



INNOVATIVE TECHNOLOGICAL SOLUTIONS FOR THE DESIGN AND PRODUCTION OF TACTICAL EQUIPMENT

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Abstract: *Clothing products and tactical equipment are ideal for personalization and customization according to consumer requirements, which do not fit into standard sizes (body size and atypical conformations or special requirements) and are an important niche for the garments sector.*

The paper presents the implementation of the innovative technological solutions for the design and production of tactical equipment, highlighting the importance of personalization 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 the products obtained at SC TACTICA OUTDOOR SRL by applying innovative technological solutions for the design and production of tactical equipment, already validated by the National Research-Development Institute for Textiles and Leather - INCDTP.

Innovative technological solutions for the design and production of tactical equipment include a number of software such as virtual body drawing software (avatar), automated design software with Made-to-measure, simulation and virtual modeling software. These innovative technological solutions were applied in the process of manufacturing a tactic equipment, resulting in a personalized product according to the individual body size of the subject.

The paper promotes the application of intelligent clothing CAD, supporting the development of the garment industry.

Key words: *design, tactical equipment, innovation, virtual simulation*

1. INTRODUCTION

Nowadays the information became more easily accessible and the competition within the clothing industry also became more volatile. To be more competent, mass customization has risen to become one of the future trends of the industry [1].

Clothing products and tactical equipment are ideal for personalization and customization according to consumer requirements, which do not fit into standard sizes (body size and atypical conformations or special requirements) and are an important niche for the garments sector [2,3].

Worldwide, many companies have introduced customized fabrication technology for garments, which has allowed them to expand their business by taking over custom-made products to order. Market leadership of the Romanian clothing companies depends on their ability to introduce product innovation, to increase added value and to enter on new market segments.



Currently, at the industrial level, it can be seen that there is a lack of possibilities for customized tactical equipment, due to the increased production time (identical to a custom made garment) that cannot be accepted in a serial production company. Thus, through the implementation of the innovative technological solutions, it solves the specific problems of the companies, namely the rapid morphological analysis of subjects with body dimensions and atypical conformations and the automatic design of personalized tactical equipment, in a timely manner and according to the morphology of the wearer.

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Innovative technological solutions for the design and production of tactical equipment include a number of software such as: virtual body drawing software (avatar), automated design software with Made-to-measure, simulation and virtual modeling software.

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The paper promotes the application of intelligent clothing CAD, supporting the development of the garment industry [1].

The introduction of the innovative technological solutions for the design and production of tactical equipment within SC TACTICA OUTDOOR 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 tactical equipment:

- subject selection with body dimensions which are in the limit of standard sizes;
- extracting the body dimensions for the studied subject, which facilitates the determination of the size of the garments and whether or not it conforms to the size standards [4];
- analysis and selection of the model for the tactical equipment in the current production of the company SC TACTICA OUTDOOR SRL;
- analysis of individual body specificities needed to design customized patterns.
- design and development of customized pattern for the selected tactical equipment using Gemini Pattern Editor, the Made-to-measure module;
- modeling 2D/3D patterns and simulating the tactical equipment on the virtual body;
- 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. BODY MEASUREMENTS ANALYSIS FOR THE STUDIED SUBJECT

The individual body dimensions for the studied subject were taken over and the measurement protocol and virtual mannequin parameterization were generated, which was the basis for the design of personalized patterns in the Made-to-Measure system.

The selected subject has the following main body dimensions extracted from the measurement protocol:

- **Body height (Ic) 163 cm;**
- **Bust circumference (Pb) 78,5 cm;**
- **Waist circumference (Pt) 70 cm;**
- **Hip circumference (Ps) 90 cm.**

It was noticed that the bust circumference is at the lower limit of the standardized values according to standard SR 13545 - Clothing. Women's Body Measurement and Garment Sizes [5]. In this document, the standard bust circumference is 80 cm.

3. DESIGN AND PRODUCTION OF PERSONALISED TACTICAL EQUIPMENT

In the study, the model of the tactical equipment was analyzed and selected, which was then customized by the innovative technological design and production solutions. The company SC TACTICA OUTDOOR SRL selected the **COMBAT Costume for ground forces**, which is in its portfolio and has been developed according to the corresponding technical specification.

The tactical equipment is specially designed with certain technical modifications and is intended for antiterrorist and intervention forces of police, gendarmerie, MApN, SRI special services, SPP and other structures aimed at guarding, protecting, maintaining and restoring peace and public order.

The COMBAT costume is a woven ensemble composed of jacket and two trousers (Figure 1), which are carried by the military to training activities, shooting sessions and participating troops at international missions.

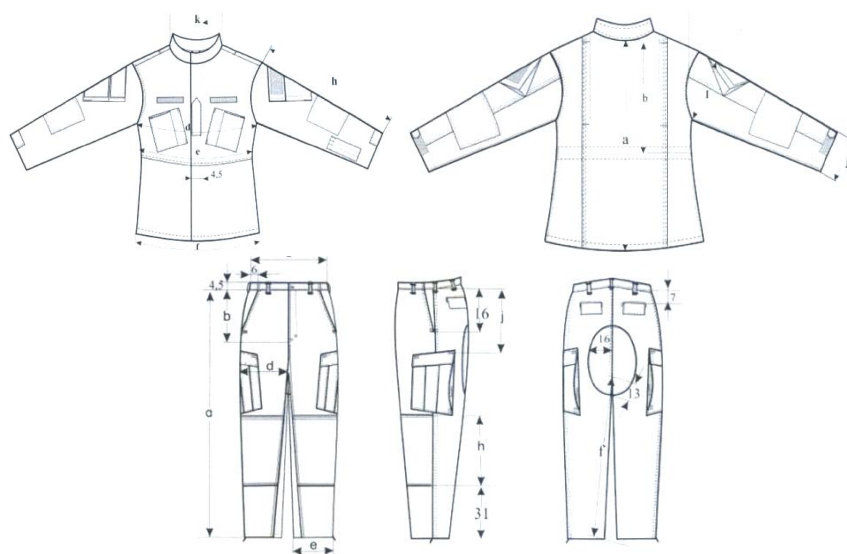


Fig. 1. COMBAT Costume for ground forces

The vest has a front closure with detachable zipper and velcro strap, waist-toe waist and oblique pockets. Upper side, waist adjustment is made with band, sleeves are provided with pockets, armrests and straps for adjusting the opening at the end.

The trousers are worn in COMBAT boots and have a straight shape that allows adjustment of waist circumference and end, pockets with oblique opening at the top and pockets with flap on the sides and back; the areas with the maximum knee and back load have duplicates of base material.

The COMBAT costume must meet the following operational requirements:

- ensure that the wearer is masked in the visible and infrared;
- allow maximum mobility of the wearer in the conditions of performing dynamic activities;
- provide resistance to wearing, thermal comfort, regardless of microclimate conditions;
- resistance of colors to repeated washing;
- keep functional features, shape, dimensions and color unchanged throughout use.

The Costume for the ground forces was made of the fabric for the COMBAT costume painted and imprinted in five-color mosaic: dark brown, light brown, green, khaki-beige and light beige.

Physical-mechanical and physical-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 the basic and model patterns for the selected tactical equipment was based on the geometric method of pattern construction, using Gemini Pattern Editor's special CAD design software, 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 tactical equipment selected and the dimensions of the body taken from the measurement protocol (Figure 2).

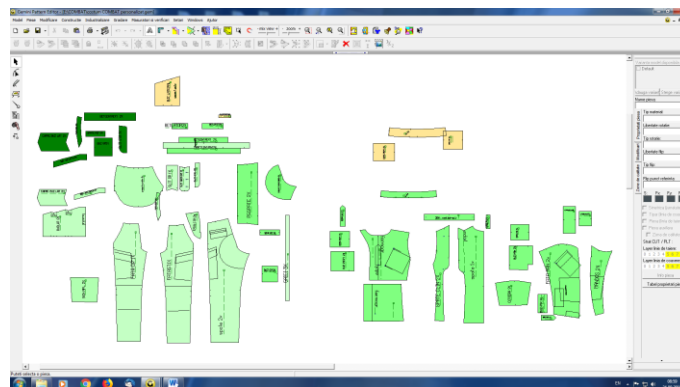


Fig. 2: The design of customized patterns of COMBAT Costume in Gemini Pattern Editor

Verification of personalized patterns matching, designed according to individual body dimensions, was accomplished by modeling 2D/3D patterns and simulating tactical equipment on the parameterized mannequin, by using Optitex PDS software for visualization, modeling and fitting the virtual body of the prototype. The virtual try-on system involves transferring and fitting tactical equipment to human body with various shapes and postures, with grade preservation. To achieve this goal, tactical equipment must be treated as elastic models and their deformation is controlled by the laws of dynamics [6].

Transforming patterns designed with the Gemini Pattern Editor into Optitex PDS from 2D to 3D, to obtain the virtual prototype of customized tactical equipment was done in the following stages [7,8,9]:

- parameterizing a virtual mannequin according to the anthropometric dimensions resulting from body measurement;
- shaping the surface of the patterns to obtain the 3D shape of the product with the addition of sewing lines and guide points (Figure 3);
- introduction of information about the materials from which the work equipment is made (fibrous composition, drape, shrinkage, mass etc.);
- 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-to-product correspondence, the software has a function that shows the degree of ease / adjustment of the product on the body, called the Tension Map (Figure 4), in which the red color shows that the product presses the body, the blue color show high legerity and green color show that the product corresponds to the dimensions. Thus, it can be seen that the jacket product corresponds dimensionally. Also, the trouser 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 patterns chosen for the jacket and the trousers that have a semi-rigid figure on the body. With this information, the designer could return to 2D patterns by making the necessary corrections.

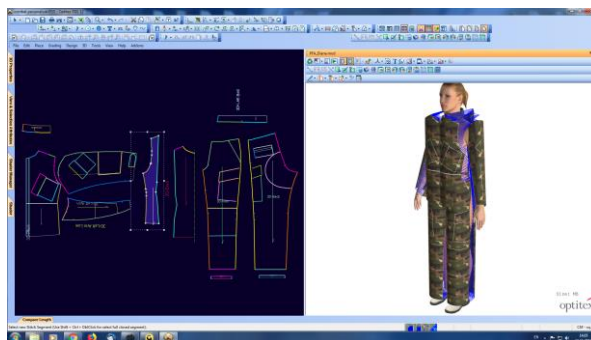


Fig. 3: The 2D patterns of the customized COMBAT Costume with seam lines

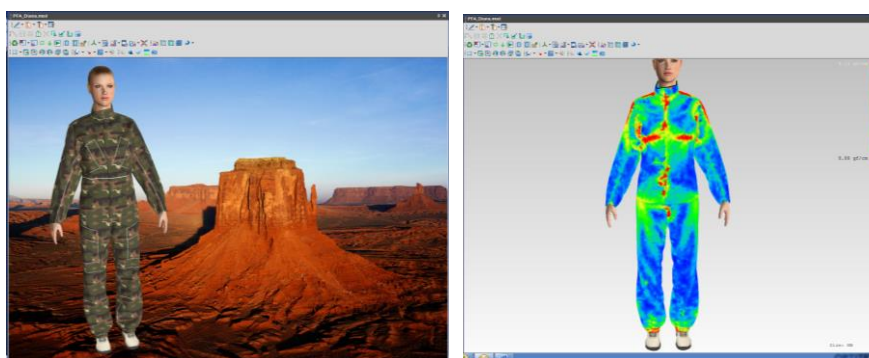


Fig. 4: Virtual try-on and verification of the customized tactical equipment

The real prototype of personalized tactical equipment selected by the beneficiary company SC TACTICA OUTDOOR SRL was tested on the actual body of the subject. Following the test, it was found that the outfit corresponds dimensionally, without forming unsightly creases or folds and without creating discomfort in wearing.



5. CONCLUSIONS

The research, through its objectives, introduced the concept of personalized tactical equipment within the beneficiary SME, applying the latest information in the field of information technology in the textile and clothing sector. The innovative aspect is conferred by the expansion of tactical equipment in an individual / personalized system, but using industrial production facilities.

The proposed innovative technological solutions are effective for pattern transfer and fitness evaluation, and can be potentially used in applications like customization or online shopping.

The main aim of this research is to encourage the SME to invest in the R&D activity by producing and launching innovative products on the market, ie the personalized and verified tactical equipment on the virtual mannequin, produced using textile materials tested in the accredited laboratories of INCDTP, through specific physical-mechanical and physical-chemical analyzes.

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