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PERSONALIZED PATTERNS FOR PEOPLE WITH DISABILITIES USING 3D MODELING

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Abstract: *The garment industry is faced with challenges related to achieving a proper fit for diverse body types, especially for individuals with physical disabilities. Standardized sizing often fails to accommodate variations such as asymmetries, differing limb lengths, and other anatomical differences. This issue is particularly significant for people with neurological body modifications, such as those caused by Multiple Sclerosis, Parkinson's disease, spinal cord injuries, or stroke. The lack of well-fitting, functional clothing options for these individuals has led to an increasing demand for personalized and functional garments.*
This study explores the potential of digital fashion technologies, such as 3D body scanning and virtual prototyping, to create customized clothing solutions. Using the CLO3D simulation system, two virtual body models were created to represent an adult woman with specific body measurements. One model represented a standard body, while the second model incorporated modifications focused on the upper torso area. The study investigates the development of functional garment patterns, highlighting differences between standard and modified body shapes, particularly in the shoulder and neck regions. By comparing these patterns and overlapping the two designs, the research aims to explore how digital tools can contribute to the development of more inclusive, comfortable, and well-fitting clothing for individuals with disabilities.

Key words: *Personalized clothing, 3d body modelling, disability fashion, virtual prototyping, functional garments, adaptive fashion*

1. INTRODUCTION

The garment industry is one of the largest and most influential sectors worldwide, playing a crucial role in the global economy. However, despite advancements in production and technology, significant inefficiencies remain. Recent studies indicate that approximately 25% of all garments produced annually remain unsold, contributing to substantial waste and financial loss [1]. One of the key factors behind this issue is the challenge of achieving a proper fit for diverse body types. Standardized sizing systems, while widely used, often fail to accommodate individual differences such as varying limb lengths, asymmetries, or body proportions that fall outside the commercially available size range.

This challenge is even more pronounced for individuals with physical disabilities. In addition to difficulties in finding well-fitting clothing, they often require functional adaptations that enhance com-

fort, mobility, and independence in daily activities. Traditional mass production methods are not designed to address these unique needs, leading to limited options for inclusive and adaptive fashion.

As a response to these issues, the demand for individualized and customized clothing has gained increasing attention in both research and industry. Advances in digital fashion technologies, such as 3D body scanning, virtual prototyping, and AI-driven pattern adjustments, offer new opportunities to improve garment fit and functionality. The growing interest in personalized fashion not only aims to enhance comfort and wearability but also contributes to sustainability efforts by reducing waste associated with ill-fitting and unsold garments [2].

This study explores the potential of digital tools and innovative design approaches in creating functional clothing solutions tailored to diverse body types, with a particular focus on individuals with disabilities. By addressing both fit and functional requirements, the research aims to contribute to the ongoing development of inclusive and adaptive fashion solutions.

2. GENERAL INFORMATION

Designing personalized garments for individuals with neurological body modifications such as those caused by Multiple Sclerosis, Parkinson's disease, spinal cord injuries, or stroke requires a comprehensive understanding of their unique needs. These garments must integrate functionality, comfort, adaptability, and aesthetics while incorporating assistive and therapeutic features to improve the wearer's daily life [3].

Functional clothing is specifically developed to address the challenges faced by individuals with disabilities, providing solutions for self-dressing difficulties, health-related concerns, ergonomic comfort, fit, style, and fashion. While many mainstream fashion brands have introduced some degree of mass customization, their solutions are typically limited to modular design approaches. This means that consumers can personalize garments using predefined design elements within a co-design framework. Although this customization enhances consumer engagement and personal branding, it does not fully resolve the critical issue of tailoring garments to individual body shapes and measurements [4,5].

A key technological advancement in the field of functional fashion is the implementation of 3D garment modeling on virtual body representations. This approach is particularly beneficial for designing both technical and functional clothing for individuals with disabilities. Traditionally, garment design involves manual draping techniques on mannequins, requiring expert craftsmanship and numerous precise adjustments. Alternatively, 2D pattern-making methods are widely practiced, particularly in digital environments, offering greater efficiency in the design process. The integration of these techniques into a 3D digital workflow not only accelerates the development cycle to meet increasing demand but also presents a cost-effective solution for creating customized, well-fitting garments [1,2].

3. METHOD APPLIED

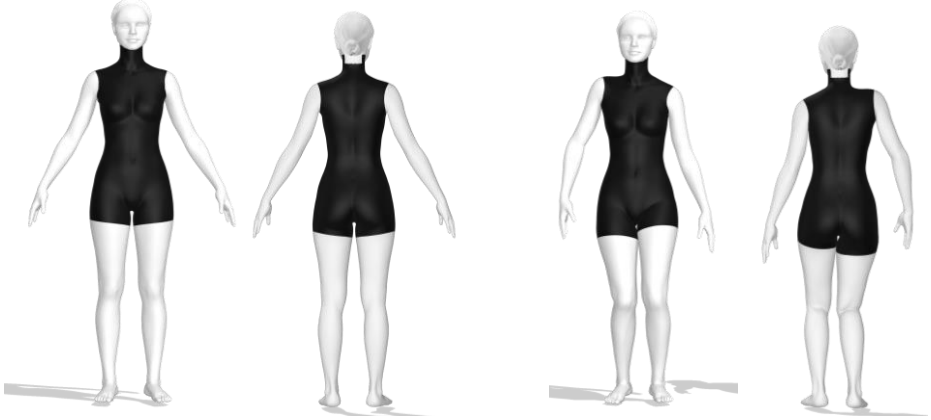
3.1. Description

To better understand the needs and relevance of the selected topic, a simulation was conducted using two body models representing an adult woman with a height of 170 cm and a bust circumference of 81 cm. The remaining body measurements were automatically adjusted by the CLO3D simulation system to ensure as much similarity as possible between the body models and the patterns generated, with minimal error in the results. This simulation approach allows for the

precise generation of body shapes and patterns, offering a better understanding of how digital tools can be used to enhance garment design [2, 6].

The first avatar *a)* from ***Fig 1*** shows a 3D simulation of a normal body, adjusted according to the parameters described above.

For the second avatar *b)* from ***Fig 1***, specific modifications were applied, focusing on the upper torso area. These modifications were based on publicly available images and publications of body modifications resulting from medical conditions with a neurological impairment. The torso was adjusted to reflect variations in shoulder width, neck circumference, and upper body asymmetry, common challenges for individuals with these conditions [2, 6].



a) b)

Fig. 1*: 3D avatar of normal and modified body*
a) front and back view of the healthy body; b) front and back view of the modified body

3.2. Method

Utilizing the dimensional characteristics obtained from the CLO3D system after the applied modifications (as illustrated in ***Fig. 1 a and b***), the upper body structure was mapped and unfolded into a 2D representation. This process creates a highly accurate model of the human body, allowing for a detailed analysis of anatomical shape variations. These variations—such as changes in the shoulder width, torso asymmetries, and neck area modifications—are crucial in understanding how to best design clothing that accommodates these specific features [2, 6].

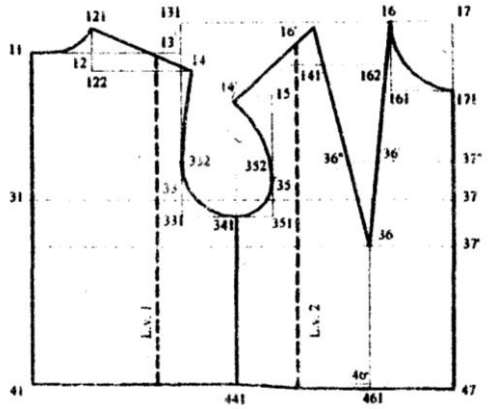
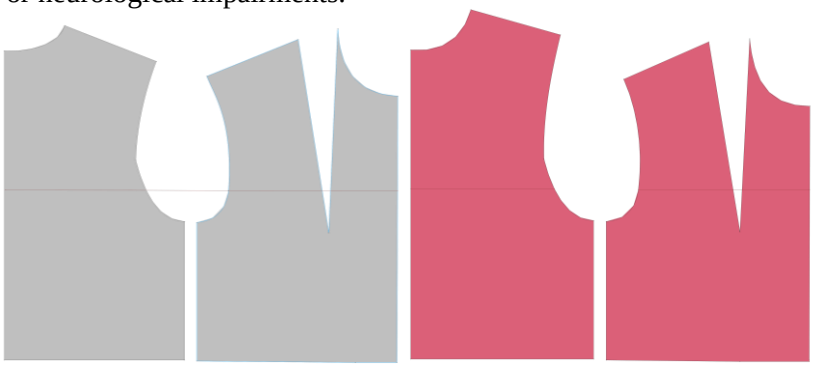


Fig. 2*: Scheme of the upper body pattern making [7]*

The unfolded 3D model was then analyzed to determine how the body's structure would influence the garment construction process. Adjustments were made in the garment's pattern to accommodate these body features and ensure better fit, comfort, and functionality. This process enabled the identification of design solutions that align with the body's anatomical needs.

Based on the scheme from ***Fig 2***, two distinct patterns were developed: one corresponding to a standard body (*Avatar a*), and another adapted for the modified body (**Avatar b**). These patterns were carefully designed to reflect the structural differences identified during the simulation process. The patterns represent the unique needs of individuals who have different body shapes, such as those with disabilities or neurological impairments.



a) b)

Fig. 3*: Normal body pattern and modified body pattern*
a) Normal avatar pattern; b) Modified avatar pattern

In this comparison presented in ***Fig 3*** the normal body pattern (representing *Avatar a*) and the modified body pattern (representing *Avatar b*) are shown side by side. This visual representation allows for a clear comparison of how the two patterns differ. Notably, the shoulder and neck areas exhibit significant differences, as these regions are often where body modifications due to neurological conditions have the most impact. This comparison underscores the necessity for garment designers to consider these variations when creating functional and comfortable clothing for individuals with special needs.

To further analyze the impact of the modifications, the two patterns—standard and modified—were overlapped. This overlap helps to visually represent the specific adjustments made to the garment patterns to accommodate the anatomical variations of the modified body.

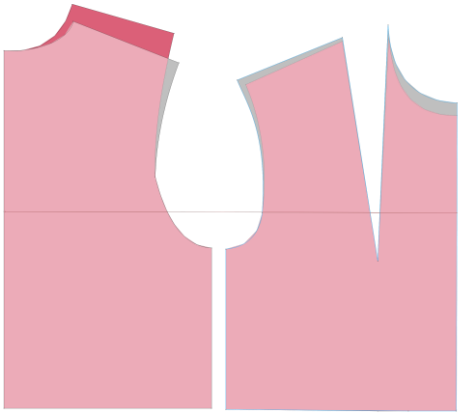
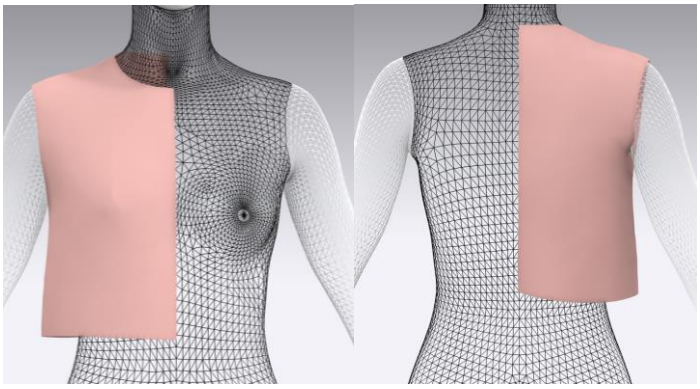
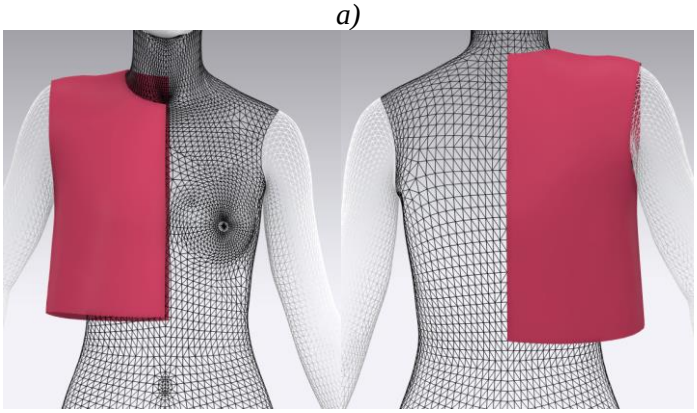


Fig. 4*: Patters overlap*

Fig 4 illustrates how the standard body pattern and the modified body pattern align when overlapped. The core framework of the patterns is kept as similar as possible to ensure that the garment's overall size remains consistent. However, visible differences in the shoulder and neck areas highlight the adjustments necessary to accommodate the anatomical differences of the modified body. The overlap emphasizes how digital modeling tools, such as CLO3D, can be used to identify and address these variations precisely, offering a tailored solution that would be difficult to achieve using traditional manual pattern-making techniques.



a)



b)

Fig. 5*: Pattern and garment simulation – front and back views.*
a) Standard body; b) Modified body.

By analyzing the overlap in ***Fig 4*** and the pattern fit in ***Fig 5***, we can see that it shows that the garments visually fit well on both body types, thanks to specific adaptations made to the pattern.

The ability to visualize and adjust body shapes digitally is a valuable tool for designers working to create functional clothing that fits diverse body types and meets the specific needs of people with disabilities or physical impairments. This process showcases how digital tools can significantly enhance the development of adaptive and inclusive fashion.

4. CONCLUSIONS

The integration of digital technologies such as 3D body modeling offers significant potential for creating personalized garments, particularly for individuals with physical disabilities or neurological body modifications. The findings of this study demonstrate the effectiveness of the CLO3D

system in adjusting garment patterns to accommodate unique body shapes, with a focus on functional adaptations for improved mobility and comfort. By comparing standard and modified body patterns, it is evident that digital tools allow for precise adjustments that would be difficult to achieve using traditional garment design methods.

The research highlights the need for further development in the field of adaptive fashion and emphasizes the importance of personalized garment solutions. The ability to tailor garments to individual body shapes not only enhances the comfort and functionality for people with disabilities but also contributes to sustainability by reducing waste associated with ill-fitting and unsold garments. Moving forward, digital fashion technologies can play a key role in addressing the diverse needs of consumers, creating a more inclusive and adaptable fashion industry.

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