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Pattern Design Methods for Non-Conventional Bodies

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Abstract. The main goal of the study presented in this paper was to compare three different methodologies of pattern design methods. The case study was based on an individual body shape with a severe deformity in the spine with additional different measurements of the bust, waist and hip girths when compared with common standard measurement tables. This methodology comparison aims primarily to identify its performance regarding garment Fit and performance, in particularly, its potential related to electronic sensor integration for vital signals monitoring. Different performance results were obtained, with the best results obtained with the flat pattern block extracted from the 3D digital model surface methodology, followed by the flat pattern block using the studied individual personal measurements and the worst results obtained with the flat pattern block developed from a typical measurements table used by the industry and fashion schools.

1. Introduction

The moment to wear clothes can be considered decisive for the sale of clothing products. During this experiment the consumer evaluates different attributes, aesthetic and technical, from the interaction of his body with the product. According to some authors, Fit performance is considered one of the most important attribute in the purchase decision [1-3]. It is considered that "fit is the ability to be the right shape and size" [4]. It is also directly connected to the anatomy, body volumes [5] and the clothing ability to cover the body [6]. However, the ineffectiveness of clothing adjustment to the body, lead consumers to dissatisfaction and consequently to refute the clothes [2, 7].

The ergonomic factors are the ones with the greatest impact in the flat pattern design process, fundamental for the performance of the garments. Similarly, the physical constitution of the user and his postural dynamics, interferes in the garment design process and consequently in the performance of the garment [8].

Focusing on the range of products with functional attributes, like smart wearable clothes for vital signals monitoring, the right fit to the wearer's body plays a fundamental role in the performance of the integrated electronic system. For this range of products, the correct position of the sensors, at specific points along the user's body, is fundamental for the monitarization process to be performed as expected [9].

In industrial clothing production are commonly used traditional pattern-making methodologies, also referred as flat pattern design. These are based on the transfer of body measurements (3D) to a flat surface (2D) [5,10]. In traditional methodologies, the measurements transferred are based on anthropometric tables. These measurement tables are normally built from data collection of a given sample, in order to serve a segment of the population or a target audience [1, 10, 11]. The flat pattern blocks still have the function of acting as guides for the stylization of different models, corroborating to the success of fit in a collection [1].

The traditional development of flat pattern blocks methods is very dependent on the accuracy of the measurements of the anthropometric tables. Therefore, several studies of data collection are being done worldwide in order to understand and contemplate the largest number of individuals. However, despite the proposed measurement tables consider a large population sample, they often fail to satisfy the continuous changing body of the population. Furthermore, the individuals with unconventional characteristics are excluded and marginalized from industrial consumption [5, 12]. Similar difficulties occur during anthropometric standard identification in high ethnic diversity populations [13].

The use of technological tools such as three-dimensional digitization supported by 3D body scanners and virtual prototyping enabled by 3D CAD software provides relevant advances related to the efficiency of ergonomic validation of projects in several product segments [1, 5, 10, 14, 15]. These tools have been available in the market for more than a decade, however, they have regular evolutions and expansion of possibilities of use, expecting continuous research advances in this area.

These technologies act as external agents that present great potential for the expansion of the methodological possibilities of developing flat pattern blocks. They help and broaden the understanding of the users' individual needs, as well as contribute to the definition of design decisions during the process of developing new products.

The present paper aims to explore the contribution of these technological pattern design methodologies, comparing its development efficiency in creating clothes to people whit non-standard bodies.

2. Methodology

The research procedure of this study falls within the exploratory field of qualitative character. The techniques adopted were; direct documentary research with a bibliographical survey and experimental research, with direct documentation of the data obtained from the development of pattern design blocks through three different methodologies: (1) flat pattern blocks developed using the "Esmod" methodology with the measurements of the "Alvanon" European mannequins (size 40 and 48); (2) flat pattern blocks developed using the "Esmod" methodology with the studied individual personal measurements; and (3) flat pattern blocks extracted from the digitized 3D body surface of the studied individual. This study aims to compare different working procedures and the fit and performance efficiency of each one, in the individual context, when attending a population target with a non-standard body shape.

3. Results and discussion

The experiment consisted in comparing garment fit performance from three different flat pattern design methodologies. Additionally, aims to observe the aesthetics and the efficiency of each method in the ability to reference points in function of the body design, as a future goal, to predict the location of sensors intended for smart wearable clothing.

The experiment studied the interaction of three variables: Body shape, textile materials and flat patterns. The first two variables are dependent and the last independent [16]. Because it represents a preliminary study related to the new technological possibilities of clothing development, it was decided to virtually simulate the body shape, the textile material and the prototype fit evaluation. The software Clo 3d version 4.1 was used in this study.

The variable "Body shape" simulates the female body shape with severe deformity in the spine and girth dimensions of bust, waist and hip, different from the standard measurements imposed by the anthropometric measurements table used in this study. The body shape simulation was done from the stylization of the standard "Avatar" available in the 3D Clo software. New dimensions of bust, waist and hip girths were defined for the used “Avatar” and the displacement of the spine was defined to enhance the differences to a standard body, producing an unique 3D body image.

For the textile material variable, a highly stable fabric was used in order to minimize the deformation of the flat pattern, and thus confirm its ability to translate the body size and shape to the two-dimensional plane. In this experiment was used the virtual simulation of 100% cotton twill. The simulation was based on real fabric samples and simulated in the software, according to the system manufacturer's instructions. Additionally it was applied a plaid print. The print was designed to aid during clothes fit visualization on the body and consequently its potential referencing.

The first sample garment was developed from the flat pattern blocks developed using the "Esmod" methodology with the measurements of the "Alvanon" European mannequins (size 40 and 48); The body shape and the measurements used were defined ty the anthropometric study carried by Alvanon for the European population, using its mannequins sizes 40 and 48. Two scenarios were presented: Method 1 - Meet the dimensions of the bust; and hip girths ignoring the waist girth; (referring to size 40) or Method 2 - Meet the waist girth dimension ignoring the bust and hip girths (referring to size 48). It was decided to evaluate both methods. The 2D drawings were directly designed on a 2D Cad System and subsequently simulated in a 3D environment. The results of the simulation wear are presented in Figures 1 and 2.

It was possible to infer that Method 1 had too much trouble in adapting itself to the body shape under study. It was possible to observe too much tension in the abdominal area. Because of that, this garment cannot be dressed.

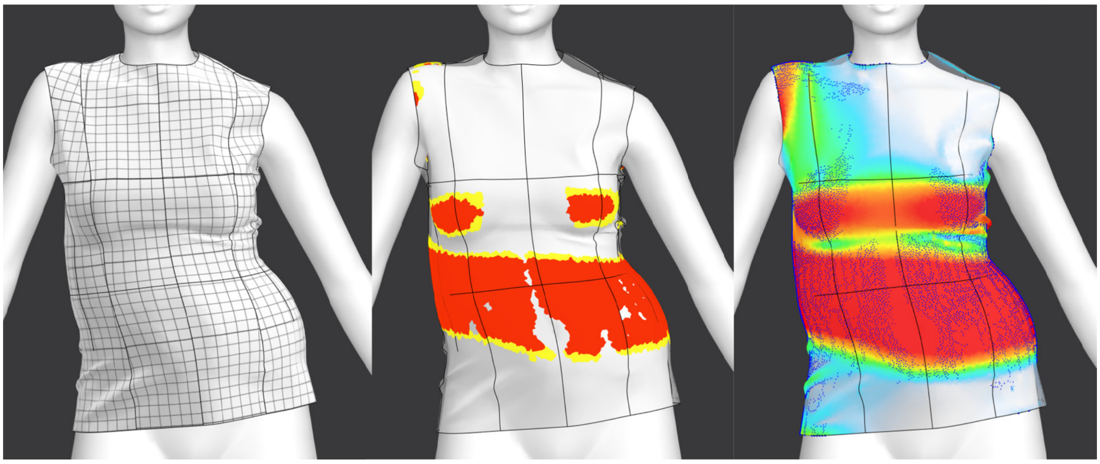

Figure 1. Methodology (1) – Method 1 - Dimensions of bust and hip girths as in mannequin size 40, ignoring the waist girth.

In Method 2, using the measurements table for size 48, we can observe that the garment is wearable, as it does not present too much compression on any part of the body. However, because of the large measurements of size 48, the garment was too baggy in the bust and hip regions, resulting in the sensors inability to operate in this garment, due to the lack of contact between the sensors and the body.

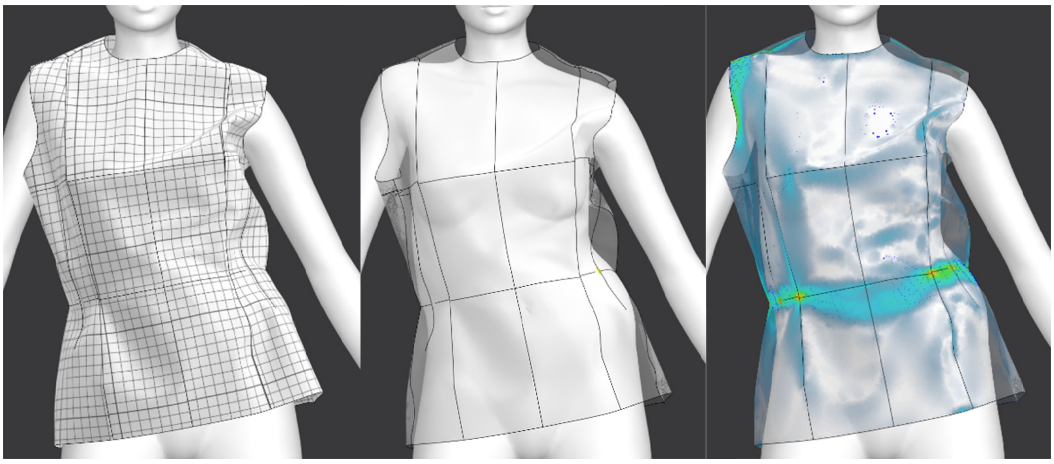

Figure 2. Methodology (1) – Method 2 - Dimensions of waist girth as in mannequin size 48, ignoring the bust and hip girths.

The second sample garment was obtained from the flat pattern blocks developed using the "Esmod" methodology, using with the waist, hip and bust girths measurements according to the individual under study personal measurements. In this experiment were maintained the same procedures of drawing and simulation as in the previous ones. The results of the simulation wear are presented in Figure 3.

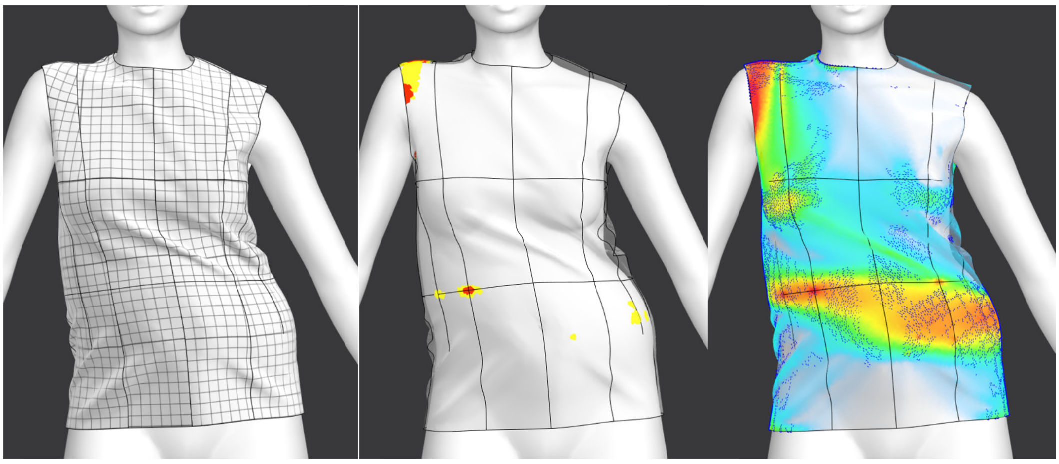

Figure 3. Methodology (2) - "Esmod" methodology with the studied individual personal measurements

It was possible to infer that a better fit result was obtained with this methodology. The virtual garment presented a more harmonious appearance and a better distribution of pressure, when compared with the previous methodologies. However, by ignoring the asymmetry of the user, the fit was compromised, because was too baggy and twisted. This condition will possibly interfere with the location and operation of wearable sensors.

In the third proposal was used the Software Clo 3D version 4.1 for the garment development, with the goal of creating a flat pattern block from the individual's body shape surface under study. The procedure adopted started by importing the 3D body model. Then, using the tools "line (avatar)" which acts on the delimitation of the 3D surface contour to convert into a 2D image, using the software "flatten" tool. The same stylistic orientation of the "Esmod" methodology was maintained. The contours were defined vertically in order to maintain an aesthetic standard for comparison. The results of the simulation wear are presented in Figure 4.

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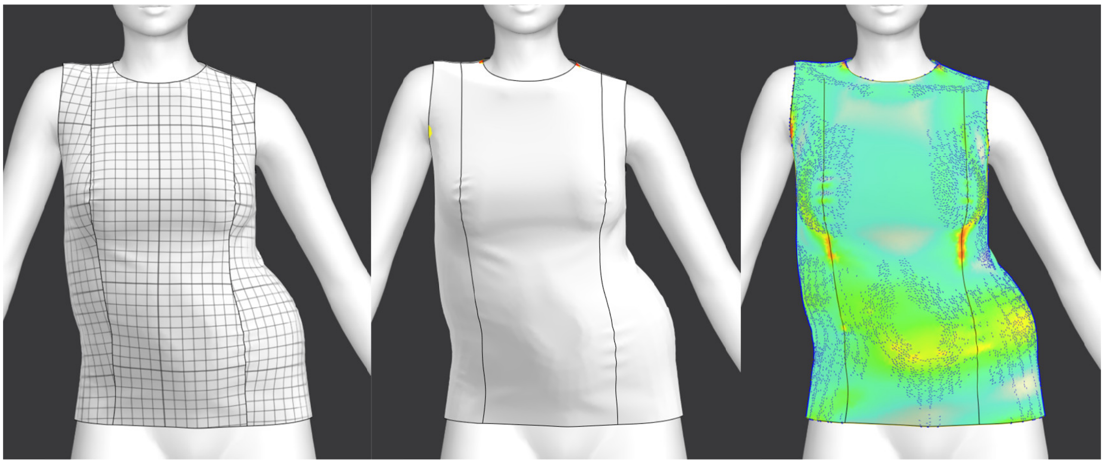

Figure 4. Methodology (3) - Pattern blocks extracted from the digitized 3D body surface of the studied individual

It was possible to infer that this third methodology performed best results regarding fit. The design of the flat patterns when dressed appeared more harmonious and balanced. It respected the particularities of the individual's body shape, resulting in a garment with six unique and not symmetrical flat patterns. We can observe that the garment when dressed, does not present baggy, twisted nor shows excessive compression. We can perceive a much more stable interaction with the body, and consequently, has a greater possibility to assure greater accuracy with wearable sensors. However, further stylisations resulting from the flat patterns block of this methodology are complex, still requiring as reference the traditional styling methodologies. Therefore, further studies in this area are required.

4. Conclusion

This study analysed three different methodologies for the construction of pattern design for the production of clothing for non-symmetrical body, aiming integration of sensors for vital signals monitoring. These methodologies are: (1) flat pattern blocks developed using the "Esmod" methodology with the measurements of the "Alvanon” European mannequins (size 40 and 48); (2) flat pattern blocks developed using the "Esmod" methodology with the studied individual personal measurements; and (3) flat pattern blocks extracted from the digitized 3D body surface of the studied individual. The purpose of this comparison was to verify the results ability in relation to Fit and the capacity of the garment to incorporate wearable sensors when considering a user with individual and non-standardized body characteristics.

It was possible to observe different performances in the three different methodologies, resulting from different interpretations of the same volumes and measurements. The first methodology was less efficient as it ignored the measurements of the individual studied. Resulting in a garment too tight, which made dressing impossible, when size 40 was used, and too loose, when size 48 was used. These results allowed us to conclude that it would be impossible to incorporate the sensors in a garment produced with this methodology and assure their positioning in the places where they are required for vital signals monitoring. Additionally, the aesthetics was very poor in both simulations. The other two methodologies reached a better fit result when compared with the first methodologies. However, they showed differences in fit efficiency and in the ability to pre-set points that meet specific body parts of the individual under study.

The personalised flat pattern block showed better compression distribution, but still has a low performance in relation to the Fit in a non-symmetrical body. As a consequence, it was possible to observe a baggy and twisted garment when clothes are worn. On the other hand, the digital extraction of the flat patterns block methodology presented a better performance regarding Fit. It respected the particularities of the drawing of the individual's body, presenting himself more balanced and stable. In contrast, it presents challenges for future stylizations, as there are no geometric points of orientation in the layout of the base, turning stylization difficult through traditional techniques.

The definition of the ease value and the properties of the materials used are essential for the location of the sensors and the proper functioning of the smart wearables. These variables were simplified in this study but require further research.

This paper presents the initial results from the research surrounding the technological possibilities of pattern design for clothing development, in particularly, its potential related to electronic sensor integration for vital signals monitoring in non-standard bodies.

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