing women's shirts using Optitex 3D technology: An effective approach for garment enterprises" was carried out to test the effectiveness of Optitex 3D software in designing a basic fashion product - women's shirts. Through survey, experimentation, and comparative analysis with the traditional method, the research aims to propose a model for applying 3D technology to small and medium enterprises in Vietnam, contributing to the digital transformation trend in the domestic garment industry.

2 CONTENT AND RESEARCH METHODS

The content of the topic focuses on clarifying the process of applying Optitex 3D software in women's shirt design through analyzing theoretical foundations, practical surveys, and direct testing. Each subsection below will present, in turn, an overview of the software, an evaluation of the traditional design process, the establishment of an experimental model, and a comparative analysis of the effectiveness between 3D design

and reality.

2.1 Research Method:

The research methodology integrates theoretical analysis with simulation experiments. Specifically, the authors synthesized academic documents related to 3D fashion design and analyzed the features and practical applications of Optitex software. In addition, interviews with industry experts - including designers, CAD/CAM technicians, and technical staff at garment enterprises - were used as a qualitative method to record practical experience and the need to apply new technology. In the experimental part, the research team designed a women's shirt model directly on the Optitex 3D platform to simulate the product design process from Pattern making to complete Simulation. Finally, the effectiveness of the 3D design was evaluated based on quantitative criteria (implementation time, material cost, technical accuracy) and qualitative criteria (aesthetic satisfaction, feedback from users and experts).

2.2 Analysis of Traditional Women's Shirt Design Process and Current Limitations

In the traditional method of designing women's shirts, the process usually begins with drawing a pattern on paper or 2D software, then cutting a sample - often called a toile - using a lightweight fabric such as muslin to check the fit and shape. According to Soni, Khar, and Ghosh (2013), the toile should be made from the same material as the final design to simulate the drape and design details accurately and to help detect errors early before the actual garment is made [4]. This sample stage often lasts several days and involves many adjustments, resulting in costly time, materials, and labor.

Industry research has also pointed out several obvious limitations of this process. Firstly, it can take up to a week to complete a prototype - which directly affects the product cycle in the fast fashion model, making it difficult for businesses to maintain competitiveness in an increasingly fast-changing market. Secondly, the cost of raw materials to produce many samples is significant, causing an average of 15% of fabric waste per sample [5]. Thirdly, if the material of the toile does not match the material of the final product, the difference in testing can lead to incorrect adjustments in mass production.

Compared with previous studies such as Goreaa et al. (2021) on seamless design, the traditional manual process still faces difficulties in coordinating between the design and engineering teams, leading to inconsistencies and errors in sewing patterns [6]. The study by Xu, Thomassey, and Zeng (2020) also pointed out that the traditional papertoilecut-sewing model is not flexible enough to meet the increasing demand for personalization despite the application of partial automation [7].

In summary, although the traditional process allows for detailed fit testing, there are significant limitations in time, cost, materials, and product personalization. In the context of the garment industry's rapid transition to a flexible manufacturing model, the application of 3D virtual prototyping technology becomes particularly urgent [8].

2.3 Overview of Optitex 3D Software and Garment Product Simulation Function

Optitex is one of the leading integrated 2D/3D fashion design software today, developed by EFI (Electronics for Imaging). This software provides a comprehensive platform for 2D technical pattern making and 3D real-time garment simulation, allowing users to visually observe the design process and correct product structure before production. The software interface is divided into two primary workspaces: the technical pattern-making area (2D Pattern) and product simulation on a virtual mannequin (3D Simulation), helping to synchronize design and sewing techniques.

Optitex allows users to directly manipulate tools such as creating patterns, editing points, adding seams, pleating, or analyzing fit-with-fit maps and tension maps. In addition, the software supports the Simulation of various fabric materials such as poplin, crepe, and satin. It allows parameters such as elasticity, thickness, and drape to be adjusted to simulate more realistic fabric effects.

The highlight of Optitex is the ability to directly connect the design stage and the production line through exporting technical pattern data (marker, layplan) and integration with CAD/CAM systems. Thanks to that, the software is suitable for training purposes and applied by many global brands in mass production, such as Nike, Levi's, and Zara [9].

In addition, internal reports from EFI developers also indicate that applying Optitex helps businesses reduce

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design time by 30 - 40% and increase coordination between design - engineering - marketing departments [10]. Compared with other software such as CLO3D or Browzwear, Optitex is highly appreciated for its industrial nature, ability to synchronize technical data, and level of customization in large manufacturing enterprise environments [11].

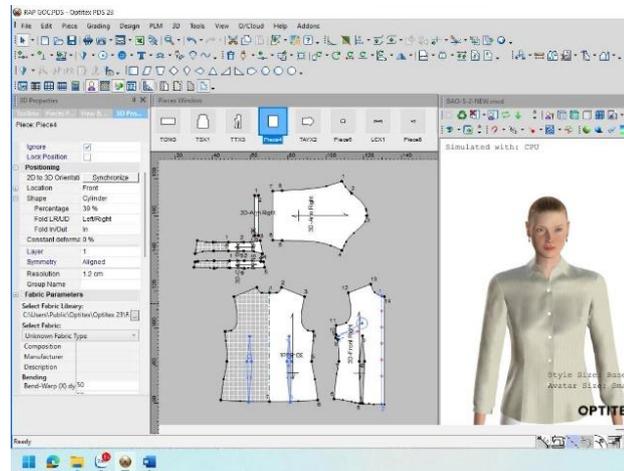


Figure 1: The main interface of Optitex 3D software displays 2D pattern space (left) and 3D Simulation (right) in parallel, supporting visual technical inspection.

2.4 Set Up Product Design Testing Model Using Optitex 3D

When conducting a test design model using Optitex 3D software, the study focused on reproducing a basic women's shirt model by converting a 2D pattern into a simulated 3D space. This process begins by entering the wearer's body parameters (such as bust, waist, hips, sleeve length, etc.) into the software to create a virtual mannequin with accurate measurements. Customizing the mannequin with personalized measurements enables accurate body simulation, enhancing design precision and testing reliability. According to Gao, Wang, and Ma (2021), the ability to simulate the wearer's shape on a digital platform contributes to creating a product model with a high degree of similarity to the actual product, helping to improve the efficiency of testing and editing designs before production [12].

Next, Optitex software was used to simulate the physical properties of the fabric, such as stretch, drape, and thickness, thereby allowing for visual testing of draping on a virtual mannequin. Park and Choi (2020) demonstrated that this Simulation can effectively reproduce the interactions between the material and the wearer's body, especially with difficult-to-handle fabrics such as leather [13]. In this step, the tension map feature plays a vital role in detecting technical defects such as tightness, excess fabric, or seam deviation before sewing the actual sample.

In addition, the study also evaluated the relationship between 2D pattern designs and 3D simulation images. According to Lee and Kim (2019), the use of Optitex 3D in a fashion design educational environment has demonstrated the ability to improve students' spatial visualization skills, thanks to the intuitive connection between flat patterns and spatial products [14]. This is valuable in training and effectively applied in business practice, helping reduce errors between design and sewing pattern techniques.

One of the highlights of the prototype model is the ability to respond to customers quickly during the product development process. Instead of relying on traditional physical prototypes, businesses can use 3D design models to exchange, edit, and approve samples online. According to a report by Alvanon (2022), many brands have switched to digital models of the entire design approval chain, shortening the average physical sample cycle by 1-2 rounds compared to the old process and saving 10% to 15% of product development costs. Integrating 3D tools such as Optitex speeds up customer feedback and improves coordination between design, engineering, and manufacturing departments [15].

In summary, the Optitex 3D testing model serves as a visual design tool and a practical solution, helping

businesses save time and costs while enhancing the accuracy of fashion product development.

2.5 Detailed Comparison of the Efficiency Between 3D Design and Realistic Design

Current studies have shown that 3D simulation design is increasingly dominating the fashion industry due to its ability to shorten time, reduce costs, and increase accuracy. According to research by Naglic, Petrak, and Stjepanovic (2021), the use of CLO 3D software allows for instant reflection of adjustments on 2D patterns through 3D models, helping to quickly detect problems with fabric tension, pressure, and shape deviation that are not visible with traditional design methods [16].

Further research by Pirch et al. (2020) also shows that, although 3D Simulation in software such as CLO 3D, V-Stitcher, or Vidya can represent reality closely, accurate fit assessment still requires users to have high expertise in garment engineering. In particular, indicators such as stress maps, strain maps, and fit maps are systematized to help check the fit and stress in key areas on the virtual product [17].

According to a report from Athos Pallas (2021), the application of 3D design in fashion product development significantly reduces design time and material waste by eliminating the need for physical prototyping. During the application of Optitex software, businesses recorded an average savings of 30% to 50% in sample development time, along with a significant reduction in the amount of fabric and consumables consumed, thanks to the ability to accurately simulate fabric structure and tension directly on the digital model. This result confirms the effectiveness of the virtual design process in optimizing production costs and promoting digital transformation in the garment industry [18]. These benefits are especially evident in projects that require quick editing and testing of many design variations in a short time.

Beyond the technical benefits, 3D design technology also impacts business processes and customer interactions. According to a report from Vogue Business (2022), brands such as Tommy Hilfiger and Calvin Klein have entirely digitized their design approval process using 3D models, reducing product development cycles by more than two weeks. Additionally, 20% of e-commerce images are replaced with 3D simulations, saving photography costs while maintaining aesthetics and high accuracy [19].

However, studies also caution that 3D is not a complete substitute for real models, especially for designs that use special rigid, elastic materials or require complex technical processing. Dinh and Nguyen's (2023) study comparing CLO3D and Modaris indicates that materials such as rigid denim or high-tech textiles still require direct testing to ensure accuracy in manufacturing.

Similarly, Delogue PLM (2021) argues that although 3D Simulation has significantly reduced the number of physical prototypes, final validation with a real product is still a mandatory step in high-end product lines or highly technical designs.

In summary, 3D design presents clear advantages in shortening product development cycles, reducing material costs, and improving the ability to edit quickly while opening up opportunities in e-commerce and digital product presentation. However, in the current conditions, combining 3D design with traditional sample inspection is still the optimal way to ensure operational efficiency and product quality in the modern fashion industry.

3 EXPERIMENT

3.1 Experimental Objectives

The experiment was conducted to verify the application of Optitex 3D software in women's shirt design by simulating the design process from 2D pattern creation to complete 3D product rendering. The goal was to evaluate the feasibility in a business environment, including form accuracy, material customization, and support for pre-production technical testing.

3.2 Experimental Procedure

Experimental content is deployed in two directions:

- **User survey:** The survey was conducted with 106 subjects related to the field of fashion design, including lecturers, students majoring in fashion design and garment technology, CAD/CAM technicians, fashion designers, and garment enterprises.

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- **Set up experimental design model :**

The testing process is conducted in the following steps:

- **Design selection:** Based on current fashion trends, three women's shirt designs with classic, modern (puffed sleeves, cropped, ruffled) and highly applicable designs were selected.

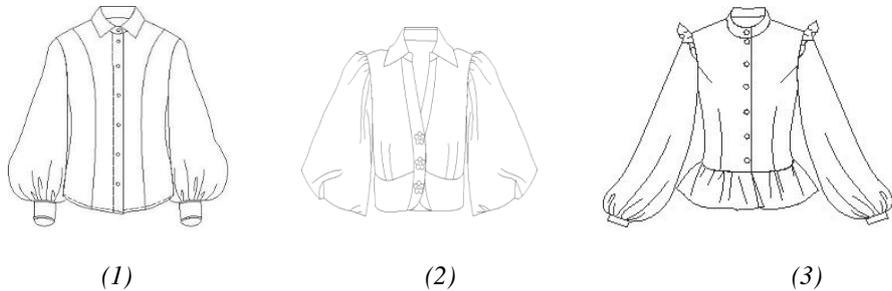


Figure 2: Flat design illustration of three women's shirt models (classic, modern, and functional) used in simulation testing.

- **2D Pattern making:** Create technical patterns using Optitex software, determine structural details such as body, sleeves, collar, placket... according to standard body parameters.

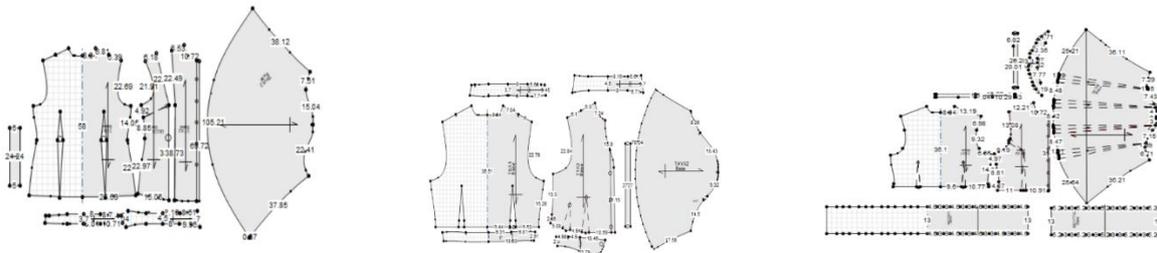


Figure 3: Technical patterns of 3 shirt models with different styles on Optitex 2D software.

- **3D Simulation:** 2D patterns are assigned position, material, thickness, and stretch parameters and simulated on virtual avatars with correct measurements. This process helps to evaluate the fit (via Fit Analysis), the balance between 2D dimensions and actual 3D shape.



Figure 4: Simulate the shirt product directly on the virtual mannequin in a 3D environment, clearly showing the drape and shape of the fabric.

- **Applying technical tools:** Functions such as Tension Map and Fit Analysis are used to evaluate tension, fit, and shape balance. Errors such as excess fabric and shrinkage are detected, and the Pattern is refined directly on the virtual model.

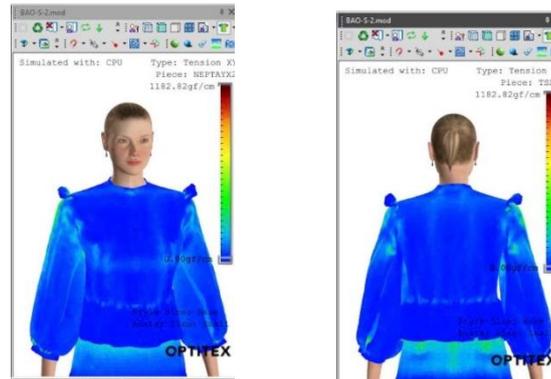


Figure 5: Tension Map depicts fabric tension in key areas of the garment, assisting in detecting technical errors.

- *Complete 3D product rendering:* Each sample is rendered with several materials (voile, crepe, poplin, etc.) and three basic colors (cream white, pink, satin gray) to evaluate visual effectiveness and support aesthetic comparison.

4 RESULTS AND DISCUSSION

4.1 Result

A survey of 106 subjects (including lecturers, fashion design students, and CAD/CAM technicians) showed that 86.8% had used Optitex 3D software in an academic or practical design environment, reflecting high technology access among the target user group.

- *Design time:* Experimental data analysis shows that, on average, a completed shirt model using Optitex 3D software takes 4.5 hours, compared to 10-12 hours using the traditional process, representing a 50-63% reduction in design time.

Survey results showed that 45.2% of participants reported a 20-40% reduction in design time, and 30.2% noted savings of 41-60%.

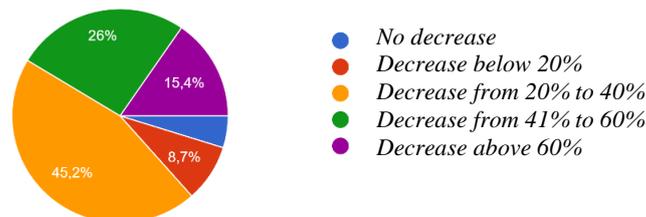


Figure 6: Graph of the percentage of respondents reporting a reduction in design time when using Optitex 3D.

- *Physical Prototype Costs:* The testing process bypasses the physical fabrication step, reducing the cost of materials and labor per prototype by an average of 30-40%. According to the survey, 47.6% of respondents agreed that 3D simulations save materials and labor, especially for complex prototypes.

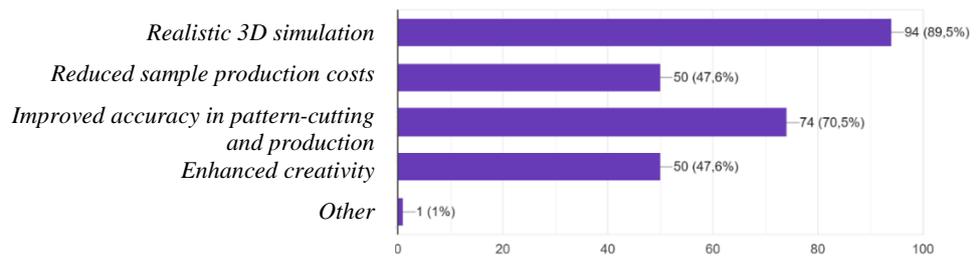


Figure 7: Percentage of respondents who believe 3D design saves on prototyping and labor costs.

- *Technical inspection with Fit/Tension Map tool:* Using the Tension Map feature, users can identify areas of over-tension, excess fabric, or misshapen fabric directly on the virtual mannequin. Feedback data is based on gf/cm², allowing technical errors to be detected before printing or putting into production.

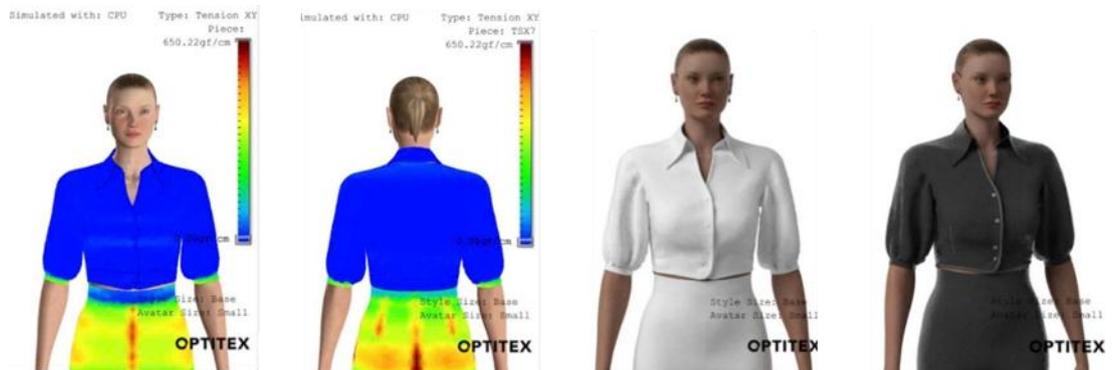


Figure 8: Tension Map shows fabric tension, supporting technical refinement before production.

- *Material and color simulation:* The experimental team rendered shirt samples in voile, crepe, and poplin materials and mixed them in cream-white, pink, and satin gray tones. The simulation results were highly similar to the real product, clearly showing details of the shape, ruffles, fabric folds, and gloss effects - serving effectively in aesthetic evaluation before printing samples.



Figure 9: Illustration of product render with three different materials (voile, crepe, poplin) to test drape and surface effect.



Figure 10: Intuitive color matching application on 3D models with three characteristic tones, supporting aesthetic effect evaluation before production.

4.2 Discuss:

Experimental and survey results have clearly shown the effectiveness of Optitex 3D software application in women's shirt design, not only in technical aspects but also in economic feasibility and commercial application potential.

- Productivity and design speed: The application of 3D design technology shortens the engineering process and increases the speed of product processing in a flexible working environment. The average time to complete a short sample from Pattern making to 3D Simulation is only about 4.5 hours, compared to 10-12 hours with traditional methods - a 50-63% reduction. This is particularly important in the fast fashion industry, where product lifecycles are short and rapid market response is essential. According to a report from AMS Atelier [20] - using Optitex 3D allows the design team to work remotely and approve samples directly on mobile devices, significantly reducing the exchange time and editing cycles between departments. This capability to support flexible work environments enhances operational efficiency and shortens time-to-market for enterprises.
- Potential for cost optimization in pilot production: Eliminating physical toiles results in 30-40% savings in material and labor costs. This figure was confirmed by almost half of the respondents, proving its feasibility even for small and medium-sized enterprises. Compare this with the study by Gao et al. (2021), which also recorded an average material savings of 35% when combining body scanning with Optitex 3D [21].
- Precision and technical control: Applying the Tension Map and Fit Map in the design process helps detect errors in tension, wrong form, or excess fabric right on the virtual model. This is a big difference from the traditional method, which requires correction after sewing the toilet. According to the official EFI Optitex manual [22], the Tension Map feature in version O/22 and above allows feedback in specific force units (gf/cm²), increasing precision compared to competing software such as CLO3D.
- Current limitations and suggestions for improvement: Although 3D Simulation has many advantages, there are still limitations in reproducing specific materials such as rugged denim, shiny silk, or high-tech fabrics. According to Dinh & Nguyen (2023), real-life sample verification is still an indispensable step in some cases, such as designing performance costumes or high-end products [23]. In addition, high software licensing costs and hardware requirements are barriers for small businesses.

Therefore, a viable strategy is to combine 3D design with a final round of physical testing to ensure absolute accuracy. At the same time, training the software operations team and investing in the right hardware are also necessary steps to optimize the implementation efficiency.

5 CONCLUSIONS

The study has provided a systematic and empirical view on the applicability of 3D design technology -

specifically Optitex 3D software - in developing women's shirts in garment enterprises. Through the analysis of traditional processes, simulation model establishment, and user surveys, the study has demonstrated that 3D design is not only a visual support tool but also a feasible solution to optimize the product design process in the context of the digital transformation of the fashion industry.

Unlike previous studies that only focused on the modeling aspect, this topic has closely linked theory and production practice by evaluating the efficiency of time, cost, and the ability to integrate design with manufacturing techniques. These results are not only of academic significance but also a premise for small and medium enterprises in Vietnam to improve their competitiveness through digital technology.

However, to maximize the benefits of 3D design technology, there needs to be a synchronous investment in technical infrastructure, human resources, and support mechanisms from software developers and training facilities. In the long term, integrating Optitex 3D helps simplify the design process and opens up the potential for wide applications in e-commerce, product marketing, and on-demand manufacturing.

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GIẢI PHÁP THIẾT KẾ ÁO SƠ MI NỮ BẰNG PHẦN MỀM OPTITEX 3D: HƯỚNG TIẾP CẬN HIỆU QUẢ CHO DOANH NGHIỆP MAY MẶC

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Tóm tắt. Thiết kế thời trang 3D đang trở thành xu hướng tất yếu trong quá trình chuyển đổi số của ngành công nghiệp may mặc. Nghiên cứu này đề xuất ứng dụng phần mềm Optitex 3D trong thiết kế áo sơ mi nữ, nhằm kiểm nghiệm hiệu quả về thời gian, chi phí và độ chính xác kỹ thuật so với phương pháp truyền thống. Thông qua khảo sát người dùng và thực nghiệm mô phỏng, nghiên cứu cho thấy công nghệ 3D có khả năng tối ưu hóa quy trình phát triển sản phẩm và hỗ trợ doanh nghiệp vừa và nhỏ nâng cao năng lực cạnh tranh. Kết quả góp phần cung cấp hướng tiếp cận phù hợp cho ngành may mặc trong bối cảnh số hóa hiện nay.

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