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RESEARCH ON OPTIMIZING THE CONSTRUCTION OF TROUSERS FOR PEOPLE WITH AMPUTATIONS USING 3D SIMULATION

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Abstract: *The construction features of waist support products depend on current fashion trends, the specific requirements imposed on the products by potential wearers and the characteristics of the materials used and of course the methodology for developing the basic construction. In the case of people with lower limb amputations, the construction also depends on the type of prosthesis and its size. The paper presents the results of the study to optimize the construction of trousers for men with amputations in the leg. The topicality of the theme is determined by the alarming increase in the number of amputations and the increased interest of specialists in creating clothing for people with disabilities. The paper aims to identify the methodology for improving the construction of the product of trousers for people with amputations of the lower limbs, using 3D simulation. The general objective of this paper is to propose a succession of optimization of the basic pattern in order to be able to be customized according to the type of amputation. The paper presents the initial data necessary in the elaboration of a customized construction. Also presented are the stages of optimizing the construction of the pants and the simulations on the body of the avatar of the pattern, even after performing the optimization. The use of 3D software allows obtaining the wearer's avatar and assigning unique features, which are taken into account when designing custom clothing products. They also allow you to check the position of the products on the body of the avatar and modify them according to the requirements.*

Key words: *3D simulation, clothes for people with disabilities, men's trousers.*

1. INTRODUCTION

While wearing trousers, the man performs a series of movements of various complexity, which act on the clothing product. Static positions also make their mark on the trousers, which are subject to various types of deformation. [1]

The prosthesis is also an important factor that acts on the positioning of the pants on the wearer's body, because its type and size were not taken into account in the design process. In order to obtain an optimal construction for the development of trousers for people with amputations of the lower limbs, 3D simulation will be performed.

2. DETERMINATION OF INITIAL DATA

As initial data for the design of clothing products with waist support are examined general data about the clothing product, its shape and data about the conformation of the human body, presented by a series of dimensional characteristics. [2]

The whole research process was simulated in a 3D software, CLO3D, because it allows obtaining the wearer's avatar with individual or standardized dimensional characteristics, using a wide range of materials, importing or developing the basic and model construction, checking the positioning of the product on the body in static and dynamic, etc.

Clothing product data:

The information presented in Table 1 is used as the initial product data.

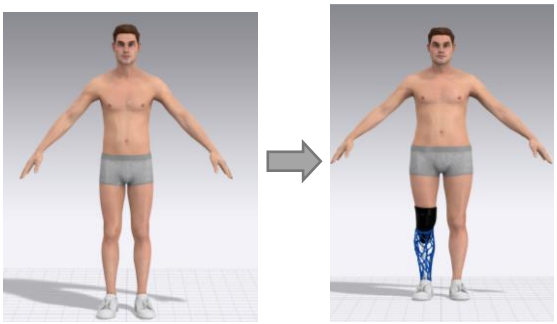
Table 1: *Characteristic of the external shape and construction of waist support clothing products*

Type of clothing product	**Destination, season**	**Size**	**Silhouette**	**The characteristic of the cut**					**Fabric**
				Degree of adjustment		**Waist line level**	**The means of creating form**		
				at the hip line	**at the end and knees**		**The front element**	**The rear element**	
Men's trousers	Every day, Spring-Fall	176-100-88	Semiadjusted	Medium	Medium	Descended	Tweezers	Tweezers	Cotton blend

Data about the wearer:

Initially, as the standard avatar offered by a 3D software was selected, which was later modified according to the characteristics of the wearer, namely the male gender and the age that is between 18-35 years. Subsequent changes were primarily related to the presence of lower limb amputation in the calf (Table 2). The avatar was also assigned the values of the dimensional characteristics taken from the literature. These values allowed the avatar to be modified and the required size obtained. [3]

Table 2: *Data about the wearer/avatar involved in the research*

Avatar	**Criteria**	**Date**
	**Gender**	male
	Age	18-35 ani
	Amputation type	inferior limb
	Amputation level	calf level
		

3. STEPS OF CONSTRUCTION OPTIMIZATION

In order to obtain an optimal construction, research has been carried out which includes an analysis of the existing methods of elaborating the construction patterns of of elaborating the construction patterns of the men's trousers product. For this purpose, the constructions of the patterns were elaborated by 4 graphic-analytical methods of calculation: Muller & Sohn, the English method after Winifred Aldrich, of the Russian author I. Grișpan and MUPI CAER. [4]

These methods are distinguished by the methodology of elaboration of the construction, the number and type of dimensional characteristics used in the calculation of the construction, by the way of presenting the parts in print, etc. [5-8]

The following are the steps to optimize the construction of men's trousers made by the MUPI CAER method.

Step 1. Development of the basic pattern. At this stage, the construction of the clothing product is elaborated. Figure 1 shows the pattern developed according to the MUPI CAER method.

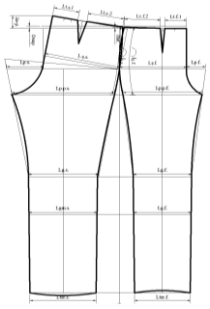
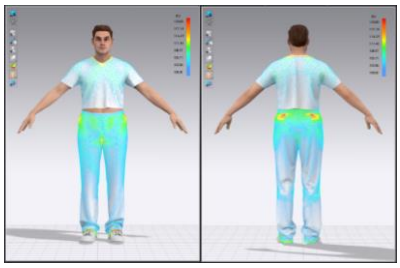
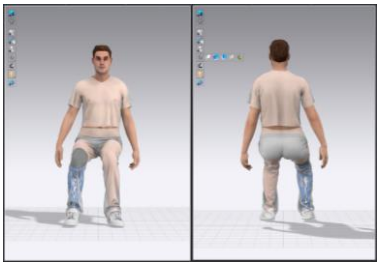
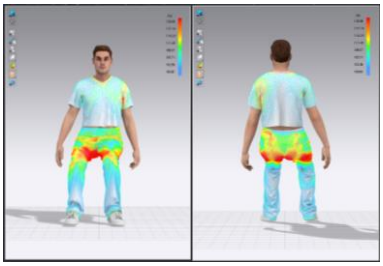


Figure 1: *Basic pattern developed according to the MUPI CAER method*

Step 2. Initial 3D simulation of static pants product - standing and sitting. This stage allows visual verification of the product's positioning on the body and analysis of critical areas of clothing fit (Table 3).

Table 3: *Simularea inițială 3D a produsului pantaloni în statică*

Front and back view standing	
	
	

Front and rear view seated	
	
	

Step 3. Defect identification and removal. The analysis of the initial simulation identified the appearance of some defects. Their detection allowed the selection of the removal method by modifying the construction (table 3).

Table 4: *Defect identification and removal*

Nr. d/o	Construction defects	How to remove the defect
1.	Long product length	Reduce the length of the product by 5.0 cm
2.	Pronounced hip line adjustment	Increase the value by 1.5 cm on the hip line
3.	Oblique skin on the back of the thigh	Changing the lower balance by 1.0 cm
4.	Skin oblique on the front and back mark	Deepening the curvilinear segment of the symmetry line of the rear element by 2.0 cm and the front by 1.0 cm
5.	Visualization of the leg prosthesis through the fabric of the part	Increase the width at the knee, leg and end line by 1.0 cm on the front mark and 1.0 cm on the back mark

By detecting and removing defects, this step allowed to modify the construction of the product. Figure 2 shows the modified construction of the product pants intended for people with leg prosthesis.

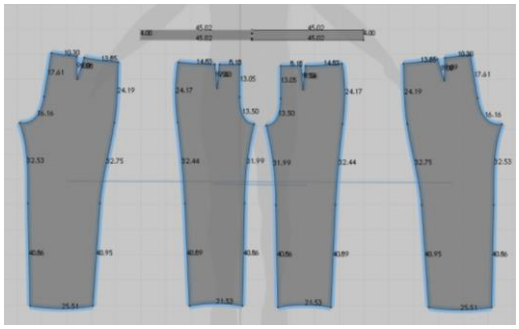
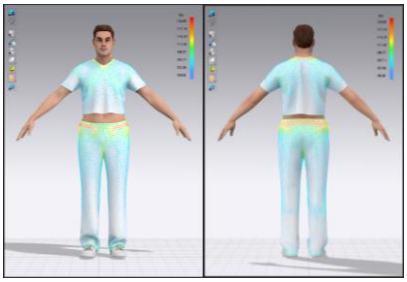
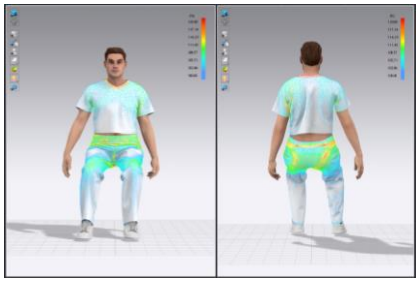


Figure 2: *Basic pattern of trouser product after removal of defects*

Step 4. Repeated 3D simulation of the pants product in static - standing and sitting. Repeated simulation allows to verify the positioning of the product on the body of the wearer and the confirmation of obtaining an optimal construction (Table 5)

Table 5: *Repeated 3D simulation of static pants product*

Front and back view standing	
	
	
Front and rear view seated	
	
	

The same sequence of analysis was applied to the other design methods mentioned above.

5. CONCLUSIONS

The research carried out made it possible to identify the main stages in order to obtain an optimal construction. The following can be seen:

- The construction of the basic type must be carried out taking into account the individual dimensional characteristics of the wearer, the presence of a disability or a prosthesis;
- The initial simulation allows to establish the mismatch of the construction of the product pattern with the shape and sizes of the wearer;
- Identifying defects and removing them allows obtaining an optimal construction;
- Repeated simulation confirms the achievement of an optimal construction and its correspondence with the shape and size of the carrier.

These steps can be applied to patterns made by various construction methods used to make garments of various shapes and purposes. Thus, we can obtain optimal constructions of functional products for people with disabilities.

Identifying the optimal construction of the men's trousers product will allow you to create a collection of models for people with limb amputations. As a further research direction, it is proposed to develop such a digital collection for people with amputations of the lower limbs using various 3D software.

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