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CUSTOMIZED WORK EQUIPMENT THROUGH INNOVATIVE TECHNOLOGY FOR DESIGN AND VIRTUAL SIMULATION

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Abstract: *Textile, clothing and technical products sector has an important impact on economic growth, sustainable development and employment.*
The paper presents the implementation of the innovative informational technology for design and customization of work equipment, highlighting the importance of personalizing clothing and its competitive advantages, from the idea to the prototype or product and testing it. The purpose of the research was to increase the competitiveness and quality of products obtained from the SC C&A Company Impex SRL, by the innovative informational technology for design and customization of work equipment, already validated by the National R&D Institute for Textiles and Leather - INCDTP.
By action of customization is understood individuality, customization and awareness that each wearer has different conformation and carry out specific activities. Customized work equipment involves the dimensional and conformational aspects of the body, respectively the product size as well as the quality-linked functionality criterion, aspects regarding its wearability and protection tested in accredited laboratories, the effects over the individual comfort.
The research implementation used 3D body scanning for analysis and determination of anthropometric measurements and conformation, 3D CAD technology for automatic rapid design of patterns in made to measure system, modeling and simulation of product in the virtual environment on customized mannequin highlighting the body-product correspondence. These recent technological advances lead to a restructuring of the clothing industry, increasing the capacity to efficiently and readily satisfy the requests of each customer or even to produce clothing items with increasingly more efficient services for the client.

Key words: *customization, equipment, design, virtual simulation*

1. INTRODUCTION

Textile, clothing and technical products sector has an important impact on economic growth, sustainable development and employment.

The competitive pressure of globalization is causing textile and garment manufacturers to lower production costs, increase their efficiency and to create leaner value-adding processes. To be able to cope with these changes, measures must be implemented, including the improvement of the internal organization, and the establishment of co-operations with external organizations to create a

continuous supply–demand network. As a result, production logistics as well as information and communication technologies have gained importance, in order to keep job functions requiring higher qualifications within Europe [1,2].

The paper presents the implementation of the innovative informational technology for design and customization of work equipment, highlighting the importance of personalizing clothing and its competitive advantages, from the idea to the prototype or product and testing it.

The purpose of the research was to increase the competitiveness and quality of products obtained from the SC C&A Company Impex SRL, by the innovative informational technology for design and customization of work equipment, already validated by the National R&D Institute for Textiles and Leather - INCDTP.

When wearing an work equipment by users that have position, sizes and conformation which are different from the standard ones, defaults will appear between the body and the product, such as the appearance of uneven surface (pleats, folds), limiting the movement of body segments and reducing the buying demand for these products [3,4].

By action of customization is understood individuality, customization, and awareness that each wearer has different conformation and carry out specific activities [5]. The introduction and application of the innovative information technology for the design and customization of the work equipment within SC C&A Company Impex SRL represents a complex process, which includes a multitude of activities, which have as final objective the obtaining of optimal correspondence between the shape of the studied body/subject and the work equipment.

To address the objectives of the work the following steps were performed:

- subject selection with extreme dimensions from the database constituted by 3D scanning of adult population in the country, through the anthropometric survey conducted in 2008-2010;
- morphological analysis of the subject to identify the possibility of a body classification in the standard types, provided in the current anthropometric standard [6,7]; for the studied subject a measurement protocol has been generated, which facilitates the determination of the size of the garments and whether or not they fit into the size standards.
- analysis and selection of the model for the work equipment in the current production of the company SC C & A Company Impex SRL;
- design and development of customized pattern for the selected work equipment;
- 3D virtual simulation of body-garment system, for the studied work equipment;
- analysis of the tensions map and gathering the necessary information in patterns remodeling, in order to adapt them to the shape and body dimensions of the subject;
- completion of design that provides the best body-product correspondence.
- realization of the real prototype and its real fitting;
- evaluation of the body-product correspondence, in a static and dynamic regime and correspondence of the product with the functions it has to fulfill;

2. MORPHOLOGICAL ANALYSIS OF THE STUDIED SUBJECT

The studied subject was scanned using the body scanner 3D VITUS XXL and the measurement protocol and virtual body or parameterized virtual mannequin (Figure 1) were generated, which were the basis for designing the personalized patterns in Made-to-Measure system. The selected subject has the following main body dimensions extracted from the measurement protocol:

- **Body height (Ic) 191.1 cm;**
- **Bust circumference (Pb) 104.2 cm;**
- **Waist circumference (Pt) 85.9 cm;**

- **Hip circumference (Ps) 108.5 cm.**

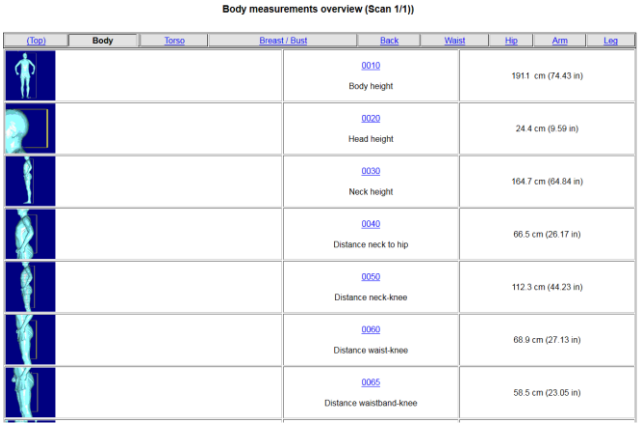

Fig. 1: *Measurement protocol resulted from the 3D body scanning*

According to the data presented in Table 1 (extracted from the anthropometric standard), it can be noticed that the body height is outside the standard SR 13544 - Clothing. Men's Body Measurement and Garment Sizes. In this standard, the maximum height of the body is 190.9 cm.

Tabel l: *Limits of interdimensional intervals for body height*

Standardized value (cm)	**Interdimensional interval** (cm)
188	185-190,9

3. DESIGN AND DEVELOPMENT OF CUSTOMISED PATTERN FOR THE SELECTED WORK EQUIPMENT

In the study, the model of work equipment was analyzed and selected, which was then customized by the innovative informational technology for design. We opted for the Antistatic and flame-retardant costume, produced by the company SC C&A Company Impex SRL.

The costume is intended to be used as a reusable work equipment against cold (for temperatures > -50°C when worn with adequate winter under-clothing), which provides limited protection for the body against occasional short-term contact with open flame or sparking, convection heat, radiation and contact heat, work carried out near low heat sources (low level risk, exposure to heat and/or fire) and medium intensity superficial mechanical aggression (abrasion, hanging).

The suit is made of jacket and trouser. The jacket has a high collar and two chest pockets. In front, the jacket closes with plastic zipper and velcro tape, covered with feint. The jacket has long sleeves that are fitted with elasticated cuffs. The trousers are fitted with a button-shaped slit, adjustable waist, and the lower part of the trousers is edged and does not have a cuff.

The stained and flame-resistant costume was made of:

• outer layer: 87% antistatic and flame retardant fabric, 12% polyester and 1% carbon fiber, 260 g/m^2;

• thermal insulating layer with a mass of about 250g/m^2;

• lining: flame retardant fabric, 100% cotton antistatic, with a mass of about 170 g/m^2.

Physical-mechanical and physico-chemical characteristics of the fabric were determined in the accredited laboratories of INCDTP. The elaborated test reports were used in textile material characterization in the 3D simulation.

The design of customized patterns for the selected work equipment was based on the geometric method of pattern construction using Gemini Pattern Editor, the Made-to-Measure module. In this module, basic patterns are created for each type of clothing item, which are then modified by specific algorithms, depending on the model of the selected work equipment and the body dimensions taken from the measurement protocol provided by the 3D body scanner (Figure 2). The patterns will be used to support the development of personalized work equipment for atypical conformations and sizes outside the size standard.

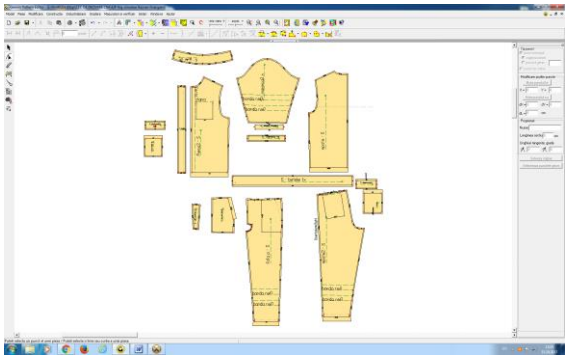

Fig. 2: *The design of customized patterns of antistatic and flame-proof costume, in Gemini Pattern Editor*

4. 3D VIRTUAL SIMULATION AND TRY-ON

Using Optitex PDS software for visualization, simulation and fitting of the prototype, the customized patterns correspondence was tested, by 2D/3D patterns modeling and simulation of the work equipment on the virtual body or the parametric mannequin.

Transforming patterns designed with the Gemini Pattern Editor into Optitex PDS from 2D to 3D, to obtain the virtual prototype of customized work equipment was done in the following sequence [8]:

• Importing the virtual body resulting from scanning or parameterizing a virtual mannequin according to the anthropometric dimensions resulting from scanning;

• shaping the surface of the patterns to obtain the 3D shape of the product with the addition of sewing lines and guide points;

• introduction of information about the materials from which the work equipment is made (fibrous composition, drape, shrinkage, mass, etc.) (Figure 3);

• virtual try-on of the product on the virtual mannequin (Figure 4);

• checking and modifying the pattern to ensure body-product correspondence.

In order to check the body-product correspondence, the software has a function that renders the degree of ease/adjustment of the product on the body, called the Tension Map (Figure 4). Thus, it can be seen that the jacket product corresponds dimensionally. Also, the trouser match fits on the waist line and is slightly wide on the hips line and at the end. The degree of ease indicated by the simulation software is justified by the jacket and trouser patterns that have a semi-rigid figure on the body. With this information, the pattern designer could return to 2D patterns by making the necessary corrections.

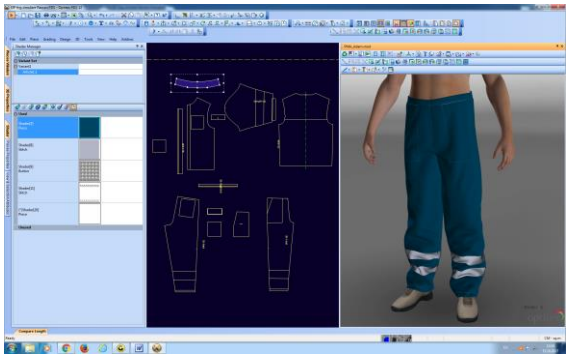

Fig. 3: *The 2D patterns of the customized work equipment, with seam lines and required characteristics of the textile material*

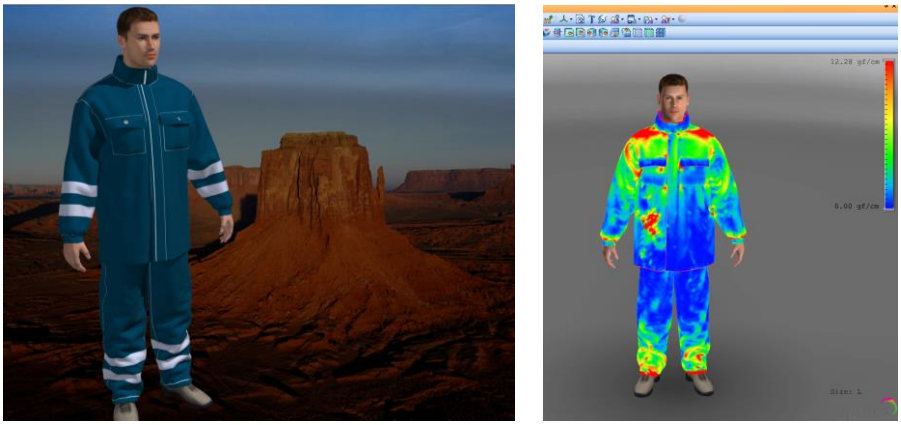

Fig. 4: *Virtual try-on and verification of the customized work equipment*

The real prototype of the customized work equipment was tested on the real body of the subject. After the test, it was found that the outfit corresponded dimensionally, without forming unsightly creases or folds and without creating discomfort in wearing.

5. CONCLUSIONS

The research implementation used 3D body scanning for analysis and determination of anthropometric measurements and conformation, 3D CAD technology for automatic rapid design of patterns in made to measure system, modeling and simulation of product in the virtual environment on customized mannequin highlighting the body-product correspondence. These recent technological advances lead to a restructuring of the clothing industry, increasing the capacity to efficiently and readily satisfy the requests of each customer or even to produce clothing items with increasingly more efficient services for the client.

The research, through its objectives, introduced the concept of personalized work equipment within the beneficiary SME, applying the latest information in the field of informational technology in the textile-clothing sector.

The innovative aspect is conferred by the expansion of the work equipment in an individual / personalized system, but using the industrial production facilities.

As a result of the analysis and evaluation of the work equipment, achieved through the application of innovative informational technology for design and simulation, it can be concluded

that it presents a good body-product correspondence, both in the virtual environment and in the real body test.

The implementation of the innovative technology encouraged the SME to invest in the R&D activity by producing and launching on the market innovative products, namely the personalized work equipment and checked on the virtual mannequin, produced of textile materials tested by various physico-mechanical and physic-chemical analyses in accredited laboratories of INCDTP.

At the same time, it has tended to align with the trends on the European textiles and clothing market, by capitalizing on the existing technical and scientific competencies within the INCDTP in the productive sector and assisting the SMEs in the development, modernization and application of new technologies and advanced production methods.

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